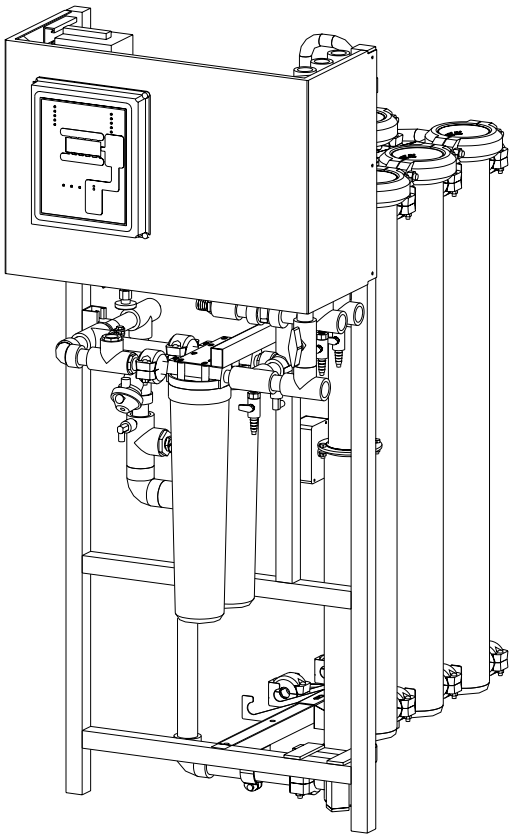
MAR COR PURIFICATION
A Cantel Medical Company

Mar Cor Purification

23G-SERIES REVERSE OSMOSIS SYSTEM

Operation and Maintenance Manual



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NOTICE

For personal and system safety, and for optimum product performance, make sure you thoroughly read and understand the contents of this manual before installing, using, or maintaining this product.

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1.0 GENERAL INFORMATION

1.1 General Description

CAUTION:
When used as a medical device, Federal law restricts this device to sale by or on the order of a physician, per 21 CFR 801.109 (b).

Your Mar Cor Purification 23G reverse osmosis 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 (RO) is the separation of one component of a solution from another component by means of pressure exerted on a semipermeable membrane. In other words, reversing the natural passage of a liquid from a concentrate solution to a more dilute solution by using external pressure. Removal of ionic, organic, and suspended/dissolved impurities occurs during the RO process. Unlike a filter, which separates by “normal” filtration, the membrane element separates using a process called cross-flow filtration. Feedwater solution is separated into two streams, permeate and concentrate, and collected from both sides of the membrane. A semipermeable RO membrane, under sufficient pressure, allows passage of purified water while rejecting and concentrating dissolved and suspended solids.

Mar Cor Purification manufactures a spiral-wound membrane package, with turbulent flow design. This membrane element module collects the purified water within a central tube (permeate tube), as represented in Figure 1.1.

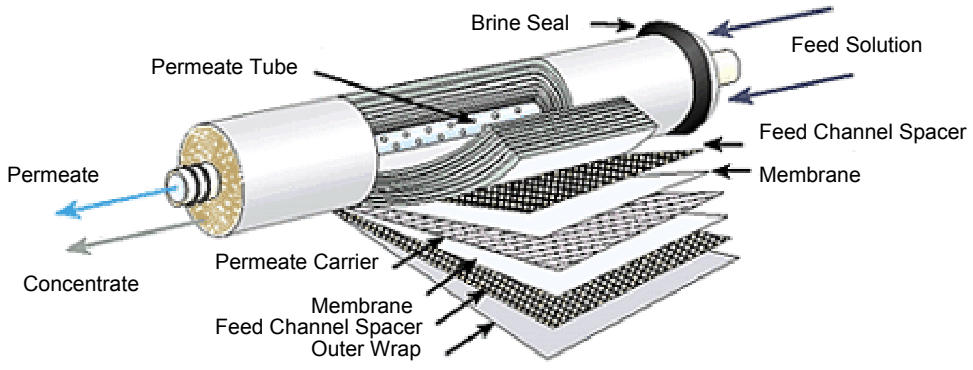


Figure 1.1 Membrane Element with Interconnectors

1.2 The Manual

This manual has been prepared to provide the operator with information on the installation, operation, maintenance, and troubleshooting of 23G Water Purification Systems.

The manual is supplemented with drawings and schematics for clarification whenever possible.

1.3 Safety Summary

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

WARNING:
Indicates statements that are used to identify conditions or practices that could result in injury or loss of life. FAILURE TO FOLLOW WARNINGS COULD RESULT IN SERIOUS INJURY OR DEATH TO HEMODIALYSIS PATIENTS OR OPERATOR.

1.3.1 Read This Manual

Prior to operating or servicing this device, this manual must be read and understood. Keep it and other associated information for future reference and for new operators or qualified personnel near the machine.

1.3.2 Use Proper Power Connections

Use proper wiring and connection methods as stated in this manual.

1.3.3 Device Labeling

Do not, under any circumstances, remove any Caution, Warning, or other descriptive labels from the devices until the conditions warranting the label are eliminated.

Operating definitions are provided to help you further understand your machine:

Permeate Rate [Product Water Rate (Qp)]

Permeate rate is the flow rate of purified water which has passed through the membrane and out of the membrane element; expressed in gal/min (gpm) or gal/hr (gph) [in metric, liter/min (Lpm) or cubic meters/hour (m3/h)]. Specified permeate rates are normally at 77°F (25°C).

Concentrate Rate [Waste Water Rate (Qc)]

Concentrate rate is the flow rate of water containing rejected solids to drain in gpm or gph (Lpm or m3/h).

Feed Rate (Qr)

Feed rate is the flow rate of incoming water in gpm or gph (Lpm or m3/h). Feedwater rate equals permeate rate plus concentrate rate.

Recovery

Recovery is the percentage (%) of feedwater converted to permeate. For example, 75% recovery means that out of a given feed rate, 75% is produced as pure water (permeate).

Concentration

Concentration equals the Total Dissolved Solids (TDS) of any stream (feedwater, concentrate or permeate) 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

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

Salt (Ionic) Passage

Salt (Ionic) Passage is the percent of dissolved salts passed through the membrane.

Primary Pressure (P_p)

Primary Pressure (P_p) is the pressure between the pump discharge and the feed port of the first membrane element housing.

Final Pressure (P_f)

Final Pressure (P_f) is the pressure between the concentrate outlet of the last housing and the concentrate valve.

Pre-filter Pressure (P_{pre})

Pre-filter Pressure (P_{pre}) is the water pressure entering the pre-filter.

Post-filter Pressure (P_{post})

Post-filter Pressure (P_{post}) is the water pressure leaving the pre-filter.

Membrane Elements

Membrane elements are the key to reverse osmosis. Interleaved layers of semipermeable membrane, spacer and permeate carrier spiraled around a central permeate tube make up the element. The spacer allows for movement of the concentrate past the membrane, and the permeate carrier carries the pure water out of the membrane element. The elements that Mar Cor Purification uses are spiral-wound membrane elements with a turbulent flow design. The membrane element collects the permeate water within the central tube, called the permeate tube.

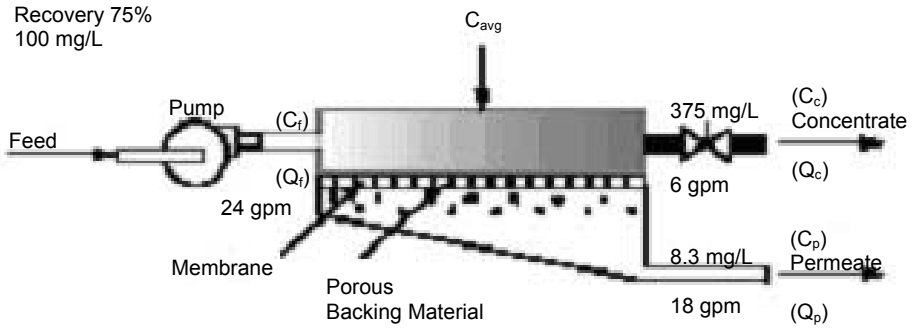


Figure 1.2 System Schematic

An example of how to calculate salt rejection and recovery:

Average Concentration (C_{avg}) = $\frac{(C_f) + (C_c)}{2}$ $\frac{100\ mg/L + 400\ mg/L}{2}$ = 250 mg/L TDS

Rejection = $\frac{(C_{avg}) - (C_p)}{(C_{avg})} \times 100$ $\frac{250 - 6.2}{250} \times 100 = 97.5\%$

Passage = $\frac{(C_p)}{(C_{avg})} \times 100$ $\frac{6.2}{250} \times 100 = 2.5\%$

Recovery = $\frac{(Q_p)}{(Q_f)} \times 100$ $\frac{6\ gpm}{8\ gpm} \times 100 = 75\%$

1.4 Flow Description

The pretreated feedwater passes through a disposable 5 micron cartridge filter (pre-filter) which removes suspended solids. Filtered water then flows to the inlet control valve. This solenoid-actuated valve is controlled by Enhanced Controller/Monitor (ECM-100) 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 laminar flow through the membrane element, which would lead to shortened membrane life.

The pump feeds water to the membrane element housings in a series and/or parallel configuration, depending upon the design flow rates. The direction of water flow is indicated by an arrow on each membrane element housing.

Permeate from each membrane element housing is collected at the permeate manifold where a common check valve prevents backflow into the membrane elements. A pressure sensor is provided to allow the ECM-100 to monitor excessive backpressure and initiate an immediate alarm and machine shutdown should the setpoint be exceeded. Permeate is directed through a turbine flow sensor and contacts a conductivity sensor before reaching the outlet point of the machine.

The concentrate leaves the last membrane element housing and flows into the manifold block. This concentrated water is then divided into recycle and concentrate streams. The recycle portion mixes with the feedwater by returning to the inlet piping, allowing higher machine recovery while still maintaining adequate crossflow through the membrane elements. The concentrate valve on a 23G machine is used to increase the concentrate flow rate for flushing. The normal concentrate flow rate is controlled by the concentrate orifice. The concentrate valve or orifice has three functions: it controls the amount of concentrate flowing to the drain; it controls the pressure within the machine; and it helps control system recovery. A solenoid-controlled Autoflush valve is also provided in the concentrate line to provide periodic intervals of increased drain flow rate controlled by the ECM-100. The concentrate portion leaving the manifold block is directed through a turbine flow sensor before reaching the outlet point of the machine.

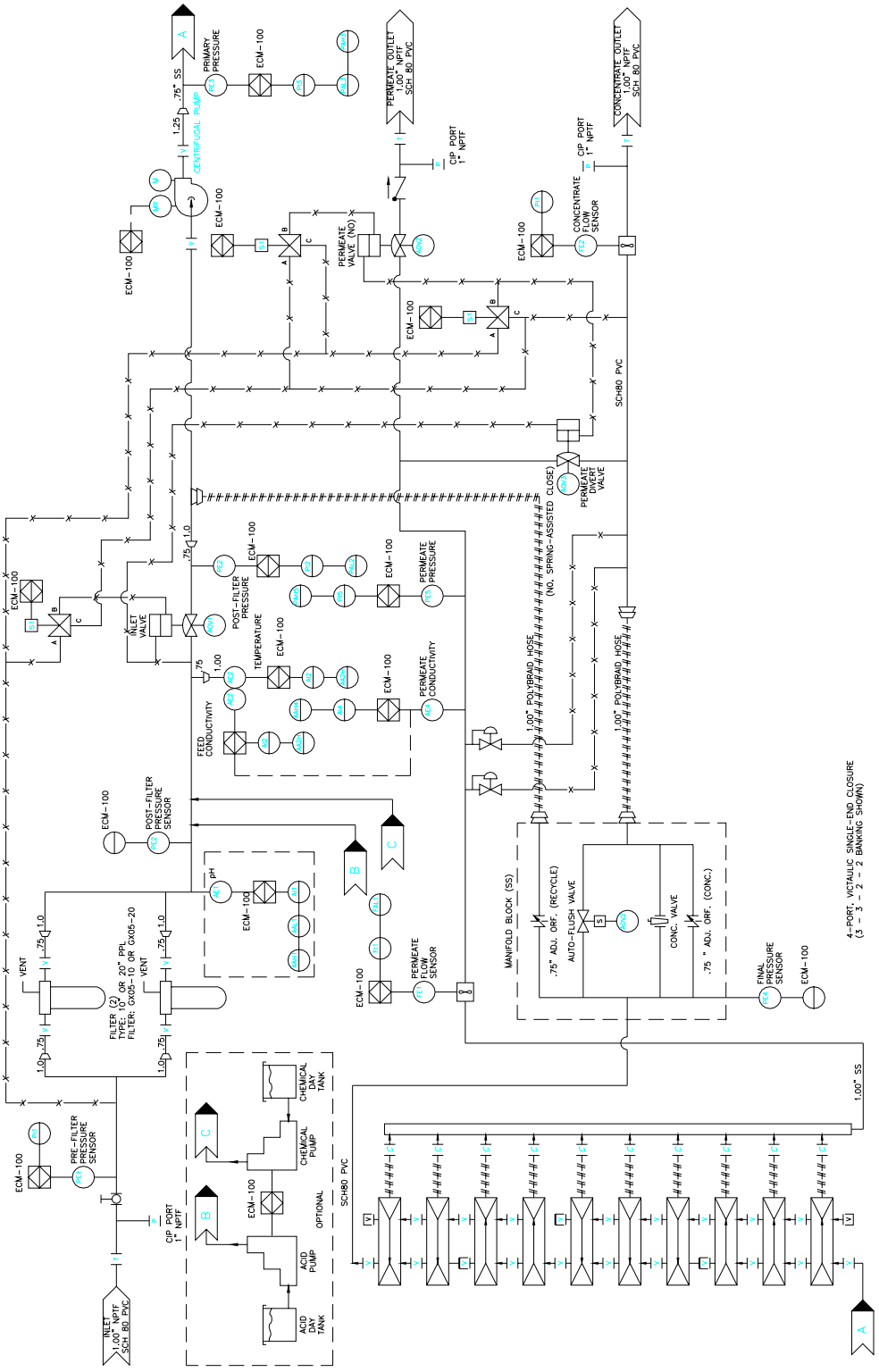


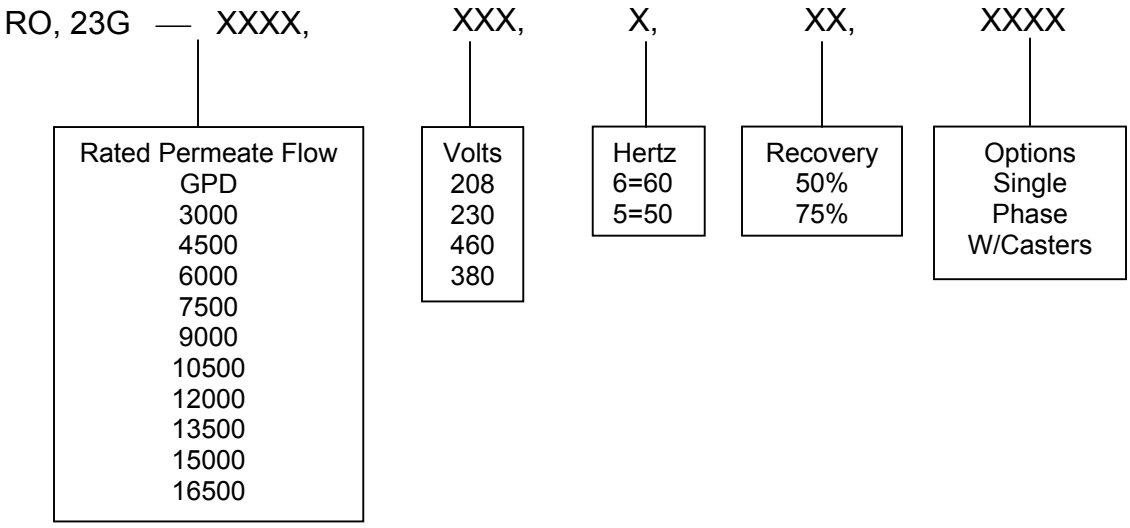
Figure 1.3 Typical Flow Diagram for 23G Systems

1.5 Machine Nomenclature

Mar Cor Purification water purification machines are numbered in such a way as to indicate the permeate flow and quality you can expect from the machine. The nomenclature (model number) of your machine is shown on the serial number label on the side panel of the machine.

Table 1.1

23G Model Number Matrix



1.6 Machine Permeate Quality

23G machines use high rejection, polymeric membrane, providing the ultimate in high purity water.

1.7 Machine Features

Mar Cor Purification 23G Series machines contain an array of useful standard features to provide additional system safety and reliability, to simplify system monitoring and data collection, and to ensure the longest membrane life.

Standard features include:

- 50% and 75% recovery models available.
- Multi-stage centrifugal stainless steel pump, submersible design.
- Enhanced controller/monitor (ECM-100); includes parameter display, alarms, and machine status indicators.
- Automatic inlet shut-off valve.
- Common check valve in the permeate line to prevent backflow.
- Pre-filter housings and 5 micron cartridge filters.
- Pre- and post-filter pressure indication.
- Primary and final pressure indication.
- Permeate backpressure indication.
- Product water divert.
- Product water pressure relief.
- Concentrate and percent rejection indication for permeate quality and membrane performance monitoring.
- Temperature indication for feedwater temperature monitoring.
- Membrane element housings made of all 304 stainless steel.
- Autoflush - programmable periodic high velocity membrane flushing to maintain long membrane life. Set at factory and adjustable in the field.
- Inlet low pressure alarm automatically shuts off the machine to prevent pump damage, should inlet pressure fall to an inadequate level.
- Components in contact with the RO water (permeate) are made of either inert plastic (nylon, poly-ethylene, Noryl*, polypropylene, PVC, EPDM, Nitrile) or stainless steel materials.
- Memory for more than 400 sets of historical operating data (generated by approximately 2.5 full months of continuous operation).
- Comprehensive alarm package, with adjustable limits and common time-out, to ensure safety and proper operation. Alarm is both visual and audible. Alarms include:

- high/low primary pressure (immediate shutdown on primary high pressure)
- low inlet post-filter pressure
- high permeate pressure (immediate shutdown)
- high/low pH
- high temperature
- high permeate conductivity
- low permeate conductivity
- low permeate flow
- low percent rejection
- high pre-filter pressure drop
- high membrane pressure drop

NOTE:
All alarms except high primary pressure, high permeate pressure, and high temperature are ignored in Clean in Place (CIP) mode.

**Noryl is a trademark of General Electric Company.*

Specifications for 23G Machines

1.7.1 RO Feedwater Specifications

The rated flow for all machines in this section is based upon the following feedwater specifications. Limits should not be exceeded without consulting the factory.

Inlet Pressure	Rated; 30 psi (2.1 bar) Maximum; 60 psi (4.1 bar) Minimum; 20 psi (1.4 bar)
Temperature[1]	35-77°F (2-25°C) not to exceed 85°F (29°C)
Langelier Saturation	Negative 0.1
Index of Concentrate[2]	
Continuous Free Chlorine (mg/L)[3]	Less than 0.1 ppm
Silt Density Index[4]	Less than 3
Iron	0 ppm
Other Impurities[5]	
Pre-filter	5 micron cartridge(s)
Inlet Connection Thread	1-inch Female National Pipe (FNPT)

1. Continuous operation over 85°F (30°C) may cause permanent decline in the membrane element performance. Actual permeate flow rates typically increase/decrease by 1.4% for each 1°F change in temperature. For other temperatures, use “Temperature Factor Chart” (Technote 113) to determine permeate rate. Contact authorized equipment supplier if feedwater is outside these parameters.

2. The Langelier Saturation Index (LSI) of the concentrate must be negative to minimize the possibility of calcium scale formation on the membrane surface. Refer to ASTM Standard D3739.
3. Chlorine should be removed prior to the PA membrane in order to prolong the functional life of the membrane element. Microbiological growth will not affect the membrane itself, but may cause fouling and significant permeate flow rate decline. See Membrane Specification Sheet for additional information.
4. Maintenance of feedwater Silt Density Index (SDI) as noted would minimize membrane fouling and extend cleaning intervals. Treatment of feed waters with higher SDI values is possible with more frequent cleaning and/or filter changes. Refer to ASTM Standard D4189.
5. Components such as silica, barium, manganese, strontium, etc., must be below saturation in the concentrate. Contact your equipment supplier for clarification if unsure.
6. It is recommended that an adjustable pressure regulator be installed just prior to the RO in order to allow adjustment of inlet pressure to RO. Regulator must be able to provide adequate flow to RO.

1.7.2 Permeate (Product Water) Flow Rate

As stated on the serial number label (assumes no permeate backpressure, 1000 mg/L TDS maximum feed concentration, and rated temperature).

To estimate the permeate output with backpressure, use the formula below:

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

Maximum Permeate Backpressure: 60 psi (4.1 bar)

Permeate Outlet: 1-inch female NPT

1.8.3 Concentrate Flow Rate

Factory set as stated on serial number label.

Concentrate Outlet 1-inch female NPT

1.8.4 Primary Operating Pressure

Motor (Hp)	Frequency (Hz)	Pump Model	Minimum Boost Primary Pressure (PSI)	Maximum Boost Primary Pressure (PSI)
3	60	QS1818VB	120	270
5	60	QS2818VB	100	250
7.5	60	QS2825VB	170	350
3	50	QS1828VB	120	280
5	50	QS2825VB	100	250

NOTE:
Boost pressure = (primary pressure — post-filter pressure).

NOTE:
Primary and final pressure parameters may vary depending upon machine design and installation conditions.

1.8.5 Pump

Multi-stage centrifugal, approximate primary operating pressure of 200 psi (13.8 bar) excluding line pressure.

NOTE:
Actual operating pressure may vary depending upon machine design and installation conditions.

1.8.6 Reverse Osmosis Machine Rejection

Typical Ionic Rejection (TDS)	95 - 99%
Average Molecular Weight Cutoff*	150 MW

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

Table 1.2 Approximate Shipping Weights and Dimensions

Model Number	Shipping Dimensions	Shipping Weight
23G 2 Element	65” D x 34” W x 78” H (165 cm D x 86 cm W x 200 cm H)	655 lbs (298 kg)
23G 3 Element	65” D x 34” W x 78” H (165 cm D x 86 cm W x 200 cm H)	685 lbs (311 kg)
23G 4 Element	65” D x 34” W x 78” H (165 cm D x 86 cm W x 200 cm H)	725 lbs (330 kg)
23G 5 Element	65” D x 34” W x 78” H (165 cm D x 86 cm W x 200 cm H)	815 lbs (370 kg)
23G 6 Element	81” D x 34” W x 78” H (205 cm D x 86 cm W x 200 cm H)	845 lbs (384 kg)
23G 7 Element	81” D x 34” W x 78” H (205 cm D x 86 cm W x 200 cm H)	925 lbs (420 kg)
23G 8 Element	81” D x 34” W x 78” H (205 cm D x 86 cm W x 200 cm H)	1025 lbs (466 kg)
23G 9 Element	81” D x 34” W x 78” H (205 cm D x 64 cm W x 200 cm H)	1060 lbs (480 kg)
23G 10 Element	81” D x 34” W x 78” H (205 cm D x 64 cm W x 200 cm H)	1100 lbs (500 kg)
23G 11 Element	90” D x 34” W x 88” H (228 cm D x 64 cm W x 224 cm H)	1200 lbs (545 kg)

1.9 Service Assistance

If service assistance is required, take the following steps:

1. Consult the Troubleshooting Section of this manual (Section 7.0). If the problem cannot be identified and corrected by any of the procedures found in the troubleshooting section, then
2. Call your equipment supplier.

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

   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

   Current operating parameters (i.e., flow, operating pressures, pH, etc.)

   Description of the problem

   Current software version (from memory chip on inside of door)

1.10 Medical Membrane Element Specification

NaCl rejection: 99.0% Average (98.0% minimum)

Based on a 2,000 mg/L NaCl solution at 225 psig (1,551 kPa) operating pressure, 77 °F (25 °C), pH 7.5, 15% recovery, after 24 hours. Individual element flow may vary 15%.

Design Parameters

Maximum pressure:	300 psig (2070 kPa)
Typical cleaning:	<200 psig (1450 kPa)
Maximum temperature	
Operating:	90 °F (32 °C)
Cleaning:	85 °F (29 °C) *
Operating pH:	5.0- 10.0
Cleaning pH:	2.0 - 11.5
Feed NTU:	< 1
Feed SDI:	< 3
Chlorine tolerance:	1,000 ppm-hours Dechlorination recommended
Maximum Delta P:	10 psig (69 kPa) per element

* CAUTION: Operating the system at above 85°F during cleaning can cause significant pump damage.

Element Performance Feed Concentration

Ion	mg/L	% Rejection
Sodium	68.0	99.4
Calcium	80.0	99.8
Magnesium	21.0	99.8
Potassium	4.1	99.4
Sulfate	163.0	99.8
Bicarbonate	132.0	99.3
Chloride	51.0	99.4
Silica	9.3	92.0
TDS	528.0	99.4

Based on a mixed salt feed solution at 225 psig (1,551 kPa) operating pressure, 77 °F (25 °C), pH 7.5, 15% recovery, after 24 hours.

2.0 INSTALLATION

2.1 Machine Location

At least 45 inches (114 cm) of space should be allowed above the membrane element housings for easy removal and loading of membrane elements. Provide adequate workspace on sides and front for easy access.

NOTE:
If necessary, housings may be detached from the frame for membrane element removal due to space restrictions around the machine.

2.2 Plumbing

2.2.1 Inlet Plumbing

The feedwater source should be plumbed to the 1-inch FNPT inlet point on the 23G machine. If the inlet pressure is in excess of 60 psi (4.1 bar) or fluctuates by more than 5 psi (0.3 bar), a pressure regulator should be installed ahead of the connection. A low pressure sensor is installed on every 23G machine to protect against low inlet pressure. The 23G should not be installed where the feedwater dynamic inlet pressure is less than 20 psi (1.4 bar). If inlet pressure is less than 20 psi (1.4 bar), a booster pump must be installed ahead of the connection.

2.2.2 Valves for Clean-In-Place (CIP)

All 23G units have separate CIP connections. Valves should be installed on both the main and inlet cleaning connections of the inlet stream. The permeate outlet and concentrate outlet plumbing streams include factory installed manual shutoff valves.

CAUTION:
Do not operate the machine with all concentrate and permeate connections closed. Severe damage to the unit may result.

2.2.3 Concentrate Outlet Connection

Connect a 1.0-inch hose or pipe to the concentrate outlet and run to an open drain. To avoid drainage to the machine during non-operation, the concentrate outlet plumbing should be placed at a height which is 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 or pipe can be any length, and the diameter should match the outlet of the machine.

NOTE:
Soft, flexible hose can be used, but must be installed in a manner which prevents “kinks” or other restrictions that will increase back pressure and reduce permeate flow rate to the drain.

2.2.4 Permeate Outlet Connection

Connect a 1.0-inch I.D. hose or pipe to the permeate outlet and run to the storage tank (if applicable) or distribution loop (after distribution loop, points of use).

The pure water (permeate) should be transported to the point-of-use via noncorroding inert-type tubing pipe or hose. Examples are: food grade flexible nylon tubing, stainless steel tubing or PVC piping.

NOTE:
Soft, flexible hose can be used, but must be installed in a manner which prevents “kinks” or other restrictions that will increase back pressure and reduce permeate flow rate to the drain.

NOTE:
Do not use copper or galvanized tubing or piping to carry the permeate. Only food grade materials and/or appropriate NSF materials should be used.

2.3 Electrical

The ECM-100 controls and monitors the operation of the 23G, requiring a dedicated 115/230 VAC 60/50Hz, 15/10 A, 220 VAC, single-phase power source. All control output devices (motor starter, solenoid valves, chemical pumps) draw power from this source (through ECM-100 relay outputs) in addition to the ECM-100 itself. Refer to Figures 2.3 and 2.4 for connection details and ECM-100 inputs and outputs.

The ECM-100 monitors system-operating parameters for alarm conditions to safeguard the machine’s operation. User variation of the alarm limits and timer presets (set at the factory) are possible by accessing the appropriate function from the system operations menu and following the respective directions for making the changes.

The 23G pump is wired at the factory to an IEC overload protection magnetic motor starter that is controlled by the ECM-100.

The procedure for connecting the electrical wiring for installation of the 23G follows:

1. Connect the ECM-100 power cord to a properly grounded 15 A, 115 VAC/60Hz or 10 A 220 VAC/50Hz, single-phase outlet. An appropriate termination should be installed on the electrical cord for 220 VAC service. Surge protection for single-phase service is recommended.

   The ECM-100 relay output contacts are rated to handle a control ON relay-type circuit. V2 relay boards, supplied in all 23G machines after November 1998, are designed to handle a maximum load of 3.0 AMPS. The current requirements of all output devices (such as a remote alarm horn and light) must be within these limits.

   The power cord of the ECM-100 should be connected to a power receptacle tied to a “protective earth” ground to ensure a safe, common ground for the entire 23G unit, including the three-phase motor. DO NOT remove the grounding wire from the pump casing, the unit frame or a power supply grounding terminal.

WARNING:
ALL SUPPLY CIRCUITS MUST BE DISCONNECTED BEFORE OBTAINING ACCESS TO TERMINALS.

2. Separate power supplies are required for CIP and main pump.
3. Connect the magnetic motor starter to the proper voltage, phase and cycles to match motor voltage and phase. Install the wires as indicated in Table 2.3 (single-phase) or Figure 2.4 and Table 2.4 (three-phase). The overload trip point on the pump motor starter may need to be adjusted slightly to match the actual voltage being provided. Check the tag on the motor starter indicating the factory wiring. A separate, fused disconnect for the motor wiring with the proper overload and short-circuit protection for the Hp and amp draw of the motor is required. Bussmann Low-Peak Yellow LPS-RKSP fuses or equal are recommended for the disconnect.

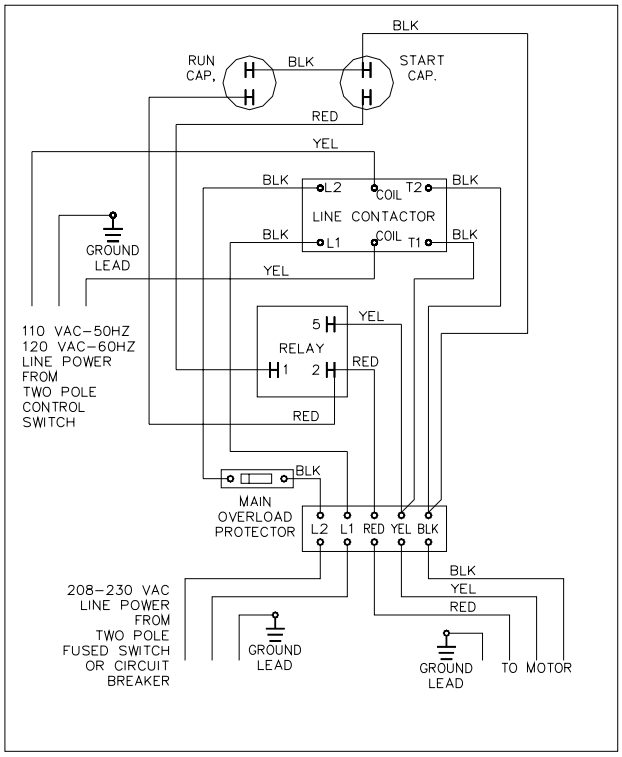
NOTE:
Field wiring must comply with all applicable national and local electrical codes.

2.4 Machine Lockout

In general, the machine should be operated in AUTO mode in which conditions are confirmed electronically. The ECM-100 terminal strip has terminals available for linking other treatment equipment, such as a softener, to the operation of the 23G machine or monitoring the status of other equipment. The status of this equipment is indicated by Light-Emitting Diode (LED) lights on the ECM-100. When operating in HAND mode, it is the operator's responsibility to ensure adequate feedwater supply and storage tank capacity.

Lockouts are ignored in HAND mode, such as full tank level, etc. CIP mode ignores temperature and pH alarms.

The Pretreatment Lockout input can be used in AUTO mode to shut down the machine (all outputs turned off) when there is an interruption of feedwater supply, such as when a pretreatment filter is backwashing. The terminals for the Pretreatment Lockout on the ECM-100's main strip look for an "open" contact to shut down the machine and illuminate the blue Pretreatment Lockout LED light.



Checking Procedure:
BE SURE POWER IS TURNED OFF

A. Main Overload Protector: (Check for continuity between the terminals.)
   1. Ohmmeter Setting: R x 1.
   2. Terminal Connections: Ohmmeter leads to overload terminals. Set switch of overload to on. Meter will read zero ohms. Set switch to off, meter will read infinity.

B. Capacitor: (Disconnect one lead from each capacitor prior to checking.)
   1. Ohmmeter Setting: R x 1000.
   2. Terminal Connections: Individual capacitor terminals.
   3. Ohmmeter Reading: Pointer should swing toward zero then drift back toward infinity. No deflection means capacitor is open. Steady low reading means it is shorted.

C. Relay Coil:
   (Disconnect lead from terminal 5.)
   1. Ohmmeter Setting: R x 1000
   2. Terminal Connections: #5 and #2 on relay.
   3. Ohmmeter Reading: 5.0 / 6.7.

D. Relay Contact:
   (Disconnect lead from terminal 1.)
   1. Ohmmeter Setting: R x 1.
   2. Terminal Connections: #1 and #2 on relay.
   3. Ohmmeter reading should be zero.

Table 2.3 Single-Phase Electrical Connections

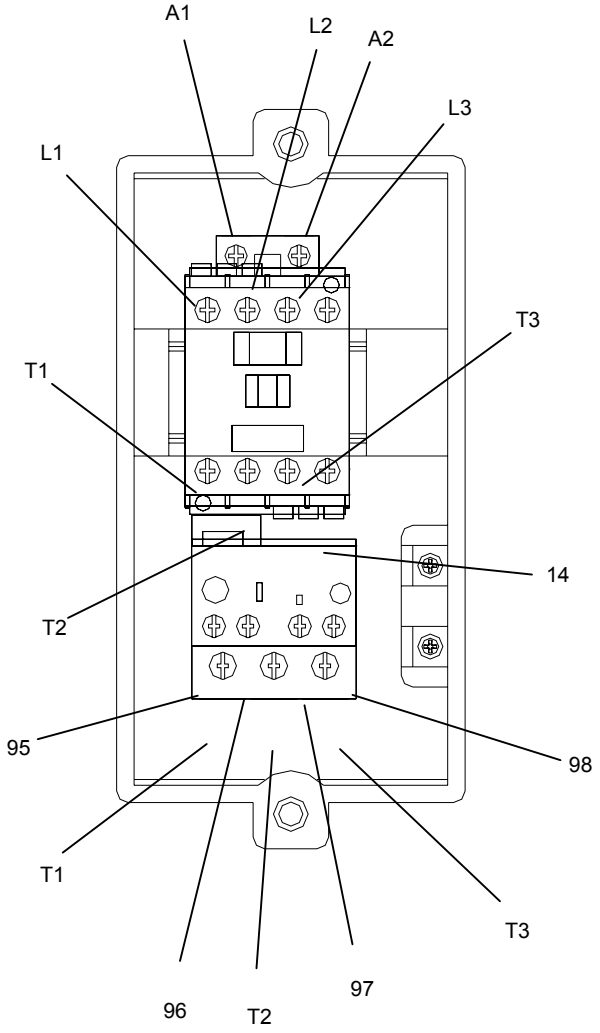


Table 2.4 Three-Phase Electrical Connections

Wire Source	Wire Color		Motor Starter/Thermal Overload Connection
	60 Hz	50 Hz	
Note: The connections listed below apply to 23G models with **THREE PHASE** motor power			
Elect Enclosure	Black	Brown	96
	White	Blue	A2
	Green/yellow		Common Ground
Motor	Red		T1
	Yellow		T2
	Black		T3
	Green/yellow		Common Ground
Motor Starter	Short Red Jumper	Short Brown Jumper	A1 to 96
External Power Supply	#1		L1
	#2		L2
	#3		L3
	Green/yellow		Common Ground

Figure 2.4 Three-Phase Motor Wiring

3.0 PREPARATION AND START-UP

3.1 Pretreatment for Water Purification

Mar Cor Purification 23G machines will operate most efficiently on filtered water with a pH less than negative concentration LSI (Langlier Saturation Index) and a Silt Density Index (SDI) of 3 or below. If the machine is operated on water with higher pHs, 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, your equipment supplier will evaluate each application and water condition and make specific recommendations to ensure continuity of membrane element warranty. Data from the water analysis is analyzed 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 your equipment supplier for review and recommendations for operation of the machine.

Before installing the machine, the feedwater must be filtered to 5 microns.

Machine feedwater must not contain the following chemicals or permanent loss of rejection and/or permeate flow may result:

- free chlorine
- cleaning chemicals, biocides or sanitizing agents, such as formalin or peroxide peracetic acid type products (until after membrane elements have been run to drain for 8 hours)
- iodine compounds
- quaternary biocides
- cationic surfactants
- detergents containing non-ionic surfactants
- cleaners not approved by Mar Cor Purification

NOTE:
A water softener should not be regenerated while the machine is running unless safeguards such as a duplex softener are used to be sure the machine is operated on softened water during regeneration. The machine has a Pretreatment Lockout feature which can be used to shut the machine off during regeneration.

3.2 Initial Start-Up

CAUTION:
When the 23G RO machine is first installed or membrane elements are changed, the RO unit must be rinsed to drain for a minimum of 8 hours before exposure to cleaners or disinfectants as irreversible membrane damage may occur.

1. Open the feed line valve. At least 20 psi (1.4 bar) dynamic feed line pressure is required.
2. Open the machine concentrate valve one or two turns. The machine concentrate valve is located below the machine control panel on the left.
3. Open the permeate CIP connection to flush the machine. The CIP fitting requires a 1.0-inch MPT threaded fitting.
4. Close the permeate outlet valve.
5. Secure the end of the hose attached to the CIP fitting to a suitable drain.
6. Verify that the concentrate outlet valve is open.
7. Verify that the concentrate CIP valve is closed.
8. De-energize the high voltage power to the pump motor starter. Energize only the 115/230 volt control circuit by pressing the ON key on the ECM-100 controller and then within 10 seconds, press the CIP key. The machine must be in HAND mode in order to start the machine alarms with the CIP key. Using the CIP key in this way will bypass many of the alarms. Let the water flow through the machine for at least five minutes under line pressure to purge air from the system.

NOTE:
The high pressure pump should not be operated during this time. If a buffer system is being used, it should be set to regulate feedwater pH at 6.5 or less. The control range for buffer pump operation is from 1.8 to 8.0 less than the high pH alarm setting. The buffer pump will turn on at 0.8 units less than the high pH setting and turn off at 1.8 units less than the high pH alarm setting.

NOTE:
When the control circuit is de-energized, there should be no flow from the concentrate outlet. The solenoid activated inlet valve should be closed when de-energized. See Troubleshooting Guide (Section 7.0) if water continues to flow after shutdown.

9. Switch off the 115/230 volt control circuit by pressing the OFF button on the ECM-100.
10. Re-energize the high voltage power to the pump motor starter. The pump should not begin to operate.
11. Close the machine concentrate valve.
12. Start the machine by pressing the ON key on the ECM-100. Ensure that the pump rotation is correct by observing the primary pressure. If the pressure is below 125 psi (8.6 bar) then the motor may be rotating backwards.

WARNING:
High voltage electricity. Qualified personnel should perform this procedure.

13. To correct rotation, turn the machine OFF. De-energize the high voltage power to the pump motor starter and the control circuit. Verify with volt meter prior to adjusting wires. Change any two of the three leads (for three-phase power) into the motor starter and recheck rotation.

NOTE:
For incorrect rotation on single-phase motor installation, contact your equipment supplier.

CAUTION:
Operation of the pump backwards may cause damage to the pump and motor in addition to loss of pressure which affects permeate rate.

14. Re-energize all power.
15. Restart the machine by pressing the ON key on the ECM-100.
16. Verify that water is flowing from the permeate CIP outlet to the drain. The machine concentrate valve is located below the machine control panel on the left.

NOTE:
The 23G machine is designed to operate with the concentrate valve closed, except during initial machine start-up/flushing, cleaning, and sanitizing.

17. During typical start-up/flushing check the primary and final pressures which should be below the typical maximum pressure of 280 psig. Field conditions may dictate slightly higher alarm setpoints (refer to Section 1.8.4).

18. Continue to operate the machine in this manner for a period of 8 hours.

NOTE:
When the 23G RO machine is first installed or membrane elements are changed, the RO unit must be rinsed to drain for a minimum of eight (8) hours before exposure to disinfectants or irreversible membrane damage may occur.

19. Check permeate and concentrate flow rates and verify that they are within the parameters listed on the machine label. Temperature correction factors should be applied.

20. If any of the machine operating parameters are outside of the specifications listed on the machine label contact your equipment supplier.

NOTE:
All operational data must be recorded on the Start-up Data Sheet (Technote 165). The Start-up Data Sheet must be submitted to the Mar Cor Purification Medical Facility in Minnetonka, MN for warranty consideration.

21. Shut down machine. Open permeate outlet valve. Close permeate CIP valve.

    Machine is ready for normal operation, however do not put into service until all applicable water tests have been completed.

    In order to ensure that the RO is performing at or above AAMI standards, it is necessary to perform an AAMI Water Quality Analysis Test. For new units, the RO must be operated (rinsed to drain) for at least two hours before taking a sample, to ensure that the membranes are free of preservatives or other contaminants which would invalidate the test.

NOTE:
Follow the procedures recommended by your water quality testing laboratory.

3.3 Daily Start-Up and Operation Checklist

NOTE:
This section may be copied for placement on the 23G machine.

CAUTION:
HAND mode is for diagnostic test and CIP. It should not be operated while unsupervised in this mode.

1. Verify that all feedwater valves and outlet valves in the permeate and concentrate plumbing are open. At least 20 psi (1.4 bar) dynamic feed line pressure is required to prevent damage to pump.
2. Make sure the ECM-100 is plugged into an appropriate circuit and the LCD screen is active.
3. If the feedwater pH is being adjusted for membrane compatibility or scale inhibition, verify that the chemical feed pump power switch is on.

NOTE:
If necessary, refer to Section 3.1 for further information on feedwater preparation.

4. Verify that the ECM-100 operating mode is AUTO. The machine operates independently of external controls, such as tank float switch and pretreatment lockout signal, in the HAND mode. In the AUTO mode, the machine operates according to signals from pre- or post- treatment equipment, tank float switches, etc.
5. Press the ON key on the ECM-100. After a short delay, the high-pressure pump will start. Alarms may occur during the first minute of operation as the RO machine operation stabilizes. Alarms may be bypassed and muted until the alarms clear. If alarms persist, address the specified alarm condition shown on the LCD screen according to the Troubleshooting Guide (Section 7.0).
6. Verify that water is flowing from the permeate outlet. For dialysis applications verify the water quality to ensure it meets the current applicable quality standards. Per the AAMI standards, “It is the responsibility of the attending physician to ensure the water quality is appropriate.”
7. The machine is now operating. If a pH buffer is being used with the pH control of the ECM, readjust pump if necessary for a slowly dropping pH reading while the injection pump is on. The control range for the buffer pump operation is from 1.8 to 0.8 less than the high pH alarm setting.

8. Daily operating logs should be completed every 8 hours. Daily Pretreat and RO Log Sheets (Technotes 141 and 142) are provided in the system manual for this purpose.

4.0 ECM-100 OPERATION

4.1 ECM-100 General Description of Operation

The ECM-100 is a state-of-the-art electronic controller/monitor designed for 23G machines. The ECM-100 controls and monitors machine operation including operating performance. Data is stored automatically by the ECM-100 at preset run-time intervals and can be downloaded to a printer or PC port via a RS-232 communication port.

4.2 ECM-100 Displays and Controls

The ECM-100 displays and controls are as follows (Reference Figure 4.5):

4.2.1 System Status Lights - Left Column

Machine On	Indicates that the machine is either running or is in standby mode.
Alarm	Indicates an alarm condition.
Tank Full	Indicates that a signal from a tank level control has put the machine in standby mode.
Pretreatment Lockout	Indicates that a signal from pretreatment equipment has put the machine in standby mode.
Permeate Divert	Indicates that the permeate is being diverted to drain.

4.2.2 System Status Lights - Right Column

RO Pump On	Indicates RO pump (main high-pressure pump) should be running.
CIP Pump On	Indicates CIP pump should be running.
Autoflush	Indicates the Autoflush valve should be open.

Auto-On Active	Indicates that the Auto-On feature is active; the machine will start automatically and run a short time if left idle for more than a preset time. (This inhibits bacteria growth during periods of non-use).
Auxiliary	Indicates that an auxiliary component is on (such as a tank transfer pump).

4.2.3 Keypad - Control Section

LED Lights

HAND - Manual on/off, ignores tank level and pretreatment lockouts.

AUTO - Signal-controlled on/off (from pretreatment or level controls).

CIP - Works in HAND only, locks out most alarms (Section 4.5.3).

Keys

On and Off

HAND/AUTO toggle

Clean-in-Place

Alarm bypass

Mute button

4.2.4 Keypad - Menu Select Section

LED Lights

U.S. - Units of measurement

Metric - Units of measurement

Keys

ARROW (scroll) keys

ENTER key

ESCAPE (ESC) key

4.2.5 Liquid Crystal Display (LCD)

Displays date, time, 10 operating parameters, and alarm or menu messages.

Menu Abbreviations:

CVAL - Current value

SETPT - Calibration set point

Q - Flow rate

PERM - Permeate

CONC - Concentrate

Figure 4.5 ECM-100 Front Panel

4.2.6 ECM-100 Passcode

Your machine is equipped with an ECM-100 controller/monitor to perform the machines electrical operations. Selected functions of the ECM-100 require entry of a passcode. This passcode access allows three functions; it allows a user to make adjustments to setpoints, view, and download historical data. The passcode is intended to provide access adjustment capability to authorized personnel. The passcode for your ECM-100 is entered by pressing the function keys on the ECM-100 keypad, in the following sequence:

1. HAND/AUTO
2. CIP
3. ALARM BYPASS

Contact your equipment supplier for assistance.

4.2.7 Factory Settings Storage

1. The “factory settings” is a copy of all menu data stored in a separate reserved storage area.
2. This data can be updated by following the procedure described as “Store Factory Settings.”
3. Mar Cor Purification factory personnel saved a copy of menu settings before the machine was shipped.
4. At installation, after timers and calibrations have been tailored for your particular application, and/or after recalibration of pH probe, the settings need to be copied to the factory settings area for permanent storage.
5. In the event that the settings have been corrupted, the menu settings can be recalled.
6. To store Factory settings:
   a. Go to the Factory Settings Menu (menu 11).
   b. Push ENTER switch. The screen will display two lines of factory settings.
   c. Enter storage code in the following sequence:

      HAND/AUTO
      CIP
      ON
      ENTER

7. To recall factory settings:
   a. Go to the Factory Settings Menu (menu 11).
   b. Push ENTER switch. The screen will display two lines of factory settings.
   c. Enter passcode (Section 4.2.6) to restore factory settings.

Contact your equipment supplier for assistance.

4.2.8 Display Menus

01 Date and Time

The Date and Time Menu should be used to change/update the respective display.

Press ENTER to select. Enter the passcode (Section 4.2.6) to allow for date and time adjustment. Use the ARROW keys to raise and lower the value, then press ENTER to store and advance to the next alarm. When all the limits have been entered, the ECM-100 will automatically return to the default menu.

02 Alarm Limits

The Alarm Limits Menu should be used to change/modify the alarm duration(s) and setpoint(s).

Press ENTER to select. Press ENTER to advance through the list. Enter the passcode to adjust any of the settings. Use the ARROW keys to raise or lower the alarm limit value, then press ENTER to store and advance to the next alarm setting or ESC to exit and leave the value unchanged. When all of the timers have been entered, the ECM-100 will automatically return to the default menu.

03 Timer Presets

The Timer Presets Menu should be used to change/modify timer durations.

Press ENTER to select. Press ENTER to advance through the list. Enter the passcode to adjust any of the settings. Use the ARROW keys to raise or lower the timer preset value, then press ENTER to store and advance to the next timer. When all of the timers have been entered, the ECM-100 will automatically return to the default menu.

04 Accumulated Hours

The Accumulated Hours Menu is used to display machine run time and nonrunning time. Times are displayed in hours.

Press ENTER to view the accumulated hours for “RUN” time and “OFF” time.

05 Log Tables

The Log Tables Menu allows the user to display and download historical machine operational data.

Press ENTER to view the data tables. Use the ARROW keys to advance through the data tables. Enter the passcode to download the data tables to a printer or computer starting with the table in view on LCD. Three pages (up to 400 lines) of historical data will be downloaded. Used the DOWN ARROW key to advance to and download older data tables, if desired, before exiting the log tables menu. Repeating the download sequence twice will download the entire historical record log (up to 10 weeks of data recorded: is adjustable to one reading per hour during a 40 hour work week).

06 Calibration

The Calibration Menu should be used to change/modify calibration parameters for sensors (flow, temperature, conductivity) and transducers (pressure).

Press ENTER to select and advance through the list. Enter the passcode to change a calibration parameter value. Use the ARROW keys to raise or lower the calibration value, then press ENTER to store and advance to the next parameter. When all calibration numbers have been entered, the ECM-100 will automatically return to the default menu.

NOTE:
When performing the two-point pH calibration, the passcode must be entered immediately prior to adjusting the calibration number for each pH CAL LOW and pH CAL HIGH. The passcode must be entered even if you have already entered the code to adjust a calibration number or parameter earlier in the list (this is to prevent inadvertent loss of pH calibration while viewing the calibration parameters). Be sure to store the Factory Settings (Maintenance Menu 11) after calibrating the pH probe.

07 Maintenance

The Maintenance Menu is used to gain access to all general operational conditions/functions (menu options 08-13).

Press ENTER to select. Use the UP ARROW key to advance through the maintenance functions. Press ENTER to select a function.

08 Print Current Values

The Print Current Values Menu is used to facilitate a download of current
operational data.

Press ENTER to print/send the data that is currently displayed on the ECM-100 screen to a printer or computer.

09 Metric/U.S. Select

The Metric/U.S. Select Menu option is used to specify the units of measure displayed on the ECM-100.

Press ENTER, then use the ARROW keys to toggle between choice of units. Press ENTER to select.

10 Perm Hi Cond Alarm

The Perm Hi cond Alarm Menu is used to specify/modify the machine's response to a high permeate conductivity condition.

Enter the passcode to select one of the three alarm responses. Use the ARROW keys to toggle through the responses. Press ENTER to select.

11 Factory Settings

The Factory Settings Menu is used to store and recall menu settings.

Enter the passcode to recall default factory settings. See Section 4.4 for saving and recalling factory settings.

12 Auto-On Tank Full

The Auto-On Tank Full Menu is used to control the machines response to a tank full condition.

Press ENTER, then use the ARROW keys to toggle between shutdown (default) and divert (used only if permeate divert option is installed). Press ENTER to select or ESC to exit.

NOTE:
If "Divert" is selected, the AUTO-ON function will come on even if the tank is full, and Perm Divert will come on anytime the tank is full (even in HAND mode).

NOTE:
Appropriate plumbing must be installed to divert permeate and to prevent overflowing the tank. The machine should be left "ON" and in AUTO. After the tank fills up normally, the AUTO-ON will periodically start-up and run for a short time to flush the machine. During this time the permeate is in DIVERT mode.

13 Comm Port Speed

The Communication (Comm) Port Speed Menu is used to set the baud rate of the RS-232 serial port.

NOTE:
The computer or printer must be set to the same baud rate as the ECM-100.

Press ENTER, then use the ARROW keys to scroll through the choices. Press ENTER to select, or ESC to leave the settings unchanged.

Refer to the ECM-100 Menu Summary included with this instruction manual for further information on ECM-100 operation.

4.3 ECM-100 Operation

The following is a description of how the ECM-100 is used to operate the 23G machine. The passcode and storage code required to make adjustments to various settings and timers are provided in Section 4.2.6 and Section 4.2.7.

1. Press ON to turn on the machine and OFF to turn it off. Press HAND/AUTO to toggle between the two operating modes. AUTO is defined as an operation which is controlled by tank level and pre-treatment lockout inputs. HAND is defined as an operation which ignores those same inputs and most alarms. The unit should not be left unattended in HAND mode.
2. On start-up, a predetermined sequence of events occurs. The inlet valve opens and the RO pump comes on (after a time delay). The permeate divert valve will close and the permeate outlet valve will open after a preset duration. The RO pump start time delay and permeate divert duration can be viewed and adjusted in the Timer Presets Menu (03).
3. Press the Menu select ARROW keys to scroll through the various system operations, 01 through 07 (pressing ENTER will select desired menu). The Maintenance Menu (07) allows access to additional operations numbered 08 through 13. After entering the Maintenance Menu (07), press the UP ARROW key to toggle through the list of maintenance operations (again, pressing ENTER will select desired menu). Press ESC twice at any time to return to the default screen, which displays the time and date and up to 10 operating parameters.

4.3.1 Selecting Parameters and Changing Settings

To select a parameter:

1. Scroll through the parameters using the ARROW keys until the desired parameter is shown on the LCD screen.
2. Press the ENTER key.
3. Scroll through the settings using the ARROW keys, until the desired setting is displayed on the LCD screen.

To change a setting:

1. Enter the passcode.
2. Raise or lower (toggle between) settings, using the ARROW keys.
3. Once the desired setting is shown on the LCD screen, press ENTER to store and advance.
4. Press ESC to cancel or change and ECS again to return to the default screen.

4.3.2 Responding to an Alarm

When the machine alarm is indicated by the ECM-100 controller, a signal is transmitted from the base unit to the ECM-100. An audible alarm will sound, the large alarm light will turn on, and a small alarm light (corresponding to the appropriate alarm condition) will identify the alarm. The mute button on the unit will silence the alarm horn, but the horn will reactivate if a new alarm condition is indicated. The alarm light will turn off and horn will silence automatically when the alarm conditions clear.

Pressing the Alarm Bypass key will add one minute to the shutdown delay timer to allow time for remedy (the alarm continues to sound, but the machine will not shutdown until after the delay).

4.3.3 ECM-100 Clean-in-Place (CIP) Operation

For CIP operation from the ECM-100 follow these steps:

1. Confirm the machine is in HAND mode (check LED light), as CIP will not work in AUTO mode.
2. Press the ON key to start the machine.
3. Within 10 seconds of pressing ON, press the CIP key; the CIP LED should illuminate.

The same sequence of events will occur on start-up as occurs when just ON is pressed, except the CIP pump will start as soon as the machines inlet valve opens and the pH buffer pump will not turn on.

The following alarms are disabled and will not activate while in CIP mode:

- high/low pH
- permeate conductivity
- low inlet pressure
- low primary pressure
- low permeate flow
- high membrane pressure drop
- high filter pressure drop
- low machine rejection alarms

NOTE:
CIP is intended to be a manual process with an operator present for the duration of the cycle.

Table 4.5 ECM-100 Alarm Settings

Alarms (Menu 02)	Range	Factory Preset
PERM COND HI	0 - 200 μS/cm (Note 1, 2)	30 μS/cm
TEMP HI	0 – 255 °F (0-123 °C)	90 °F (32 °C)
pH HI	0.0 - 14 pH units (Note 3)	7.0 pH units
pH LOW	0.0 - 14 pH units	3.5 pH units
POST FILTER PRESS LOW	0 - 99 psi [0 - 68 (bar x 10)]	12 psi [8 (bar x 10)]
PRIMARY PRESS HI	0 - 510 psi [0 - 352 (bar x 10)]	280 psi [193 (bar x 10)]
PRIMARY PRESS LOW	0 - 510 psi [0 - 352 (bar x 10)]	150 psi [103 (bar x 10)]
PERM PRESS HI	0 - 99 psi [0 - 68 (bar x 10)]	80 psi [55 (bar x 10)]
REJECTION LOW	0 - 99%	88%
FILTER PRESS DROP HI	0 - 99 psi [0 - 68 (bar x 10)]	(Note 4)
MEMBRN PRESS DROP HI	0 - 510 psi [0 - 352 (bar x 10)]	(Note 5)
PERM FLOW LOW	0.0 - 20.1 gpm (0.0 - 76.5 L)	(Note 6)

1. Adjustments range for “Permeate Conductivity High” alarm is 0 - 50 μS/cm for Rev D3 software; 0 - 200 μS/cm for Rev EO or higher software.
2. Below 200 μS/cm, there are 2.5 units of specific conductance (μS/cm) per unit of TDS (ppm or mg/L CaCO3).
3. If an acid injection pump is installed, the high pH alarm determines when the chemical pump turns on. Once the pH rises to 0.8 units below the alarm setting, the pump turns on. After the chemical pump lowers the pH to 1.8 units below the alarm setting, the pump will be turned off.
4. Set alarm limit at 8 psi [6 (bar x 10)] greater than drop observed during data collection for QA test form.
5. Set alarm limit at 1.5 x the drop observed during data collection for QA test form.
6. Set alarm limit at 60% of flow observed during data collection for QA test form.

Table 4.6 ECM-100 Timer Settings

Timers (Menu 03)	Range	Factory Preset
RO PUMP DELAY	1 - 99 sec[1]	6 seconds
START-UP PERM DIVERT	0 - 99 min	2 minutes
AUF PERIOD	0 - 99 hr	1 hour
AUF DURATION	0 - 99 min	6 minutes
ALARM SHUTDOWN DELAY	0 - 99 sec	15 seconds
LOG PERIOD	0 - 99 hr	1 hour
AUTO-ON PERIOD	0 - 99 hr	(see note 2)
AUTO-ON DURATION	0 - 99 min	(see note 3)

1. An RO pump delay of 0 will disable the RO pump.
2. If used set to 4 hours.
3. Set duration to 15 minutes.

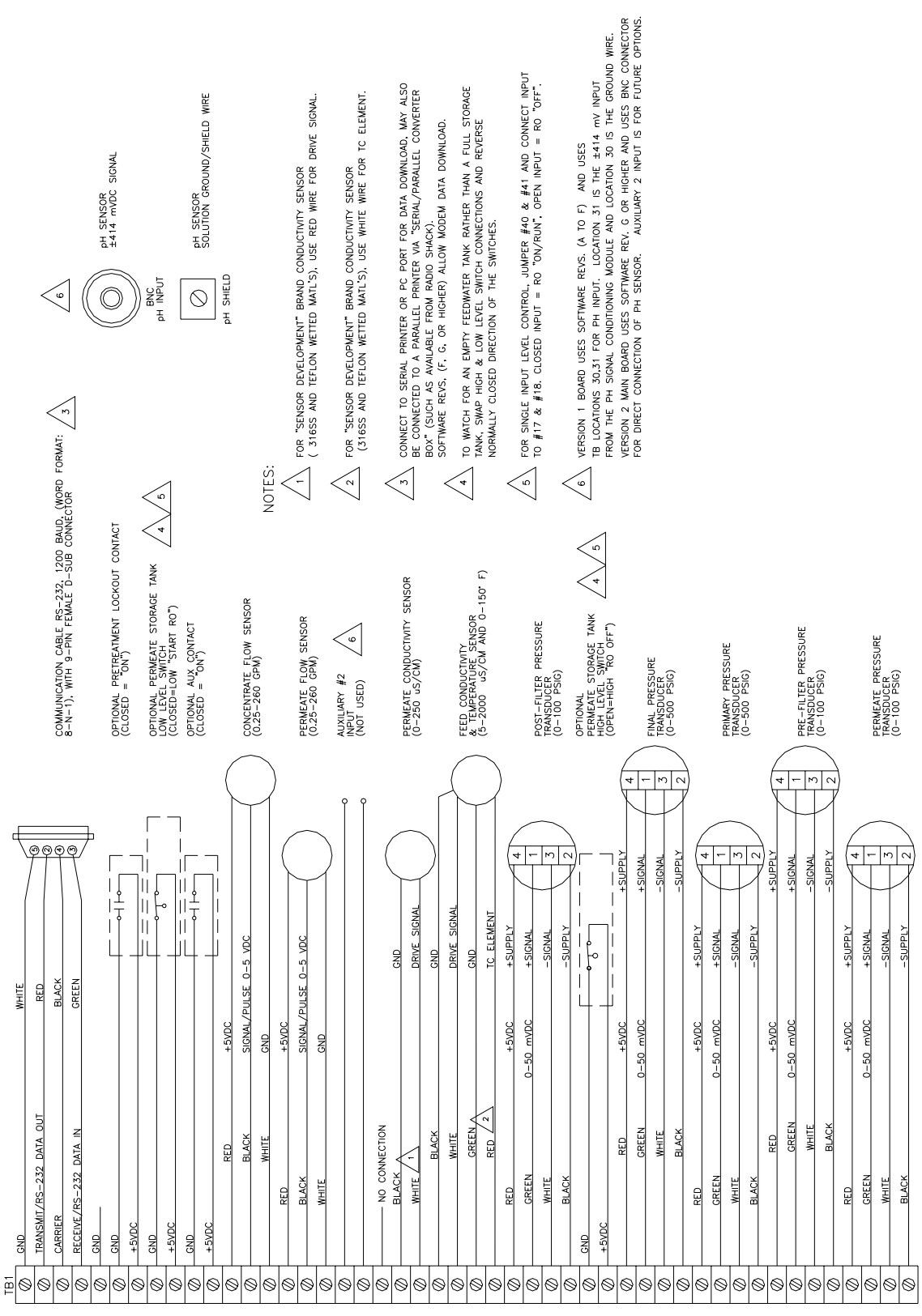


Figure 4.6 23G Series ECM-100 Main Board Electrical Diagram

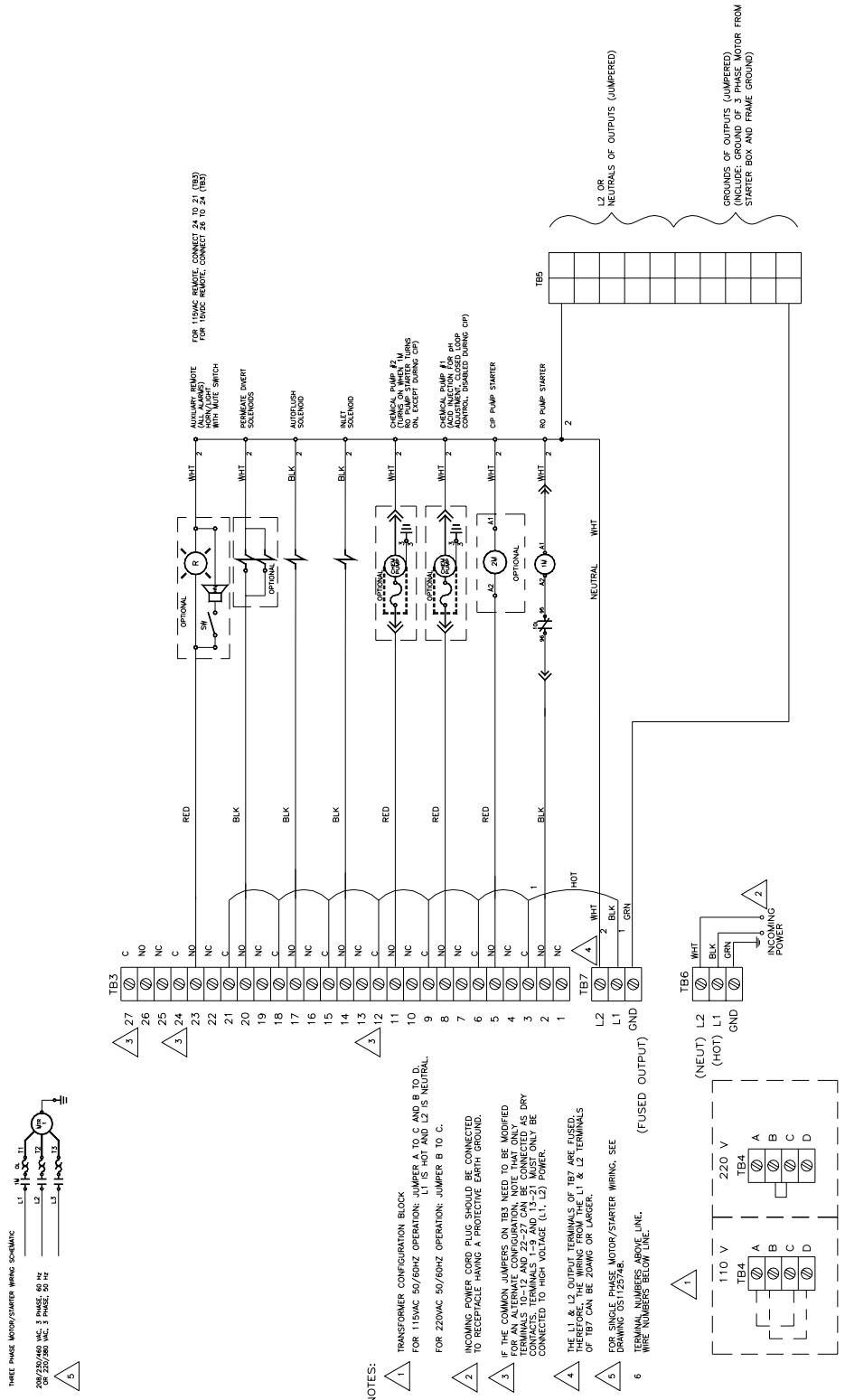
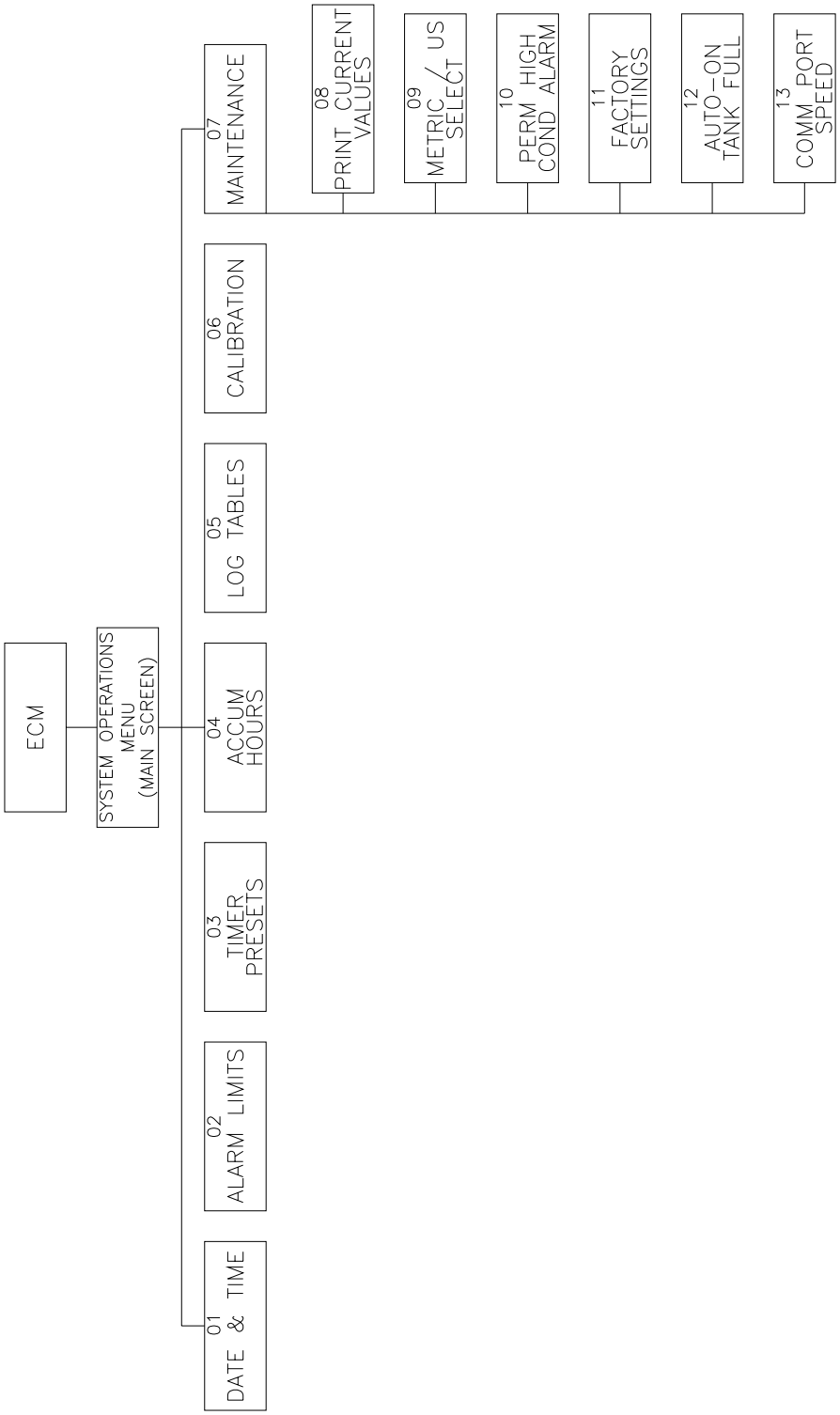


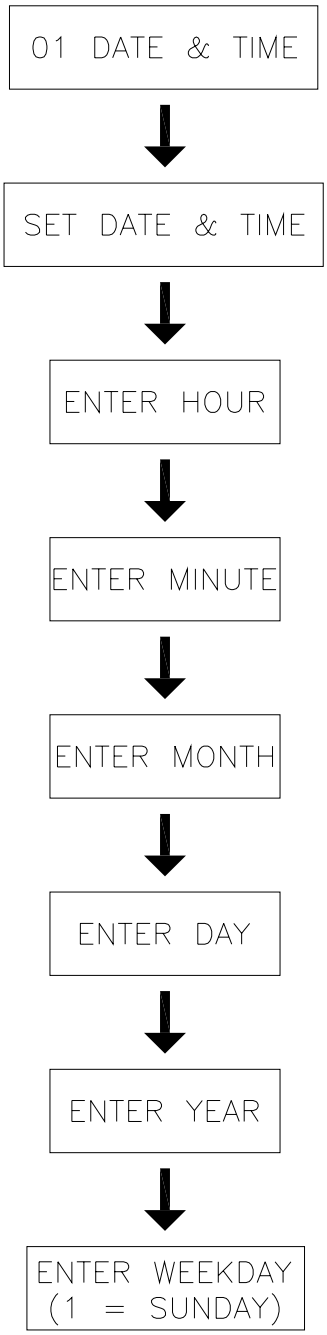
Figure 4.7 23G ECM-100 Relay Board Electrical Diagram

4.4 ECM-100 Display Screens

4.4.1 ECM Display Screen Hierarchy



4.4.2 Detail of Date and Time Operation (Menu 01)



PASSCODE REQUIRED FOR SETPOINT ADJUSTMENT (refer to Section 4.2.6)

Passcode:

Enter the passcode by pressing the following keys in sequence:

1. HAND/AUTO
2. CIP
3. ALARM BYPASS

Store Changes:

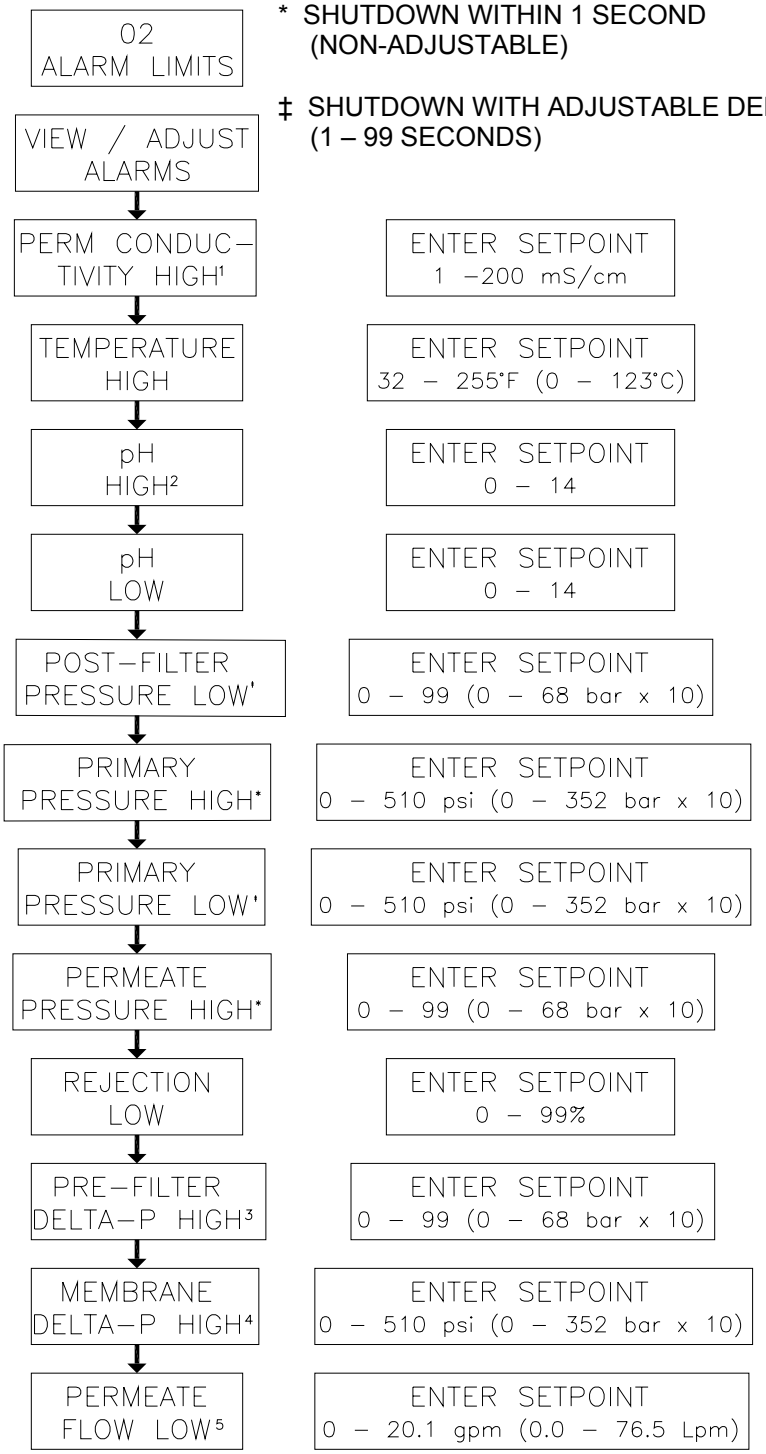
Once changes are made:

Press ENTER to store changes or

Press ESC to exit

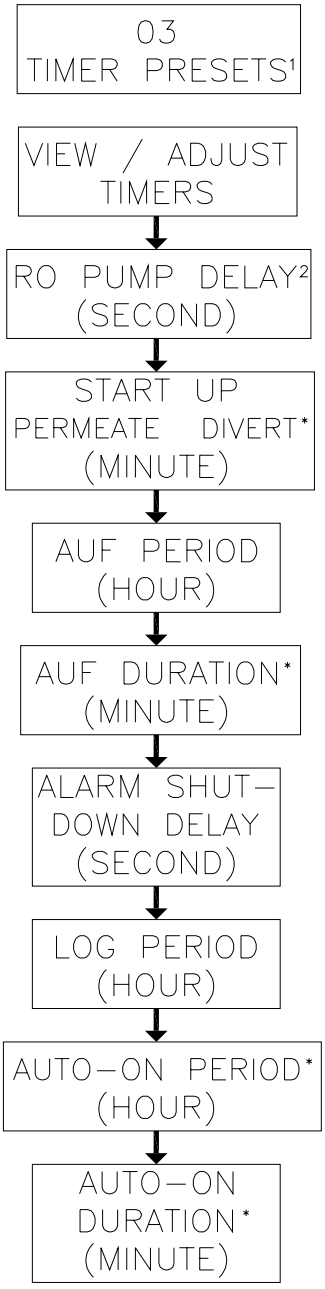
Press ESC again to exit back to default menu

4.4.3 Detail of Alarm Limits Operation (Menu 02)



Refer to Table 4.5 ECM-100 Alarm Set Points for notes 1, 2, 3, & 4.

4.4.4 Detail of Timer Presets Operation (Menu 03)



***MACHINE MUST BE IN AUTO MODE TO FUNCTION**

PASSCODE REQUIRED FOR SETPOINT ADJUSTMENT

The time from when the inlet valve opens until the high pressure pump starts (at machine ON, and after tank full or pretreatment lockout).

The amount of time the machine stays in "Permeate Divert" mode (at ON in AUTO and after tank full or pretreatment lockout). Typically set for 2 minutes.

How often the Autoflush comes on (typically every 1 hour), based on "run hours" timer.

The amount of time (3-6 minutes) at the end of every "AUF Period" (usually every hour) that the concentrate flow is increased in order to rinse the membrane.

The amount of time which certain alarms will sound before shutting down the machine (See Section 4.6.3).

How often the current display readings are saved to the History Log and sent to the RS-232 printer/computer.

How often the machine will start up automatically when OFF (in AUTO mode), based on "off hours" timer. To prevent stagnation overnight and on weekends (typically every 4 hours).

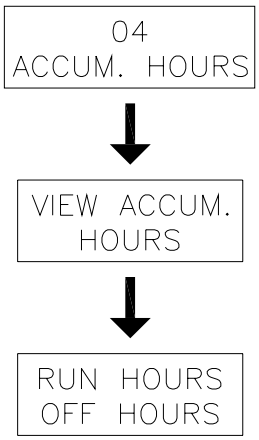
The amount of time that the machine stays on during an AUTO-ON cycle (typically 15 minutes).

1 All values are 0-99.

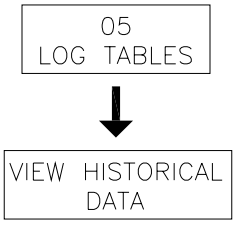
2 An RO pump delay of "0" will disable the pump (see Troubleshooting Section).

* Use is optional.

4.4.5 Detail of Accumulated Hours Operation (Menu 04)



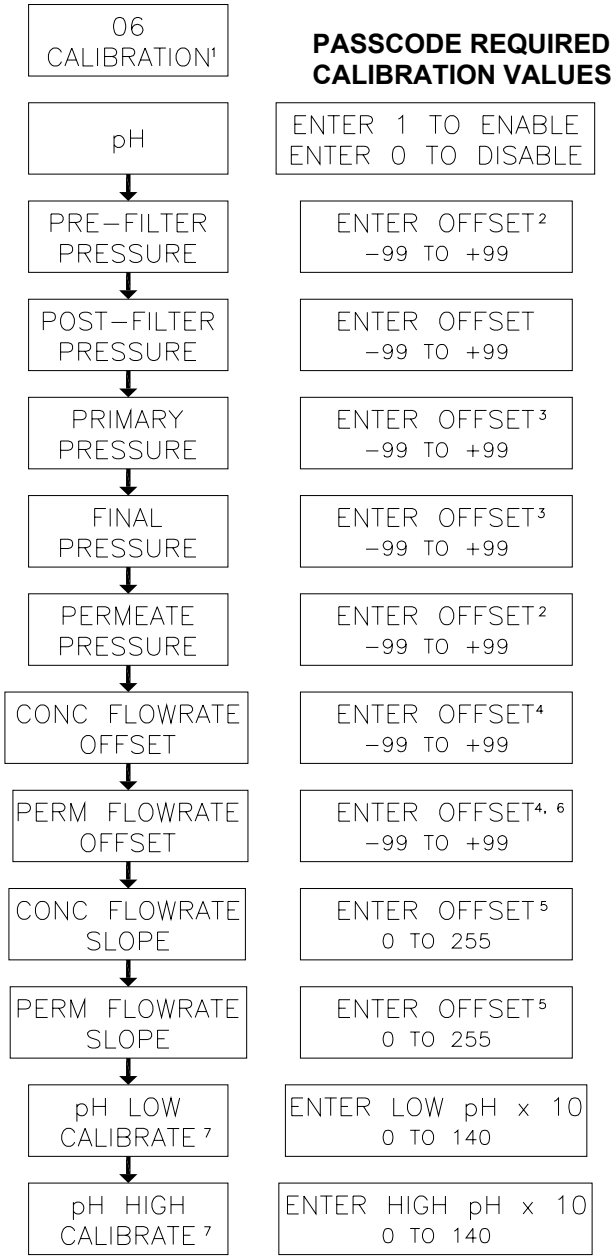
4.4.6 Detail of Log Tables Operation (Menu 05)



Records over 400 historical entries. Historical entries can be downloaded.

Displays 10 operating parameters, date, and time of entry. Use arrow keys to scroll through entries.

4.4.7 Detail of Calibration Operation (Menu 06)



1 Adjustment ranges remain the same whether in U.S. or Metric units; the settings are dimensionless.

2 Each offset unit for 100 psi sensors is equal to 0.50 psig (0.0345 bar).

3. Each offset unit for 500 psi is sensors is equal to 2.0 psig (0.138 bar).

4 The standard 1-inch flow turbine should be calibrated with a flow offset of zero. Each offset unit equals 0.0264 gpm (0.1 Lpm).

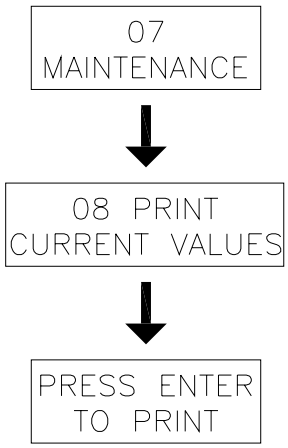
5 The “slope” for both flows should be set to 36 ± 2 for 1-inch turbines. The slope has units of Lpm/(100 turbine revolutions).

6. Setting the Flow Offset to 99 will force the flow readings to 0.1 to temporarily by-pass a failed flow sensor or turbine until replacement is installed.

7. To calibrate pH, the passcode must be entered separately for each item, and the pH electrode must be put in two different pH reference solutions (4.0 for Low and 10.0 for High, or 4.0 and 7.0, or 7.0 and 10.0).

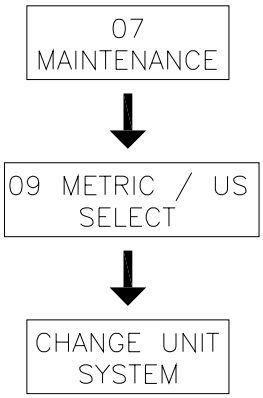
8. Pressure offsets are for field personnel to easily enter minor adjustments to the operating pressure readings without recalibrating and are used to temporarily “dial-out” a transducer that is beginning to fail, in order to keep the machine running until the sensor can be replaced. Adjustment of these offsets reduces the accuracy of the readings throughout their operating range.

4.4.8 Detail of Print Current Values Operation (Menu 08)

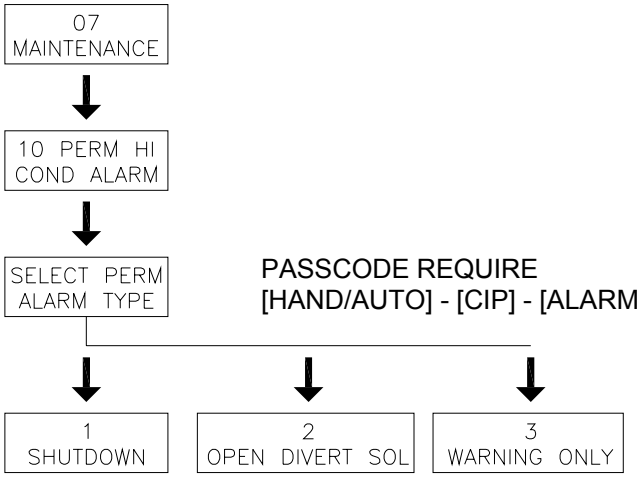


Use the arrow keys to scroll through the maintenance menu.

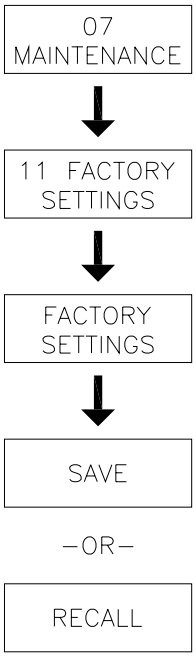
4.4.9 Detail of Metric/US Select Operation (Menu 09)



4.4.10 Detail of Perm High Conductivity Alarm Operation (Menu 10)

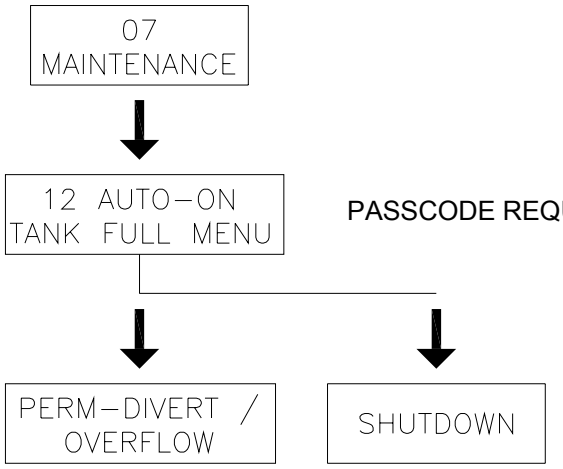


4.4.11 Detail of Factory Settings Operation (Menu 11)



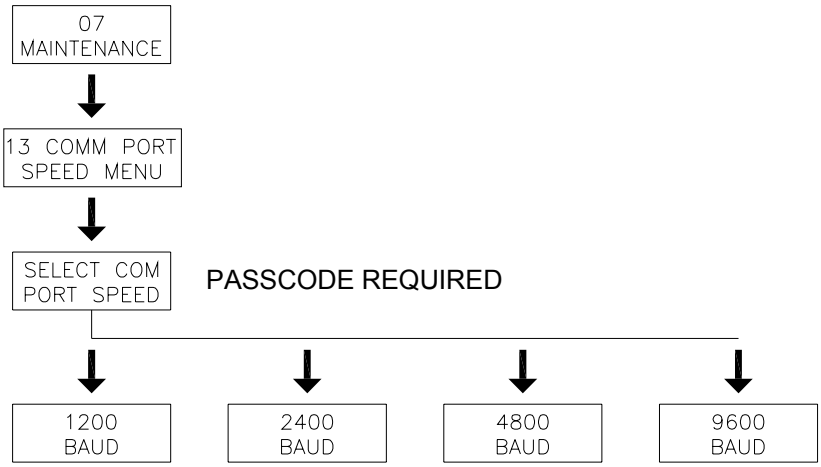
STORAGE CODE REQUIRED Refer to Section 4.2.7
PASSCODE REQUIRED Refer to Section 4.2.6

4.4.12 Detail of Auto-On Tank Full Operation (Menu 12)



PASSCODE REQUIRED

4.4.13 Detail of Comm Port Speed Operation (Menu 13)



5.0 MACHINE OPERATION AND MAINTENANCE

Proper maintenance of the 23G RO system in accordance with this manual and good medical practices is essential when the system is used in a medical application for water purification for use in hemodialysis. FAILURE TO FOLLOW THE REQUIREMENTS SET FORTH IN THIS SECTION AND GOOD MEDICAL PRACTICES COULD POSE A RISK OF SERIOUS INJURY OR DEATH TO HEMODIALYSIS PATIENTS.

Mar Cor Purification 23G RO systems have been designed to operate with a minimum of operator attention. Like all mechanical systems they will operate longer and with less trouble when routine maintenance is performed regularly. Maintenance on an Mar Cor Purification reverse osmosis system is typically limited to completing performance logs, cleaning, flushing, sanitizing, changing pre-filters, regular maintenance, and replacement of damaged or failed parts. The maintenance procedures are as follows: (specific instructions follow the maintenance schedule).

There are seven preventative maintenance procedures which must be performed on a regular basis:

1. Maintain the pH buffer system (if applicable).
2. Changing the pre-filter cartridges.
3. Flushing the machine.
4. Verifying product water quality.
5. Cleaning the machine with approved Mar Cor Purification cleaners.
6. Sanitizing the machine with approved Mar Cor Purification sanitizing agents.
7. Cleaning and checking calibration of pH and conductivity probes.

5.1 Daily Requirements

NOTE:
Allow water temperature to stabilize before attempting to record results. This prevents errors due to fluctuating temperatures.

Operating performance data should be recorded daily and kept on file and submitted to your equipment supplier or Mar Cor Purification. Daily log sheets are included in the instruction manual package and are useful for recording performance data. In addition, data automatically stored by the ECM-100 can be downloaded to a printer or computer to facilitate and simplify record keeping. Copies of Mar Cor Purification Daily Log Sheets will be required by Mar Cor Purification if a warranty question arises.

WARNING:
Determination of microbial culturing and disinfection frequency is the responsibility of the operating facility. Failure to conduct timely microbial culturing and disinfection could pose a risk of serious injury or death to hemodialysis patients.

1. Observe and record hardness level in the feedwater to the RO (for systems with softener pretreatment).

NOTE:
Check the softener output for hardness at the beginning of each day and at the end of each operational day to confirm adequate softener capacity. The hardness level should be less than 1 grain per gallon (GPG).

2. Observe and record salt level in brine tank (for systems with softener pretreatment).
3. Observe and record Total Chlorine (Chlorine/Chloramine) concentrations in the feedwater of the RO. Follow instructions included in each test kit.

WARNING:
Take corrective action or contact the equipment supplier if any pre-treatment device fails to provide adequate treatment of feed water.

4. Allow water temperatures to stabilize before recording Mar Cor Purification Daily log sheet data.
5. Observe and record the pre-filter inlet and post-filter outlet pressure gauges on the Operation Log. The difference in the pressure values will measure the condition of the pre-filter cartridge. When the pressure differential (delta P) doubles above the clean delta P, the cartridges need to be changed. Refer to Section 5.9 for pre-filter cartridge replacement procedure. Change out frequency is at least weekly.
6. Observe and record primary and final pressures on the Operation Log.
7. Observe and record the concentrate (reject) and permeate (product) flow rates on the Operation Log. Allow water temperatures to stabilize before attempting to record results, to prevent errors due to fluctuating temperatures.

8. Observe and record the percent rejection and permeate conductivity displayed on the ECM-100 display.
9. Measure and record the feed water temperature on the Operation Log. A hand held thermometer may be used. The water temperature has a significant effect on the flow rate of the RO membrane.
10. Flushing

    The machine should be flushed daily to remove sediment from membrane surfaces. For flushing during on-line operation all Mar Cor Purification 23G machines are equipped with an Autoflush feature, which automatically increases the concentrate flow rate on an intermittent basis.

5.2 Weekly Requirements

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

1. Replace pre-filters weekly or when pressure drop doubles from new conditions. Refer to pre-filter replacement procedure (Section 5.9).
2. Observe and record the permeate conductivity using a hand held/independent meter. Recalibrate ECM-100 as necessary.
3. Observe and record inlet pH. Recalibrate ECM-100 as necessary.

5.3 Quarterly Requirements

The actions below should be performed every 30 to 60 days.

1. Clean/sanitize the membrane elements. Refer to Section 5.6 for the membrane cleaning/sanitizing procedure.

   Cleaning/sanitizing the machine is vital because contaminants and/or biological materials accumulate on the membrane surface potentially reducing the permeate flow rate and affecting the permeate quality. A layer left on the membrane may cause permanent damage and reduce membrane life. A decrease in permeate flow rate, a decrease in salt rejection, or an increased pressure drop across the machine will indicate when cleaning is required. Cleaning/sanitizing may be required as often as once per week or as infrequently as once every two months, depending upon local water supply conditions.
2. Sanitize the machine. Refer to Section 5.7 for the sanitizing procedure. Prior to any sanitization, cleaning with AD-20 (or equivalent) is required to prevent potential membrane damage.

5.4 Semi-Annual requirements

1. Tighten all electrical screws in the control box.

> **NOTE:**
> Disconnect from both sources of power prior to opening control box.

2. Tighten high voltage wires to motor starter.

5.5 Annual Requirements

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

1. An AAMI Water Quality Analysis of the product water should be conducted **at least** yearly.
2. Check the ECM monitoring for accuracy. Recalibrate as necessary.
3. Check the instrumentation for correct functioning.
4. Check the valves for correct operation.
5. Check the tubing and fittings for leaks or wear.
6. Check the switches and lights for correct operation.

5.6 Flushing

> **NOTE:**
> If the machine is to be turned off for more than 4 hours, it should be programmed to flush to drain for 15 minutes every 4 hours. This should minimize the growth potential of biological components in the machine. An AUTO-ON period can be set in the timer Preset Menu (03) of the ECM-100 to prevent water from stagnating. Menu (12) must also be set to permeate divert.

The machine should be flushed daily to remove sediment from membrane surfaces. For flushing during on-line operation, all Mar Cor Purification 23G machines are equipped with an Autoflush system, which automatically increases the concentrate flow rate on an intermittent basis.

1. To manually flush the unit, open the machine concentrate valve so the concentrate flow rate is 20 to 30% higher than during normal operation. Operate for 10 to 20 minutes and close concentrate valve.

CAUTION:
Do not operate the machine with more than 30% additional concentrate flow without prior approval from Mar Cor Purification. Operation above this flow rate may damage the pump and motor.

2. Use the AUTO-ON commands in the Timer Presets Menu (03) of the ECM-100, to flush the machine automatically during extended shutdown periods (over 4 hours). If using the AUTO-ON command, the machine must be in the AUTO mode. The AUTO-ONACTIVE LED will illuminate when the AUTO-ON period and duration timers are set above zero.

5.7 Step-Wise Cleaning

NOTE:
Mar Cor Purification recommends sanitizing your machine after cleaning.

Foulants such as minerals, silt, and organic substances may collect on the membrane element surface and cause the membrane element to foul and diminish in its function. Many of these foulants are prevented by proper selection of pre-treatment equipment, while others are treatable with more sophisticated designs. Regardless of the foulant, it is essential to clean the membranes promptly once cleaning is indicated. The longer a foulant is allowed to remain in contact with the membrane element, the more difficult it will be to remove.

Routine cleaning of the membrane elements in conjunction with regular sanitizing and flushing will keep bacteria counts at a minimum and membrane element performance at its best. Cleaning removes the silt, organic, and mineral deposits that collect on the membrane surface, which if left untreated, encourage bacteria growth. It will eventually impair the membrane elements' ability to perform.

There are a variety of indications for cleaning membranes. The most common is a reduced product flow rate. Remember that a reduction in inlet water temperature can also result in a reduced flow rate. Refer to the "Temperature Correction Factor" (Technote 113) to determine the reduction in flow that can be attributed to reduced water temperature. Clean the membranes whenever the temperature compensated flow rate drops by 10%. A loss in the membrane performance (percent rejection) or increase in TDS of the product water may also be an indication to clean the membranes. Observation of the decrease in either permeate flow rate or salt rejection, or an increased pressure drop across the machine also indicates when cleaning is required. A good preventative maintenance practice is to clean the membranes every 30 - 60 days, and more often if needed.

NOTE:
Cleaning may be required as often as once every week or infrequently as once every two months, depending upon the local water supply conditions.

For more information, or for instructions on long-term machine shutdown (greater than 72 hours), contact your equipment supplier.

Read and understand all instructions prior to beginning procedure.

CAUTION:
RO units must be rinsed to drain, with normal pressures for a minimum of 8 hours prior to first exposure to disinfectants or irreversible damage may occur to sepralators. This includes start-up of machines with new membranes and membrane element replacements.

WARNING:
Follow all Material Safety Data Sheet (MSDS) precautions and Occupational Safety and Health Administrating (OSHA) standards when introducing a chemical (i.e., cleaning and sanitizing agents).

A typical CIP system includes a tank, pump, connecting hoses which are connected to the machine in a manner that allows a closed loop for recirculation of cleaning solutions. Contact your equipment supplier for assistance in designing, installing, and implementing a suitable CIP system.

CAUTION:
Prior to sanitizing, a thorough cleaning with AD-20 or similar product is required to avoid membrane damage.

To circulate the cleaning solution through the machine, use non-collapsible hose piped to feed the machine from the CIP tank through the CIP pump.

5.7.1 Installation of the 23G CIP

1. Remove cover on tank and remove the Clean-In-Place (CIP) hoses and fittings.
2. Remove plugs on feed, permeate, and concentrate CIP ports on right side of the 23G. Install the valves and quick release fittings provided.

3. Hook up the CIP feed hose to the quick connect fitting on the pump. Hook the other end of the hose to the quick connect fitting on the CIP tank.
4. Place the CIP skid near the 23G so all CIP lines will reach CIP ports on the machine.
5. Connect the feed permeate and concentrate lines to the CIP tank quick connect on CIP pump and then to the CIP port on the machine. Open the CIP valves on the machine.

5.7.2 Cleaning/Sanitizing with 23G CIP

1. Start the 23G and allow the permeate to fill the 23G skid tank to the desired level. Turn machine off by pushing the Off button on the ECM-100 controllers.
2. Add and mix desired amount of cleaner or sanitizer to the CIP tank.
3. Mix chemical cleaning solution in a suitable (clean) tank with purified water. RO permeate is best. Use the following to determine cleaning solution volume:

Cleaning Solution Volume $\geq$ (Permeate Flow + Concentrate Flow) x3

Permeate and Concentrate are specified in gpm (Lpm)

Cleaning solution volume will be in gallons (L)

4. Remove the feed CIP line from the quick connect fitting on the side of the CIP pump. Connect it to the quick connect fitting on the CIP feed port on the side of the 23G.
5. Connect the concentrate CIP line to the quick connect port on the CIP skid. Attach the other end to the quick connect concentrate CIP port on the 23G.
6. Close the feedwater valve which provides water from pretreatment to the machine.
7. Close the permeate and concentrate outlet valves on the back side of the front panel.
8. Then connect the long cord from the starter box on the CIP skid to the pigtail bell fitting on the back side of the controller box.
9. Connect 115-volt power to the Medical cord, located on the starter box on the CIP skid.

10. Return to the ECM-100 controller and push the HAND/AUTO button to HAND. The Hand Mode light will illuminate. Push the On button, and both the 23G pump and the 23G skid pump will start. See Cleaning in the 23G Operator's Manual for cleaning instructions.

NOTE:
The CIP system must provide positive feed pressure to the RO machine. Mar Cor Purification strongly recommends using a CIP pump to provide sufficient inlet pressure (20 - 30 psi [1.38 - 2.07 bar]) to the high pressure RO pump during cleaning. Failure to provide adequate inlet pressure will damage the RO high pressure pump.

11. In between cleaning processes rinse out the CIP container by following step 3 above. Fill and drain the tank several times to rinse the cleaner or disinfectant out of the CIP container. After allowing the tank to fill, turn off the 23G. Empty the tank by removing the CIP hose from the CIP feed port on the 23G. Allow the tank to empty out to a floor drain.
12. After rinsing the tank well, the CIP skid is ready for further cleaning/sanitizing or for storage.
13. Recirculate the cleaning solution at the same flow rate and pressure used for flushing.

NOTE:
DO NOT allow cleaning temperature to exceed 85°F (29°C). The ECM-100's high temperature alarm is factory preset at 90°F (32°C).

CAUTION:
Cleaning above 85°F can cause significant damage to the pump.

14. Recycle the cleaning solution 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 use of a heat exchanger will allow the temperature rise.
15. Turn the machine OFF and allow the cleaner to soak for 20 minutes.
16. If applicable, turn the CIP pump control circuit OFF.

CAUTION:
Do not leave cleaning solution in the machine for a period longer than one hour. The cleaning solution may damage the membranes and the machine during an extended period of contact.

17. To flush the cleaner from the machine close the CIP inlet valve.
18. Open the inlet feed valve.
19. Open the CIP tank drain valve.
20. Permeate and concentrate will continue to flow to the CIP tank and then to the drain.
21. Operate the machine as described in Steps 18 - 20 for 30 - 60 minutes.
22. The cleaner is sufficiently flushed-out when the feed pH and permeate conductivity are restored to nearly their previous levels. Typically, chemical test kits may also be used to verify the absence of chemical residual.
23. To return the machine to service, open the permeate valve.
24. Open the concentrate valve.
25. Close the CIP permeate valve.
26. Close the CIP concentrate valve.
27. Press the OFF key on the ECM-100. The CIP LED light will turn off.
28. Install new pre-filters.

NOTE:
Mar Cor Purification recommends sanitizing machine after cleaning. Proceed to sanitizing (Section 5.7).

29. Place the machine in AUTO mode by pressing the HAND/AUTO key. The AUTO LED light will illuminate.

NOTE:
The RO must be operated in AUTO mode in order to respond to float switches, pretreatment and other alarms.

5.8 Sanitizing Using a CIP System

WARNING:
Determination of microbial culturing and disinfection frequency is the responsibility of the operating facility. Failure to conduct timely microbial culturing and disinfection could pose a risk of serious injury or death to hemodialysis patients.

CAUTION:
RO units must be rinsed to drain with normal pressures for a minimum of 8 hours prior to first exposure to disinfectants or irreversible damage may occur. This includes start-up of machines with new membranes.

WARNING:
Follow all MSDS precautions and OSHA standards when introducing a chemical (i.e., cleaning and sanitizing agents).

Sanitizing frequency may be reduced by running the machine continuously. If the machine must be turned off for more than 4 hours, it should be programmed to flush to drain for 15 minutes every 4 hours. This should minimize the accumulation of bacteria onto membrane surfaces. An AUTO-ON period can be set in the Timer Menu (03) of the ECM- 100 to minimize the potential of water from becoming stagnate.

NOTE:
The Pretreatment Lockout and Tank Level Full signals will override the AUTO-ON feature.

Performing a regularly scheduled sanitizing procedure for the machine may be required to control bacterial growth. The machine must be cleaned and pre-filters changed prior to sanitizing for greatest effectiveness. A 1% peracetic acid-based disinfectant, or 0.5% formaldehyde is typically used.

Peracetic acid-based sanitizers are oxidants, and PA membranes are sensitive to oxidants. The presence of transitional metals such as iron on the membrane will catalyze this oxidation reaction, leading to rapid membrane performance degradation. The use of peracetic acid-based chemicals is acceptable under the following conditions:

- Prior to peracetic acid-based chemical use, the membrane is cleaned with a low pH cleaner to free the membrane of iron and other transitional metals.
- The peracetic acid-based chemical solution is mixed with water free from iron and other transitional metals. RO water is preferred.

- The peracetic acid-based chemical solution temperature is kept at or below 77°F (25°C). Ice or other cooling methods may be required to keep temperature down.
- The PA membranes' exposure to the peracetic acid-based chemical solution does not exceed one hour per week at a chemical solution concentration of ≤1%.

CAUTION:
Prior to sanitizing, a thorough cleaning with AD-20 or similar product is required to avoid membrane damage.

The 23G machine has a CIP feed port into which sanitizing solution can be fed from a CIP tank and pump. In this case, sanitizing can be accomplished with the same procedure used for cleaning.

Refer to Section 5.6.2 Cleaning/Sanitizing with CIP.

5.9 Membrane Element Cleaners and Sanitizers for 23G Machines

Table 5.7 Dry Chemical Cleaners

Cleaner	Description	Part Number	Quantity
AD20	Dry acid-detergent for cleaning PA membrane. Recommended for mineral scale.	OS1155421	45 lb. pail
AK110	Dry alkaline-detergent for PA membranes. Recommended for situations in which organic fouling is a problem.	OS1155417	45 lb. pail

Table 5.8 Liquid Chemical Cleaners

Cleaner	Description	Part Number	Quantity
NP-03	Acidic cleaner for removing inorganic precipitate salts.	OS1144616	1 gal (3.8 L)

5.10 Pre-Filter Replacement Procedure

Five 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 replacement is typical. An increase in pressure drop across the filter indicates the pre-filter cartridges need changing. Use only Mar Cor Purification 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 or sanitizing of the membranes elements.

1. To change the pre-filter, turn the water supply off. The pre-filter inlet and outlet gauges should read zero psi.
2. Remove the pre-filter bowl by rotating it counterclockwise.
3. Remove the old filter.
4. Install the new filter.
5. Re-install the pre-filter bowl.

NOTE:
Failure to change pre-filters may void machine warranty.

5.11 Recording Performance Data

Operating performance data should be recorded daily and kept on file or submitted to your equipment supplier or Mar Cor Purification. Copies of data sheets will be required by Mar Cor Purification if a warranty question arises. Daily Log sheets are included in the instruction manual package and are useful for recording performance data. In addition, data automatically stored by the ECM-100 can be downloaded to a printer or computer file to facilitate and simplify record keeping. Refer to Section 6.6.

In addition to the date, time and 10 “on-screen” performance data readings, the ECM-100 will also download a record of permeate pressure and an alarm code. The alarm code provides a record of what causes machine shutdown conditions. See Section 6.6 for downloading data.

NOTE:
Copies of the logs should be submitted to your equipment supplier.

5.12 Preparing Machine for Movement

Contact your equipment supplier for moving, storage and shipping instructions.

5.13 Membrane Element Replacement

As time progresses, the efficiency of the membrane elements will begin to decline. Generally, the salt rejection of the membrane will not change significantly when properly operated on water until about two years after installation. Under ordinary conditions, the permeate rate may decline slightly after one to two years of operation. This period can be extended with frequent flushing and cleaning as outlined in these instructions.

If the membranes are to be saved, they must be cleaned and then sanitized before removal from the machine.

5.13.1 Membrane Element Removal

1. Disconnect the permeate tubing from the permeate manifold.
2. Remove the end cap and housing adapter from the membrane element housing.
3. Remove the membrane element from the membrane element housing.
4. Inspect the membrane element housing. Clean as necessary to remove any contaminants, obstructions, etc.

5.13.2 Membrane Element Installation

CAUTION:
Membrane elements are packaged with a small amount of biocide solution to prevent biological growth. Provide adequate ventilation and use protective gloves and eye protection when handling. Membrane elements must be kept moist at all times in order to prevent possible damage to the membrane material.

CAUTION:
Upon start-up of a new machine or installation of new membranes machine must be operated with permeate running to drain for a period of 8 hours in order to flush out all membrane preservatives. Failure to properly flush the membranes can result in patient safety issues.

NOTE:
New membranes may produce 10 - 15% higher permeate flow than specified. Slight adjustment of recycle and concentrate orifice may be required to reduce flow rate.

1. Remove the new 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 reused for disposal of the old membrane element.
3. Remove the membrane element from the bag and remove the foam protectors from each end of the membrane element. Set membrane aside in a clean space and continue.
4. New O-rings should be installed when membranes are replaced. Make sure that all parts are clean and free from dust and dirt. Examine O-rings for nicks or cuts and replace if damaged.

NOTE:
O-rings are not included with membrane elements. See Spare Parts List to order new O-rings.

5. Locate the concentrate seal holder on one end of the membrane element, and place the U-cup" concentrate seal (brine seal) into the groove of the concentrate seal holder with the open side of the U-cup facing away from the membrane element body. Note new direction of flow. The open side of the U-cup is on the upstream end of the membrane element.

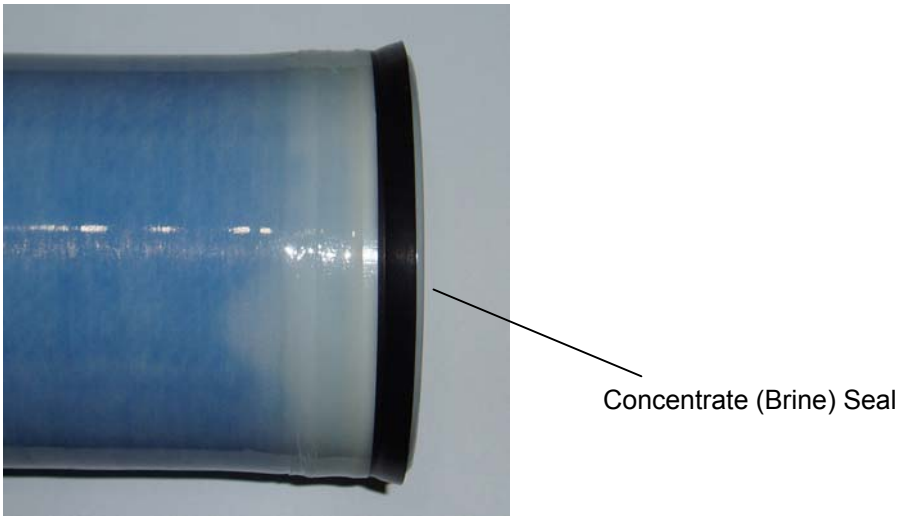


Figure 5.8 Brine Seal at Exit End

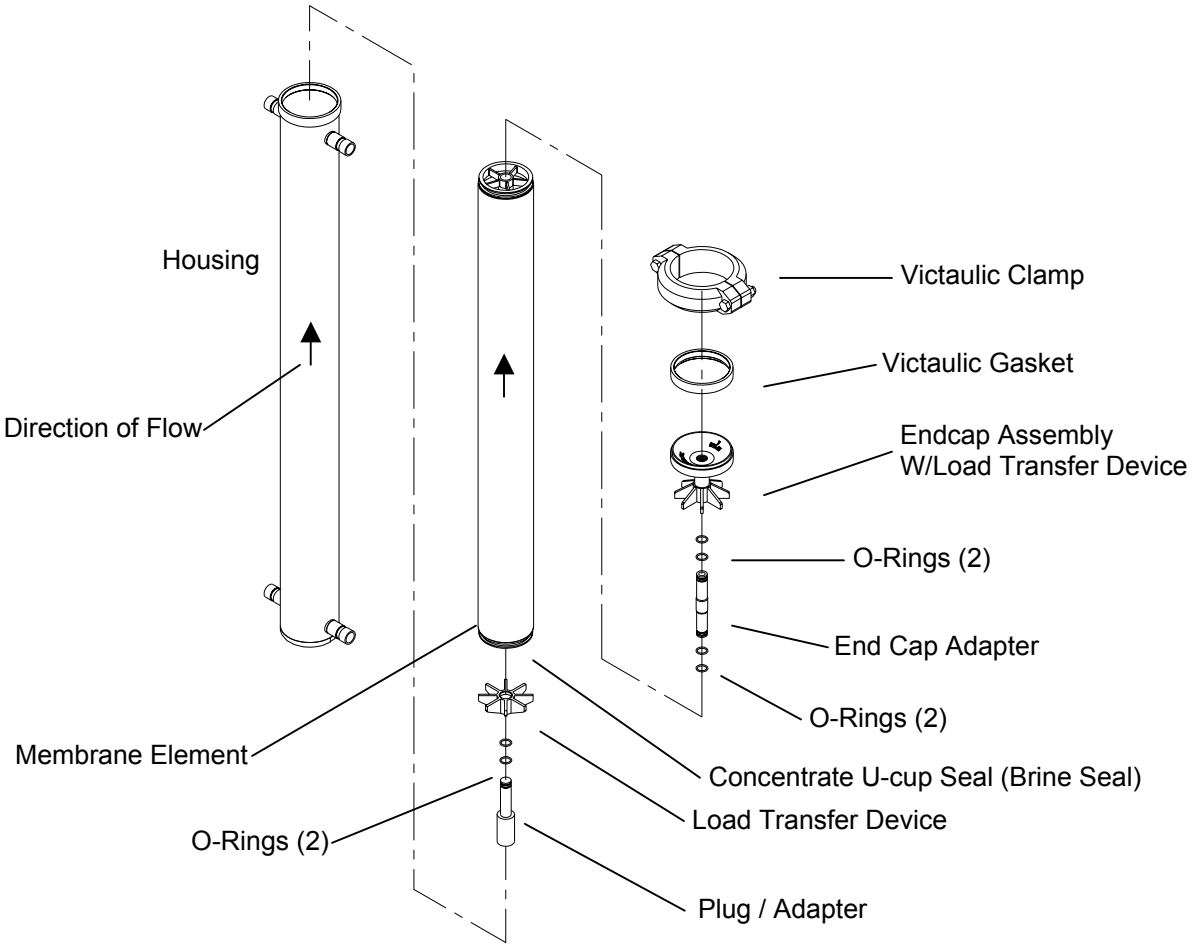


Figure 5.9 Membrane Element Installation

6. Apply a small amount of water-soluble lubricant (such as glycerine or KY jelly) to the entire surface area of one O-ring. Slide the O-ring over the housing adapter until it drops into the O-ring groove. Make certain the O-ring does not twist while sliding onto the interconnector. Repeat until all O-rings are installed on the adapter and interconnector. The adapter has two O-rings and the interconnector has four O-rings. See Figure 5.9.

CAUTION:
Do not use petroleum jelly or other petroleum-based material as they may damage elastomer and/or thermoplastic.

7. Determine the direction of feed flow in the membrane element housing. Be sure to look at the “Direction of Flow” arrow on each membrane element housing; they may be different within a given machine. Be sure element direction of flow matches housing direction of flow on the plastic component.
8. The open side of the U-cup concentrate seal must be placed at the end of the membrane element housing closest to the housing feed port/connection.
9. Once the membrane element orientation has been determined, install a housing adapter into the end of the permeate tube with a gradual twisting/turning motion. Install the plug adapter into the end of the permeate tube that will be closest to the lower end of the housing (e.g., nearest the floor).
10. Insert the membrane element in the housing (including U-cup seal and housing adapter) with a smooth and gentle twisting motion. Ensure that the housing adapter (installed in Step 9) sits at the bottom of the housing.

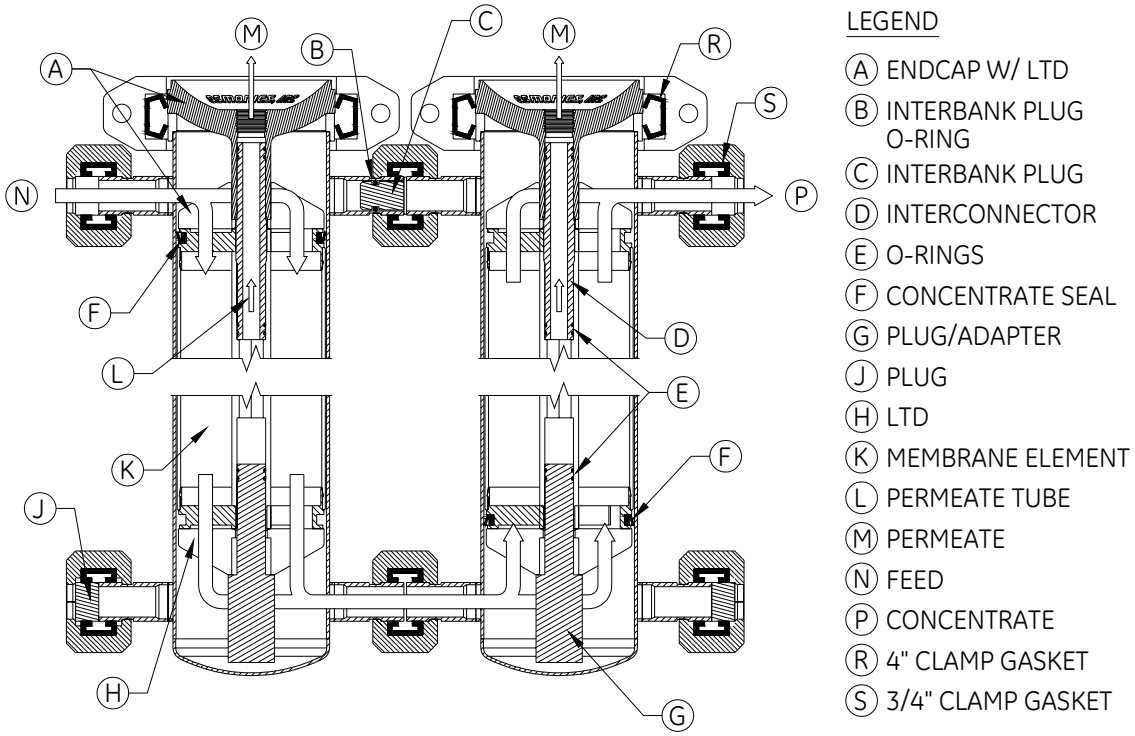


Figure 5.10 Cross Sectional View Membrane Element and Housing Flow

11. Insert an interconnector into the permeate tube located closest to the open end of the housing.
12. Install the end cap and affix the closure device.
13. Reconnect the permeate tube to the permeate manifold.
14. Repeat for other membrane elements as necessary.
15. Before putting the machine back into normal operation, run the permeate and concentrate streams to drain for at least 8 hours. This is done to ensure that all the preservatives have been removed from the membrane elements and prevent irreversible damage.

    Machine is ready for normal operation, however do not put into service until all applicable water tests have been completed.

    In order to ensure that the RO is performing at or above AAMI standards, it is necessary to perform an AAMI Water Quality Analysis Test. For new units, the RO must be operated (rinsed to drain) for at least two hours before taking a sample, to ensure that the membranes are free of preservatives or other contaminants which would invalidate the test.

NOTE:
Follow the procedures recommended by your water quality testing laboratory.

5.14 Flow Control Adjustments

NOTE:
Prior to any adjustments, make sure that temperature is constant, AUTOFLUSH is off, and concentrate valve is closed.

Refer to Figure 5.11, Flow Control Manifold.

CAUTION:
The flow control orifice valves are sealed to prevent tampering, and should not be adjusted by unauthorized personnel. Damage to the machine may occur and physical injury is possible.

- The flow control orifices are factory set; according to the design specifications of the machine.
- Adjustment of the orifices in the field are permitted only with the approval of the equipment supplier.
- Permeate flow rates which exceed design specifications will shorten the life of the membranes, degrade the quality of the permeate output, and may cause injury to dialysis patients.

CAUTION:
The large orifice nuts at the base MUST NEVER be turned.

- The large nuts must remain in the position set at the factory; with the 4 dimples from both nuts lined up with each other in a straight line (longitudinal with the block).
- Tightening these nuts (even by a small amount) will cause damage to the O-ring located under the nuts.
- Over-tightening the locking nuts will damage the threads and may cause leaking the next time that the orifice is adjusted.

CAUTION:
Improper adjustment of the flow control orifices can cause serious damage to the machine, and/or personal injury.

5.14.1 Leaks

During adjustment it is normal for a very small amount of water to leak from under the larger nut of the orifice, and/or from around the locking nut on the orifice adjustment screw.

- To correct leaking under the large nut, the two O-rings need to be replaced. Contact your equipment supplier for assistance.
- Any other leaks on the machine should be corrected promptly. Any cracked or broken fittings must be replaced. Contact your equipment supplier for assistance.

NOTE:
There is a large amount of interaction between the concentrate valve and the two orifices. Make sure concentrate valve is closed during orifice adjustment. Adjusting one of them will affect the setting of the other. To change the permeate or concentrate output of the machine, both orifices will usually need to be adjusted in small amounts, alternating between the two several times, until the correct settings are reached.

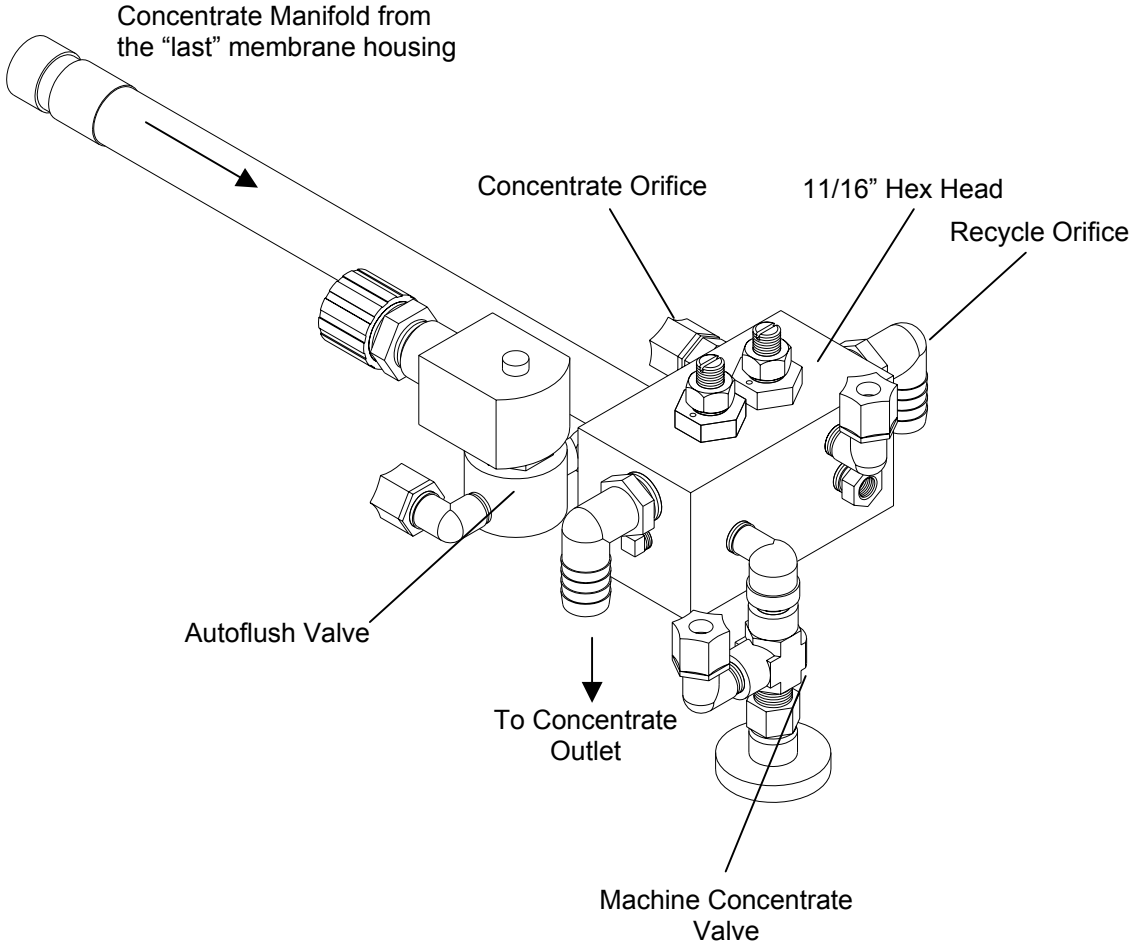


Figure 5.11 Flow Control Manifold

Do not make adjustments when the Autoflush light is ON. Always wait until the Autoflush finishes and the light goes out before adjusting the orifices. Make sure concentrate valve is closed.

1. Concentrate Orifice - screwdriver adjustment.
   - Adjusts the concentrate flow output to the drain.
   - Adjust so that the concentrate flow rate matches the value printed on the machine nameplate. To adjust the concentrate flow rate:

Adjusting the Orifices - requires two wrenches and a large screwdriver.

   a. Use one wrench to hold the large nut and prevent it from turning.
   b. Use another wrench to loosen the locking nut, adjust the flow with the screwdriver.
   c. Tighten the locking nut after.
      - While adjusting, make sure that the primary pressure reading is less than 275 psi (19.0 bar), and more than 150 psi (10.3 bar).
      - Clockwise (in) reduces the concentrate flow rate, causing higher primary pressure and higher permeate flow.
      - Counterclockwise (out) increases the concentrate flow rate.

WARNING:
Be careful not to unscrew the adjustment too far, or the screw will blow out of the orifice and may cause injury.

2. Recycle Orifice - screwdriver adjustment.
   - Controls the amount of concentrate being recycled back to the pump.
   - Adjusts the primary pressure and permeate flow rate.
   - Adjust so that the permeate flow rate matches the value printed on the machine nameplate. To adjust the permeate flow rate:

Adjusting the Orifices - requires two wrenches and a large screwdriver.

a. Use one wrench to hold the large nut and prevent it from turning.

b. Use another wrench to loosen the locking nut, adjust the flow with the screwdriver.

c. Tighten the locking nut after.

- While adjusting, make sure the pump boost pressure (primary pressure less pre-filter pressure) reading never goes outside of value listed in Section 1.8.4.
- Clockwise (in) increases primary pressure and permeate flow rate.
- Counterclockwise (out) reduces primary pressure and permeate flow rate.

WARNING:
Be careful not to unscrew the adjustment too far, or the screw will blow out of the orifice and may cause injury.

It may be necessary to adjust orifices several times to attain the proper settings.

Occasionally the permeate flow rate output of the machine is too high, and cannot be adjusted low enough, even when the recycle orifice is all the way open (unscrewed nearly all the way out). This condition most often occurs right after the membranes have been replaced, and indicates that the permeate rate characteristic (flux rate) of one or more of the membranes may be abnormally high.

- If the permeate conductivity reading is also abnormally high (% rejection is low), the problem is most likely caused by a bad O-ring seal in one of the membrane housings.
- If the % rejection reading is normal or higher than normal, then the membranes are good, but one or more has a water product rate at the high end of product specification range. Contact your equipment supplier for assistance.

5.15 Permeate Divert

Factory-installed valves divert the RO permeate to drain for a preset period of time upon machine start-up or when the RO permeate exceeds a preset conductivity level. This optional feature ensures good quality water flows to storage or to points of use. A start-up divert timer setting in the timer presets menu of the ECM-100 controls the duration of permeate divert each time the machine starts up. A high conductivity level is set in the Alarm Limits menu so that permeate is diverted should the conductivity exceed that level. The divert mode can be disabled if desired by setting the start-up permeate divert timer to zero and selecting WARNING ONLY or SHUT DOWN from the permeate high conductivity alarm function menu (10).

5.16 Product Water Pressure Relief

The factory-installed product water pressure relief hardware includes two 1/4-inch thermoplastic pressure relief valves which relieve excessive permeate backpressure based on a set point. Backpressure can be the result of pressurized storage tanks, pressurized distribution loops, restrictions in permeate plumbing and/or other factors which prevent permeate from flowing from the machine. The valves are typically factory preset to 60 psi (4.1 bar).

Allowing the machine to operate with permeate pressure greater than 60 psi (4.1 bar) may cause premature failure of the respective diaphragm valve. The diaphragm valve is a “normally closed” valve that is designed to fail in the closed position, as required for normal (non-divert) operation. Should this valve fail, the machine will operate in the normal mode with permeate flowing to the tank/distribution loop.

6.0 FEATURES AND ACCESSORIES

Accessory connections are provided on both the input and output terminal strips of the ECM-100. Accessory outputs can be used to control chlorine or dispersant feed pumps; accessory inputs can be used to control pre- or post-treatment equipment. The output connections are switched by relays and power to the outputs will be shut off if machine is turned off due to an alarm condition.

The ECM-100 allows you to connect to a printer and a personal computer. These features allow you to store and print data on the 23G’s current and historical performance.

6.1 Level Controls

Float switches pressurized storage tank switches or other level controls may be connected to the ECM-100's tank level control inputs. To recognize the tank level status, the ECM-100 must be in the AUTO mode.

A level control system with "one" input signal may be connected to the ECM-100 across terminals 17 and 18 of the main strip. Terminals 40 and 41 must be jumpered together in this case. An open status will shut down the machine and a closed status will allow it to run.

CAUTION:
The level control contacts must be dry, non-powered, and compatible with 5 V signals.

NOTE:
The level control feature of the ECM-100 can be configured for two inputs – a high level (tank full) switch and a low level switch. If properly connected, when both switches open, the ECM-100 will shut down the machine and illuminate the blue Tank Full LED light. As the level in the permeate storage tank drops, the high level switch will close but the machine will remain locked-out until the tank level drops to the height that causes the low level switch to close as well. When both switches are closed, the ECM-100 will restart the machine. As the level in the tank rises and the low level switch opens, the machine will continue to run. Only when the high level switch opens will the machine shut down. To utilize the two input configuration, connect the level controls to terminals 17 and 18 and terminals 40 and 41. See Figure 1.3 for connection points.

It is possible to connect the high and low level switch inputs in reverse positions on the ECM-100 terminal strip to achieve level control of a feed water ballast tank. In this case, the machine will shut down on an "empty" tank condition.

NOTE:
If the machine operation is controlled by the lockout status of pretreatment, but not controlled by a storage tank level, then jumper wires must be installed between terminals 17 and 18 and between terminals 40 and 41. The machine must be in AUTO mode to recognize the pretreatment signal or tank level signals.

CAUTION:
In all cases "dry" contacts must be used. This eliminates the possibility of voltages from any other source feeding into the ECM-100 terminals.

6.2 pH Controller/Sensor (ECM-100-pH)

A factory installed pH sensor can be connected to your ECM-100. A high/low pH alarm is included with the pH sensor and should be set at pH 7 and 4, respectively (unless special instructions or conditions indicate otherwise) to protect against excess or loss of buffer feed. If the high pH alarm deactivates the machine, the buffer tank and buffer pump must be checked to ensure that buffer is being fed properly, and that the pump is primed. The system is restarted by pressing OFF and then ON on the ECM-100. This will energize the chemical pump so it can be properly adjusted. The system will stop again according to the alarm timer if the pH remains in the high or low alarm range. When wired for acid pump control, the ECM-100 will turn on the acid pump at 0.8 pH units less than the high pH alarm limit and will turn off the acid pump at 1.8 pH units less than the high pH alarm limit whenever the RO pump is running (except during CIP mode).

Initial calibration of pH sensors is done at the factory. Accuracy should be rechecked at startup and at least monthly when in service, with a test kit or laboratory pH meter. Permeate pH must not be used for calibration of the ECM-100 pH reading or adjustment of the chemical pump. To calibrate the pH reading, refer to the calibration procedure included in Section 8.0.

The pH probe may have to be cleaned or replaced some time after 6 to 24 months of operation, depending on the type of use. Refer to the Spare Parts List (Section 11.0) for specific Mar Cor Purification part numbers. Clean by soaking the glass electrode for10 minutes in a 2 pH acid (the type used for buffer).

NOTE:
23G machines built after September 1997 contain Version 2 (V2) circuit board. This new circuit board includes the extra electronic components built into the circuit board. When ordering replacement pH kits identify whether you have Version 1 (machines built prior to September 1997) or Version 2 (machines built after September 1997).

6.3 Remote Alarm Interface – Six Channel

The six channel remote is mounted outside the ECM-100 enclosure to power a six channel remote alarm system. Wires from the alarm should be routed through a gasket cord grip on the side wall of the ECM-100 enclosure. Connect the positive and negative wires to the proper power supply terminals.

6.4 Printer/Computer Interface

The ECM-100 is designed to allow data downloads to a computer or a printer. The basic process of downloading the information to a printer or computer is the same. Data can be downloaded as individual lines of information (Current display), or large groups of information (Historical log). If a computer or printer is left connected to the ECM-100 for long periods of time, the ECM-100 will display and download (echo) each successive set of operational data as it is stored in the historical log table(s). The user can define the frequency of operational data storage by accessing the Timer Presets Log Period (Menu 02) on the ECM-100.

6.4.1 Printer Interface

The ECM-100 includes a 9-pin female serial communication port which will allow you to interface with a printer. Two print functions are provided: Current display and History Log. See Section 6.6.6 for Print Functions.

6.4.2 Computer Interface

The serial cable on the ECM-100 is wired at the factory to connect directly to a personal computer, requiring only a standard 9-pin serial extension cable of appropriate length and software.

The RS-232 communication configuration is:

Baud Rate 1200, 2400, 4800, or 9600, (user must specify)

Data Length 8 bits

Parity None

Handshaking Xon/Xoff

6.4.3 Computer Connection

Software Requirements

Requires serial communications software on your computer, such as:

HyperTerminal® (included with Windows 95, 98, NT, ME, 2000, or XP)

Microsoft Terminal® (available separately for Windows 3.1)

Crosstalk® and Procomm® (versions available separately for almost any computer)

- or any of a number of similar commercial products.

To capture data from ECM-100 to a PC using HyperTerminal®

Go to the windows application (START menu) and choose "Programs"→"Accessories"→"Communications"→"HyperTerminal"

You will then need to choose a file name, i.e. "**23G RO data"** click **OK**

You will then need to choose the connection, i.e. **COMM 1, COMM 2** etc. click **OK**

You will then be prompted to choose a BAUD rate. The baud rate on the computer should match the baud rate on the ECM-100 controller. You can verify the baud rate on the controller by going to menu 13 on the ECM-100. (Refer to the O & M manual for instructions to change the baud rate. The factory setting on the ECM-100 Baud rate is 1200). The ECM-100 has four different baud rates to choose from (1200, 2400, 4800 and 9600). The higher the baud rate the faster the information will be transferred.

You will also need to choose flow control, you should choose **"Xon/Xoff"** and click **OK**

At the top of the hyper terminal screen choose "Transfer"→"Capture text", you will then need to give a file name, i.e. "23 Data Oct 2003". Once you choose the file name, put it on your desktop so that it is easier to find once the information has been down loaded.

You are now ready to start downloading the information from the ECM-100. Go to Menu 05 "LOG TABLES" and press "ENTER", "Historical Values" will be displayed. You then will need to enter the pass code "HAND/AUTO", "CIP", "ALARM BY-PASS", at this point you will see the letter "P" in the upper right hand corner of the display screen, this denotes that the information is being transferred to the computer.

Once the information is downloaded, it can be put in different formats, MS Excel is recommended so that different data points can be isolated and trended if desired. The following table (6.10) defines the two digit codes used to help determine errors.

Table 6.10 Two-Digit HyperTerminal Alarm Codes

Number on Left	Number on Right
0 No Alarm	0 No Alarm
1 Metric	1 Permeate Conductivity High
2 Permeate Divert	2 High Temperature
3 Metric and Divert	3 High pH
4 HAND mode	4 Low pH
5 Metric and HAND mode	5 Low Post Filter Pressure
6 Permeate DIVERT and HAND mode	6 High Primary Pressure
7 Metric and Divert and HAND mode	7 Low Primary Pressure
8 CIP	8 High Permeate Pressure
	9 Rejection Low
	A Prefilter Delta P
	B Membrane Delta P
	C Permeate Flow Low
	D Tank Full
	E Pretreatment Lockout

Table 6.11 Example ECM-100 History Log

DATE	TIME	PRESSURES					FLOWS		pH	TEMP	REJ	Cp	ALARM
		PRE	POS	PRI	FIN	Pp	Qc	Qp					
12/10/06	15:41	41	40	260	192	56	02.2	06.8	7.6	77	96.8	04	00
12/10/06	14:41	41	39	258	192	53	02.2	06.8	7.6	75	97.4	04	00
12/10/06	13:41	40	39	258	190	54	02.2	06.7	7.5	77	97.1	04	00
12/10/06	12:41	37	35	256	188	50	02.2	06.1	7.5	71	96.2	05	00
12/10/06	11:41	41	39	260	190	56	02.2	06.7	7.5	77	96.9	04	00
12/10/06	10:41	38	37	258	190	51	02.3	06.2	7.4	71	95.4	05	00
12/08/06	20:26	42	40	260	192	58	02.1	07.1	7.5	73	96.5	04	00
12/08/06	18:26	41	40	260	192	56	02.2	06.8	7.4	78	97.3	04	40
12/08/06	15:23	05	03	132	098	39	01.5	02.8	N/A	77	97.4	04	05
12/08/06	09:44	41	39	260	190	56	02.2	06.8	N/A	78	97.5	04	00
12/08/06	07:44	40	38	258	190	55	02.2	07.1	N/A	77	97.2	04	00
12/08/06	05:44	41	39	258	190	55	02.3	06.7	N/A	77	97.6	04	00
12/08/06	03:44	42	40	260	192	56	02.3	06.5	N/A	75	96.8	04	00
12/08/06	01:41	41	39	258	190	53	02.3	06.6	N/A	75	97.3	04	00
12/07/06	23:41	41	39	258	190	54	02.3	06.6	N/A	75	96.6	04	00
12/07/06	21:41	41	39	260	190	54	02.2	06.7	N/A	75	96.7	04	00
12/07/06	19:41	41	39	260	192	55	02.2	06.8	N/A	77	96.4	05	00
12/07/06	17:12	40	38	258	190	83	02.3	01.4	N/A	73	95.8	06	08
12/07/06	15:12	42	40	258	190	57	02.4	07.1	N/A	80	96.3	04	00
12/07/06	13:12	41	39	258	190	55	02.2	07.1	N/A	78	96.4	04	00
12/07/06	11:12	42	40	258	190	56	02.3	06.8	N/A	78	97.1	04	00
12/07/06	09:12	41	39	258	190	54	02.3	06.8	N/A	77	97.4	04	00

A printout of the ECM-100 History Log provides valuable information about the 23G. From the example above (Table 6.11):

- Permeate Pressure High Alarm at 17:12 on 12/07/06
- Inlet Pressure Low Alarm at 15:23 on 12/08/06
- The operator ran the machine in the HAND mode for a short time on 12/08/06, and enabled the pH probe.
- On 12/10/06, before 1:40 am, the operator changed the Log Period Timer Setting from 2 hours to 1 hour.

Hardware Requirements

All new IBM personal computers and clones are supplied with a standard 9-pin male serial port, which uses the standard 9-pin extender cable.

If your computer has only one serial port connection being used by your mouse, you will have to either add a second serial port for connecting to the ECM-100, or unplug the mouse and connect the cable going to the ECM-100 and operate your computer from the keyboard. This may require rebooting.

CAUTION:
Nearly all computers have a 25-pin male connector, which is a parallel printer port. Do not connect the ECM-100, modem or any other serial device to this port.

If your computer has a 25-pin female connector (most likely a serial port), then you will need to use either a 9-pin (M) to 25-pin (M) adapter connector with a standard 9-pin extender cable, or a 9-pin (M) extender cable instead. A M-M (male-to-male) or F-F (female-to-female) gender adapter may be needed if the available extender cable has the wrong port connection.

All of these parts are commercially available at computer and office supply stores.

6.4.4 Printer Connections

Connecting to a Serial Printer

Nearly all serial printers have a 25-pin female connector, so you will need a 9-pin (M) to 25-pin (M) cable, or 9 x 25 adapter to use with the standard 9-pin extender cable, and a “Null Modem” adapter or cable type. In some cases a gender adapter may be needed with a standard IBM serial printer cable or if your only available cable has the wrong style end. These components are commercially available at computer and office supply stores. The green and red wires at terminals #45 and #47 can be switched to provide the same cross-cross effect as a “Null-Modem.”

Printer settings (refer tot he documentation provided with your printer):

Baud Rate 1200, 2400, 4800, 9600 (user must specify)

Parity None

Data Bits 8

Handshake Xon/Xoff

Go to Section 6.4.5 and complete Print Test.

Connecting to a Parallel Printer

Requires a “Serial-to-Parallel” (S-P) converter box between the ECM-100 cable and the cable to the printer (which typically uses a 36-pin Centronix connector).

NOTE:
If a serial printer is not available, a S-P converter box is commercially available at computer and office supply stores.

Use a standard (Centronix style) printer cable from the printer to the “Parallel” port on the S-P converter. Connect the ECM-100 to the serial port on the S-P in the same manner for connecting to a serial printer (described in the previous section).

Converter settings (refer to the documentation provided with our converter):

Baud Rate 1200, 2400, 4800, or 9600, (user must specify)

Parity None

Data Bits 8

Handshake Xon/Xoff

Direction Serial-to-parallel (S-P)

6.4.5 Print Test

The print test below prints the current displays on the ECM-100.

1. On the ECM-100 keypad, press the ARROW keys to scroll to the “Maintenance Menu” (07).
2. Press ENTER select the “Maintenance Menu.”
3. Press the ARROW keys to scroll to “Print Current Values.”
4. Press the ENTER key.

Pressing the ENTER key caused the ECM-100 to output two lines of text and numbers to the printer representing the readings currently being displayed on the LCD screen.

Figure 4.6 indicates where the wires for the ECM-100 communication cable are placed on the main board terminal strip, should they become disconnected or require replacement.

6.4.6 Print Functions

Printing Current Displays

1. Connect printer to ECM-100 as described in Printer Connections.
2. Print current displays as described in Print Test.

Printing History Logs

1. Connect printer to ECM-100 as described in Printer Connections.
2. Perform print test as described in Print Test.
3. On the ECM-100 keypad, press the ARROW keys to scroll to the “Log Tables Menu” (05).
4. Press ENTER select the “Log Tables Menu.”
5. Enter passcode to download historical data. Refer to Section 4.2.6.

All historical data will be sent to the printer and printed in chronological order.

7.0 TROUBLESHOOTING

This troubleshooting guide can assist you in identifying common operating problems you may experience with your machine. Many of these problems can be easily corrected by the operator; however, for those that persist or are not understood, you should contact your equipment supplier.

Have the following information available when calling your equipment supplier:

1. Machine installation date
2. Model number (found on right-hand side of front panel)
3. Serial number (found on right-hand side of front panel)
4. Daily Log Sheets
5. Description of problem
6. Software version from software module.

Troubleshooting Guide - Machine Performance		
Symptom	**Possible Causes**	**Remedies**
Low operating pressure	Pre-filters clogged.	Replace pre-filter cartridges.
	Faulty pressure transducer(s), cable(s) or connection(s) (other pressures and flows normal).	Check terminal strip connections. Disconnect the pressure transducer cable at the sensor end and inspect for possible water corrosion damage. Expose the soldered tabs to reveal a possible short or broken connection. Take care to avoid breaking the wires or pinching the soldered wire end together when reinstalling the cover onto the plug and into the sensor body. Try plugging the pressure transducer into other pressure transducer cables to isolate the problem to the sensor cable. Temporarily install a manual pressure gauge to compare readings. Repair or replace the transducer or cable.
	Insufficient feedwater pressure or flow.	Check the feed pressure, open feedwater valve, and check for restrictions.
	Inlet diaphragm valve not opening.	Check the inlet diaphragm valve for proper operation.
	High flow rates.	Close the machine concentrate valve (do not close concentrate outlet valve), check the permeate and concentrate flow rates.
	Pump not operating correctly.	See pump instructions. Contact your equipment supplier for assistance.
Low operating pressure (cont.)	Insufficient electrical power.	Check the fuses or circuit breakers and measure the voltage.
	Pump rotating backwards (three-phase power only).	Switch any two of the three-phase leads to the motor starter.
High operating pressure	Dirty or fouled membranes.	Flush, clean, and sanitize the membranes..
	Recycle or concentrate orifice plugged	Disassemble the piping to the recycle/concentrate flow block and remove foreign material from the machine concentrate valve stem or orifice.
	Inaccurate pressure indication.	Install a temporary manual gauge to compare readings, and check sensor and cable as desired for “Low Operating Pressure.” Replace or calibrate as required.
	Restricted or reduced permeate flow rate.	See possible causes for low permeate rate.
	Primary or final pressure transducer out of calibration.	Calibrate or replace. Check transducer for fouling.
Excessive membrane	Severely fouled or dirty	Flush, clean, and sanitize the membranes.

Troubleshooting Guide - Machine Performance		
Symptom	**Possible Causes**	**Remedies**
pressure drop [over 15 psi (1.0 bar)] per membrane (Note: membrane pressure drop equals primary pressure - final pressure)	membranes.	
	Restricted flow at housing inlet or outlet.	Check for blockage of concentrate flow at inlets and outlets of element housings.
	Telescoped membrane covering membrane housing outlet port.	Ensure that the anti-telescoping device (ATD) is located properly on the membrane.
	Concentrate or recycle flow rate too high.	Adjust orifice.
	Primary or final pressure transducer out of calibration.	Calibrate or replace. Check transducer for fouling.
Pressure does not drop when concentrate valve is opened	Dirty concentrate valve.	Disassemble and clean the valve.
Low permeate flow rate (0 gpm to 20% less than desired)	Dirty or fouled membrane.	Flush, clean, and sanitize the membranes.
	Operating on cold water less than 55°F (13°C).	Install a hot/cold feedwater tempering valve if more permeate flow is needed. Operate with a feedwater temperature of 72-77°F (22-25°C).
	Low operating pressure.	See possible causes for low operating pressure.
	Concentrate flow too high.	Manual concentrate valve not closed. Autoflush is on or stuck. Verify proper Autoflush valve operation and correct if needed.
	Permeate pressure alarm activating due to back pressure on permeate line resulting in instant machine shutdown.	Check the permeate plumbing for restrictions; measure the flow from individual permeate tubes. Verify that the distribution loop is not deadheaded beyond the permeate pressure alarm set point.
	Membrane elements installed with concentrate seal reversed or damaged.	Refer to Membrane Element Installation (Section 5.13.2) for proper membrane and concentrate seal installation. Replace damaged concentrate seals. After correcting membrane element and concentrate seal installation, clean and sanitize membrane elements.
	Faulty flow turbine or cable (all pressures normal).	Switch sensor cables between concentrate and permeate flow turbines to isolate the problem to cable or turbine.
	Cable or turbine element	Repair or replace the cable or turbine.

Troubleshooting Guide - Machine Performance		
Symptom	**Possible Causes**	**Remedies**
	damaged.	
	Sensor cable not fully inserted into flow turbine element housing.	Insert the cable so it snaps into place.
	Flow indicator inaccurate (possibly due to fouled turbine in sensor).	Check the flow rate manually with a stopwatch and calibrated container. If reading is off from ECM-100 display by >10%, check for a fouled turbine and clean or replace as required. Check settings in Calibration Menu (06).
	ECM-100 flow reading “lockup”.	Pressing the ESC button usually clears the lockup. Power down for 2 minutes, check Alarm Limits and Calibration Menu settings, recall Factory Settings.
Low concentrate flow rate, normal or higher than normal operating pressure (0 gpm to 20% less than desired)	Dirty or fouled membrane elements.	Flush, clean, and sanitize the membrane elements.
	Concentrate valve or concentrate orifice pressure not properly adjusted.	Remove the concentrate valve stem and/or disassemble the plumbing to the orifice. Clean the orifice as required.
	Concentrate outlet line restricted.	Examine the concentrate line for obstructions or kinks, and repair or replace the tubing.
	Faulty flow turbine or cable (all pressures normal).	Switch sensor cable between concentrate and permeate flow turbines to isolate the problem to cable or turbine.
	Cable or turbine element visibly damaged.	Repair or replace the cable or turbine.
	Sensor cable not fully inserted into flow turbine element housing.	Insert the cable so it snaps into place.
	Flow indicator inaccurate (possibly due to fouled turbine in sensor).	Check the flow rate manually with a stopwatch and calibrated container. If the reading is off from the ECM-100 display by >10%, check for a fouled turbine and clean or replace as required. Check setting in Calibration Menu (06).
	ECM “lockup” (software version E6.9 or greater).	Pressing the ESC button should clear the lockup. Power down for two minutes, check Alarm Limits and Calibration Menu settings, and recall Factory Settings.
Low rejection and high permeate flow (hydrolyzed membranes)	Membrane elements dirty or fouled.	Flush, clean, and sanitize the membrane elements.
	O-ring seal broken or damaged.	Check the sealing surfaces on the O-ring groove, interconnectors, and end caps.

Troubleshooting Guide - Machine Performance		
Symptom	**Possible Causes**	**Remedies**
		Replace damaged parts.
	Recovery too high.	Adjust concentrate/recycle orifices.
	Membrane elements oxidized due to chlorine break through.	Verify proper operation of pretreatment (chlorine removal/carbon filtration). Damage is irreversible, replace membranes.
Low rejection and high permeate flow (hydrolyzed membranes) (continued)	New membrane elements oxidized due to cleaning and sanitizing prior to completion of 8-hour flush to drain procedure.	Operate machine for a minimum of 8 hours to remove biocide and stabilize permeate. Refer to Membrane Element Installation (Section 5.13.2).
	Membrane element life expired.	Replace membrane elements (clean and evaluate before replacing).
	Concentrate membrane element seal backward or damaged.	Reverse position or replace seal.
	Excessive permeate back pressure.	Check permeate outlet valves or inlet valves.
	Concentrate flow too high.	Check to see if machine is in auto flush.
Low rejection	Inlet diaphragm valve not closing when machine is turned off.	Clean or replace the inlet solenoid valve. Make sure the inlet diaphragm valve stops the water flow when shut off.
Declining rejection (or high permeate conductivity)	Dirty or fouled membrane elements.	Flush, clean, and sanitize the membrane elements.
	Change in incoming feedwater quality.	Open the concentrate valve and flush. Test the water for pH, hardness, TDS, and iron content. A water analysis should be sent to your equipment supplier for review.
	Conductivity or rejection reading(s) inaccurate or sensor(s) fouled.	Calibrate the sensors with the standard solution or check the readings with another conductivity meter. Check the connections between the sensor and ECM-100 board. Check the permeate conductivity calibration. If the rejection reading is still not matching your calibration with a handheld instrument sampling feed and permeate, then check the feed conductivity calibration. The readings are most precise at a temperature of 77°F (25°C). Clean and/or replace the sensors. Check flow recovery.
	O-ring seal broken or damaged.	Check the sealing surfaces on the O-ring groove, interconnectors, and end caps. Replace damaged parts.
	Damaged membrane elements.	Replace membrane elements.

Troubleshooting Guide - Machine Performance		
Symptom	**Possible Causes**	**Remedies**
Declining rejection (or high permeate conductivity) (continued)	Overfeeding buffer solution due to improper adjustment of pump or low inlet pressure.	Check the pH of the concentrate and adjust to 6.0. Check the inlet pressure to be sure siphoning of the buffer solution is not occurring. Check pH probe calibration.

Troubleshooting Guide – EMC-100 Display Failures		
Symptom	**Possible Causes**	**Remedies**
Permeate conductivity consistently reads over range (“O/R”) and/or triggers the alarm	Permeate conductivity value in excess of maximum value and/or alarm setpoint, broken wire, probe fouled or defective.	Check the wiring connections on the Main Board terminals 27 and 28. Clean the permeate conductivity probe, check calibration. Contact your equipment supplier for assistance.
One or more pressure readings on ECM-100 Display screen are zero or unusually high	Faulty pressure transducer(s), cable(s), or connection(s).	Disconnect the pressure transducer cable at sensor end and inspect for possible water corrosion damage. Expose the soldered tabs to reveal a possible short or broken connection. Take care to avoid pinching the soldered wire ends together or breaking the wires when reinstalling the plug on the cable end and into the sensor body. Try plugging the pressure transducer into other pressure transducer cables to isolate the problem to the sensor or sensor cable. Repair or replace the sensor or cable. Calibrate sensor.
One or more pressure readings on the ECM-100 are “drifting” over a period of time (days), requiring repeated calibration	Calibration characteristics of pressure transducer have changed and transducer may be failing.	Refer to pressure calibration (Section 8.0). Replace transducer if necessary. Contact your equipment supplier for assistance. Debris in port of transducer.
pH reading on ECM-100 display is off by greater than 0.4 units, when check in a standard solution of 4 and 7 or 10 at ambient temperature	Faulty pH probe.	Check by soaking for 10 minutes in a 2 pH acid solution. Recalibrate the pH probe monthly. Replace and calibrate pH sensor as required.
	Faulty pH probe.	On V2 boards, check for 3.1 to 3.3 volts DC at the pH test points on J3 with the probe in a 4.0 pH solution, and 2.4 to 2.6 volts when in 7.0 pH solution or 1.6 to 1.9 volts in a 10.0 pH solution.
pH reading (continued)	Life expectancy for a pH probe is 18 to 24 months.	The pH probe may need to be replaced. Replace and recalibrate probe.
Temperature in ECM-100 cannot be	Temperature circuit failure.	Refer to ECM-100 Troubleshooting (Section 4.7).

Troubleshooting Guide – EMC-100 Display Failures		
Symptom	**Possible Causes**	**Remedies**
adjusted		
Water leaking from permeate and/or diaphragm valves	O-ring or diaphragm failure.	Replace valve. Contact your equipment supplier for assistance. Check fitting.
Tank level control feature does not work	Faulty float/tank level control.	Replace float/tank level control.
	Input wires not properly connected.	Refer to Section 6.1 and Figure 4.6.
	Incompatible level controller.	
Water flowing when machine is turned off	Inlet solenoid valve or diaphragm valve not closing or seating properly. Solenoid and diaphragm valve tubed incorrectly.	Clean or replace the valve(s). Clean and sanitize the membranes immediately. Water must not pass through inlet when the machine is off.
ECM-100 display screen backlighting flickers (Note: a slight flicker is normal)	Power line disturbance.	Install a surge protector and AC line emi/rfi filter device between the ECM power cord and the power source. Note: Some minor flickering is normal. Check for loose fuse on relay board, loose wiring connection and ribbon cable between boards.
LCD screen blank or contains garbled text	Power line interruption or electrical noise.	Pressing the ESC button should clear screen, power down for 2 minutes and restart.
Most or all lights are off	Blown fuse or loose ribbon cable between Main and Relay Boards.	Check fuses, check and reseat the ribbon cable. Check for loose fuse holder.
	Bad Relay/Main Board.	Contact your equipment supplier for assistance.
	Lost 110/220 VAC power to the ECM-100.	Contact your equipment supplier for assistance.
	Power surge possibly due to lightening strike or voltage surge.	Replace damaged parts and install a surge protector. Contact your equipment supplier for assistance.

Troubleshooting Guide – 23G System Failures		
Symptom	**Possible Causes**	**Remedies**
23G electrical machine shutdown	ECM-100 “lockup” (usually due to power fluctuation).	Power down for 2 minutes, then restart. Check alarms, timers, and calibration settings. Recall Factory Settings.
	Thermal overload relay tripped	Turn the machine of, reset the relay, check the motor amp draw and line voltage, Adjust the overload relay based on the motor amp draw if required. Check for excessive pressure or flows.
Machine will not turn on	Alarm condition has turned off machine.	Check the ECM-100 display for Alarm identification. Remedy the alarm. The ECM-100 will remain in a state of alarm until the OFF key is pressed.
	Thermal overload in motor starter.	Check amp draw of the motor and reset thermal overload.
	Motor and/or pump not operating properly.	See pump instructions. Contact your equipment supplier for possible repair or replacement.
	Fluid temperature over 90°F (32°C).	Check the feedwater supply temperature. Maximum operating temperature is 90°F (32°C).
	No power to machine.	Check the fuses or circuit breakers, measure the voltage.
23G machine blowing fuses	Faulty wiring to pretreatment or tank level switches.	Remove wires at 17, 38, 40, and 42 to isolate problem. Repair as needed.
	Shorted flow sensor.	Flow pickup sensor hot to the touch. Replace and calibrate sensor.
	Shorted pressure transducer or faulty cable.	Contact your equipment supplier for assistance.
	Fault on Main Board.	Contact your equipment supplier for assistance.
One or more of the motors or solenoid valve is not being energized	Faulty solenoid or wiring, or faulty Relay or Main board.	Observe the lights on the ECM-100 front panel, check timer, and alarm settings. Check for AC power out of the appropriate terminal on the Relay Board.
	Loose connection at the Relay Board.	Check all connections.

7.1 Emergency Alarm Bypass

CAUTION:
The following are regarded as emergency conditions. Bypass of the alarm will defeat the automatic safety protection features of the ECM-100. Bypass of these measures may cause damage to the machine or be severely detrimental to product water quality if the condition being monitored goes into an actual error state while the sensor is being bypassed. Depending on which sensor is being bypassed, the machine operation will need to be monitored closely until the problem is repaired (while replacement parts are in transit). In many cases, the machine can be run for short periods in emergency situations by simply turning it on in the Manual or CIP mode. The machine should never be left unattended in the Manual or CIP mode.

WARNING:
When the machine is operating in the CIP mode, all alarms except HIGH TEMP, HIGH PRIMARY, AND HIGH PERMEATE, are ignored. OPERATION OF THE 23G MACHINE WHILE THE ALARM SYSTEM IS BYPASSED COULD POSE A RISK OF SERIOUS INJURY OR DEATH TO HEMODIALYSIS PATIENTS**.**

CAUTION:
The procedures listed below are temporary. Prolonged operation as described below will damage the machine. These procedures should only be used to allow production of product water until repairs can be completed. The machine should be continuously monitored while operating in this mode.

WARNING:
Disconnect power from RO when working in any of the control boxes or serious injury may occur.

7.1.1 Permeate Conductivity High or Rejection Low Alarms

Use a hand-held conductivity test meter to ensure that the water quality is acceptable. Disconnect the white wire from terminal 27 on the Main Board and terminal strip (the reading will go to 1 μS). Recheck conductivity until the problem is repaired.

If this remedy does not work, contact your equipment supplier.

7.1.2 Rejection Low Alarm Due to Failed Feed Conductivity Probe

Install a short piece of wire between terminals 24 and 25 on the Main Board terminal strip (forces reading to 2550 μS).

If this remedy does not work, contact your equipment supplier.

7.1.3 Temperature High Alarm

Switch wires to use the temperature element which is encapsulated in the Permeate Conductivity probe. Remove the red and green wires from terminals 23 and 24, and connect the red and green wires from the permeate conductivity probe cable to terminals 23 and 24.

If this remedy does not work, contact your equipment supplier.

7.1.4 pH Alarms

Disable the pH function by entering zero (0) in the Calibration Menu (06). Then move the wire connecting terminal 8 to terminal 11 on the Relay Board and adjust the chemical feed pump carefully for a slow continuous feed. Test the pH frequently (hand-held pH meter or test kit) and readjust the pump accordingly.

If this remedy does not work, contact your equipment supplier.

7.1.5 Pressure

- First check the wiring connections, and clean any corrosion from the connector on the back of the transducer.
- A slowly drifting pressure reading over a period of several days can be temporarily corrected by adjusting the offset setting in the Calibration Menu (restore to original values for calibration of new sensors).
- Adjusting the offset value adjusts the entire operating range of the sensor.
- To bypass a pressure sensor or cable, power down and remove the cable from the Main Board terminal strip (see Figure 4.6).
- Add a short length of wire from the terminal where the white wire was just removed, and connect it to a neighboring pressure terminal containing a white sensor wire.
- Add a second length of wire from the terminal where the green wire was removed, and connect it to the neighboring pressure terminal containing a green wire (connect Primary to Final, Permeate to Pre- or Post-Filter).

- Power up and set the pressure offset in the Calibration Menu (06) to obtain a nearly normal reading for the pressure being bypassed.
- Restore the offset settings and wiring when the new transducer is installed.
- The new transducer must be calibrated (see Section 8.2).
- Remove transducer and clean port.

If this remedy does not work, contact your equipment supplier.

7.1.6 Permeate Flow (Stuck at Zero)

- Check flow turbine to ensure it spins freely.
- First check connections (Figure 4.6), power down for 2 minutes, recall Factory Settings and check the values in the Calibration Menu (06).
- Switch sensor cables, or insert the permeate cable into the concentrate turbine (the machine will run normally with a concentrate flow reading of zero).
- Unplug the cable from its turbine, and set the flow offset in the Calibration Menu to 99 (forces the flow reading to 0.1), then set the permeate low flow alarm to 0.0.
- Return to the proper settings after the problem is corrected.
- Remove turbine and blow through it to be sure it spins freely.

If this remedy does not work, contact your equipment supplier.

7.2 General ECM-100 Reference/Troubleshooting Guidelines

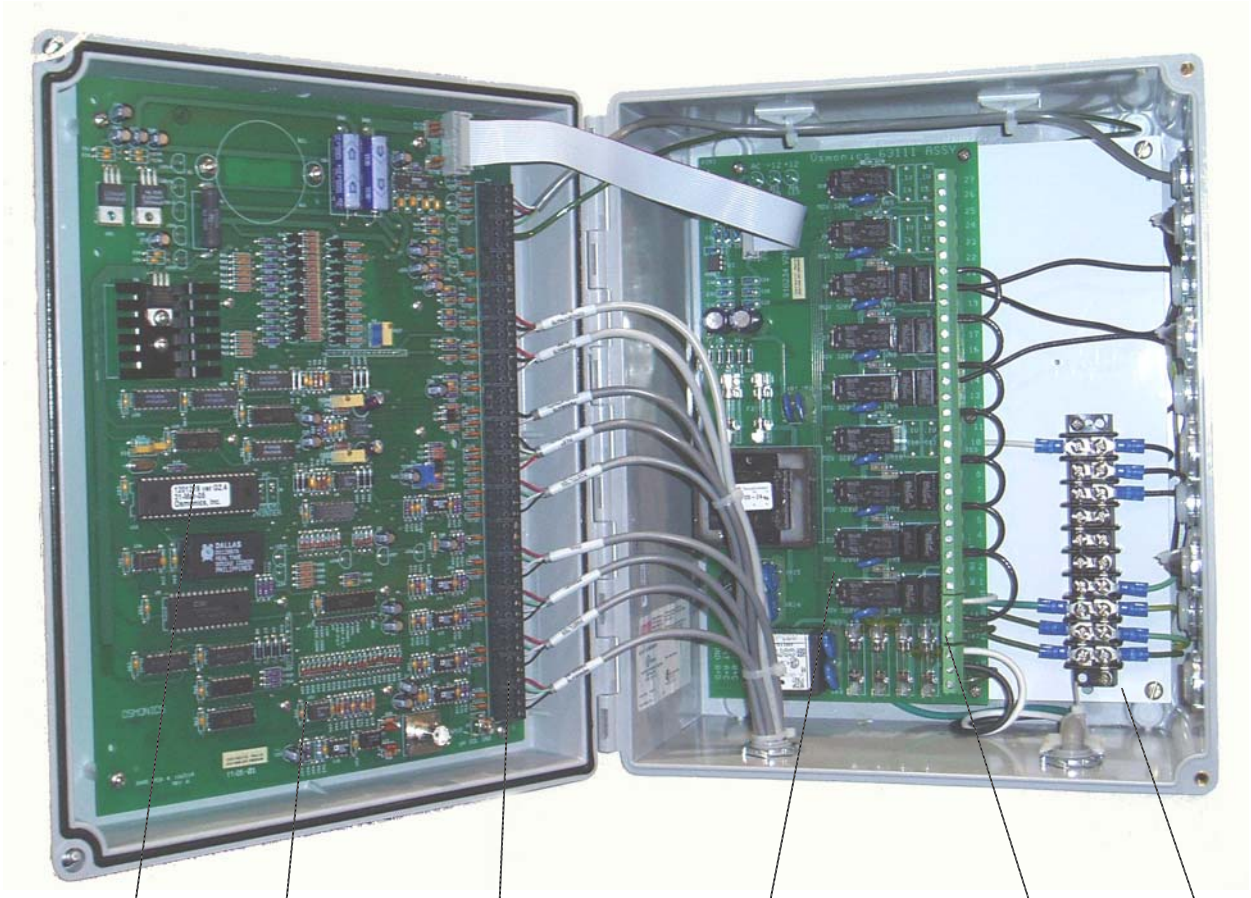


Figure 7.11 ECM 100

7.2.1 Resetting the ECM-100

If exterior problems (such as power surges, lightening storm) have damaged the ECM-100. Power down (disconnect) to reset the ECM-100. A high quality inline surge protector suppressor is recommended to avoid related problems.

1. Press the ECM-100 OFF key to turn the machine OFF.
2. Disconnect the power to the ECM-100 (for single-phase machines, also disconnect power to the motor controls). Let machine sit for at lest 2 minutes to dissipate energy stored in the reactive power supply devices.
3. Reconnect the ECM-100 power cord.
4. Start the machine. If persistent alarms occur, verify that the settings are still valid in the following menus: Alarm Limits, Timer Presets, Calibration and Permeate High Conductivity Alarm. Compare the settings to the settings on the machine Start-Up Data Sheet and Alarm Presets Data Sheet.
5. Where settings are not valid, recall the “Factory Settings” to restore original parameters. (If the settings were saved after the last change.)
6. If settings are still not valid, reset according to parameters recorded on the Start-Up Data Sheet and Alarm Presets Data Sheet.

7.2.2 If sporadic, unexplained alarms occur, check the Main ECM-100 Board Terminal Strip on back door for good connections.

CAUTION:
This procedure should be performed by qualified electrical service personnel only.

1. Turn the machine OFF.
2. Disconnect the power to the ECM-100. Disconnect motor power as well.
3. Visually inspect for signs of damaged components.
4. Gently tug on each wire on the main board terminal strip to test for good electrical contact.
5. Contact your equipment supplier for assistance in repairing any loose or broken wires.

6. Ensure the terminal board is firmly connected to the main board by gently pressing on the top of the strip, pushing it toward the main board.

CAUTION:
Do not apply too much pressure - you may damage the board.

7. Reconnect power and test for proper operation. For additional assistance contact your equipment supplier.

7.2.3 If sporadic, unexplained alarms occur, check the Relay Board Terminal Strip for good connections (Relay Board).

WARNING:
ELECTRICAL SHOCK HAZARD - SERVICE TO BE PERFORMED BY QUALIFIED ELECTRICAL PERSONNEL ONLY!

1. Turn the machine OFF.
2. Disconnect the power to the ECM-100. Disconnect motor power as well.
3. Closely inspect each wire connection to see that none are broken, frayed, or loose in their screw terminal and that all crimp terminal ends are squeezed tightly on the wire and firmly screwed to the terminal block.
4. Ensure that all terminal block screws and jumper links are securely fastened.
5. Check for blown fuses, and squeeze the fuse holder clips together slightly to hold the fuses securely.

For additional assistance contact your equipment supplier.

7.2.4 Low Rejection Warning (Due to High Purity Feed Water)

The ECM-100 may exhibit a low rejection warning condition when the factory default low rejection alarm setpoint of 88% is used with high purity feed water. The permeate conductivity may be acceptable, but the percent (%) rejection may read low enough to cause an alarm.

The ECM-100 calculates % rejection using the following equation:

$$\% \text{ Rejection} = \left[1 - \frac{\text{Permeate Conductivity}}{\text{Feed Conductivity}} \right] \times 100$$

Since the % rejection is based on a ratio between the feed conductivity and the permeate conductivity, higher quality feed water may result in a low % rejection alarm. Higher recovery will typically lower the permeate rejection using the ECM- 100 calculations.

If a low % rejection alarm results from high purity feed water when the permeate conductivity is at acceptable levels, the following three methods could be used:

1. Reduce low % rejection alarm setpoint.
2. Adjust the feed conductivity calibration potentiometer for a slightly higher feed conductivity reading. See Section 8.0 for calibration of feed conductivity.

NOTE:
Adjusting feed conductivity to a slightly higher reading will result in an inaccurate feed conductivity displayed on the ECM-100.

3. Use a resistor in place of the feed sensor. Remove the feed conductivity input and replace with a resistor to simulate a feed conductivity. A 10 K ohm resistor would indicate 250 μS.

NOTE:
To properly monitor permeate conductivity make sure the PERM HI COND ALARM Menu in the Maintenance Menu (07) is properly set. See Section 4.6.10 for accessing Permeate High Conductivity Alarm Menu**.**

For additional assistance contact your equipment supplier.

7.2.5 Verifying the Temperature Circuitry of the Main Board

1. Turn the machine OFF.
2. Unplug the power cord for the ECM-100.
3. Disconnect the temperature sensor wires from terminal posts 23 and 24.
4. Cover the temperature sensor wires which were removed from terminal posts 23 and 24 with electrical tape. Secure these wires in a location that prevents contact with the main circuit board.
5. Install a 3 K ohm resistor between terminal posts 23 and 24.
6. Connect the power cord for the ECM-100.
7. Adjust potentiometer marked “temp” (V2) until the temperature reads 77°F (25°C).

NOTE:
If the temperature cannot be adjusted then the main board may need to be replaced. Contact your equipment supplier.

8. Unplug the power cord and remove the 3 K ohm resistor, and install the temperature sensor wires.
9. If the above steps do not correct the problem, replace the feed conductivity probe.

NOTE:
When installing a new feed conductivity probe, unplug the power cord, make all connections, and then plug the power cord in.

NOTE:
The temperature sensor can be temporarily bypassed while waiting for replacement parts by installing a 3 K ohm resistor between terminals 23 and 24.

7.2.6 Difficulty Calibrating Permeate Conductivity

The integrity of the permeate conductivity circuitry on the main logic board can be verified by connecting a fixed resistor in place of the conductivity probe.

1. Turn the machine OFF.
2. Unplug the power cord for the ECM-100.
3. Disconnect the permeate conductivity wires from terminal posts 27 and 28.
4. Install a 5 or 10 K ohm resistor between terminal posts 27 and 28.
5. The resulting conductivity should be displayed on the ECM-100.
   - 10 K ohm should give a reading of 10 μS.
   - 5 K ohm should give a reading of 20 μS.
6. If the ECM-100 does not display the correct permeate conductivity then the main board may need to be replaced. Contact your equipment supplier.

Refer to Troubleshooting Guide (Section 7.0) for additional information.

7.2.7 Information to Obtain Before Contacting Your Equipment Supplier

1. Machine installation date.
2. Model number (found on right-hand side of front panel).
3. Serial number (found on right-hand side of front panel).
4. Daily Log Sheets.
5. Detailed description of problem.
6. Software version from software module.

8.0 23G SOFTWARE

8.1 Calibration Procedures

NOTE:
If the software for your main logic board is labeled G2.1 or higher, you have a Version 2 (V2) main logic board.

V1 and V2 main logic boards and relay boards are interchangeable (i.e., you could have a V1 main logic board and a V2 relay board and vice versa).

23G machines built after 1997 contain Version 2 (V2) circuit boards. This new circuit board includes extra electronic components built into the circuit board. When ordering replacement parts identify whether you have V1 (machines built prior to 1997) or V2 (machines built after 1997). Contact your equipment supplier with questions.

Normally, the only sensor requiring periodic calibration is the pH probe, which should be checked semi-annually.

8.2 pH Calibration Procedure - Software Version V2

1. Obtain two standard pH reference solutions with different pH values. Solutions of pH 4.0 and 7.0 or of pH 4.0 and 10.0 are recommended.
2. Remove the pH sensor from the incoming waterline, and rinse in tap water.
3. From the calibration menu, use the ENTER key to scroll to the pH cal low menu item. Before changing the pH calibration value, place the wetted end of the pH sensor in the standard solution with the lower pH. Swirl it a little and **leave it dipped** - with at least 1 inch of the sensor length submerged (so that the metal body of the probe is in contact with the solution by approximately 1/4-inch).
4. On the ECM-100, enter passcode 1. Using the ARROW keys, change the pH cal low setting to be 10 times that of the pH of the solutions. For example, 40 for 4.0 solution. The number indicates tenths of a pH unit. Press the ENTER Key to store the calibration value and go on to the high pH limit.
5. The next setting in the calibration menu is pH cal high. Before dipping the pH sensor in the high pH solution, rinse the pH sensor with pH neutral water. The pH sensor may also be rinsed with some of the high pH solution. Place the sensor in the standard solution of higher pH. Swirl it a little bit and **leave it dipped** - with at least 1 inch of the sensor length submerged.
6. On the ECM-100, enter passcode 1 again. Using the ARROW keys, change the pH cal low setting to be 10 times that of the pH of the solution. For example, 70 or 7.0 solution or 100 for 10.0 solution. Again, the number indicates tenths of a pH unit. Press the ENTER key to save the new reading.
7. Calibration is now complete. To check it, rinse the probe with tap water and dip it into the low pH solution again to see if it reads accurately. Repeat the calibration if necessary.

8. Rinse or blot away any remaining droplets of the pH solution and reinstall the pH sensor into the incoming waterline.
9. Generally this 2-point pH calibration procedure should be repeated on a bi-monthly basis. Some situations will require more frequent recalibration while others will require less.
10. If the probe does not seem to be responding, try soaking it in a 2.0 pH acid for 10 minutes. Repeat the calibration.
11. If the probe will not calibrate after 2 or 3 attempts, refer to the pH section in the Troubleshooting Guide (Section 7.0).
12. Save the settings using passcode 2 in the maintenance menu Factory Settings.

8.3 Logic Board

NOTE:
For machines equipped with Rev G2.2 software as shipped (V2 Logic Board). These documented specifications are subject to change, depending on the unique characteristics of each machine during quality assurance (QA) testing. Any "user" variation of these specifications (including any software upgrades) in the field (after the machine has left Mar Cor Purification shipping dock) is solely the responsibility of the user to document and control.

Menu #2

Alarms	ECM Adjustment Range	Alarm Limit
PERM COND HI	0-200 μS/cm[ab]	30 μS/cm
TEMP HI[c]	0-225°F (0-123°C)	90°F (32°C)
pH HI[c]	0.0-14 pH units[d]	9.0 pH units
pH LOW[c]	0.0-14 pH units	3.5 pH units
POST-FILTER PRESS LOW[c]	0-99 psi (0-68 [barX10])	12 psig (8 [barX10])
PRIMARY PRESS HI[e]	0-510 psi (0-352 [barX10])	280 psig (193 [barX10])
PRIMARY PRESS LOW[c]	0-510 psi (90-352 [barX10])	150 psig (103 [barX10])
PERM PRESS HI[e]	0-99 psi (0-68 [barX10])	80psig (55 [barX10])
REJECTION LOW	0-99%	88%
FILTER PRESS DROP HI	0-99 psi (0-68 [barX10])[f]	14
MEMBRN PRESS DROP HI	0-510 psi (0-352 [barX10])[g]	108
PERM FLOW LOW	0.0-20.1 gpm (0.0-6.5L)[h]	2.6

a. Adjustment range of "Permeate Conductivity High" alarm is 0-50 μS/cm for Rev D3 software; 0-200 μS/cm for Rev E0 or higher software.
b. Below 200 μS/cm, there are 2.5 units of specific conductance (μS/cm) per unit of Total Dissolved Solids (ppm or mg/L as $CaCO_3$).
c. Shutdown alarms with adjustable delay (1-99 sec).
d. If an acid injection pump is installed, the high pH alarm determines when the chemical pump turns on. After the chemical pump lowers the pH to 1.8 units below the alarm setting, the pump will be turned off.
e. Shutdown within one second (non-adjustable).
f. Set alarm limit at 8 psi (6[barX10]) greater than drop observed during data collection fro QA test form.
g. Set alarm limit at 1.5X the drop observed during data collection for QA test form.
h. Set alarm limit at 60% of flow observed during data collection for QA test form.

Menu #3

Timers	ECM Adjustment Range	Alarm Limit
RO PUMP DELAY	1-99 sec[a]	6 sec
START-UP PERM DIVERT	0-99 min (select 0 or 2 min)[b]	2 min
AUF PERIOD	0-99 hr	1 hr
AUF DURATION	0-99 min	6 min
ALARM SHUTDOWN DELAY	0-99 sec	15 sec
LOG PERIOD	0-99 hr	1hr
AUTO-ON PERIOD	0-99hr[c]	0 hr
AUTO-ON DURATION	0-99 min[c]	0 min

a. An RO pump delay of 0 will disable the RO pump.
b. Select zero (0), if permeate divert option is not installed. Select 2 min, if it is installed.
c. When enabled, typical settings are auto-on period of 4 hours, and auto-on duration of 15 minutes.

Menu #6

Calibrate	ECM Adjustment Range[a]	Alarm Limit
pH	0 or 1	(Disable or Enable)
PRE-FILT PRESS	-99 to +99 OFFSET UNITS[bc]	-06
POST-FILT PRESS	-99 to +99 OFFSET UNITS[bc]	-06
PRIMARY PRESS	-99 to +99 OFFSET UNITS[dc]	-08
FINAL PRESS	-99 to +99 OFFSET UNITS[dc]	-08
PERMEATE PRESS	-99 to +99 OFFSET UNITS[bc]	-06
CONC Q OFFSET	-99 to +99 OFFSET UNITS[ef]	00
PERM Q OFFSET	-99 to +99 OFFSET UNITS[ef]	00
CONC Q SLOPE	0-255 SLOPE UNITS[gf]	37
PERM Q SLOPE	0-255 SLOPE UNITS[gf]	37
pH CAL LOW	0-140 pH units[h]	40 or 70
pH CAL HIGH	0-140 pH units[h]	100

a. Adjustment range remains the same whether US or Metric units are enabled.
b. There are 0.50 psig (0.0345 bar) per offset unit of pre-filter, post-filter, and permeate pressure.
c. Pressure transducer calibration offset value for V2 main logic board (software Rev. G or higher) should set to d. There are 2.00 psig (0.138 bar) per offset unit of primary and final pressure.
e. The standard 1-inch flow turbine should be calibrated with a flow offset of -04 ±4 for both the permeate and concentrate. There are 0.10 Lpm (0.0264 gpm) per offset unit.
f. When using a 2-inch turbine for flows above 50 gpm, use a flow offset of 45 and a slope of 148. The 2-inch turbine is only used on special high flow machines which use the ECM-100 as a special feature.
g. The “slope” for both permeate and concentrate flows should be set to 36 ±2 for the 1-inch flow turbine. The slope has units of: Lpm/(100 turbine revolutions).
h. To calibrate the pH, pass code 1 must be entered and the pH electrode must be put in two pH standard solutions (4.0 and 7.0 or 4.0 and 10.0).

8.4 Temperature Calibration Procedure

8.4.1 Cleaning the Feed Conductivity Sensor

1. Turn machine OFF.
2. Locate and remove the feed conductivity sensor

The temperature sensor is encapsulated in the feed conductivity sensor. The feed conductivity sensor is located downstream of the pre-filters and above the inlet diaphragm valve. A bucket or container may be needed to catch the water when the feed conductivity sensor is removed.

3. Clean any debris or residue from the probe tips with a clean towel.

If either one of the tips is broken off, the probe must be replaced.

4. Install the feed conductivity sensor back in the machine.

8.4.2 Calibrating the Temperature

NOTE:
Machine should be running while calibrating temperature.

1. Take a sample of the feedwater [about 8 ounces (0.24 L)] from the feed sample port on the inlet of the machine. Measure the temperature with a recently calibrated thermometer.
2. Locate potentiometer marked “temp” on the main circuit board.

The circuit board for the potentiometers is located in the door of the ECM-100 enclosure.

The potentiometer marked "temp" is located just below the center of the board.

3. Adjust the potentiometer marked "temp" until the temperature on the ECM-100 display matches the temperature of the hand-held thermometer.
   - Clockwise (CW) rotation lowers the temperature reading.
   - Counterclockwise (CCW) rotation raises the temperature reading.
4. If the temperature reading on the ECM-100 will not adjust see Troubleshooting (Section 7.0).

8.5 Conductivity Calibration Procedure

8.5.1 Measuring the Conductivity of Feed and Permeate Samples

NOTE:
The 23G displays conductivity in microSiemens (μS).

NOTE:
Use a hand-held, recently calibrated conductivity meter. The meter should read in microSiemens (μS).

NOTE:
Some hand-held meters are not temperature compensated and, therefore only accurate at 77°F (25°C).

1. Take a sample of the feedwater [about 8 ounces (0.24 L)] from the feed sample port on the inlet of the machine. Measure the conductivity with a recently calibrated conductivity meter.
2. Take a sample of the permeate [about 8 ounces (0.24 L)] from the permeate sample port on the machine. Measure the conductivity with a recently calibrated conductivity meter.

Be sure to rinse the conductivity meter thoroughly in a stream of water from the feed sample valve before taking feed sample reading and permeate sample reading. Follow the manufacturer's instructions for calibrating with a conductivity meter.

8.5.2 Verifying the Percent Rejection Reading on the ECM-100

Calculate the ECM-100 percent rejection using the following equation:

$$\% \text{ Rejection} = \left[1 - \frac{\text{Permeate Conductivity}}{\text{Feed Conductivity}} \right] \times 100$$

If the percent rejection reading is inaccurate, the feed or permeate conductivity probes may need to be calibrated.

8.5.3 Displaying the Feed Conductivity on the ECM-100

1. Press the ESC key twice to return to the default menu.
2. Press the ARROW keys to scroll to Alarm Limits Menu (02).
3. Press the ENTER key to select the Alarm Limits Menu.
4. Press the ENTER key to scroll down to the “Rejection Low” alarm function.
5. Enter passcode by pressing the following three keys in sequence:
   a. HAND/AUTO
   b. CIP
   c. ALARM BYPASS
6. Change the “Rejection Low” alarm value to 42 by pressing the DOWN ARROW.

When the rejection low alarm value is set at 42, the feed conductivity will be displayed in the “% Rejection” location on the ECM-100.

8.5.4 Calibrating the Feed Conductivity

If the ECM-100 feed conductivity reading matches the hand-held meter reading, then the feed conductivity is calibrated.

1. Press the ENTER key to save the value.
2. Press the ESC key twice to exit back to the default screen
3. Proceed to Permeate Calibration (Section 8.10.7).

If the feed conductivity reading and the hand-held meter reading differ by more than 2.0 μS, continue with the procedure below.

If the feed conductivity reading is less than 005 or greater than 2550, see Troubleshooting (Section 7).

NOTE:
Machine must be running while calibrating the feed conductivity.

4. Open the ECM-100 door by loosening the two captivated screws in the right side of the enclosure.

5. Locate the potentiometer marked “feed” on the main circuit board.

The circuit board for the potentiometers is located in the door of the ECM-100 enclosure.

The potentiometer marked “feed” is located in the center of the main circuit board.

6. Adjust the potentiometer marked “feed” until the ECM-100 feed conductivity reading matches the conductivity as measured by the hand-held meter [at 77°F (25°C) for some meters].
   - Counterclockwise (CCW) increases the conductivity reading.
   - Clockwise (CW) decreases the conductivity reading.

NOTE:
The 23G displays conductivity in microSiemens (μS).

NOTE:
If the feed conductivity cannot be calibrated with the potentiometer marked “feed” the sensor may need to be replaced.

7. Shut off the machine, remove the feed conductivity probe and check to be sure it is not fouled and the graphite tips are not broken.
8. Reinstall the feed conductivity probe.

8.5.5 Restoring the Rejection Low Alarm Setting

1. Press the UP ARROW to change the Rejection Low alarm back to its original setting (the factory default for Rejection Low is 88%).
2. Press the ENTER key to save the new value.
3. Press ESC twice to exit back to the main screen.

8.5.6 Calibrating the Permeate Conductivity

If the ECM-100 permeate conductivity reading matches the hand-held meter reading, then the permeate conductivity is calibrated (proceed to Section 8.10.6 Restoring the Rejection Low Alarm Setting).

If the permeate conductivity reading is 1.0 or less refer to ECM-100 Troubleshooting (Section 4.7).

1. Take a sample of the permeate from the permeate sample port [about 8 ounces (0.24 L)] in order to establish the known conductivity.
2. Measure the permeate conductivity reading from the sample collected.

Be sure to rinse the conductivity meter thoroughly in a stream of water from the permeate sample valve before taking the reading.

3. Locate the potentiometer marked “perm” on the main circuit board.

The main circuit board is in the door of the enclosure.

The potentiometer marked “perm” is in the center on the right-hand side of the circuit board.

4. While the machine is running, adjust the potentiometer marked “perm” until the ECM-100 permeate conductivity reading matches the conductivity as measured by the hand-held meter [at 77°F (25°C) for some meters] while the machine is running.
   - Counterclockwise (CCW) increases the conductivity reading.
   - Clockwise (CW) decreases the conductivity reading.
5. Saving to Factory Settings (Menu 11).

NOTE:
Whenever a value is adjusted it must be saved in the Factory Settings Menu (11).

- Press ESC twice to return to the ECM-100 default menu.
- Press the ARROW keys to scroll to the Maintenance Menu (07).
- Press ENTER to select the Maintenance Menu.
- In the Maintenance Menu, use the ARROW keys to scroll to the Factory Settings Menu (11).
- Press ENTER to select Factory Settings.

Two lines of factory settings will be displayed.

- Enter the storage code using the following keys in sequence to save the settings:
  a. HAND/AUTO
  b. CIP
  c. ON
  d. ENTER

8.6 Pressure Transducer Calibration Procedure

1. De-energize the 23G pump and shut inlet valve to the 23G.
2. Energize the 23G controller.
3. Push the HAND/AUTO button to the HAND mode. Then push the controller ON button, wait two seconds and push the CIP button. Observe the CIP button illuminate. In several seconds you will hear the inlet solenoid valve open. The pump should not start.
4. Open the feed, permeate, and concentrated sample valves. Let the machine drain several minutes until the water is almost completely drained out.
5. Push the UP arrow to advance to the calibration menu, then push the ENTER button until you reach pre-filter pressure.
6. Insert pass code to change value on the pre-filter pressure reading on the ECM-100 screen by pushing HAND/AUTO, then CIP, then the ALARM/BYPASS buttons.

7. Use the UP arrow on the controller to advance the pre-filter pressure reading on the screen to 6. Wait 15 seconds for the controller to accept calibration information. Then push the DOWN arrow slowly until it goes to the next lower number, waiting 15 seconds between number changes. Continue with this procedure until you reach zero. Wait 15 seconds then push the ENTER button. This enters the calibration information into the menu and also advances you to the post-filter pressure. Use the same procedure for post-filter, primary, and final pressures. When you reach the permeate pressure, the number that was changed to 6 is on the left of the word calibrate on the second line. Calibrate the permeate pressure by using the same procedure used on the other pressure transducers. When zero has been reached, wait 15 seconds and then push ENTER several times until you are out of the menu. Close all sample valves.
   Open the inlet valve. Turn machine on to allow water to flow through machine for 2 to 4 minutes to refill machine with water before starting. Push the OFF button on the ECM-100 controller, then push the HAND/AUTO button to AUTO position. The machine is now ready to start up. Check to make sure all feedwater valves are open. Observe the presence of pre-filter water pressure on the ECM-100 screen. Energize the 23G pump. Then push the START button on the ECM controller. Observe the pressures as the machine starts up. With every thing running well, the calibration of the five pressure transducers is completed.

NOTE:
The machine is designed to run in AUTO mode. Prior to restarting the machine, confirm that the machine is in AUTO mode.

8. Press the ON key to turn machine on.
9. If unable to calibrate the ECM-100 as described above, see ECM-100 Troubleshooting (Section 7).

8.7 Flow Calibration Procedure

8.7.1 Measuring Permeate Flow Rate

1. Check and record the ECM-100 permeate flow while the machine is running.
2. Turn the machine OFF.
3. Install a 1-inch I.D. flexible hose [at least 4 feet (1.2 m) in length] to the CIP permeate fitting. The CIP fitting requires a 1-inch MPT threaded fitting.
4. Open the permeate CIP valve.

5. Close the permeate outlet valve.
6. Secure the end of the hose attached to the CIP fitting.
7. Turn machine ON.
8. After 15 - 20 seconds of operation measure the permeate flow.

   Measure the permeate flow with an accurate stopwatch. Record the time needed to collect water in a container with a known volume. Use the formula below to calculate volume:

$$\text{gallons per minute (gpm)} = \left[\frac{\text{\# of gallons}}{\text{\# of seconds to fill container}} \right] \times 60$$

   Mar Cor Purification recommends using a 5 gallon (19 L) container with 1 gallon (1 L) increments.
9. Compare the flow reading from Step 1 to the flow rate calculated in Step 8.

   If the two readings differ by more than 0.3 gpm (0.07 m^3/h) adjust the calibration settings as described in Section 8.7.3 to 8.7.5.

8.7.2 Measuring Concentrate Flow Rate

1. Check and record the ECM-100 concentrate flow while the machine is running.
2. Turn the machine OFF.
3. Install a 1-inch I.D. Flexible hose [at least 4 feet (1.2 m) in length] to the CIP permeate fitting. The CIP fitting requires a 1-inch MPT threaded fitting.
4. Open the concentrate CIP valve.
5. Close the concentrate outlet valve.
6. Secure the end of the hose attached to the CIP fitting.
7. Turn machine ON.

8. After 15 - 20 seconds of operation measure the concentrate flow.

   Measure the concentrate flow with an accurate stopwatch. Record the time needed to collect water in a container with a known volume. Use the formula below to calculate volume:

$$\text{gallons per minute (gpm)} = \left[\frac{\text{\# of gallons}}{\text{\# of seconds to fill container}} \right] \times 60$$

   Mar Cor Purification recommends using a 5 gallon (19 L) container with 1 gallon (1 L) increments.

9. Compare the flow reading from Step 1 to the flow rate calculated in Step 8.

   If the two readings differ by more than 0.3 gpm (0.07 m^3/h) adjust the calibration settings as described in Section 8.7.3 to 8.7.5.

8.7.3 Calibrating the Concentrate and Permeate Flow Rate Offsets

NOTE:
The machine should be running.

Calibrating Concentrate Flow Rate Offset

1. Press the ARROW keys to scroll to the Calibration Menu (06).
2. Press ENTER to select the Calibration Menu.
3. Press ENTER until the “Conc Flowrate Offset” is displayed.

4. The “Conc Flowrate Offset” should read 00. If it does not read 00:
   - Enter the passcode in the following sequence to adjust the reading:
     a. HAND/AUTO
     b. CIP
     c. ALARM BYPASS
   - Press the ARROW keys to set the "Conc Flowrate Offset" to 00.
   - Press ENTER to save the new value.

   The Concentrate Flow Rate Offset is now calibrated.

Calibrating Permeate Flow Rate Offset

NOTE:
It is not necessary to enter the passcode for additional adjustments in the Calibration Menu.

1. Press ENTER until the “Perm Flowrate Offset” is displayed.
2. The “perm Flow Rate Offset” should read 00. If it does not read 00:
   - Press the ARROW keys to set the “Perm Flowrate Offset” to 00.
   - Press ENTER to save the new value.

   The Permeate Flow Rate Offset is now calibrated.

8.7.4 Verifying the Concentrate and Permeate Flow Rate Slopes

Verifying the Concentrate Flow Rate Slope

NOTE:
It is not necessary to enter the passcode for additional adjustments in the Calibration Menu.

1. Press ENTER until the “Conc Flow Rate Slope” is displayed.

2. The “Conc Flow Rate Slope” should read 37. If it does not read 37:
   - Press the ARROW keys to set the “perm Flow Rate Slope” to 37.
   - Press ENTER to save the new value.

The above steps verify the factory default sets for the concentrate and permeate flow rate slopes. The following procedure will calibrate the slopes.

Verifying the Permeate Flow Rate Slope

NOTE:
It is not necessary to enter the passcode for additional adjustments in the Calibration Menu.

1. Press ENTER until the “Permeate Flow Rate Slope” is displayed.
2. The “Perm Flow Rate Slope” should read 37. If it does not read 37:
   a. Press the ARROW keys to set the “Perm Flow Rate Slope” to 37.
   b. Press ENTER to save the new value.
   c. The above steps verify the factory default sets for the concentrate and permeate flow rate slopes.

8.7.5 Calibrating the Concentrate and Permeate Flow Rate Slopes

Calibrating the Concentrate Flow Rate Slope

1. Press ESC twice to return to the ECM-100 default menu.
2. Press the ARROW keys to scroll to the Calibration Menu (06).
3. Press ENTER to select the Calibration Menu.
4. Press ENTER to scroll to the “Conc Flow Rate Slope.”

5. Enter the passcode in the following sequence to adjust the reading:
   a. HAND/AUTO
   b. CIP
   c. ALARM BYPASS
6. While machine is running, compare the concentrate flow rate on the ECM-100 to the bucket test concentrate flow rate measured in Step 8 of Calculating Concentrate Flow Rate (Section 812.2).
7. If the flow rates differ by more than 0.3 gpm (0.07 m^3/H) the "Conc Flow Rate Slope" needs to be adjusted (increased or decreased to reflect the actual flow rate of the bucket test).
8. If the flow rate displayed on the ECM-100 is less than the bucket test the Concentrate Flow Rate Slope setting must be increased. If the flow rate displayed on the ECM-100 is more than the bucket test the "Conc Flow Rate Slope" must be decreased.
   - Press the ARROW keys to increase or decrease the slope by increments of 2 and compare the Concentrate Flow Rate to the bucket flow rate.
   - Press ENTER to save the value.

NOTE:
In order for the ECM-100 to acknowledge the new slope value wait 20 seconds after ENTER is pressed for a new reading.

9. Observe "Conc Flow Rate." If additional adjustment is necessary, repeat Step 8.

It may be necessary to repeat this process several times in order to properly calibrate the concentrate flow rate.

If the flow reading is always low, even with a slope value of 46, refer to ECM-100 Troubleshooting (Section 4.7).

NOTE:
Actual flows tend to fluctuate somewhat normally, so extreme accuracy is often not possible.

Calibrating the Permeate Flow Rate Slope

1. Press ESC twice to return to the ECM-100 default menu.
2. Press ENTER to scroll to the Calibration Menu (06).
3. Press ENTER to select the Calibration Menu.
4. Press ENTER to scroll to the “Perm Flow Rate Slope.”
5. Enter the passcode in the following sequence to adjust the reading:
   a. HAND/AUTO
   b. CIP
   c. ALARM BYPASS
6. While machine is running, compare the concentrate flow rate on the ECM-100 to the bucket test permeate flow rate measured in Step 8 of Calculating Permeate Flow Rate (Section 8.12.1).
7. If the flow rates differ by more than 0.3 gpm (0.07 m^3/h) the Permeate Flow Rate Slope needs to be adjusted (increased or decreased to reflect the actual flow rate of the bucket test).
8. If the flow rate displayed on the ECM-100 is less than the bucket test the Permeate Flow Rate Slope setting must be increased. If the flow rate displayed on the ECM-100 is more than the bucket test the Permeate Flow Rate Slope must be decreased.
   - Press the ARROW keys to increase the slope by increments of 2 and compare the Permeate Flow Rate to the bucket flow rate.
   - Press ENTER to save the value.

NOTE:
It will take 20 seconds after ENTER is pressed for a new reading for the ECM-100 to acknowledge the new slope value.

9. Observe Permeate Flow Rate. If additional adjustment is necessary, repeat Step 8.

It may be necessary to repeat this process several times in order to properly calibrate the concentrate flow rate.

If the flow reading is always low, even with a slope value of 46, refer to ECM-100 Troubleshooting (Section 4.7).

NOTE:
Actual flows tend to fluctuate. Extreme accuracy is not required.

9.0 RETURNED GOODS AUTHORIZATION PROCEDURE

If you wish to return goods for warranty evaluation and/or credit, please have your original sales order, invoice, and device serial number available when you call Mar Cor Purification. Call Mar Cor Purification at (800) 633-3080 and request Technical Support. A 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 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 into a non-hazardous condition prior to shipping.

10.0 SERVICE ASSISTANCE

If service assistance is required, please take the following steps:

1. Consult the troubleshooting section of this manual (Chapter 5). If the problem cannot be identified and corrected by any of the procedures found in that section, then
2. Contact your Facility Equipment Technician. If the technician is unable to help then
3. Call Mar Cor Purification Technical Support Department at (800) 633-3080. Technicians are available for all calls between 7:00 a.m. and 4:30 p.m. CST, Monday through Friday. Technicians are also available at other times for **emergency calls only**. Product consultants will be on hand to discuss the problem with you and endeavor to rectify it over the phone. If the problem appears to be of a more serious nature, you will be given instructions regarding the action to be taken. Prior to making the phone call, you must be prepared to answer two questions:

   What RO do you have; i.e., 23G-6000?

   What is the serial number of your RO? (Label found on side of RO.)

   RO SERIAL NUMBER: _____

11.0 SPARE PARTS LISTS

Valves	**Part Number**
Control Solenoid, Stainless Steel, 3-way, 1/4 inch (Inlet, Diverts Solenoid) 220 Volt, 50 Hz	OS1202126
Control Solenoid, Stainless Steel, 3-Way, 1/4 inch, (Inlet, Diverts Solenoid) 110 Volt, 60 Hz	OS1112563
Sampling Valve, PVC, 1/4 inch, (Feed Permeate and Concentrate)	ME40291
Valve Needle, 316, 1/4 inch MPT, Straight (Concentrate Valve) (Flow Block)	OS1110979
Valve, Actuated, 1 inch Diaphragm Inlet Aquamatic Valve (Non-Spring, Permeate Divert)	OS1225678
Valve, Actuated, 1 inch Diaphragm Divert Aquamatic Valve (Spring, Concentrate)	OS1225680
Inlet Shut-Off Ball Valve, PVC, 1 inch, SOC, MIP	OS1113157
Valve, Sol, Stainless Steel, 1/4 inch FPT, 110 Volt/60 Hz (Autoflush, Flow Block)	OS1153037
Valve, Sol, Stainless Steel, 1/4 inch FPT, 220 Volt /50 Hz (Autoflush, Flow Block)	OS1162324
Valve, Relief, Pressure, Plastic, 0.25 FPT (Permeate Pressure) (2 per machine)	OS1113930
Valve, 1 inch, Aquamatic (Plumbing Inlet)	OS1110643

Prefilters	**Part Number**
Prefilter Cartridge, PPL, 10 inch, 5 micron, GX05-10 (40/ctn) (2 per machine)	ME40063
Prefilter Cartridge, PPL, 20 inch, 5 micron, GX05-20 (20/ctn)(2 per machine)	ME40170
Housing, FLT, PPL, 10.00, Blue, with Pressure Relief (2 per machine)	OS1157219
Housing, FLT, PPL, 20.00, Blue, with Pressure Relief (2 per machine)	OS1110573

6-Channel Remote	**Part Number**
Kit, 6-Channel Alarm Package (base and remote alarm) (complete 6CH) 60Hz	OS1162028
Kit, 6-Channel Alarm Package (base and remote alarm) (complete 6CH) 50Hz	3016119
6-Channel Remote Unit and Cable	OS1162032
Temperature Switch	OS1116319
Pressure Switch, SS, 60 PSI	OS1117699

Flow Block and Connectors	**Part Number**
Kit, O-ring, 0.75 Adjustable Orifice	OS1156745
O-ring, Viton, 110, 70 DUR (Orifice Plunger O-ring)	OS1114311
O-ring, Viton, 115, 70 DUR (Orifice Base O-ring)	OS1113269
O-ring, EPDM, 014, 70 DUR (Orifice Base, Tip O-ring)	OS1143426
Hosebarb, Nylon, 90°, 3/4 inch Hosebarb x 1/2 inch MPT	OS1111835
Hosebarb, Nylon, 90°, 3/4 inch Hosebarb x 1 inch MPT	OS1114832
Hosebarb, Nylon, 3/4 inch Hosebarb, x 1/2 inch MPT	OS1111540
Hosebarb, Nylon, 3/4 inch Hosebarb, x 3/4 inch MPT	OS1111836

Flow Block and Connectors	Part Number
Hosebarb, Nylon, 3/4 inch Hosebarb, x 1 inch MPT	OS1113279
Connector, PPL, 1/4 inch Tube x 1/4 inch MPT	OS1110294
Connector, PPL, 3/8 inch Tube x 1/4 inch FPT	OS1110293
Connector, PPL, 1/4 inch Tube x 1/8 inch MPT	OS1110039
Elbow, PPL, 90°, 1/4 inch Tube x 1/4 inch MPT	OS1110129
Elbow, PPL, 90° 3/8 inch Tube x 1/4 inch MPT	OS1110069
Elbow, PPL, 90°, 1/4 inch Tube x 1/8 inch MPT	OS1110301
Tee, PPL, 3-way, 1/4 inch Tube x 1/4 inch Tube x 1/4 inch Tube	OS1110305
Tee, PPL, 3-way, 1/4 inch Tube x 1/4 inch Tube x 1/8 inch MPT	OS1143153
Tee, PPL, 3-way, 1/4 inch Tube x 1/4 inch Tube x 1/4 inch MPT	OS1110306
Plug, Pipe, Nylon, Square, 1/8 inch MPT	OS1110036
Plug, Pipe, Nylon, Square, 1/4 inch MPT	OS1110519
Plug, Pipe, Nylon, Square 1/2 inch MPT	OS1112653
Plug, Pipe, Nylon, Square 1 inch MPT	OS1111742
Tubing, Polyethylene, .25 inch, Blue	ME60067
Tubing, Polyethylene, .375 inch, Blue	ME60049
Coupling, Delrin, 3/8 inch MNPT x Body (Female Coupling for Permeate Manifold)	OS1162024
Coupling, Delrin, 3/8 inch Tube x Insert (Attaches to P/N OS1162024)	OS1162025

Sensor	Part Number
Sensor, Flow, Hall-Effect, Pickup Cable (Permeate and Concentrate, Cable Only)	OS1156630
Sensor, Flow, Turbine, 1 inch Element (Permeate and Concentrate)	OS1156637
Transducer, Pressure, 0-100 psi (0-6.9 bar), with Cable	OS1158824
Transducer, Pressure, 0-500 psi (0-34.5 bar), with Cable (220 Volt, ECM-100 Controller)	OS1158825
Sensor, pH, Electrode Only (115 Volt, ECM-100 Controller)	1233199
23G pH Option Kit	OS1202592
Sensor, Conductivity, Feed Water, with Cable (Also Senses Feedwater Temperature)	OS1157517
Sensor, Conductivity, Permeate Water, with Cable	OS1157516

Electrical	**Part Number**
PCB Assembly, Main Logic Board, ECM-100 60 Hz	OS1163521
PCB Assembly, Main Logic Board, ECM-100 50 Hz	3013742
PCB Assembly, Relay Board, ECM-100	OS1163520
Motor Starter/Relay Kit, three-phase, 115 Volts (Includes Starter and Relay)	
3.7 - 12.0 Amps	OS1223325
12.0 - 32.0 Amps	OS1223326
Motor Starter/Relay Kit, three-phase, 220 Volts (Includes Starter and Relay)	
3.7 - 12.0 Amps	OS1223328
12.0 - 32.0 Amps	OS1223329
Communication Cable, ECM-100 (Connects ECM-100 to Printer or Computer)	OS1158314
Bracket, Mounting, Enclosure, ECM-100 (4 needed)	OS1202746
Connector, Electrical Cord, ECM-100	OS1116409

Membrane Elements	
Machine Type	Membrane Part Number
23G	OS1229398

WARNING: Installation of membrane elements other than those specified for the machine as shown above can cause premature membrane element failure, may void warranty, and may invalidate 510 (K) acceptance of a specific machine.

4-Inch Housing Spare Parts	**Part Number**
End Cap, Housing, Plastic, SH, HP808A (1 per Housing)	OS1117469
Membrane Element Housing, SH-1/411 (304) 4 Port, Victaulic	OS1157305
Interconnector Kit, 4 inch Membrane Element with O-rings (1 Per Housing)	OS1117167
O-ring, EPDM, Interconnector (Requires 6 O-rings per Housing)	OS1118748
Concentrate Seal, EPDM, U-Cup for 411 Membranes	ME41035
Plug, Interbank, (Requires 1 Interbank O-ring, P/N OS1158675)	OS1156928
O-ring, Interbank, -207, EPDM, 70DUR	OS1158675
ATD for Permeate Plug (1 Per Housing)	OS1117827
(Installed at Bottom of Housing to Support Membrane Element)	
Permeate Plug (1 Per Housing) (Installed on Bottom of Housing)	OS1157934
Victaulic Coupling, Complete with EPDM Gasket, 4 inch	OS1153148
Jaco Fitting Permeate Out 1/2 inch MPT x 3/8 inch (Located on Top of Housing)	OS1110103

Test Kits	Part Number
pH Test Kit, Range 4-10 Standard Units	OS1155478

Clamps	Part Number
Victaulic Coupling, Complete with EPDM Gasket, 3/4 inch	OS1157369
Victaulic Coupling, Complete with EPDM Gasket, 1-1/4 inch	OS1157370
Victaulic Coupling, Complete with EPDM Gasket, 4 inch	OS1153148

Miscellaneous	Part Number
Kit, Expansion, Frame (Required to expand machine from 4 to 10 housings)	OS1158312
Kit, Expansion, Frame, EL (Required to expand to 11 or 12 housings)	OS1159055
Kit, SHA Expansion (Plumbing parts provided to add 1 Stainless Steel Housing, Membranes Extra)	OS1157184
Permeate Pressure Relief Kit	OS1157220
Foot, Self-Leveling, Threaded (Used with 1-1/2 inch or 1-1/2 inch Adapter)	OS1156927
Adapter, 1-1/4 inch, Square (1 Each, Used on Frame Extension Only)	OS1158310
Adapter, 1-1/2 inch, Square (3 Each, Used on “Main” 23G Frame)	OS1158311
Plumbing, High Pressure, Spool Piece, 3/4 x 8-1/4 inch (Used in Front of Concentrate Return Plumbing in place of Housing)	OS1156775
Plumbing, Intermediate, Stainless Steel, 1 inch (U-Shaped Concentrate Crossover Plumbing)	OS1155820
pH Test Kit, Range 4-10 Standard Units	OS1155478
Large Casters (3 required)	OS1160132
Small Casters (1 required with three of OS1160132)	OS1160133
Lexan Cover Replacement	OS1156570

NOTE: Machine expansion may require a change in pump and motor assembly. Contact your equipment supplier.

NOTE: Please provide the Model and Serial number of your machine when calling for information.

Pump and Motor Assemblies (Three-Phase, 60 Hz)

Motor (hp)	23G Model* # of Elements	Pump and Motor Assembly Part Number Voltage			Pump Out Part Number	Overall Length (Center to Center)	Flow Pattern
		(208)	(230)	(460)			
3	2	OS1221460	OS1221461	OS1221462	OS1160151	5.6” (14.2 cm)	1-1
	3	OS1221460	OS1221461	OS1221462	OS1160151	5.6” (14.2 cm)	2-1
	4	OS1221460	OS1221461	OS1221462	OS1160151	5.6” (14.2 cm)	1-1-1-1
	5	OS1221460	OS1221461	OS1221462	OS1160151	5.6” (14.2 cm)	2-1-1-1
	6	OS1221460	OS122146	OS1221462	OS1160151	5.6” (14.2 cm)	2-2-1-1
5	7	OS1221466	OS1221467	OS1221468	OS1158704	17.85” (45.3 cm)	2-2-2-1
	8	OS1221466	OS1221467	OS122146	OS1158704	17.85” (45.3 cm)	2-2-2-2
	9	OS1221466	OS1221467	OS1221468	OS1158704	17.85” (45.3 cm)	3-2-2-2
	10	OS1221466	OS1221467	OS1221468	OS1158704	17.85” (45.3 cm)	3-3-2-2
7.5	11	OS1222528	OS1222530	OS1222531	OS1201028	34.9” (88.6 cm)	3-3-3-2

*23G machine model numbers are designated “OSMO-23G-HR(PA)____”.

Pump and Motor Assemblies (Three-Phase, 50 Hz)					
Motor (hp)	**23G Model* # of Elements**	**Pump and Motor Assembly Part Number Voltage (380)**	**Pump Out Part Number**	**Overall Length (Center to Center)**	**Flow Pattern**
3	2	OS1221470	OS1203384	5.6” (14.2 cm)	1-1
	3	OS1221470	OS1203384	5.6” (14.2 cm)	2-1
	4	OS1221470	OS1203384	5.6” (14.2 cm)	1-1-1-1
	5	OS1221470	OS1203384	5.6” (14.2 cm)	2-1-1-1
	6	OS1221470	OS1203384	5.6” (14.2 cm)	2-2-1-1
5	7	OS1222537	OS1160150	17.85” (45.3 cm)	2-2-2-1
	8	OS1222537	OS1160150	17.85” (45.3 cm)	2-2-2-2
	9	OS1222537	OS1160150	17.85” (45.3 cm)	3-2-2-2
	10	OS1222537	OS1160150	17.85” (45.3 cm)	3-3-2-2

Pump and Motor Assemblies (Three-Phase, 50 Hz)					
Motor (hp)	**23G Model* # of Elements**	**Pump and Motor Assembly Part Number Voltage (380)**	**Pump Out Part Number**	**Overall Length (Center to Center)**	**Flow Pattern**
3	2	OS1126238	OS1203384	5.6” (14.2 cm)	1-1
	3	OS1126238	OS1203384	5.6” (14.2 cm)	2-1
	4	OS1126238	OS1203384	5.6” (14.2 cm)	1-1-1-1
	5	OS1126238	OS1203384	5.6” (14.2 cm)	2-1-1-1
	6	OS1126238	OS1203384	5.6” (14.2 cm)	2-2-1-1
5	7	OS1126246	OS1160150	17.85” (45.3 cm)	2-2-2-1
	8	OS1126246	OS1160150	17.85” (45.3 cm)	2-2-2-2
	9	OS1126246	OS1160150	17.85” (45.3 cm)	3-2-2-2
	10	OS1126246	OS1160150	17.85” (45.3 cm)	3-3-2-2

Pump and Motor Assemblies (Single-Phase, 60 Hz)					
Motor (hp)	**23G Model* # of Elements**	**Pump and Motor Assembly Part Number Voltage**	**Pump Out**	**Overall Length (Center to Center)**	**Flow Pattern**
		(230)	**Part Number**		
3	2	OS1221459	OS1223706	7.9” (17.5 cm)	1-1
	3	OS1221459	OS1223706	7.9” (17.5 cm)	2-1
	4	OS1221459	OS1223706	7.9” (17.5 cm)	1-1-1-1
	5	OS1221459	OS1223706	7.9” (17.5 cm)	2-1-1-1
	6	OS1221459	OS1223706	7.9” (17.5 cm)	2-2-1-1
5	7	OS1221465	OS1223741	22.41” (49.3 cm)	2-2-2-1
	8	OS1221465	OS1223741	22.41” (49.3 cm)	2-2-2-2
	9	OS1221465	OS1223741	22.41” (49.3 cm)	3-2-2-2
	10	OS1221465	OS1223741	22.41” (49.3 cm)	3-3-2-2

*Pumps and motor assemblies manufactured prior to February 2000 used different pump and motor assemblies than shown above due to a change in actual motor size. Contact your equipment supplier for assistance with ordering the correct item(s).

NOTES:

Call **(800-633-3080)** for additional information or visit **www.mcpur.com.**

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FAX: 952-988-6661