SIEMENS

Operation and Maintenance Manual

Vantage™ Reverse Osmosis Systems

M83 Series

Model # **[Model No]**
Serial # **[Serial No]**

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CAUTIONS AND WARNINGS

Prior to operating or servicing this device, this manual must be read and understood. If something is not clear, call for assistance before proceeding. Keep this and other associated manuals for future reference and for new operators or qualified service personnel.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, as well as local codes and regulations.

To avoid electrical shock hazard, do not remove covers or panels when power is supplied to the device. Do not operate the device when covers or panels are removed.

WARNING **A faulty pump motor or wiring can be a serious shock hazard if it or surrounding water is accessible to human contact. To avoid this danger, DO NOT remove any grounding wire from the system.**

DISCLAIMER STATEMENT

This operation and maintenance manual is intended to be used with the component manufacturer literature provided in the Appendix. These manuals should provide complete and accurate information to meet your operating and/or service requirements based on the information available at the time of publication. However, Siemens Water Technologies assumes no responsibility for the technical content of the manufacturer literature.

This manual should be read fully and understood before installation, operation or maintenance of the system is attempted. The information in this manual may not cover all operating details or variations or provide for all conditions in connection with installation, operation and maintenance. Should questions arise which are not answered specifically in this manual, contact the Siemens Water Technologies Technical Support Department at the phone number provided on the cover of this manual.

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MANUAL USER'S GUIDE

This manual describes the procedures necessary to install, operate, and maintain your Siemens Water Technologies equipment. Please read this manual carefully before installing and operating it. The equipment warranty may be voided if installation or operation instructions are not followed correctly.

Warnings, Cautions, and Notes are used to attract attention to essential or critical information. Warnings and Cautions will appear before the text associated with them, and notes can appear either before or after associated text.

WARNING **Warnings indicate condition, practices, or procedures which must be observed to avoid personal injury or fatalities.**

CAUTION **Cautions indicate a situation that may cause damage or destruction of equipment or may pose a long term health hazard.**

NOTE: *Notes are used to add information, state exceptions, and point out areas that may be of greater interest or importance.*

EQUIPMENT SUPPORT

Siemens Water Technologies continually strives to provide safe, efficient, trouble-free equipment using the optimum technology for your application. If problems should develop, Siemens Water Technologies's worldwide network of technical support will be available to provide assistance. For service, sales, parts, or additional manual copies call your area representative or Siemens Water Technologies, Technical Support Department at the number provided on the cover of this manual.

GENERAL SAFETY GUIDELINES

WARNING **This equipment operates at high voltage and high pressure, has moving parts and hazardous chemicals that may cause serious injury or fatality if not operated and maintained according to the procedures outlined in this manual.**

A. No one should use or service this equipment without proper training and supervision. It is the responsibility of the owner to ensure that this equipment is used properly and safely, strictly following the instructions contained herein.

a. Remain alert at all times during the operation of this equipment. Do not get near this equipment if you are drowsy or impaired in any other way.

b. Always wear safety equipment (safety glasses, gloves) for protection while working on the equipment.

c. Refer to Material Safety Data Sheets prior to handling hazardous chemicals.

d. Always operate the equipment at the parameters specified.

e. Never connect the system to piping that has not been approved by Siemens Water Technologies. If there are any doubts, please call your local branch.

f. Never remove any components from the unit while under pressure.

g. No one under the age of 18 years of age should operate or be allowed near this equipment.

h. Warning labels have been placed on the equipment to remind the operator of certain hazards. Never remove these labels. If any warning label is illegible or missing, please contact us for a free replacement.

i. Proper maintenance assures the equipment will run properly and can lower the risk of injury. Be sure to follow the instructions on maintenance carefully.

j. Be sure to maintain all equipment, tools and sub-systems used with the equipment.

k. Continuously inspect the system for leaks and damage. Correcting problems as they occur will help prolong the life of the system.

l. Use Lock-Out and Tag-Out devices when servicing the unit.

m. This manual should be used as a guidance tool and should not replace common sense. If you are unsure about a procedure, ask your supervisor. Siemens Water Technologies welcomes any questions you may have. We can arrange to provide on-site training if necessary.

SAFETY PRECAUTIONS

The purpose of this manual is to provide the user with the necessary information to operate this equipment without undue risk. Failure to follow the instructions laid forth in this manual may put the operators at risk of injury and possible fatality. Please read this entire manual before beginning any procedure. This Operations and Maintenance Manual should remain with the equipment at all times, to act as a ready reference guide for anyone who operates this equipment.

SAFETY EQUIPMENT

Below is a list of equipment and materials that should be kept nearby the equipment. The equipment is the bare minimum required to maintain a safe working environment.

n. Lock-out and Tag-out devices for servicing and shutdowns.

o. Eyewash/safety shower for any chemical accidents.

p. Safety glasses are to be worn at all times.

q. Earplugs should be worn when encountering high levels of noise.

r. Gloves that offer protection from the chemicals used herein.

s. Steel toe work boots for protection against heavy equipment and components.

1.0 INTRODUCTION

1.1 GENERAL SYSTEM DESCRIPTION

The purpose of this section is to introduce the user to the equipment. A thorough understanding of the equipment will help when installing, testing, and operating the system. Refer to the drawings supplied in the Appendix for further clarification.

This product series utilizes 300 psi, ASME coded, Protec RO housings, Filmtec membranes, and a Grundfos CRN series pump. There are three different model packages within this RO series. These are described below.

A. Economy

The Economy model utilizes an MC-10 controller and rotameters for flow on the product, reject, and reject recycle lines.

B. Plus

The Plus model utilizes a Siemens S7-200 Series PLC controller with a Siemens TP 177A 6" monochrome touch screen HMI or an Allen-Bradley MicroLogix 1100 controller with an Allen-Bradley PVC600 6" color touch screen HMI. The inlet and reject flows are Signet paddlewheels connected directly to the PLC for the Siemens controls and connected to the multi-parameter analyzer for the Allen-Bradley controls. Product flow is calculated and reject recycle is measured with a rotameter.

C. Deluxe

The Deluxe model also utilizes a Siemens S7-200 Series PLC controller with a touch screen HMI or an Allen-Bradley MicroLogix 1100 controller with a touch screen HMI. The RO pump is controlled by a Siemens variable frequency drive (VFD). The inlet and reject flows are Signet paddlewheels connected directly to the PLC for the Siemens controls and connected to the multi-parameter analyzer for the Allen-Bradley controls. Product flow is calculated and reject recycle flow is measured with a rotameter. This model also contains an on-board CIP system. A loose shipped chemical CIP tank and hoses are combined with the RO VFD controlled pump and RO filter housing to provide the on-board cleaning system.

1.2 THEORY OF REVERSE OSMOSIS

Water

Water exists in nature as a pure substance, but typically not in pure form. Many substances will readily combine with water. When water comes into contact with these substances they either become dissolved solids, such as minerals, gases and organic compounds or they become suspended solids such as clay, silt and micro-organisms.

Dissolved Solids

Mixtures containing dissolved solids are commonly called solutions. Solutions form when a solute material, such as salt (sodium chloride), becomes dissolved in a solvent, such as water.

When a particle of salt contacts water, the salt disintegrates and spreads evenly throughout the water until the salt as a solid no longer exists. The salt molecules are still present, but they now exist in a liquid phase as part of the solution and are now referred to as dissolved ions. These ions carry either a positive or negative electrical charge, and will hereby be referred to as cations if they carry a positive charge and anions if they carry a negative charge.

Suspended Solids

Suspended solids, materials that do not dissolve in a solvent, exist as unevenly distributed particles in a mixture. Suspended solids larger than 5 microns are filtered out by the cartridge filters prior to the reverse osmosis membrane elements.

Ionic Content and Water Quality

The presence of ionic material (dissolved solids) in a solution increases the solution's conductivity, or the ability to conduct electricity. Consequently, the use of a conductivity measurement device may be used as a means to approximate the amount of dissolved solids in a solution. The higher the conductivity potential of the solution, the higher the dissolved solids content will be. Unfortunately, the presence of dissolved and suspended solids may be detrimental to many water based operations, such as the production of steam for power generation, the rinsing of electronics components after manufacturing, and the preparation of food and pharmaceutical materials, just to mention a few. Consequently, these dissolved and suspended solids must be removed from the water prior to use in these and many other applications. One effective method of removing the majority of these contaminants is referred to as Reverse Osmosis.

Osmosis

Osmosis is a natural phenomenon that occurs when two solutions with different concentrations of dissolved solutions are separated by a SEMI-PERMEABLE MEMBRANE. In natural osmosis, the solvent or water in this application travels through the membrane from the solution with the lower concentration of ionic materials to the solution with the higher ionic concentration. This process continues until the ionic concentration of both solutions is equal or until the resultant passage of the water through the membrane reaches the *osmotic pressure* of the solution if the solutions are trapped in a container.

Reverse Osmosis

Reverse Osmosis is the reversal of this natural phenomenon, by the application of external pressure on the solution that contains the higher concentration of dissolved ions, thus forcing water through the semi-permeable membrane in the opposite direction, leaving behind the dissolved ions and the suspended solids. In the Reverse Osmosis process, the water that passes through the membrane is commonly referred to as permeate, or product, water. The water that remains behind the membrane along with the dissolved and suspended solids is referred to as the reject, brine, or reject water.

The table below gives some approximate osmotic pressure values as an example of how much pressure must be applied to the solution with a greater ionic concentration before any water will pass through a membrane into a solution containing a lesser ionic concentration.

SODIUM CHLORIDE CONC.	APPROX. OSMOTIC PRESSURE
100 PPM	1 PSIG

1,000 PPM	11 PSIG
10,000 PPM (brackish water)	110 PSIG
35,000 PPM (sea water)	350 PSIG

It is impractical to convert all of the water processed to product water for several reasons including the osmotic pressure which develops as a result of the concentration of the dissolved ions which accumulate on the one side of the membrane, and the inability to keep the membrane free from suspended solids that would foul the surface of the membrane if not removed.

The rate of product water passage (or productivity) through the membrane is referred to as the flux rate and is generally expressed in "gallons per square foot of membrane surface per day" or in "gallons per day per reverse osmosis cartridge". The flux rate of a particular membrane is generally limited by several factors including: temperature, operating pressure, and the surface flushing action to keep the membrane surface free of suspended solids.

The rate of recovery of feed water converted into product water is generally expressed in the form of a percentage, with the ratio of product water being expressed as the recovery rate. For example if the feed flow rate to the RO unit is 200 GPM and the product rate from the RO unit is 150 GPM the rate of recovery would be expressed as 75%. The remaining 50 GPM did not pass through the membrane. It is referred to as the reject water and would be discarded (i.e., not recovered).

Membrane rejection is an expression of the ability to restrict the passage of dissolved ions through the membrane, and is generally expressed as a percentage. That is, if the feed water to the membrane contains 100 PPM of dissolved solids, and the resulting product water contains only 2 PPM of dissolved solids after processing, the resultant dissolved ions rejection rate is 98%. The opposite of this expression is also sometimes used and is known as the salt passage rate, which, for our example, would equal a rate of 2%. A membrane rejection rate of 100% is not practical due to imperfections in the membrane and the construction of the membrane element.

Practical Applications

Reverse osmosis becomes practical for water treatment when synthetic, semi-permeable membrane material is packaged in a suitable membrane element. Typically the elements are constructed of one of two classifications of membrane material, acetate/triacetate or polyamide. These materials are then arranged into one of two element configurations; hollow fiber or spiral wound. Selection of the membrane material and element configuration are based on numerous factors including water chemistry, space limitations, product water quality requirements and system pre-treatment design. For this discussion, only the spiral wound element configuration will be described, based on the design of the RO unit covered by this Manual.

The spiral wound membrane configuration is constructed from a flat sheet membrane that is first folded and sealed to form an envelope with one opened end. Porous backing material, placed inside the envelope separates the membrane sheets and forms a flow channel between them. The opened end of the envelope is then attached and sealed around a plastic product tube that is perforated, which allows the product water, or permeate, to pass into the product tube.

For compactness, the envelope of membrane material is then wrapped around the product tube in a spiral wound fashion with a coarse plastic screen, referred to as a brine channel screen, being

included in the wrap, which creates a flow channel between the surfaces of the membrane where the feed water enters the element and the reject, or brine flow, passes out of the element. The element is then covered with an outer wrap of semi-rigid fiberglass for protection and to assist in maintaining a uniform round shape. The final dimensions of the element are usually approximately 40" long by either 4" or 8" in diameter.

The elements are then put into one or more cylindrical pressure vessels, which can contain one to six membrane elements depending on the unit design.

Pressurized feed water is introduced into one end of the vessel. Some of the water, driven by the feed pressure through the RO pressure vessel feed port, permeates through the membrane and passes into the product tube and exits the pressure vessel from the pressure vessel product port as product water, less most of the dissolved solids and all of the suspended solids. The remainder of the water passes along the surface of the membrane with the rejected dissolved and suspended solids and passes out of the pressure vessel as reject, or reject flow, from the pressure vessel reject port.

The pressure vessels are generally arranged in stages when more product water is desired than one vessel can produce. The staging of the vessels is designed to optimize the water flow patterns across the surface of the membranes. This uniform water flow promotes good flushing velocity across the membrane surface to prevent the accumulation of suspended solids on the surface which would then foul the membrane and reduce the productivity. Multiple stages are referred to as arrays.

A simple example of an array would be a unit containing three vessels, with two vessels plumbed in parallel in the first stage and the third vessel plumbed in series after the first two vessels in the second stage. In this case, the feed water to the unit is first split into two streams with each half being directed into one of the first stage vessels. On entering these two vessels, some product water is produced from each and collected from the two pressure vessel product ports, which are connected together outside of the pressure vessel in a common product water header. The water that is not recovered is passed out of the vessels as reject, along with the dissolved and suspended solids. This water is then collected into a common first stage reject header (or reject header) and directed to the feed of the third vessel which is plumbed in series behind the first two vessels, where the process is again repeated. The second stage product is added to the first stage product. The second stage reject is directed through a control valve and disposed of along with most of the dissolved and suspended solids.

Recovery Limitations

As previously described, product recovery is the ratio of water volume recovered as product water compared to the volume of water supplied to the RO unit as feed water. Naturally, in an ideal situation you would like to recover all of the water, but this is not practical for several reasons as described below.

If all of the water that was processed were converted to product water, there would be no water available to flush the membrane surface area free of remaining suspended solids. Consequently, the suspended solids would build up on the surface of the membrane and gradually restrict the flow of product water until no permeate or product water could be produced.

The presence of some dissolved solids such as silica, barium, strontium or calcium and magnesium when present with carbonate or sulfate ions restricts the recovery of an RO unit more than other dissolved solids, due to their limited solubility in water. For example, the presence of silica (SiO_2) in the feed water is often times the limiting factor in RO recovery, because it starts to precipitate out of solution when it reaches a concentration of 100-120 PPM. That means that if the feed water contains 30 PPM of SiO_2 then the recovery of product water is limited to about 75%, because the SiO_2 concentration will be increased by 4 times which will result in a silica concentration in the RO reject of approximately 120 PPM which is the limit of it's solubility. If you tried to recover 80% of the water, the concentration of SiO_2 would reach 5 times the feed water concentration or approximately 150 PPM and start to precipitate, fouling the membrane surface.

1.3 MECHANICAL COMPONENT DESCRIPTION

The major mechanical components that make up the RO unit are described below.

Automatic Feed Water Control Valve
An automatic valve is mounted in the RO unit feed piping. This valve will shut off flow to the unit when it shuts down. A solenoid valve mounted on the Control Panel controls the operation of this valve. The solenoid requires 80 PSIG instrument air from an external source.

Feed Pressure Gauge
The line pressure on the filter inlet and outlet are displayed on a 0-100 PSI pressure gauge. The gauge has a 100mm stainless steel case, and is constructed of all stainless steel wetted parts and is glycerin filled.

Pre-filter
This RO unit has a 5 micron RO pre-filter to assist in protecting the membranes. The housing is fabricated from 304L stainless steel and is designed to receive cartridges with DOE connections. A 4R x 3H (4 filters, 30" high) is utilized on the 30, 45, and 60 gpm units. A 7R x 3H is utilized on the 75 and 100 gpm units.

High Pressure Pump
The RO unit has a Grundfos CRN series high pressure booster pump mounted to the frame to boost the feed water to the required operating pressure for the reverse osmosis membranes. The pump is a vertical multi-stage type with stainless steel construction of all wetted parts. The Deluxe model high pressure pump motor is driven by a Siemens Variable Frequency Drive to conserve energy and to provide the necessary flow rates for CIP. The pump is designed to provide the pressure and flow necessary to operate the system.

Low Feed Pressure Switch
A low feed water pressure switch is provided to protect the pump. It is adjusted to shutdown the RO unit if the inlet feed water pressure drops below the setpoint. The switch is wired through a delay timer to allow short pressure drops such as those that occur when the pump starts up.

Pump Discharge Throttling Valve
The water discharged from the high pressure pump is regulated by a stainless steel ball valve on the

Economy and Plus models. The Deluxe model utilizes this valve as an open/closed valve for CIP. By adjusting the position of the valve, you can regulate the flow and pressure feeding the first stage pressure vessels of the RO unit. The valve is also equipped with a locking device, which must be used to maintain correct valve position.

Pump Discharge Pressure Gauge
The outlet pressure from the high pressure pump is displayed on a 0-400 PSI pressure indicator. This gauge has a 63mm stainless steel case, and is constructed of all stainless steel wetted parts, and is glycerin filled.

Pump Discharge Pressure Switch
A high discharge pressure switch is provided to protect the downstream components of the system from excess pressure and to minimize pressure relief discharges. It is adjusted to shutdown the RO unit immediately if the pump discharge pressure exceeds the setpoint.

Pressure Relief Valve
The high pressure, 316 SST trimmed relief valve is ASME code stamped and sized to protect the RO Pressure Vessels from over-pressurization.

High Pressure Manifold
The pressurized feed water is piped through 316L stainless steel high pressure manifolding. The manifold is constructed of butt welded Schedule 10 fittings and pipe. The manifold sections are joined by flexible couplings and flanges. The manifold sections are designed to accommodate future expansion of the system with minimum rework.

Reverse Osmosis Pressure Vessels
The RO unit has 8" round, ASME Code Stamped pressure vessels mounted to the frame. The vessels are constructed of fiberglass. The side ported vessels are close coupled to reduce manifolding. The inlet and outlet connections are 316L stainless steel with groove type connections.

Reverse Osmosis Membrane Elements
The RO unit is designed for 8" x 40" reverse osmosis membrane elements housed in pressure vessels on the frame. The standard elements are constructed of Thin Film Composite (TFC) membrane material. The membranes are designed to reject over 98% of the dissolved solids and over 99% of the suspended solids and organic material.

Reject Throttling Valves
The reject flow back pressure is regulated by two globe valves. One allows flow to recycle back to the inlet while the other sends flow to drain. These valves are used to control the differential pressure across the membrane surface which in turn regulates the recovery rate of the system.

Interstage Pressure Gauge
The inter-stage pressures and the final reject line are displayed on 0-400 PSI pressure gauges. The gauges have a 63mm stainless steel case, are constructed of all SST wetted parts, and are glycerin filled.

Feed & Product Piping
The feed and product piping for this RO unit are Schedule 80 PVC.

Sample Valves
There is a sample valve on the product line of each pressure vessel. These valves provide an opportunity to analyze the product water flowing from each pressure vessel. The locations of these valves permit the operator to isolate the product water of a vessel from that of all other vessels.

There is a sample valve on the common product line of the RO. This valve provides an opportunity to analyze the final combined product water flowing from the RO membranes.

1.4 ELECTRICAL COMPONENT DESCRIPTION

Motor Starter Panel (Economy)
The frame mounted Motor Starter Panel is UL/cUL listed. It houses the main disconnect switch, solenoid valves, and soft-start motor starter. The door of the Motor Starter Panel contains the disconnect switch handle and the flow monitor.

Main Control Panel (Plus and Deluxe)
The frame mounted Main Control Panel is UL/cUL listed. It houses the main disconnect switch, PLC, solenoid valves, and soft-start motor starter (Plus model only) or variable frequency drive (Deluxe model only). The door of the Main Control Panel contains the disconnect switch handle, emergency stop pushbutton, the alarm horn, alarm indicator light and the HMI terminal.

COMPONENT DESCRIPTION

Fused Disconnect
The main disconnect switch for the Control Panel is a Fused Disconnect Switch. This switch serves as the main power disconnect to the Control Panel.

Motor Controller
A Siemens Model MM430 VFD (460 VAC) or MM440 (575 VAC) is provided for speed control of the RO Pump on the Deluxe model. The Plus model is equipped with a standard motor starter.

Programmable Logic Controller (PLC)
A Siemens S7-200 or Allen-Bradley MicroLogix 1100 PLC is provided for machine control on the Plus and Deluxe models.

Human Machine Interface (HMI)
A Siemens TP177A Monochrome Touch Panel or Allen-Bradley PanelView Component C600 HMI is provided for operator interface on the Plus and Deluxe models.

Flow meters (Plus and Deluxe models only)
There are two flow sensors on the RO unit. They will display the flow rates for the feed and reject flows on the HMI terminal. The flow sensors are Signet model 2536 paddlewheel flow sensors. The RO Product Flow is also calculated as the feed flow minus the reject flow and displayed on the HMI.

% Rejection Monitor
A percent rejection monitor is provided to indicate the overall system rejection of dissolved solids in the feed water. The monitor will alarm if the product water quality is out of limits for more than 1 minute. The unit will shut down on low quality if it is out of limit for 5 minutes. The 4-20mA outputs from the monitor are wired to terminals for data acquisition if required. This parameter is also displayed on the HMI.

Alarm Horn
An alarm horn is mounted on the door of the Control Panel to give an audible warning during an alarm status condition.

1.5 FUNCTIONAL DESCRIPTION

The Reverse Osmosis (RO) Unit may be started or stopped from the MC-10 / HMI Terminal. The RO Unit is designed to run continuously as necessary unless there is a fault condition as identified in the Alarm Chart. Optional valves may be provided in the RO Permeate piping to direct flow based upon system operation. Equipment operating status and valve positions are defined in the Operating Sequence Matrix.

The RO Unit has three (3) main modes of operation; Off, Service, and Standby. These operating modes are further defined as follows.

Off

The RO Unit has been stopped by the operator.

Service

Service mode is defined as the RO has finished performing the Quality Rinse (described below) and there is a call for water. The RO Unit has several run permissives that must be satisfied before it may be started. They are identified as follows:

1) The RO Unit is started.
2) The Pretreatment Lockout is satisfied.
3) RO Feed water Pressure is adequate as measured by PSL-03.
4) The RO is not faulted.

The RO Unit will perform a Pre-Service Flush and Quality Rinse prior to entering the Service mode of operation. Refer to the Operating Sequence Matrix for valve positions and equipment operating status during these steps.

The RO High Pressure Pump, PU-01, is off during the Pre-Service Flush. The inlet feed water valve, FV-01, is opened and flush water is directed across the RO membranes to drain via valve FV-02. The feed water pressure to the pump must satisfy the feed water low pressure switch, PSL-03, for 30 seconds before the Pre-Flush is considered complete. An alarm is provided in the event that the pressure is not satisfied. Refer to the Alarm Chart further detail.

The RO High Pressure Pump is turned on after the Pre-Service Flush. The RO Unit enters the "Quality Rinse" phase whereby the low quality alarm contact is monitored and required to show good quality for a period of sixty (60) seconds before the RO may enter either the Service or Standby mode. RO Permeate water may be diverted during this period if the optional RO permeate valves are installed. An alarm is provided in the event that the RO unit does not meet the quality set point within one minute. The RO Unit is shutdown in the event that the quality is not met after 5 minutes. Refer to the Alarm Chart for further details.

Once quality has been met at the outlet of the RO, the customer's need for water is evaluated. If the customer is requiring water from the RO, the RO enters the Service mode. In this mode, the optional Product Service Valve FV-03 is opened. Five (5) seconds later, the optional Product Divert Valve FV-04 is closed. Water is sent to the customer until either the call for water is no longer true or there is a system fault.

The RO Unit will continue to run unless it is turned Off, the call for water is removed, or one of the run permissives listed above is not satisfied.

The shutdown sequence for the RO is as follows:

1) The RO Unit is requested to stop.
2) The RO High Pressure Pump shuts off immediately and the Shut Down Flush timer is started.
3) The feed water inlet valve, FV-01, remains open and the Concentrate Bypass Valve FV-02 is opened. The optional Product Divert Valve, FV-04, is opened and the optional Product Service Valve FV-03 is closed.
4) At the end of the Shut Down Flush sequence all solenoid valves are de-energized.

Standby

Standby mode is defined as the RO has finished performing the Quality Rinse (described above) and there is not a call for water. If the RO remains in this mode for a preset time, as entered from the HMI terminal (Plus and Deluxe models only), it will enter a Standby Flush for a preset amount of time. The factory standard times for Standby and Standby flush are 120 minutes and 5 minutes respectively. Refer to the Operating Sequence Matrices for further details.

CIP Support (Deluxe model only)

The RO pump is used during cleaning operations. RO membrane cleaning is a manual operation requiring chemicals to be added to the CIP tank and mixed with water. Hoses are utilized to direct the cleaning agents across the various membranes as necessary. The RO may be cleaned one vessel at a time or up to three vessels at a time.

A screen is provided on the HMI terminal for RO cleaning. The operator selects the cleaning mode as either 1, 2, or 3 vessels. The flow rate control for the VFD controlled pump is varied depending upon the number of vessels to be cleaned in a parallel fashion. Proper flow rates are automatically entered depending upon the number of vessels to be cleaned. The flow rates are adjustable from the HMI in the event that they need to be revised based upon actual conditions.

Once the hoses are properly connected and the proper number of vessels is selected, then the operator may start the RO pump from the HMI screen and the pump will maintain the required flow rate until commanded to stop or if there is a low flow condition. There is only one alarm associated with the cleaning process. The feed flow to the pump must be at least 20 GPM or the pump will be stopped and a low flow alarm will be generated. Reference the Alarm Chart for further detail.

MC-10 Controller (Economy models only)

There are only two levels of security. The default level does not require any operator login. A user must input the access code in order to make any changes to the system (Password factory set as 12345).

HMI Functionality (Plus and Deluxe models only)

The HMI terminal is provided with several screens for control of the RO System. There are only three levels of security. The default level does not require any operator login. The default operator may view operation only. Login and Logout buttons are located on the Main Screen along with navigation buttons to the other operating screens. A user must be logged in as either "OPER" or "ADMIN" in order to make any changes to the system (Password factory set as follows: Oper 1111, Admin 725).

A complete description of the HMI screens and their functions is contained in the Controls Write-up (specific to the controls package selected – Siemens or Allen-Bradley) attached as an appendix to this manual. Please refer to the attached controls documents such as the Controls Write-up, Operating Sequence Matrix (OSM), and the Alarm Chart for more specific details on system operation.

2.0 INSTALLATION

The purpose of this section is to provide general information on installation of new equipment. All equipment must be installed according to applicable codes. Refer to the Equipment Specification drawing supplied in the Appendix to ensure there is adequate support and clearance around the RO unit.

Installation of the RO unit consists of the following steps:

1. Uncrate and move the unit to the installation site.
2. Anchor the skid to the foundation.
3. Install the feed, product and reject plumbing lines.
4. Connect the electrical high voltage power wiring.
5. Connect air supply to regulator feeding the solenoid valves.
6. Install any pre-treatment equipment and interlock to RO unit.
7. Install any post-treatment equipment and/or storage tank and interlock to RO unit.

2.1 REQUIRED TOOLS AND PARTS

The tools and parts specified in this section are the bare minimum required to install the RO unit at the site. The use of other tools and parts may be necessary, depending on the location chosen and other parameters.

Required Tools
Lock-Out/Tag-Out equipment
safety glasses, gloves, earplugs
moving equipment
hammer drill with masonry bit
pipe cutting, bending, gluing equipment
electrical multi-meter

Required Parts
concrete anchor bolts (size determined by local seismic calculations).
plumbing and electrical materials as required
regulated air supply line
product pressure relief valve (supplied with product divert kit if procured)

2.2 EQUIPMENT INSTALLATION GUIDELINES

1. All lifting and moving procedures must be performed by experienced construction workers using standard rigging methods.

2. Before beginning any equipment handling procedures, refer to the appropriate sections in the Occupational Health and Safety Administration (OSHA) manual #2206: "General Industry Standards." Also, refer to any other applicable literature and information for cranes, lift trucks, and other equipment used for lifting and moving.

WARNING **Damaged lifting devices can fail in service and cause severe personal injury and/or equipment damage. Never use slings or cables that are cut, frayed or kinked. Refer to OSHA manual #2206 for information on inspecting lifting devices for damage.**

3. Make sure all equipment used for lifting and moving is properly maintained and is in good repair.

4. Be sure that components being lifted are balanced and will not tip or slip out of the lifting device.

5. When moving components with a forklift, be careful not to damage components.

6. Avoid "ramming" the lifting forks under pieces; use a crane or pry bar to lift the piece up enough to drive the forks under.

2.3 EQUIPMENT INSTALLATION PROCEDURES

1. Locate a level, flat, clean, hard surface, capable of supporting the weight of the RO unit. Refer to the Equipment General Arrangement Drawing to determine the floor loading requirements and the service access space requirements for the unit.

NOTE: *This area should have a local floor drain to carry away water which will fall to the floor during operation, testing, and servicing this equipment.*

2. Lay out the area that the RO System will occupy.

WARNING **Improper handling procedures can damage equipment and/or cause possible injury or fatality.**

3. Move the RO unit to the location laid down in the previous step.

WARNING **Safety equipment should be worn at all times to avoid personal injury while securing equipment.**

4. Drill holes in the pad through the frame tie down holes.

5. Level the RO unit by installing shim stock under the frame near the frame tie down holes.

6. Install the anchor bolts and secure the frame to the anchor bolts using flat washers, lock washers, and nuts.

WARNING **Do not use the RO unit to support external piping. All plumbing runs should be supported per manufacturers' recommendations and local codes.**

7. Install the feed water plumbing line. The plumbing runs should never be smaller than the actual RO inlet pipe size, and may need to be larger for pipe runs over 50 feet.

NOTE: *The plumbing materials should be of non-corroding materials (PVC, SST, etc.) Use of this material will reduce the tendency to foul the membranes from metal precipitation.*

8. Install the product water plumbing line. For the Auto Flush feature, two automatic valves should be installed in this line near the storage tank. (See P&ID) This will allow the RO unit to rinse the piping to drain during start-up.

NOTE: *If this feature is used, install a pressure relief valve between the RO and the automatic valves. Also it is recommended to install a manual divert to drain line for use during cleaning cycles.*

9. Install the reject line directly to an open drain.

NOTE: *As a general rule, no valves should be installed in this line. If necessary, install a relief valve set at no greater than 5 PSIG. The valve should be directed to a visible drain so relief is obvious.*

If the reject drain is below the level of the RO unit, install a vacuum breaker valve or open pipe leg on the reject line. This will prevent siphoning of all water out of the RO unit during shutdown.

10. Install a tank level sensing device with an adjustable deadband. We recommend a pressure switch with inches of water scale. The deadband will prevent frequent start/stop action of the system during run time.

11. Connect a regulated air supply to the inlet port of the regulator on the upper left side of the Control Panel or Power Distribution Panel. The air pressure needs to be 80 to 100 PSIG and capable of flowing 2 SCFM.

The plumbing installation should now be complete. Check the plumbing to ensure all joints are properly connected and supported.

Electrical Installation

WARNING **The following steps consist of electrical work to be performed by a qualified electrician only.**

1. Employ a Lock Out Device and Lock Out Tag on the RO unit disconnect switch, located

on the front of the Control Panel. Do not energize the main power at this time.

CAUTION **Support all conduit runs per local code requirements and to the conduit manufacturers' recommendations. Improperly supported lines could cause equipment failure.**

2. Run electrical conduit for the high voltage power supply between the Control Panel and the main power supply.

3. Run electrical conduit between the Control Panel and any pre-treatment equipment lock-out relays. ***If there is no pre-treatment equipment in the system, a jumper must be installed on the terminals in the Control Panel for the pre-treatment lockout function.*** Refer to the electrical schematic drawing in the Appendix for terminal numbers. The unit will not run without this jumper.

4. Run electrical conduit between the Control Panel and the product water storage tank level sensing device.

5. Run electrical conduit between the Control Panel and any chemical injection pumps. Terminals are provided in the Control Panel for 120 VAC power to chemical injection pumps. The three different chemical pumps are energized at different times so care must be taken to terminate the pumps on the correct terminals. Refer to the electrical schematic drawing in the Appendix for the proper terminal numbers.

6. Verify that all electrical connections are secure and wired per the electrical schematic.

7. Remove the Lock-Out / Tag-Out equipment from the main power supply for the RO unit, and energize the circuit.

8. Verify that the voltage supplied is correct and matches the Voltage Identification Tag on the pump motor and inside the Control Panel.

3.0 OPERATION

3.1 INITIAL STARTUP

The following procedure should be performed for the initial startup of the RO System or to restart the system if it has been idle and secured for a long term shutdown.

Required Equipment and Materials
Lock-Out and Tag-Out equipment
Personal safety equipment, such as safety glasses and gloves
Prefilter cartridge elements
Portable TDS monitor
Chlorine test kit
Portable pH meter

Pre-Startup Checklist:

1. Verify that the RO System is selected as off.
2. Confirm the storage tank is ready to receive water and the drains are all clear.
3. Check to ensure there are no repairs or service in progress to the RO unit or down stream equipment.
4. Verify that the valves on the RO unit are set up correctly.
5. Verify the pre-treatment equipment is on-line and ready to supply the RO unit.
6. Test the water quality (TDS, chlorine, temperature, pH) to verify it is within the limits of the membrane elements. Refer to membrane literature in appendix if necessary.
7. If the RO membranes were not installed at the factory, they need to be installed now, before proceeding with the start up. Refer to Section 4.3 for loading instructions.

3.2 PRE-START, LOW PRESSURE SYSTEM FLUSHING

CAUTION

New RO membrane elements are shipped with a chemical preservative applied to the membranes. It is hazardous to your health and will contaminate product water supplies. It must be flushed from the membranes prior to using the RO product water.

1. Verify that the feed water pressure to the RO unit is within 30 to 60 PSIG. If there is no feed pressure, momentarily override FV-01, with HV-01 closed, until the pressure has stabilized. The inlet pressure will also need to be verified as 30 to 60 psig while in operation at steady state. (If the pressure is too low, you may need to install a feed water

booster pump to avoid low pressure fault shutdowns. If the pressure is too high, you must install an automatic pressure regulating valve to protect the low pressure pump seals and PVC piping from over pressurization.)

2. If applicable, fully open the manual product divert to drain valve. Verify there is no obstruction of this valve. If the automatic divert valves were installed, they will automatically divert to drain when the system is off.

3. Open the clean, dry air supply valve going to the regulator and verify regulator set to 80 psig.

4. Verify that the manual feed water valve (HV-01) is fully CLOSED.

5. Fully open the reject and reject recycle valves (HV-03 & HV-04).

6. Manually override the RO unit automatic feed water valve and open this valve. This will enable the RO unit to flush while the power is off at step 7. This can be done by over-riding the solenoid valve on the side of the Control Panel.

CAUTION **Always open the manual valves slowly to prevent water hammer from damaging the piping and components.**

7. Slowly open the manual feed water isolation valve (HV-01) to allow water flow into the RO unit. Also open the filter vent valve (V-01) to bleed the air out of the cartridge filter. Close when air is bled out.

8. Verify flow through the unit by checking the feed inlet pressure gauge on the wet instrument panel. Check for water flow out of the reject drain line.

9. Allow the flushing process to run for a minimum of 15-30 minutes. This will assure all the membrane preservatives will be flushed out.

10. When flushing is complete, re-connect any previously disconnected air lines and return the valves to the operating position. Remove the manual over-ride on any solenoids which may have been manually operated.

3.3 NORMAL OPERATION

Use this section for daily startup or to restart the system after a short term shutdown.

1. **BEFORE starting the RO unit, verify that the following conditions exist:**

DEVICE	CONDITION
RO system is selected OFF at the MC-10 Controller or HMI	SYSTEM OFF
Starter Panel disconnect switch (MCP)	ON
Main Control Panel / Motor Starter Panel disconnect switches (inside Main Control Panel / Motor Starter Panel)	ON
Manual feed water isolation valve (HV-01)	OPEN
Instrument isolation air valve	OPEN
Standby Flush mode selection at the HMI or MC-10 Controller (OFF-AUTO)	AUTO
Pump discharge throttling valve (HV-02)	1/8 to 1/4 OPEN (FULL OPEN FOR DELUXE MODEL)
Reject throttling valve (HV-03)	OPEN
Reject recycle throttling valve (HV-04)	25% Open
Automated reject bypass ball valve	CLOSED
Off-skid valves in the reject to drain line (if applicable)	OPEN
Off-skid valves in the process supply line (if applicable)	OPEN
Off-skid product divert valve (if applicable)	OPEN
Pre-treatment equipment	ready for use
Post-treatment equipment	ready for use
Storage tank	ready for use

IF ALL THE ABOVE CONDITIONS EXIST, THE SYSTEM IS READY TO START. CLOSE AND LATCH THE CONTROL PANEL DOOR BEFORE STARTING THE RO UNIT. IF ONE OF THE SETTINGS IS INCORRECT, CORRECT THE SETTING PRIOR TO PROCEEDING.

2. Place the RO System "On". This will start the system, beginning with the Pre-Service Flush step.

NOTE: *The pump will not start for 30 seconds. When you place the system "On", the feed inlet valve opens to fill the unit with water under low pressure. This purges any air out of the unit. (If any leaks are noticed at this time, turn off the system and correct the leaking component before the pump starts.) After the 30 second delay, the pump will start. If the system does not start up after the initial 30 second delay, check the storage tank. If it is full, the system will not start until the tank drops below the start fill point by the tank level sensing device. If the low feed pressure alarm is on, the system also will not start.*

3. Verify that the product, reject, and reject recycle flows are correct. If not, adjust the pump discharge throttling valve and the reject valves until the correct parameters are reached (Deluxe model only requires adjustment of the reject throttling and reject recycle valves). Adjustment procedure:

   First (Economy and Plus Models), adjust the unit to make the correct amount of RO product water by adjusting the system pressure. This can be accomplished by regulating the pump discharge throttling valve. Further OPEN the valve to *increase* the system operating pressure and productivity, further CLOSE the valve to *reduce* the system operating pressure and productivity. Once this flow is correct, make a note of the operating pressure.

   Second, adjust the unit to discharge the correct amount of reject to drain flow by adjusting the reject throttling valve HV-03. OPEN the valve to obtain a *higher* flow rate or CLOSE the valves to *reduce* the flow rate.

   Third, adjust the unit to recycle the correct amount by adjusting the reject recycle throttling valve HV-04. OPEN the valve to obtain a *higher* flow rate or CLOSE the valves to *reduce* the flow rate.

   Repeat steps as needed until all the proper flows are reached.

NOTE: *On the Deluxe, this is some what of a "balancing act" between the reject and recycle valves as the reject flows change while the VFD adjusts to maintain the product flow. As the VFD increases, the reject flow increases and as the reject and recycle valves close, the VFD will decrease, and so on.*
On the Economy and Plus units, as the pump discharge throttling valve is opened, the product and the reject flows will increase. You may have to adjust the pump discharge throttling valve to reestablish the operating pressure to obtain the correct product flow as established in the first step.

4. Once the RO unit is operating at the parameters outlined on the Process and Instrumentation Diagram included in Section 5.3, record the operating parameters on the data collection form. (A sample form is in Section 5.1.) It is imperative to record the operating parameters daily, since RO trouble shooting may require a trended analysis of the RO operating parameters.

NOTE: *If the RO will not start, or can not achieve the correct flows, go to the trouble shooting section for more information.*

5. If the RO unit shuts down due to a fault condition, you must turn reset the alarm.

3.4 SHORT TERM SHUTDOWN PROCEDURE

NOTE: *There are two methods for shutting the RO unit down.*

***Short term shut down** is for when the system will be down for a short period of time, as*

to perform brief maintenance or service.

***Long term shut down** should be used for when the system will be down for a prolonged shutdown, as for major repairs, modifications or going out of service.*

1. Turn the RO System OFF. Install a Lock Out device and a Lock Out Tag on the Main Disconnect Switch.

2. Isolate the feed water to the skid and install a Lock Out device and a Lock Out Tag on the valve.

3. Once the feed water inlet pressure indicator reads zero (PI-01), it is safe to service the unit.

The system is now isolated from the standpoint of electrical and hydraulic energy and can now be safely serviced. To restart system, simply open the manual feed water valve and place the RO System On from the RO Control Screen on the HMI terminal.

3.5 LONG TERM SHUTDOWN PROCEDURE

If the system is to be down for a period longer than 7 days, it is recommended that a biocide be pumped into the membrane elements to prevent biological growth. Prior to shutting down the system, read and perform the procedure in Section 4.6.

CAUTION **Failure to store the membranes in a biocide for long term shutdown can cause irreversible damage to the membranes due to bacterial growth.**

1. Turn the RO OFF and turn the disconnect switch to the OFF position.

2. Install a Lock-Out device and a lock Out Tag on the disconnect switch.

3. If the RO membranes are to be left in the vessels, go to Section 4.6.

4. Fully close the manual feed water isolation valve and install a Lock-Out device and a lock Out Tag on the valve.

5. If applicable, you may also have to fully close any process valves located in the RO unit product line down stream of the product divert to drain valve junction to prevent unwanted RO product water from passing this point, and install Lock-Out / Tag-Out equipment on the valve.

   The RO UNIT is now isolated from a standpoint of electrical energy and hydraulic or water pressure energy and may be safely stored for up to a year. If longer storage is required, the membranes need to be removed and stored under more controlled conditions. Contact us for more details.

4.0 MAINTENANCE

4.1 MAINTENANCE SCHEDULE

PROCEDURE	FREQUENCY
Check system for leaks and failures	Daily
Check feed water chlorine levels	Daily
Collect operational data and adjust valves to achieve proper flow rates	Daily
Change prefilter cartridge elements	monthly or when the pressure differential reaches 10-15 PSIG, which ever occurs first
Lubricate pump motor bearings	4 times a year
Calibrate instrumentation	2 times a year
Clean RO membrane elements	When normalized productivity rate drops by more than 15% of the clean membrane normalized productivity rate, when the RO feed pressure increases by 25 PSIG over the clean feed pressure, or when the RO rejection rate drops by more than 3%
Replace RO membrane elements	When cleaning the membranes fails to restore the proper performance *

* Contact Siemens Water Technologies for replacement.

4.2 FILTER CARTRIDGE REPLACEMENT

Required down time: 25 minutes

The following is required:
replacement filter cartridges
adjustable wrench

1. Shut down RO unit as described in Section 3.4.
2. Wait until the automatic feed water valve fully closes, as evidenced by the feed inlet pressure indicator (PI-01) winding down to 0 (zero) psig.
3. Open the vent valve on top of the filter housing to relieve any pressure, drain the water in the filter housing by opening the drain valve.
4. Remove the top of the filter housing by loosening the v-band.
5. Remove the old filter cartridge elements and dispose of them.
6. Rinse the filter housing out with fresh water.

7. Install the new filter elements by setting them over the holes in the bottom of the filter housing. Place the tension springs over the holes on top the new elements.

8. Replace the top of the filter housing and tighten v-band.

9. Restart system as described in Section 3.2, and check for leaks around the top o-ring seal.

10. If no leaks are observed, the RO unit is back in normal service.

11. If a leak is detected, turn the RO unit off, wait for the automatic feed water valve to fully close, remove the top, and inspect the o-ring for damage. If damage is observed, replace the o-ring.

4.3 MEMBRANE ELEMENT REPLACEMENT

Required down time: 2 - 6 hours

You will need the following:
safety equipment (glasses, boots, etc.)
Lock-Out / Tag-Out equipment
rubber mallet
24 liquid ounces of glycerin
set of new membrane elements

1. Secure the unit for a short term shutdown as described in Section 3.4

2. Remove the product pipe connection from the end of the pressure vessel by un-screwing the PVC union in the product lines. Some water will inevitably drain from the disconnected plumbing, so be prepared for a wet floor.

NOTE: *The flow arrowhead sticker located on one end of the pressure vessel indicates the direction of flow through the pressure vessel. You must unload and reload the new RO membrane elements in the direction of flow. This greatly reduces the chance of rolling or damaging the brine seals.*

3. To determine the correct procedure for pressure vessel end cap disassembly, consult the pressure vessel manufacturer's literature in the Appendix.

4. Remove the retaining rings that hold the end caps.

5. Carefully remove the end caps by applying even steady pulling force on them.

NOTE: *Be sure to make note of which end cap came out of which end of the pressure vessel so they may be reinstalled in the same vessels.*

6. Push the old membrane elements out of the pressure vessel in the direction of the flow arrowhead sticker on the outside of the vessel.

7. Remove the membrane product tube adapters from the old membrane elements if they did not remain on the vessel end caps and keep them. Dispose of the old membrane elements.

8. If Film-Tec membranes not used, check the o-rings on the inter-connectors for damage and replace any that show signs of wear or damage. (It is a good idea to replace all the o-rings at the same time you replace the RO membrane elements). Apply a liberal coating of glycerin to the o-rings and brine seals before they are inserted back into the pressure vessel.

9. Remove enough new RO membrane elements from the protective packaging to fill one pressure vessel.

10. Install the inter-connectors between the RO membrane elements as you load them into the vessel.

11. Load the new membrane elements in the pressure vessel in the same direction as the flow arrowhead sticker. Make sure that the membrane brine seal is on the end to enter the pressure vessel last.

NOTE: *The flow arrow on the new RO membrane element should match the flow arrowhead sticker on the pressure vessel.*

12. Carefully reinstall the product tube adapters on the ends of the membrane element product tubes. Apply a liberal amount of glycerin on the o-rings to make installation easier.

13. Place 4 spacers on the product tube adapter, then carefully reinstall the end caps back in the ends of the pressure vessel, *taking care to put them in the same ends that they came out of.* Use a small amount of glycerin on the o-rings to make installation easier.

14. Carefully tap the end caps into place, using the rubber mallet. If the end cap will not reinsert the necessary distance, remove the end cap and one spacer. Then repeat this step. Re-assemble the end cap assembly per manufactures instructions.

NOTE: *Due to spacer compression, an additional spacer may be required after the unit has operated. This is especially true with warm water applications (75°F or greater).*

15. Carefully reinstall the retaining rings in both ends of the pressure vessel.

16. Once all the membranes are replaced, reinstall the product piping connections.

17. Check all connections and vessels carefully.

The RO unit is now ready to be put back into service.

4.4 TROUBLESHOOTING

PROBLEM: CONTROL POWER IS OFF

CAUSE	ACTION
Power source disconnect is opened or fuses have blown.	Check the power source and fuses.
RO unit Control Panel low voltage circuit breaker may be tripped.	Check the Control Panel low voltage circuit breaker and reset it if necessary.

PROBLEM: RO UNIT WILL NOT START

CAUSE	ACTION
The RO water storage tank may be full.	No action is required. Unit may be indicating "Standby Mode" if Standby is selected as Auto.
The RO unit pre-treatment interlock may be engaged because of a filter backwash or a softener regeneration cycle.	Check the operational status of the pre-treatment system. Check out the Control Panel circuitry to ensure the proper jumpers have been installed.
Low feed pressure fault may have caused the RO unit to drop out of service.	Check the Alarm List for any active alarms. Reset alarms as necessary. Allow the RO unit to restart, and check that the feed pressure is at least 10 PSIG.
The RO water storage tank level sensing device may be broken or require adjustment.	Inspect the electrical functioning of the RO water storage tank level sensing device. Inspect the settings of the RO water storage tank level sensing device.
The RO unit Control Panel may have an electrical component failure.	Inspect all components of the Control Panel.

PROBLEM: AUTOMATIC FEED WATER VALVE WILL NOT OPEN

CAUSE	ACTION
Solenoid valve may have failed.	Replace the solenoid valve.
Feed water valve actuator may have failed.	Repair or replace the actuator.

PROBLEM: RO UNIT PRODUCTIVITY IS LOW

CAUSE	ACTION
RO unit operating set point has been changed.	Verify proper set point.
RO unit product back pressure is excessive.	Check the pressure of the RO unit product piping; it should not exceed 10 PSIG. If it does, determine what is causing the pressure drop and reduce it.
RO unit feed water temperature is colder then usual. (Lower feed water temperatures require a higher operating pressure.)	Check the RO unit feed temperature. If it has decreased, increase the operating pressure to compensate for this low temperature operation.
RO unit membrane elements may be fouled.	Determine the nature of the foulant and clean and/or sanitize the membrane elements.
Flowmeter readings not accurate (Plus and Deluxe Models).	Verify correct operation of flow sensors and flow meters. Calibrate or replace if necessary.
RO pretreatment failure.	Inspect all pretreatment systems for problems.

PROBLEM: RO UNIT REJECTION IS LOW

CAUSE	ACTION
RO unit recovery is too high.	Reduce RO unit recovery to match values listed in RO operating spec sheet in the Appendix.
Shift in feed water chemistry (oxidants in feed water).	Check feed water chemistry. If substantially different from the original design feed water chemistry, have a new RO performance projection run to determine what the rejection rate characteristic should be.
Mechanical leak in the membrane system.	Inspect all RO product tube adapter o-ring seals.
RO feed water temperature increase.	Check feed water temperature. Install or adjust temperature controls, if necessary.
RO unit reject to waste flow out of adjustment.	Check flow parameters and adjust system as stated in Section 3.3.
RO unit membrane elements may be fouled.	Determine the nature of the foulant and clean and/or sanitize the membrane elements.

PROBLEM: CAN NOT ACHIEVE PROPER FLOW READINGS

CAUSE	ACTION
Flow Sensors not operating correctly (Plus and Deluxe Models).	Verify correct operation of flow sensors. Calibrate or replace if necessary.
Control valves not properly adjusted.	Reset the control valves as stated in Section 3.3.
Control valve may have failed.	Check that there are no obstructions or damage to the control valves. Check seats on ball valves for excessive wear.

4.5 RECOMMENDED SPARE PARTS

The spare parts list included in the appendix contains all items critical to the operation of the unit. Due to the great diversity of spare part requirements of different customers, the list in its entirety is supplied. It is recommended that the customer break this list into three different priority levels:

Priority A Parts: Includes the bare minimum of spare parts and consumables.

Priority B Parts: Includes spare parts that have a tendency to need replacement within a five year period. Failure of most of these items would cause an unscheduled shutdown.

Priority C Parts: For customers who foresee difficulty in obtaining spare parts in a timely manner, or who cannot shutdown for more than a 24 hour period.

4.6 RO Membrane Element Long Term Storage Procedure

The solution we recommend is a 0.5 to 1.0% solution of sodium bisulfite for membrane preservation. For conditions where freezing may be a problem, the solution should also contain up to 18% (by weight) glycerin or propylene glycol. Refer to RO membrane data sheet in Appendix for further information.

The following equipment and materials are needed:

CIP Cleaning Skid (for Economy and Plus models)
RO Product Water or DI Water
Sodium Bisulfite (food grade)
Propylene Glycol or Glycerin (if required)
Safety Equipment

1. Adjust the valves on the cleaning skid or hook up hoses and configure the valves on the Deluxe model RO unit for recirculation. For Deluxe, see CIP Section 4.8 for more detail for connecting hoses #1 and #6 to perform the recirculation.

2. Fill the cleaning tank with the appropriate quantity of RO product water or DI water.

CAUTION **Do not use a solution of greater than 1.0%. The pressure vessel end caps will be damaged otherwise.**

3. Add the correct amount of sodium bisulfite powder to the cleaning tank using the following proportions:

   0.5% solution sodium bisulfite - .042 lbs. per gallon
   1.0% solution sodium bisulfite - .084 lbs. per gallon

   If applicable, add the appropriate amount of freeze protection (glycerin or propylene glycol) to the solution at this point. (Refer to Table 1 & 2 at the end of this section)

4. Close the proper valves on the product and reject lines to prevent solution from entering the storage tank.

5. Connect hoses from the RO unit product and reject outlets back to the cleaning tank.

6. Recirculate the solution for at least 5 minutes to allow for complete mixing.

For Economy and Plus Models

7. Verify/Close the RO pump discharge throttling valve.

8. Connect the supply hose from the cleaning skid to the cleaning port on the first stage feed manifold.

9. Fully open the RO unit reject valves.

10. Reset the valves on the cleaning skid to the normal position.

For Deluxe Models

7. Open the RO pump discharge throttling valve.

8. CLOSE the 3-way mix valve (HV-06) for both directions.

9. Verify/connect hose #5 from CIP-9 to the tank and verify/connect Hose #3 from CIP-8 to the tank.

10. Verify HV-01 is Closed and HV-08 is Open.

For All Models (continued)

11. Start the cleaning skid pump or press start pump on the HMI CIP menu for the Deluxe Control Screen.

12. Allow the solution to circulate through the RO unit for 30 minutes.

13. Turn off the cleaning skid or press Stop Pump on the HMI CIP Control Screen (Deluxe) and disconnect the hoses.

14. Fully close the manual feed water isolation valve and install a Lock-Out device and a Lock Out Tag on the valve.

15. If applicable, fully open the product divert-to-drain valve and install a Lock-Out device and a Lock Out Tag on the valve.

16. If applicable, you may also have to fully close any process valves located in the RO unit product line down stream of the product divert to drain valve junction to prevent unwanted RO product water from passing this point, and install a Lock-Out device and a Lock Out Tag on the valve.

17. Drain the pump, manifold piping, and hoses.

18. Seal all openings to prevent the membrane elements from drying out.

19. Tag the RO unit with the date and type of solution the membranes are stored in so that it is properly flushed prior to being put back into service.

The RO unit is now ready to be stored. Be sure to follow the Initial Startup in Section 3.1 when ready to put the unit back in service.

Table 1
FREEZING POINT OF PROPYLENE GLYCOL - WATER MIXTURES

% glycol by VOLUME	Specific Gravity 15.6°C. (60°F)	Freezing Point °C.	Freezing Point °F.
5	1.004	-1.1	30
10	1.006	-2.2	28
15	1.012	-3.9	25
20	1.017	-6.7	20
25	1.020	-8.9	16
30	1.024	-12.8	9
35	1.028	-16.1	3
40	1.032	-20.6	-5
45	1.037	-26.7	-16
50	1.040	-33.3	-28

Table 2
FREEZING POINT OF GLYCEROL (GLYCERIN) - WATER MIXTURES

% glycerin by WEIGHT	Specific Gravity 15.0°C. (59°F)	Freezing Point °C.	Freezing Point °F.
10	1.02415	-1.6	29.1
20	1.04935	-4.8	23.4
30	1.07560	-9.5	14.9
40	1.10255	-15.5	4.3
50	1.12985	-22.0	-7.4
60	1.15770	-33.6	-28.5
70	1.18540	-37.8	-36.0
80	1.21290	-19.2	-2.3
90	1.23950	-1.6	29.1

4.7 RO MEMBRANE ELEMENT CLEANING

NOTE: *To clean the membrane elements in situ, a CIP skid (stands for Clean In Place) is required for the Economy and Plus Models (See Section 4.8 for Deluxe Model Cleaning Procedure). The CIP skid can be purchased from* us *if you want to do your own cleaning on the Economy and Plus Models. However, cleaning services are available from the most service branches. Call the local sales and service office for details.*

Read the following section to help you understand why RO membrane elements need to be cleaned, and the nature of the foulants that can be encountered.

NOTE: *RO membrane element cleaning is a complex process and if done incorrectly, could damage or destroy the membrane elements. A complete cleaning procedure is described in the CIP operating manual.*

It should be noted that a decrease in water temperature will result in a decrease in product water flow and increase in the differential pressure across the membrane. This is not indicative of a requirement for cleaning.

The data collected after the first 24 to 48 hours of operation of the RO unit should be used as a baseline for the above parameters. It is critical that the data collection sheets, supplied in the Appendix, are completely filled out on a daily basis.

You will find it necessary to clean the RO UNIT from time to time as a result of the natural accumulation of some type of membrane surface foulant. This requirement to clean the RO UNIT membranes will be evidenced by one or more of the following symptoms including, a *reduction* in the NORMALIZED PRODUCTIVITY RATE, a *reduction* in the RO UNIT TOTAL DISSOLVED SOLIDS REJECTION RATE, or an *increase* in the RO UNIT OPERATING PRESSURE, in spite of no change in the RO UNIT feed water temperature. In general, this procedure should not be required more then three (3) times per year or about every four (4) months. If you find that this procedure is required more frequently then this, you should have one of our representatives evaluate the effectiveness of your pre-treatment system or the current RO UNIT operating parameters. Most cleaning procedures consist of the preparation of a specific cleaning chemical formulation made up in warm water, which is then recirculated through the RO UNIT elements, followed by an extended soak period in the cleaning solution, followed by another recirculation cycle, and completed with a thorough rinse cycle.

The RO UNIT membrane foulants usually consist of one or more of three common classes of foulants including; SUSPENDED SOLIDS, ORGANIC FOULANTS AND PRECIPITATED DISSOLVED SOLIDS. A brief explanation of the nature of each type of foulant will is below.

SUSPENDED SOLIDS FOULANTS

Suspended solids fouling is among the most common RO UNIT foulants. This fouling condition results from the incomplete removal of suspended solids such as silt and clay particles from the RO UNIT feed water. In as much as some of these particles are less then 0.2 micron in size, it is not practical to attempt to remove all of them so this type of membrane fouling is eventually inevitable in all RO UNITS. This is most common to systems operating on a surface water supply. The trick is to try to eliminate as much of the suspended solids material as possible, through good pre-treatment filtration practices including, proper selection and operation of multimedia filtration, the correct selection and maintenance of cartridge filters, and the possible use of chemicals aimed at dispersion of suspended solids. This type of foulant is generally evidenced by a *gradual* reduction in the NORMALIZED PRODUCTIVITY RATE with *no reduction* in the TOTAL DISSOLVED SOLIDS REJECTION RATE.

ORGANIC FOULANTS

Organic fouling of thin film composite membranes is very common and may take place as a result of two different mechanisms. The first mechanism may be through the presence of organic material present in the RO UNIT feed water in the form of humic or fulvic acids, which end up in the water supply as a result of rotting vegetation. Obviously this is more of a problem when using surface water supplies as opposed to well water supplies.

The second mechanism is the result of actual biological growth taking place on the membrane surface as a result of the lack of an oxidant in the RO UNIT feed water to kill off these

microorganisms. It is usually impractical to totally eliminate all organic foulants from the RO UNIT feed water, so all you can do is try to take reasonable precautions through the possible use of ultraviolet sterilizers on the RO UNIT feed water, conduct good maintenance procedures on the multimedia filters, including periodic sterilization cycles, and the use of approved biocides on the RO UNIT MEMBRANE ELEMENTS. This type of foulant is evidenced by a *gradual reduction* in the NORMALIZED PRODUCTIVITY RATE with either *no reduction* or a *slight increase* in the TOTAL DISSOLVED SOLIDS REJECTION RATE.

PRECIPITATED DISSOLVED SOLIDS FOULANTS

Precipitated dissolved solids fouling is generally the least common foulant to plague RO UNIT membranes. This type of fouling generally occurs when the RO UNIT recovery is run too high, thus concentrating the dissolved solids in the feed water to the last few membranes beyond their solubility limits. The most common constituents of this type of foulant are Silica (SiO_2), Calcium Carbonate ($CaCO_3$), Calcium Sulfate ($CaSO_4$) and various forms of Iron (Fe) and Aluminum (Al). Generally this type of fouling is preventable through good administrative control of RO UNIT recovery, and maintenance of pre-treatment equipment including ion exchange softeners and antiscalant injection systems. This type of foulant is evidenced by a gradual reduction in NORMALIZED PRODUCTIVITY RATE with a *minor reduction* in the TOTAL DISSOLVED SOLIDS REJECTION RATE.

Refer to the manual included with the optional CIP skid for complete cleaning instructions.

4.8 ON BOARD RO MEMBRANE ELEMENT CLEANING PROCEDURE (Deluxe Models)

Due to the number of RO membranes and the membrane manufacturers available, it is impossible to provide cleaning parameters that pertain to every membrane. With that in mind, below is a table that provides some general parameters that pertain to the two most common types, TFC (Thin-Film-Composite) and CA (Cellulose Acetate), of RO membranes available. With the different membrane manufacturers there come different operating and cleaning parameters. Since the TFC membrane is the predominant membrane of choice, the focus of the cleaning procedure will be in regards to the TFC membrane.

CAUTION **To prevent the membrane warranty from being voided, always refer to your actual membrane manufacturers data to establish recommended cleaning parameters prior to beginning the membrane cleaning process.**

Element Type	Feed Pressure (PSIG)	pH Range	Maximum Temperature* ($^oC/^oF$)	Vessel Diameter (inches)	Flow Rate/PV (GPM)
TFC	20-60	1-12	30/86	8	25-40
CA	20-60	3-8	40/104	8	30-40

*Cleaning solution effectiveness increases with increased temperature.

It is recommended that RO permeate quality water, or better, be used to mix the cleaning chemicals and during the rinse portion of the cleaning process. If this quality of water is not available, a good, chlorine free and other oxidizing agent free, filtered clean water supply is acceptable.

NOTE: *Chlorine free water is not required when cleaning CA membranes.*

The major mechanical components used in CIP are described below.

Storage Tank
A storage tank is loose shipped and to be located on the floor near the CIP connections at the left end of the unit (when facing the control panel). This tank is designed to mix, in batch quantities, the cleaning solutions to be used. The tank is constructed of high density polyethylene (PE) and has a removable lid for easy addition of chemicals.

Pump
The RO unit has a VFD controlled pump to allow usage for CIP operations. The pump is designed to provide the pressure and flow necessary to clean the RO membranes.

Filter Housing
The cartridge filter on the RO skid doubles as the CIP filter. It is designed to contain double open end, 5 micron, nominal rated filter cartridges to filter the cleaning solution and removed foulants from the RO reject prior to returning to the CIP tank. The filter cartridges should be disposed of after each cleaning.

CIP Hoses
The hoses are supplied with the Deluxe Model RO unit for performing membrane cleaning. These hoses are rated for high and low pH cleaning solutions.

CLEANING CHEMICAL SELECTION

Cleaning RO membranes is not an exact science. There are as many different cleaning chemicals as there are membranes manufacturers. Due to the different types of foulants that may or may not be present in your system, this manual can only serve as a recommended guide to cleaning chemicals. The best thing to do is try the different chemicals and see which give the best results.

Below is a condensed list of cleaning chemicals that we recommend:

1. **LOW pH CLEANER:** A solution of 0.1% hydrochloric acid and warm can be used to remove suspended and precipitated dissolves solids. Care must be taken to stay within the pH limits of the membranes. For pH and temperature information reference the membrane literature in the RO Manual.

NOTE: *The pH of the hydrochloric acid solution can be adjusted using NaOH (caustic soda).*

2. **HIGH pH CLEANER:** A solution of 0.05 caustic soda and warm water can be used to remove organic fouling. This can only be done if it is preceded by the low pH cleaner above. Again, care must be taken to stay within the pH limits of the membranes.

NOTE: *The pH of the caustic soda solution can be adjusted using HCl (hydrochloric acid).*

For additional recommendations on specialty cleaning chemicals, contact our representative or the Technical Support Department at the number on this manual's front cover.

CLEANING PROCEDURE

Required RO Down Time: 4-8 hours

Required Equipment and Materials

Lock-Out and Tag-Out equipment.
Personal safety equipment, such as safety glasses and gloves (See chemical MSDS sheets for additional requirements).
Cartridge filter elements.
Portable pH meter.
Membrane cleaning chemicals.
RO permeate water or clean filtered, chlorine free water, up to 120°F

Pre-Cleaning Checklist:

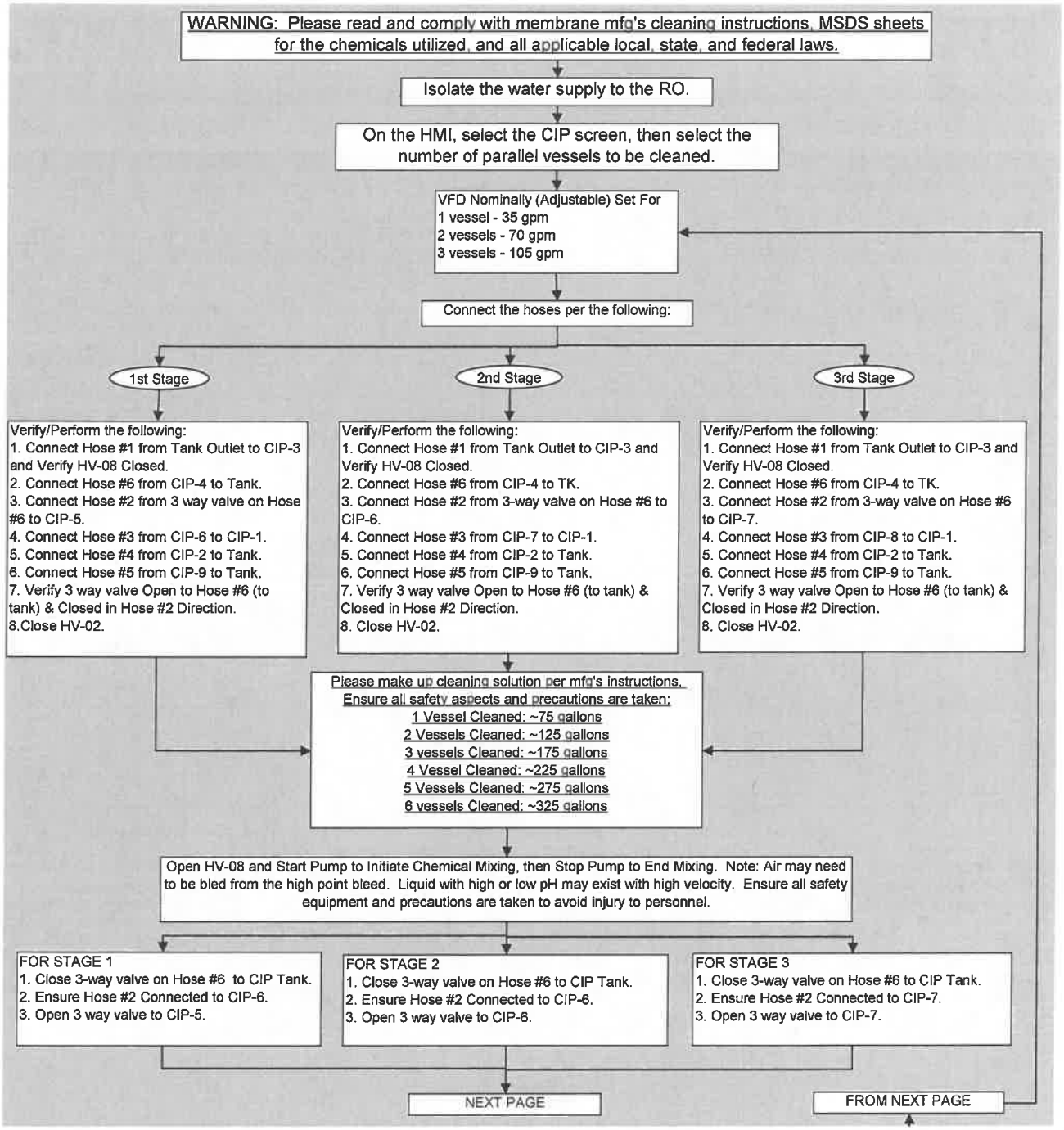
1. Confirm the RO storage tank is full.
2. Confirm that the volume of water in the storage tank will suffice during the cleaning procedure (approximately 4-8 hours).
3. Verify that safety shower and eye wash stations are functional.
4. Verify that the Power switch on the RO Control Panel is OFF.

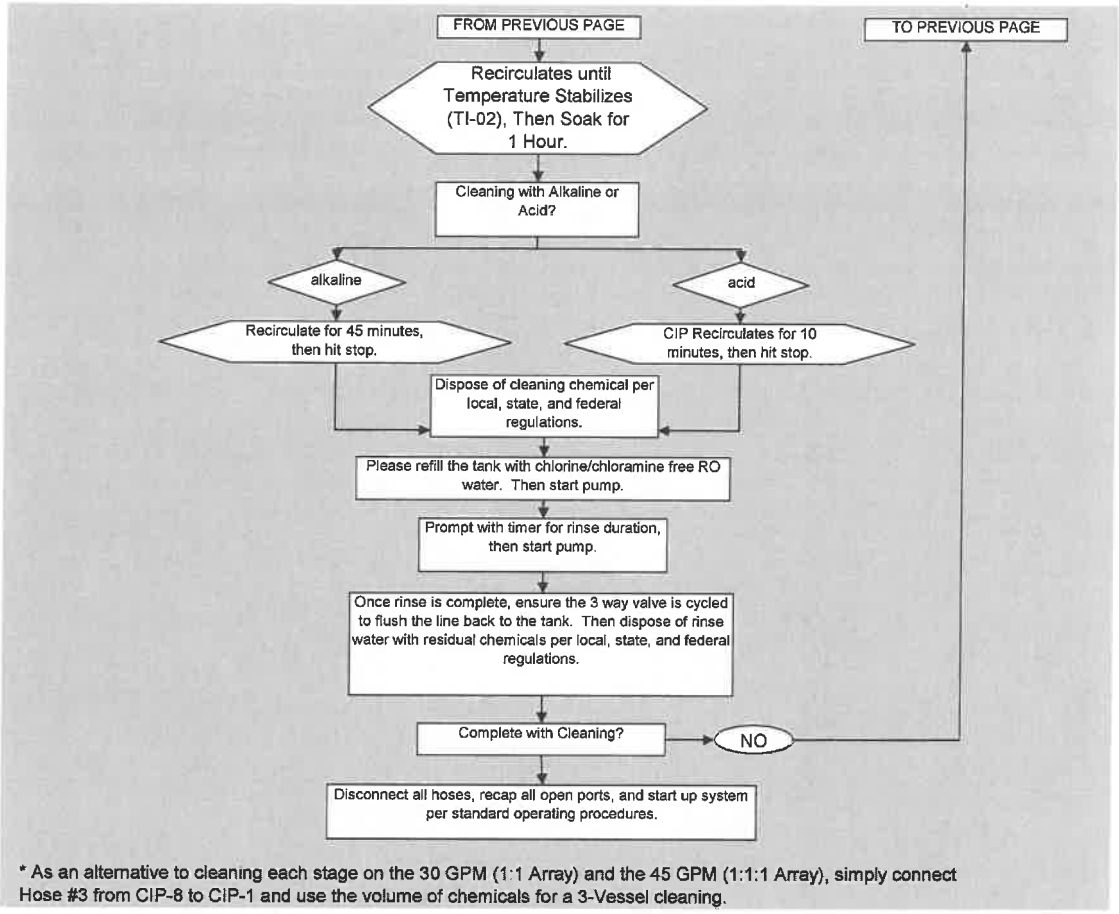
CIP Set Up and Performance

1. Install new filter cartridges in the filter housing on the RO unit.
2. Set up and perform cleaning per the flow diagram on the following two pages.

WARNING **NEVER ADD WATER TO ACID OR CAUSTIC OR A VIOLENT REACTION WILL OCCUR. THIS CAN CAUSE SEVERE CHEMICAL BURNS. ALWAYS ADD THE CHEMICAL TO THE WATER.**

DO NOT LEAVE THE CLEANING HOSES CONNECTED TO THE MANIFOLDING WHEN CLEANING IS COMPLETE. THEY ARE NOT RATED FOR THE PRESSURE GENERATED WHILE THE RO UNIT IS OPERATING.


WARNING: Please read and comply with membrane mfg's cleaning instructions, MSDS sheets for the chemicals utilized, and all applicable local, state, and federal laws.
Isolate the water supply to the RO.
On the HMI, select the CIP screen, then select the number of parallel vessels to be cleaned.
VFD Nominally (Adjustable) Set For
1 vessel - 35 gpm
2 vessels - 70 gpm
3 vessels - 105 gpm
Connect the hoses per the following:
1st Stage
2nd Stage
3rd Stage
Verify/Perform the following:
1. Connect Hose #1 from Tank Outlet to CIP-3 and Verify HV-08 Closed.
2. Connect Hose #6 from CIP-4 to Tank.
3. Connect Hose #2 from 3 way valve on Hose #6 to CIP-5.
4. Connect Hose #3 from CIP-6 to CIP-1.
5. Connect Hose #4 from CIP-2 to Tank.
6. Connect Hose #5 from CIP-9 to Tank.
7. Verify 3 way valve Open to Hose #6 (to tank) & Closed in Hose #2 Direction.
8.Close HV-02.
Verify/Perform the following:
1. Connect Hose #1 from Tank Outlet to CIP-3 and Verify HV-08 Closed.
2. Connect Hose #6 from CIP-4 to TK.
3. Connect Hose #2 from 3-way valve on Hose #6 to CIP-6.
4. Connect Hose #3 from CIP-7 to CIP-1.
5. Connect Hose #4 from CIP-2 to Tank.
6. Connect Hose #5 from CIP-9 to Tank.
7. Verify 3 way valve Open to Hose #6 (to tank) & Closed in Hose #2 Direction.
8. Close HV-02.
Verify/Perform the following:
1. Connect Hose #1 from Tank Outlet to CIP-3 and Verify HV-08 Closed.
2. Connect Hose #6 from CIP-4 to TK.
3. Connect Hose #2 from 3-way valve on Hose #6 to CIP-7.
4. Connect Hose #3 from CIP-8 to CIP-1.
5. Connect Hose #4 from CIP-2 to Tank.
6. Connect Hose #5 from CIP-9 to Tank.
7. Verify 3 way valve Open to Hose #6 (to tank) & Closed in Hose #2 Direction.
8. Close HV-02.
Please make up cleaning solution per mfg's instructions.
Ensure all safety aspects and precautions are taken:
1 Vessel Cleaned: ~75 gallons
2 Vessels Cleaned: ~125 gallons
3 vessels Cleaned: ~175 gallons
4 Vessel Cleaned: ~225 gallons
5 Vessels Cleaned: ~275 gallons
6 vessels Cleaned: ~325 gallons
Open HV-08 and Start Pump to Initiate Chemical Mixing, then Stop Pump to End Mixing. Note: Air may need to be bled from the high point bleed. Liquid with high or low pH may exist with high velocity. Ensure all safety equipment and precautions are taken to avoid injury to personnel.
FOR STAGE 1
1. Close 3-way valve on Hose #6 to CIP Tank.
2. Ensure Hose #2 Connected to CIP-6.
3. Open 3 way valve to CIP-5.
FOR STAGE 2
1. Close 3-way valve on Hose #6 to CIP Tank.
2. Ensure Hose #2 Connected to CIP-6.
3. Open 3 way valve to CIP-6.
FOR STAGE 3
1. Close 3-way valve on Hose #6 to CIP Tank.
2. Ensure Hose #2 Connected to CIP-7.
3. Open 3 way valve to CIP-7.
NEXT PAGE
FROM NEXT PAGE



* As an alternative to cleaning each stage on the 30 GPM (1:1 Array) and the 45 GPM (1:1:1 Array), simply connect Hose #3 from CIP-8 to CIP-1 and use the volume of chemicals for a 3-Vessel cleaning.

FAILURE TO REPLACE THE STAINLESS STEEL PLUGS AND PVC FLANGES MAY RESULT IN DAMAGE TO THE EQUIPMENT AND THE POSSIBILITY OF SERIOUS INJURY TO THE OPERATOR.

WARNING

3. Record a new set of RO operating data on the DATA COLLECTION FORM. This information can be used as baseline data to schedule the next RO membrane cleaning.

MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets (MSDS) for cleaning chemicals are not included in this manual. They should be included with the cleaning chemicals you purchase. For quick reference, place them in this manual after this page.

5.0 APPENDIX

5.1 RO DATA COLLECTION FORM

SYSTEM IDENTIFICATION: _____

WEEK ENDING DATE: _____

See calculated values on next page.

RO UNIT OPERATING PARAMETERS	S	M	T	W	T	F	S
RO Cartridge Filter Pressure Drop (PSI)[1]							
RO Cartridge Filter Outlet Pressure (PSI)							
RO Cartridge Filter Inlet Pressure (PSI)							
Feed Flow Rate (GPM)[2]							
Product Flow Rate (GPM)[3]							
Reject Flow Rate (GPM)							
Reject Recirculation Flow Rate (GPM)							
Product Recovery (%)[4]							
Feed Water Temperature (^{o}F)							
Feed Water pH (0-14)							
Feed Water Chlorine Concentration (PPM)							
Feed Water Total Hardness (PPM)							
Feed Water SiO2 (PPM as SiO2)							
Feed Water Conductivity (mg/l)							
RO 1^{rst} Stage Conductivity (mg/l)							
RO 2nd Stage Conductivity (mg/l)							
RO 3rd Stage Conductivity (mg/l)							
RO Final Reject Conductivity (mg/l)							
RO Percent Rejection (%)[5]							
RO 1^{rst} Stage Operating Pressure (PSI)							
RO 2nd Stage Operating Pressure (PSI)							
RO 3rd Stage Operating Pressure (PSI)							
RO Final Reject Operating Pressure (PSI)							
RO Normalized Productivity (GPM)[6]							
DATA TAKEN BY:							

COMMENTS:

Calculated Values:

1. **RO FILTER PRESSURE DROP** is equal to filter inlet pressure MINUS filter outlet pressure.

2. **RO FEED FLOW** rate (Economy only) is equal to RO product flow plus the RO reject Flow.

3. **RO PRODUCT FLOW** rate (Plus and Deluxe only) is equal to the RO Feed Flow minus the RO Reject Flow.

4. **RO PRODUCT RECOVERY** is equal to the RO product flow rate DIVIDED by the RO feed flow rate, MULTIPLIED by 100.
    i. EXAMPLE: Product flow = 30 GPM
        a. Feed flow = 40 GPM
        b. (30 ÷ 40) x 100 = 75% recovery

5. **RO PERCENT REJECTION*** is equal to the RO feed conductivity MINUS the RO product conductivity, DIVIDED by the feed conductivity, TIMES 100.
    i. EXAMPLE: Feed conductivity = 380 micromoh
        a. Product conductivity = 5 micromoh
        b. {(380-5) ÷ 380} x 100 = 98.6% rejection

    - The RO Quality monitor is set up at the factory to display this value.

6. **NORMALIZED PRODUCTIVITY** is a true indication of membrane performance. It is calculated as follows:

    NPF = MPF X TCF X (225÷MFP)

    Where:

    NPF = NORMALIZED PRODUCTIVITY FLOW
    MPF = MEASURED PRODUCT FLOW
    TCF = TEMPERATURE CORRECTION FACTOR (See table next page)
    MFP = MEASURED FEED PRESSURE

    EXAMPLE: MPF = 35 GPM
    FEED WATER TEMP = 60 °F, THEN TCF = 1.44
    MFP = 285 PSIG

    NPF = 35 x 1.44 x (225÷285)
    NPF = 35 x 1.44 x .789
    NPF = 39.8

RO FEED WATER TEMPERATURE CORRECTION FACTOR

TEMP °F	TCF	TEMP °F	TCF
34	3.64	70	1.12
36	3.18	72	1.08
38	2.93	74	1.05
40	2.68	76	1.02
42	2.47	78	0.97
44	2.29	80	0.93
46	2.14	82	0.90
48	2.01	84	0.88
50	1.88	86	0.86
52	1.77	88	0.82
54	1.68	90	0.79
56	1.59	92	0.77
58	1.51	94	0.75
60	1.44	96	0.73
62	1.36	98	0.70
64	1.30	100	0.68
66	1.24	102	0.65
68	1.17	104	0.63

RO OPERATING SPECIFICATION SHEET

ALL FLOW RATES EXPRESSED AS GALLONS PER MINUTE (GPM). OPERATING AT DIFFERENT GFD RATINGS WILL PROVIDE DIFFERENT FLOW RATES, HOWEVER THIS UNIT IS DESIGNED TO OPERATE AT 18-20 GFD, OPERATING OUTSIDE THESE FLOWS IS NOT RECOMMENDED WITHOUT CONSULTING SIEMENS WATER TECHNOLOGIES

BW30-400/34i Membranes

ARRAY	QTY	GFD 16	GFD 17	GFD 18	GFD 19	GFD 20
3M 1:1	6	27	28	30	32	34
3M 1:1:1	9	40	43	45	48	50
3M 2:1:1	12	53	57	60	63	67
3M 2:2:1	15	67	71	75	79	83
3M 3:2:1	18	80	85	90	95	100

NOTE: UNHIGHLIGHTED CELL INDICATES DESIGN POINT (NOMINAL FLOW), FOR WHICH PUMPS WERE SIZED. VALUES LISTED ABOVE ARE NOMINAL FLOW RATES BASED ON AVERAGE FEED WATER CONDITIONS. A CHANGE IN WATER TEMPERATURE AND OR WATER QUALITY CAN SIGNIFICANTLY ALTER THE ACHIEVABLE FLOW RATES OF THE RO SYSTEM.

TO OBTAIN OPTIMAL OPERATING PARAMETERS FOR THE SYSTEM, BASED ON THE FEED WATER CONDITIONS, PLEASE SUBMIT A WATER ANALYSIS OF THE FEED WATER TO THE OUR APPLICATIONS DEPARTMENT, AND WE WILL RUN A COMPUTERIZED RO PROJECTION FOR THE SYSTEM.

OPERATING THE RO UNIT OUTSIDE OF THESE PARAMETERS COULD CAUSE PREMATURE MEMBRANE FAILURE OR RESULT IN EXCESSIVE CLEANING REQUIREMENTS.

5.2 QA DATA SHEETS

See QA Data sheet that follows this page.

5.3 DRAWINGS

There are 15 different models of this RO unit. Only the drawings checked below that apply to your system will be included in this section.

	1.DWG #	Model	DESCRIPTION
	S8801-020	ALL	Equipment Specifications
	S8801-200A	ALL	General Arrangement Drawing
	S8801-001	Economy	Process and Instrumentation Diagram – 30 GPM
	S8801-002	Economy	Process and Instrumentation Diagram – 45 GPM
	S8801-003	Economy	Process and Instrumentation Diagram – 60 GPM
	S8801-004	Economy	Process and Instrumentation Diagram – 75 GPM
	S8801-005	Economy	Process and Instrumentation Diagram – 100 GPM
	S8802-001	Plus	Process and Instrumentation Diagram – 30 GPM
	S8802-002	Plus	Process and Instrumentation Diagram – 45 GPM
	S8802-003	Plus	Process and Instrumentation Diagram – 60 GPM
	S8802-004	Plus	Process and Instrumentation Diagram – 75 GPM
	S8802-005	Plus	Process and Instrumentation Diagram – 100 GPM
	S8803-001	Deluxe	Process and Instrumentation Diagram – 30 GPM
	S8803-002	Deluxe	Process and Instrumentation Diagram – 45 GPM
	S8803-003	Deluxe	Process and Instrumentation Diagram – 60 GPM
	S8803-004	Deluxe	Process and Instrumentation Diagram – 75 GPM
	S8803-005	Deluxe	Process and Instrumentation Diagram – 100 GPM

ELECTRICAL DOCUMENTATION

	S8801-050	Economy	Electrical Schematic
	S8802-050	Plus	Electrical Schematic (Siemens PLC / HMI)
	S8803-050	Deluxe	Electrical Schematic (Siemens PLC / HMI)
	S8802-050A	Plus	Electrical Schematic (Allen-Bradley PLC / HMI)
	S8803-050A	Deluxe	Electrical Schematic (Allen-Bradley PLC / HMI)

5.4 COMPONENT MANUFACTURERS LITERATURE

Component	Manufacturer	Model/Series Number	Included
Pump	Grundfos	CRN Series	
Pressure Vessels	Protec	PRO-8-300-SP-3	
RO Membranes	Dow/Film-Tec	BW30-400	
RO Membranes	Dow/Film-Tec	BW30-400/34i	
RO Membranes	Dow/Film-Tec	LE-400	
Multiparameter Monitor	Signet	8900	
PLC (Siemens option)	Siemens	S7-200 Series (6ES7 214-2BD23-OXBO)	
HMI (Siemens option)	Siemens	TP 177A (6AV6 642-0AA11-0AX1)	
PLC (Allen-Bradley option)	Allen-Bradley	MicroLogix 1100 (1763-L16BWA)	
HMI (Allen-Bradley option)	Allen-Bradley	PanelView Component C600 (2711C-T6C)	
Flow Sensor	Signet	2536 Series	
pH/ORP Monitor (optional)	Signet	3-8750-2	
pH Sensor (optional)	Signet	3-2774	
ORP Sensor (optional)	Signet	3-2775	

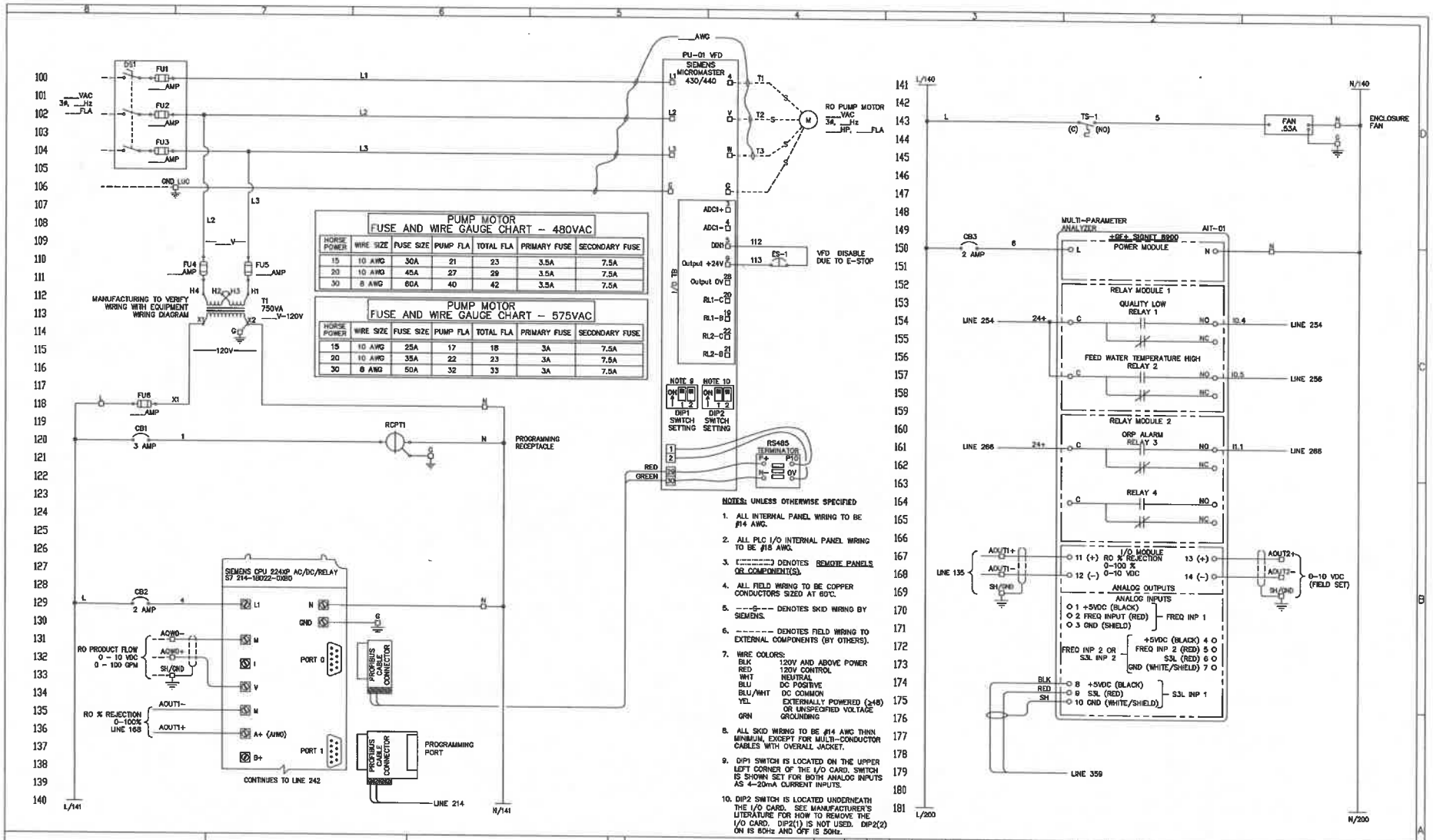
5.5 MATERIAL SAFETY DATA SHEET(S)

Title	Use
Sodium Bisulfite	RO membrane preservative

5.6 SPARES

See the attached sheet(s) for Part Numbers, Descriptions, and Quantity used on the unit.

Contact Technical Support at the toll free number of this manual's front cover for current parts prices and/or ordering information



PUMP MOTOR FUSE AND WIRE GAUGE CHART – 480VAC						
HORSE POWER	WIRE SIZE	FUSE SIZE	PUMP FLA	TOTAL FLA	PRIMARY FUSE	SECONDARY FUSE
15	10 AWG	30A	21	23	3.5A	7.5A
20	10 AWG	45A	27	29	3.5A	7.5A
30	8 AWG	60A	40	42	3.5A	7.5A

PUMP MOTOR FUSE AND WIRE GAUGE CHART – 575VAC						
HORSE POWER	WIRE SIZE	FUSE SIZE	PUMP FLA	TOTAL FLA	PRIMARY FUSE	SECONDARY FUSE
15	10 AWG	25A	17	18	3A	7.5A
20	10 AWG	35A	22	23	3A	7.5A
30	8 AWG	50A	32	33	3A	7.5A

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL INTERNAL PANEL WIRING TO BE #14 AWG.
2. ALL PLC I/O INTERNAL PANEL WIRING TO BE #18 AWG.
3. [----------] DENOTES REMOTE PANELS OR COMPONENT(S).
4. ALL FIELD WIRING TO BE COPPER CONDUCTORS SIZED AT 60°C.
5. ---G--- DENOTES SKID WIRING BY SIEMENS.
6. ------- DENOTES FIELD WIRING TO EXTERNAL COMPONENTS (BY OTHERS).
7. WIRE COLORS:
   - BLK 120V AND ABOVE POWER
   - RED 120V CONTROL
   - WHT NEUTRAL
   - BLU DC POSITIVE
   - BLU/WHT DC COMMON
   - YEL EXTERNALLY POWERED (≥48) OR UNSPECIFIED VOLTAGE
   - GRN GROUNDING
8. ALL SKID WIRING TO BE #14 AWG THHN MINIMUM, EXCEPT FOR MULTI-CONDUCTOR CABLES WITH OVERALL JACKET.
9. DIP1 SWITCH IS LOCATED ON THE UPPER LEFT CORNER OF THE I/O CARD. SWITCH IS SHOWN SET FOR BOTH ANALOG INPUTS AS 4–20mA CURRENT INPUTS.
10. DIP2 SWITCH IS LOCATED UNDERNEATH THE I/O CARD. SEE MANUFACTURER'S LITERATURE FOR HOW TO REMOVE THE I/O CARD. DIP2(1) IS NOT USED. DIP2(2) ON IS 60Hz AND OFF IS 50Hz.

THIRD ANGLE PROJECTION

BORDER: 22X34D | PRINT NOT TO SCALE | INTL REF:

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN
5	REVISED WIRE #5 ON ES1	3/23/13	JR	JRM	MJL	ECN 08
4	REVISED SOLENOIDS, CR1, PS1	1/23/12	JKJ	MJL	MJL	ECN 08
3	REVISED PUMP MOTOR TABLES	4/12/11	JKJ	TJS	TJS	ECN 08
2	REVISED RELAY NUMBERS TO MATCH CONTROLS DOCUMENTS	1/12/11	JH	JRH	JRH	ECN08
1	REVISED RELAY TERMINAL NUMBERS AND DETAILED RS485 BUS TERMINATOR	7/12/10	JH	JRH	JRH	ECN08

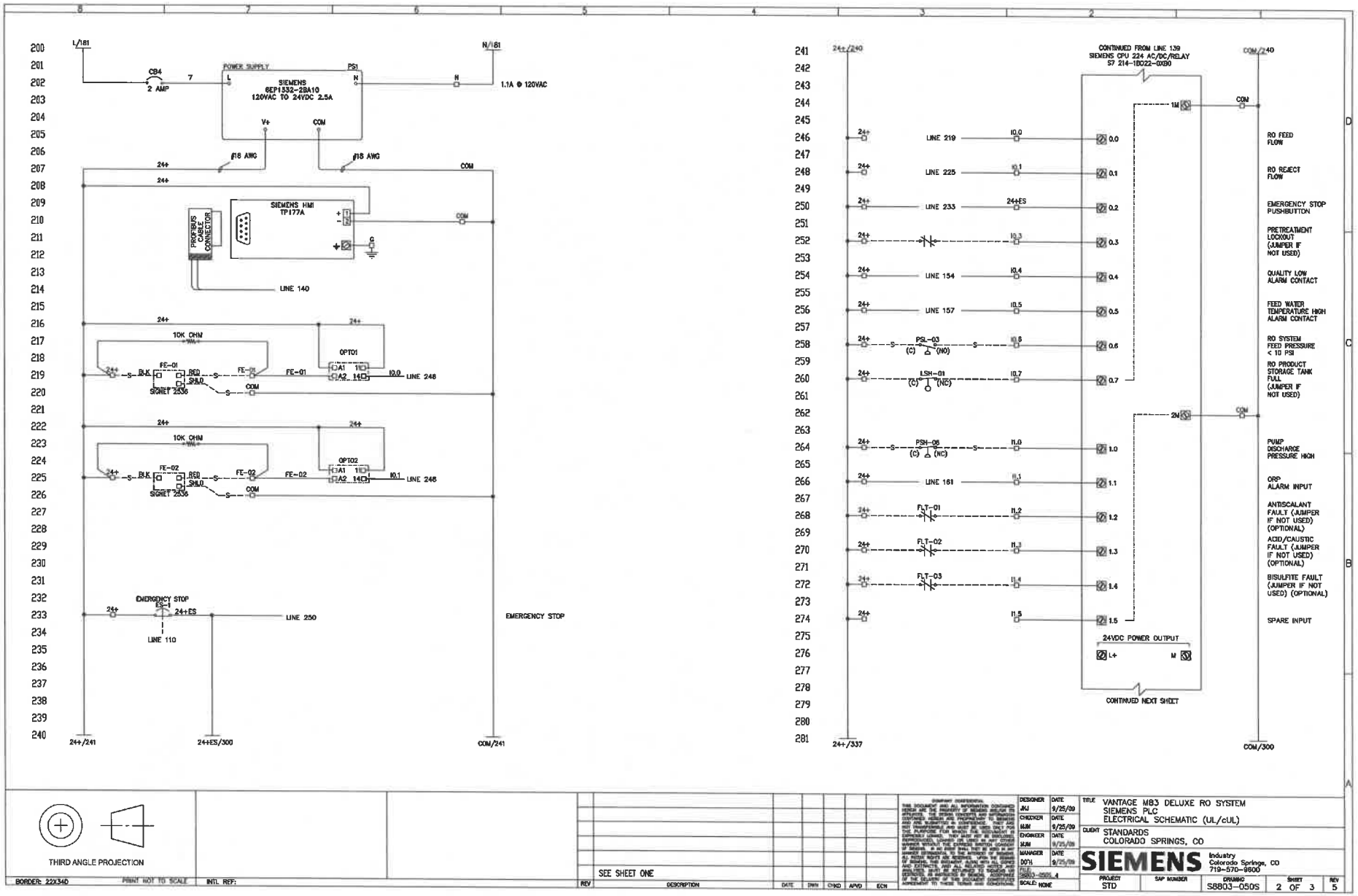
DESIGNER	JKJ	9/25/08
CHECKER	MJM	9/25/08
ENGINEER	MJM	9/25/08
MANAGER	DOH	9/25/08
FILE	(SIEG)-0505_4	
SCALE	NONE	

TITLE: VANTAGE MB3 DELUXE RO SYSTEM
SIEMENS PLC
ELECTRICAL SCHEMATIC (UL/cUL)

CLIENT: STANDARDS
COLORADO SPRINGS, CO

SIEMENS Industry Colorado Springs, CO 719-570-9800

PROJECT	SAP NUMBER	DRAWING	SHEET	REV
STD		S8B03-050S	1 OF 3	5



THIRD ANGLE PROJECTION

BORDER: 22X34D PRINT NOT TO SCALE

INTL REF:

SEE SHEET ONE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

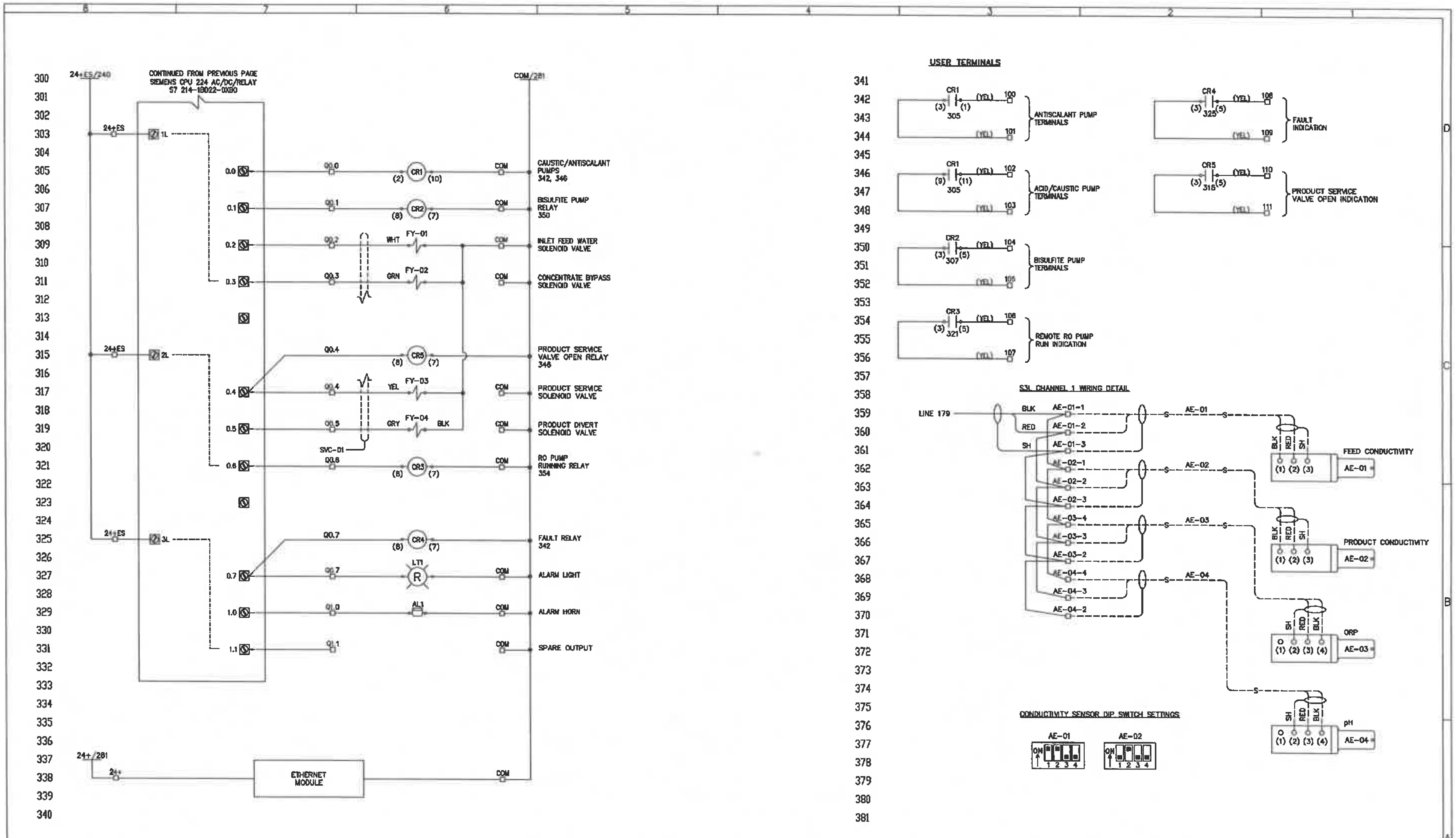
DESIGNER	JKJ	DATE 9/25/09
CHECKER	MJM	DATE 9/25/09
ENGINEER	MJM	DATE 9/25/09
MANAGER	DO'H	DATE 9/25/09
FILE	S8803-050S_4	
SCALE	NONE	

TITLE: VANTAGE M83 DELUXE RO SYSTEM
SIEMENS PLC
ELECTRICAL SCHEMATIC (UL/cUL)

CLIENT: STANDARDS
COLORADO SPRINGS, CO

SIEMENS Industry Colorado Springs, CO 719-570-9600

PROJECT	SAP NUMBER	DRAWING	SHEET	REV
STD		S8803-050S	2 OF 3	5



THIRD ANGLE PROJECTION

BORDER: 22X340 | PRINT NOT TO SCALE | INTL REF:

SEE SHEET ONE

REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN

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DESIGNER: KKJ	DATE: 9/25/08
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ENGINEER: MJM	DATE: 9/25/08
MANAGER: DO'N	DATE: 9/25/08
FILE: S8803-050S_4	SCALE: NONE

TITLE: VANTAGE M83 DELUXE RO SYSTEM
SIEMENS PLC
ELECTRICAL SCHEMATIC (UL/cUL)

CLIENT: STANDARDS
COLORADO SPRINGS, CO

SIEMENS Industry
Colorado Springs, CO
719-570-9600

PROJECT	SAP NUMBER	DRAWING	SHEET	REV
STD		S8803-050S	3 OF 3	5