OPERATION AND MAINTENANCE MANUAL

UF-6-HF
ULTRAFILTRATION SYSTEM

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Introduction

This manual includes the operating instructions and recommended maintenance practices for safe and effective use of an Ultrafiltration (UF) system capable of producing 6 gpm of filtered water.

The system is completely self-contained and includes equipment required for unattended automatic operation. All equipment is skid-mounted and controlled by a single local control system.

It is recommended that the user read this entire manual and closely study the equipment, instrumentation, and controls before operating the UF system.

Technologies Utilized

Microfiltration – A small microfilter is installed on the UF system as pre-treatment for the ultrafiltration membrane. It is a screen-type mesh filter rated for about 80 mesh (200 micron) filtration.

Ultrafiltration - An ultrafiltration (UF) system uses hydrophilic capillary membranes to separate a high percentage of suspended and dissolved molecules. Only certain types of molecules, like water, can pass through the membrane. Other larger molecules, like organic compounds, proteins, oils, and suspended solids do not pass through the membrane and are left behind. The membrane is made of thin "hollow-fibers" with an inside diameter of between 0.8 and 2.0 mm with microscopic pores that let water pass through while acting as a barrier to stop dissolved and suspended particles.

The UF membrane used on the system are an "outside-in" configuration where the feed water stays on the exterior of the membrane fiber and the filtered water passes into the core of the hollow fiber. The UF membrane can be "backwashed" by pumping filtered water in opposite direction of the feed flow through the inside of the fiber. The efficiency of the backwash can be enhanced by adding chemicals (such as acid or hypochlorite) into the backwash water.

As shown in Figure 1, water permeates the minute pores of the membrane and is delivered as purified product water. The impurities in the water do not pass through the membrane, and are instead concentrated in the reject stream that is flushed to the drain or recycled back to the feed water.

The system is designed to operate in conjunction with two customer-supplied tanks; the Raw Water Tank and the UF Filtrate Tank.

Specifications

The UF system is designed to produce up to 6 GPM of effluent per feed water conditions in accordance with Table 1. The UF system is shown in Figure 2 below.

Raw Water Capacity	7 GPM (450 l/h)
Treated Water Capacity	6 GPM (350 l/h)
Dimensions	51” L x 32” W x 73” H
Approx. Dry Weight	900 lbs
Approx. Operating Weight	1,000 lbs
Ambient Temperature	5 – 35 C

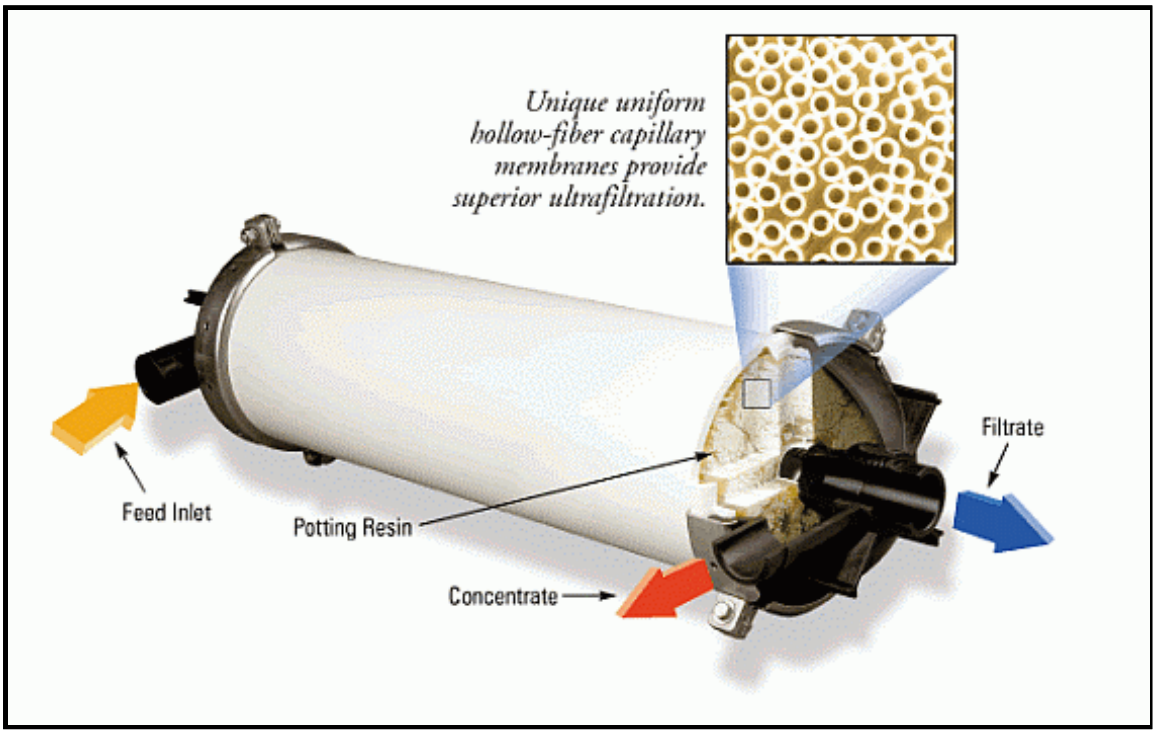

Figure 1- The Ultrafiltration Process using Hollow-Fiber Membranes

System Requirements and Operating Guidelines

Piping Connections

The following connections are required to operate the UF system. Refer to the General Arrangement drawing in Appendix D for more information.

Raw Water Inlet – A flange connection of 1.25” is provided for inlet of the untreated water from the Raw Water Tank. Due to the height of the raw water tank, this connection should have some nominal amount of pressure (at least 1-2 psi).

Temperature of the feed water must not exceed 113º F (45º C). The raw water inlet flow to the UF system should not exceed 10 gpm.

Concentrate Recycle Outlet - A flanged connection of 1/2" is provided for recycle of the concentrate water back to the Raw Water Tank. This outlet should have less than 10 psu pressure.

Filtered Water Outlet – A flanged connection of 3/4" is provided for outlet of the treated wastewater to the UF Filtrate Tank. This outlet is not pressurized.

Concentrate Outlet/Drain – A flanged connection of ¾" is provided for outlet of the UF concentrate and UF backwash effluent. This outlet is not pressurized, therefore the tubing or piping used for discharge from this drain pipe should be run to an open drain in a free and unrestricted manner. Any restrictions or blockage in the drain can cause backpressure which can overflow the storage tanks.

Membrane Drain – A flanged connection of ¾" is provided for draining of the UF membranes. This outlet is not pressurized, therefore the tubing or piping used for discharge from this drain pipe should be run to an open drain in a free and unrestricted manner. Any restrictions or blockage in the drain can cause backpressure which can overflow the storage tanks.

UF Filtrate Inlet – A flange connection of 1.25" is provided for inlet of the filtered water from the Filtrate Tank. Due to the height of the UF Filtrate tank, this connection should have some nominal amount of pressure (at least 1-2 psi). Temperature of the filtered water must not exceed 113º F (45º C). The filtered water inlet flow to the UF system should not exceed 10 gpm.

Electrical Connections

A single electrical connection is required for the UF system. This connection should be a 3-conductor connection, with each conductor having a diameter of at least #14AWG (2.5 mm2). Since the standard electrical supply is 60Hz/220-230V/1-phase, the 3-conductors should include L1, L2, and ground. These connections should be made to the top of circuit breaker CB1 as shown in the electrical drawings included as Appendix C. The electrical service required is 20 amperes.

Note: We recommend that a licensed electrician make the electrical service connection to the UF system install your unit in accordance with local and national electrical codes.

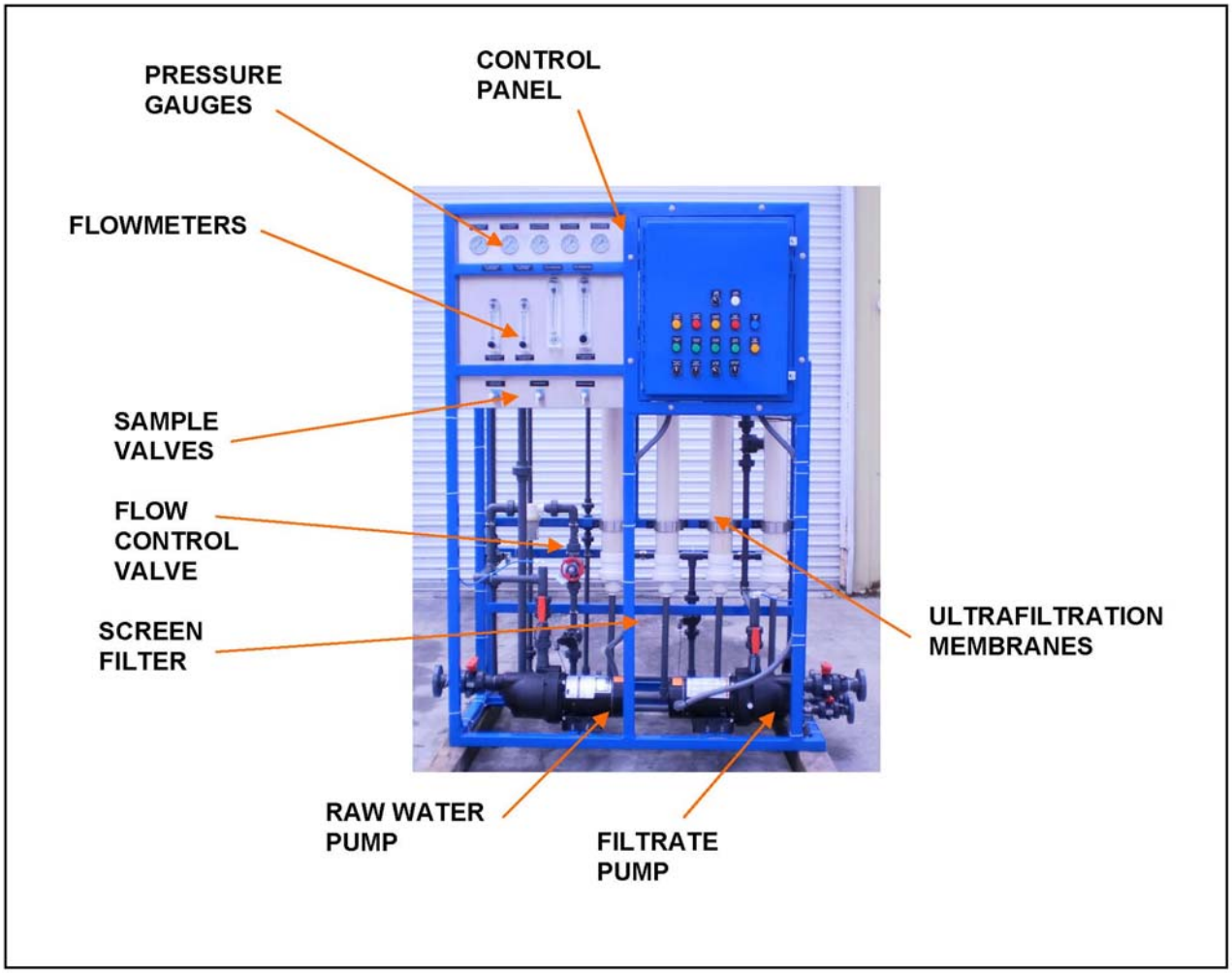

Figure 2 – UF System

Feed Water Requirements

Nothing has a greater effect on the performance of any membrane-based filtration system than the feed water quality. For lasting performance it is important to supply the UF systems with the feed water quality shown below in Table 1.

Note: The projected performance is based on feed water at a temperature of 25°C. Lower feed water temperature will reduce system production. It is very important to meet the feed water requirements. Failure to do so will cause the membranes to foul and may void the warranty.

pH	2 - 11
TDS	up to 10,000 mg/L
TSS	up to 500 mg/L
Temperature	15 to 35 C
Hardness	< 300 ppm as CaCO3
Turbidity	< 50 NTU
Iron	< 5 mg/L
Oils and Greases	< 0.1 mg/L
Solvents, phenols	< 0.1 mg/L

Table 1 – Recommended Feed Water Characteristics

Automatic Operation

The UF system is intended for automatic operation and as such will initiate different functions without much advance indication. The user should be familiar with these automatic functions and make sure that the site conditions are suitable for automatic and unattended operation. In general, it should be understood that when the system is setup for automatic operation, the individual pumps and valves will start and stop automatically depending on the solution level in the three storage tanks.

Raw Water Fill – The Raw Water Tank will automatically be refilled if the pipe connection to the Raw Water Tank is constantly pressurized and the Raw Water Tank level is not full.

UF System Start/Stop – The UF system is equipped with level switches in the Raw Water and Filtrate Tanks which will be used by the local control panel to automatically start and stop the UF system. Indicator lamps on the front control panel will indicate the status of the system.

Start-Up

The UF system is free standing and requires no special installation, however, if placed on an uneven floor, the system may vibrate. Adjustable leveling legs are supplied to facilitate installation.

Carefully inspect your system before start-up. Check all plumbing and electrical connections. Connections may have loosened during shipment.

Step-by-Step Setup Instructions

Refer to the Control Panel Layout drawing included as Figure 3.

1. Confirm that all piping connections are made to the system and the following isolation valves are open and all customer-supplied tank drain valves are closed:

OPEN: BV01 - Raw Water Inlet
BV04 / BV05 – Filtrate Pump Suction / Discharge
BV07 – Filtrate Outlet

CLOSED: BV02 / BV03 – Raw Water Pump Suction / Discharge
BV06 – Drain

2. Confirm that the electrical service is ON and power is available to the UF system.

3. Open the Screen Filter housing and examine the condition of the screen filter element. Remove and clean the element if necessary.

4. Place the REFILL VALVE selector switch in the AUTO position. If the Raw Water Tank is not full, the refill valve will open and the green REFILL VALVE OPEN light will illuminate. Untreated water should begin to flow into the Raw Water Tank.

5. Place the manual valves in the positions corresponding to the FILTRATION mode of operation. For FILTRATION MODE, the manual valve positions are as follows:

   OPEN: BV01 – Raw Water Inlet
   BV02 – Raw Water Pump Suction
   BV03 – Raw Water Pump Discharge
   BV04 – Filtrate Pump Suction
   BV05 – Filtrate Pump Discharge
   BV07 – Filtrate Outlet

   CLOSED: BV06 –Drain

   The manual valve positions specified in paragraph 5 above allow for the filtrate water to be collected until the Filtrate Tank is full. Once the Filtrate Tank is full, the system will stop. The user will need to pump out or drain some water from the Filtrate Tank in order for the system to run continuously.

6. Place the UF MODE selector switch in the FILTRATION position. This switch only controls the operation of the system when the RAW WATER PUMP H-O-A switch is in the HAND position.

7. Place the RAW WATER PUMP selector switch in the AUTO position. If the Raw Water Tank is not empty and the UF Filtrate Tank is not full, the UF system will run and the green RAW WATER PUMP RUN light will illuminate (after a short time delay of about 10 seconds) and the UF filtrate water will begin to flow into the UF Filtrate Tank.

Note: Do not change the valve positions while the Raw Water Pump or the Filtrate Pump are running!!!

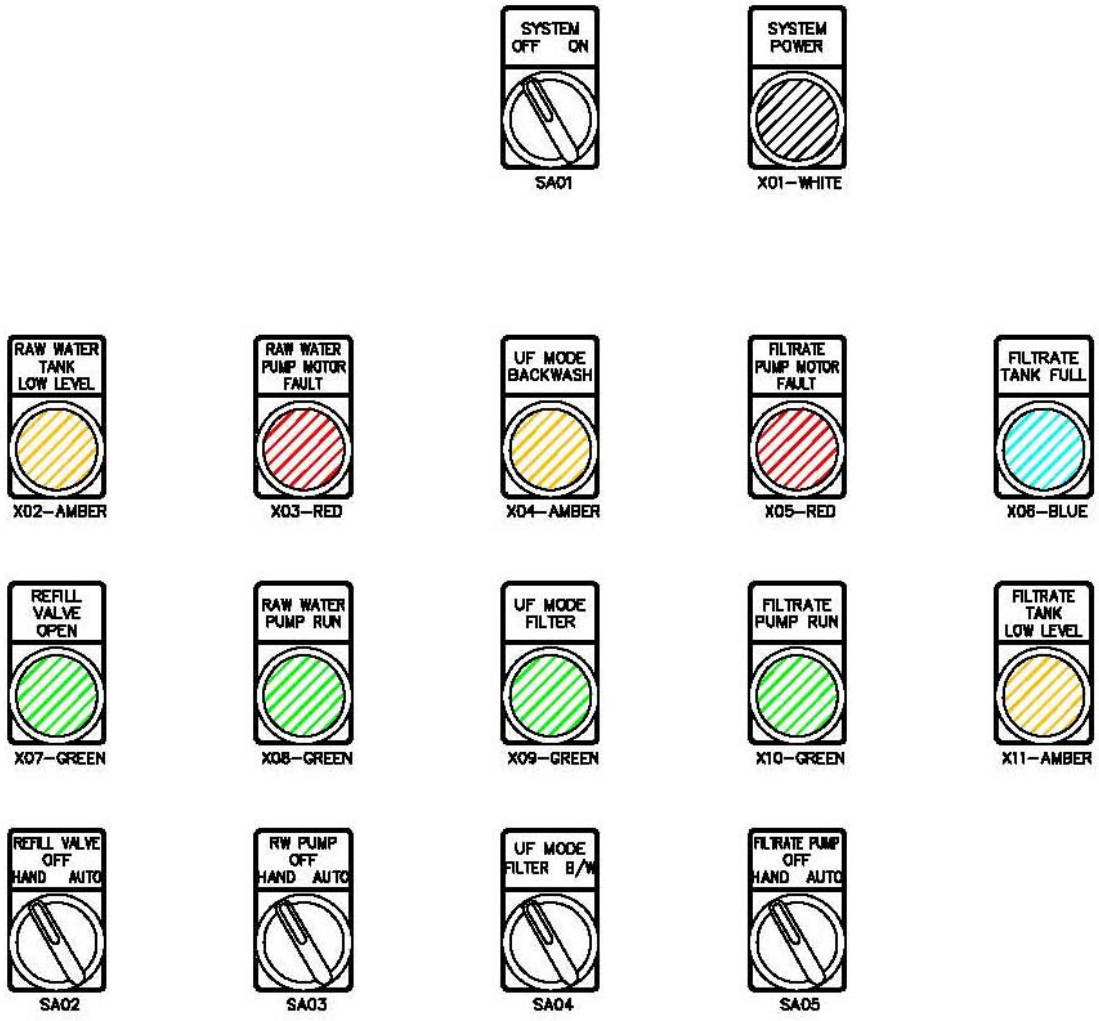

Figure 3 – Layout of Control Panel Indicators and Operators

8. Locate the flowmeters labeled UF CONCENTRATE TO DRAIN and UF CONCENTRATE RECYCLE. Adjust the control valves on these flowmeters (CV02 and CV03) to the desired flow rates for each stream. The recommended values for each are between 0 to 1 GPM. There should be some flow evident on one or both of these flowmeters. Although the UF system will function with little or no concentrate flow, fouling of the UF membranes will occur more rapidly and more frequent backwashing may be needed unless some concentrate water (at least 10% of the feed) is allowed to go to drain and between 10-25% of the feed flow is recycled to the Raw Water Tank.

9. Locate the pressure gauges labeled UF FEED PRESSURE and UF CONCENTRATE PRESSURE. Confirm that both gauges indicate pressures of less than 30 psi (2 bar).

If the UF FEED PRESSURE exceeds 30 psi (2 bar), adjust (close) the Raw Water Pump flow control valve (CV01) until the UF FEED PRESSURE is less than 30 psi (2 bar). This action may result in a decrease in UF FILTRATE flow.

10. Place the FILTRATE PUMP selector switch in the AUTO position. This will enable the Filtrate Pump to run when the UF membrane is backwashed. If the Filtrate Tank is not empty, the UF system will be backwashed periodically and the green FILTRATE PUMP RUN light will illuminate (after a short time delay of about 10 seconds).

    The UF membrane is designed for periodic backwash. The frequency of the backwash will depend on the quality of the feed water and the flux rate. In most cases, backwashing every 15 to 60 minutes is recommended. The interval is preset at the factory for 30 minutes. If the filtrate flow for a given feed pressure decreases more than 25%, the backwash frequency should be increased.

    While backwashing, locate the flow meter labeled BACKWASH FLOW. When the UF Backwash cycle begins, first adjust the BACKWASH FLOW flow meter to a flow rate of about 7 GPM (26 LPM).

11. Complete the Operation Log with your Start-Up data and return to CON-SERV MANUFACTURING to validate your system's warranty. Save a copy of your start-up information for your records. We recommend that you maintain your Operation Log for your system.

Equipment Operation

Operation of the UF system is performed by use of controls, valves, and instruments. Described below are the devices that are used to operate the UF system. The user should be familiar with these devices – their location and function - before operating the UF system.

Raw Water Tank – this tank is customer-supplied and has four (4) level switches installed.

The two lower switches (L and LL) are used to protect the Raw Water Pump from running dry and the two higher switches (H and HH) are used to control when the automatic refill valve will open. UF concentrate water can be returned to this tank if so controlled via the flowmeter and control valve (CV02) on the front panel.

Raw Water Pump - The Raw Water Pump supplied is a single-stage, centrifugal type pump which operates during filtration and flush modes of the UF system. Follow these guidelines for proper operation of the pump:

- The pump must NEVER be run dry. Operating the pump without sufficient feed water could damage the pump. Make sure the pump suction valve (BV02) is open when the Raw Water Pump HOA system selector switch is in the HAND or AUTO position.

- Do not let the pump “dead-head” by allowing blockage in the discharge piping. The discharge valves (BV03 and CV01) must be open and the screen filter should not be clogged.

Screen Filter – The UF system is supplied with a particulate pre-filter that filters out most particles over 200 microns in size before the water is pumped through the Ultrafiltration membrane. The microfilter will eventually become clogged with trapped particles and will need to be cleaned by washing the filtration element. This is done by removing the screen filter element from the housing and manually rinsing trapped particles out using running tap water.

Ultrafiltration Membrane Modules - Four (4) hollow-fiber UF membrane modules are installed on the UF system. The UF membranes are intended to be operated automatically, so there is essentially nothing to operate on the membrane unless they need to be cleaned or removed. Drain valves are installed to permit drainage of any residual water from the module prior to removal. The membrane cleaning procedure is described in detail in another section of this manual.

Flowmeters and Control Valves – There are four (4) control valves installed, three (3) of which are integrated into a flowmeter . These control valves (CV01 – CV04) are the primary means for the user to control the recovery and backwash flow for the UF operation. The following guidelines should be considered when operating these flowmeters and control valves:

- One of the two “concentrate” flowmeters should have some positive flow rate. It is not essential that both flowmeters display a flow, but there should be some concentrate flow.

- The backwash flowmeter should be set once to the recommended flows, then left alone. Other than to confirm that the valves are adjusted to provide the recommended flows, there is no need to regulate this valve during each backwash.

UF Filtrate Tank – this tank is customer-supplied and has four (4) level switches installed. The two lower switches (L and LL) are used to protect the UF Filtrate Pump from running dry and the two higher switches (H and HH) are used to control when the UF System starts and stops when it is in AUTO mode.

Filtrate Pump - The Filtrate Pump supplied is a single-stage, centrifugal type pump which operates during the backwash mode of the UF system. Follow these guidelines for proper operation of the pump:

- The pump must NEVER be run dry. Operating the pump without sufficient feed water could damage the pump. Make sure the filtrate pump suction valve (BV04) is open when the Filtrate Pump selector switch is in the HAND or AUTO position.

- Do not let the pump “dead-head” by allowing blockage in the discharge piping. The filtrate pump discharge valve (BV05) and backwash flow control valve (CV04) must be open when the UF Filtrate Pump is running.

Pressure Gauges – Liquid-filled pressure gauges are installed at numerous points in the UF system to measure and display the operating pressures. The normal operating range of each pressure gauge is displayed in Table 2 below:

Pressure Gauge	Normal Range (psi)
Screen Filter Inlet (PI01)	20 - 40
UF Membrane Feed (PI02)	10 - 15
UF Concentrate (PI03)	10 – 15
UF Filtrate (PI04)	< 5
UF Backwash (PI05)	20 – 40

Table 2 – Normal Operating Pressures

Most of the pressures indicated in Table 2 should remain reasonably constant over time unless there is some damage or line blockage. The exceptions to this condition are the UF membrane feed and concentrate pressures. These pressures are influenced by many factors, most notably the feed water temperature. When the feed water is colder (less than 25C), the pressure required to make an equivalent amount of UF filtrate will increase.

In addition to the feed water temperature, the membrane pressures will increase as the membrane ages and/or becomes fouled. One can assume the operating pressure will increase about 5-15% per year simply due to deterioration of the membrane performance. Pressure increases due to scaling can be overcome by membrane cleaning.

Flowmeters – Rotometer-type flowmeters are installed at numerous points in the UF system to measure and display the flow rates of the treated water. The normal operating range of each flowmeter is displayed in Table 3 below:

Flowmeter	Normal Range
UF Concentrate Recycle (FI01)	0 - 1 GPM (4 lpm)
UF Concentrate to Drain (FI02)	0 - 1 GPM (4 lpm)
UF Filtrate (FI03)	6 GPM (23 lpm)
UF Backwash (FI04)	7 GPM (26 lpm)

Table 3 – Normal Operating Flow Rates

Selector Switches and Operators - There are three (3) 3-position HAND-OFF-AUTO (H-O-A) selector switches installed on the Control Panel. When these switches are in the HAND position, the device or system they control will run, regardless of the level detected by any level controls used.

Placing the switch in the OFF position will stop the system but the control panel will be energized. Use the AUTO position if you want the system to start and stop automatically based on the tank level.

There is one (1) 2-position OFF-AUTO switch installed. The UF MODE selector switch allows the user to run the system manually in either the FILTRATION or the BACKWASH mode.

Alarms and Indicators – There are three green indicator lamps corresponding to the three HOA switches, as described previously in this manual. In addition, there are eight (8) warning and/or alarm indicator lamps, as follows:

Raw Water Tank Low Level (amber) – when the Raw Water Tank Level drops below the LL level switch in the Raw Water Tank, this indicator lamp will illuminate and the Raw Water Pump will stop if the Raw Water Pump HOA Switch is in the AUTO position. The Raw Water Pump will not restart until the tank level rises to above the L level switch.

Filtrate Tank Low Level (amber) – when the Filtrate Tank Level drops below the LL level switch in the Filtrate Tank, this indicator lamp will illuminate and the Filtrate Pump will stop if the Filtrate Pump HOA switch is in the AUTO position. The Filtrate Pump will not restart until the tank level rises to above the L level switch.

Filtrate Tank Full (blue) – when the Filtrate Tank Level rises above the HH level switch in the Filtrate Tank, this indicator lamp will illuminate and the Raw Water Pump will stop if the Raw Water Pump HOA switch is in the AUTO position. The Raw Water Pump will not restart until the tank level drops to below the H level switch.

Raw Water Pump Motor Fault (red) – if the Raw Water Pump motor draws excessive current, the motor starter will trip and this indicator lamp will illuminate. The motor can be restarted and the light will go out after the motor starter is reset to the START position (this is done by opening the control panel and pressing the START button on the motor starter OL1).

Filtrate Pump Motor Fault (red) – if the Filtrate Pump motor draws excessive current, the motor starter will trip and this indicator lamp will illuminate. The motor can be restarted and the light will go out after the motor starter is reset to the START position (this is done by opening the control panel and pressing the START button on the motor starter OL2).

UF Mode Filtration (green) – when the UF system is in FILTRATION mode, either manually or automatically, this indicator lamp will illuminate.

UF Mode Backwash (amber) – when the UF system is in FILTRATION mode, either manually or automatically, this indicator lamp will illuminate.

System Maintenance and Membrane Cleaning

The UF system is designed for extended periods between membrane cleaning by frequent backwash of the UF membrane. However, the automatic backwash and flush cycles only extend the periods between maintenance, and some cleaning of the devices installed on the system may be required.

Each of the filtration systems has their own maintenance requirements, as outlined below. Mechanical devices such as the pumps, valves, controls, and instruments are designed for continuous duty and a long service life. Proper care of the equipment such as keeping the equipment clean and dry will extend its useful life.

Micron Filter – the screen inside the filter housing is intended to last for years, but in the event of damage or irreparable fouling, the screen can be replaced. The screen can also be removed and cleaned manually as needed.

UF Membrane Module – the UF membrane modules will have to be replaced after about two to three years of service. In the interim, the only maintenance of the UF membranes will be chemical cleaning. In the event of extended downtime, preservation of the membrane may be required.

Membrane Cleaning

Periodic cleaning of the membrane(s) can improve system performance and is the most important and complicated maintenance procedure required. In normal operation, mineral scale, biological matter, colloidal particles, and organic substances can foul the membranes and must be removed to restore performance. Cleaning procedures and chemicals vary depending on the type of foulant to be removed.

WARNING: Cleaning chemicals are dangerous and can cause injury and damage to the environment. Read and comply with all safety and disposal precautions listed on the Material Safety Data Sheets (MSDS's).
It is the user's responsibility to comply with all applicable local regulations.

CON-SERV MANUFACTURING supplies a complete line of membrane cleaning stations that can be used to clean membranes; however, if a cleaning station is not available, the membrane can be cleaned using the UF system and some additional accessories.

The following instructions are typical of cleaning most types of hollow-fiber UF membranes. For more precise information, refer to the Appendix for the specific instructions from the manufacturer of the membranes installed on this system.

Inorganic Membrane Cleaning

Use an acid cleaning solution to remove inorganic salts such as CaCO3, CaSO4, BaSO4 and metal oxides (i.e., iron) from the membranes. Do not use sulfuric acid because it may cause calcium sulfate to precipitate on the membrane(s).

Acceptable cleaning solutions (all compositions given by **weight**):

- CON-SERV MANUFACTURING Cleaning Solution #1 (0.5 kg per 60 liters of RO water).
- A solution of 0.2% hydrochloric acid (HCl),
- A solution of 0.2% sulfamic acid (NH_2SO_3H), or

The solution will be most effective if maintained at 95°F (35°C). The pH of the solution should be around 2.

Organic Membrane Cleaning

Use an alkaline cleaning solution to remove silica, biofilms, and organics from the membranes.

Acceptable cleaning solutions (all composition given by **weight**):

- CON-SERV MANUFACTURING Cleaning Solution #2 (0.5 kg for every 60 liters of RO water).
- A solution of 0.1% sodium hydroxide (NaOH) and 0.1% of tetra-sodium salt of ethylene diamine tetraacetic acid (Na-EDTA)

The pH of the solution should be approximately 12. The temperature of the solution should not exceed 86°F (30°C).

Membrane Cleaning Instructions

These directions describe how the membranes can be cleaned using only the devices installed on the UF system. Please follow the directions elsewhere in this manual regarding the operation of the specific devices and equipment installed on the UF system skid.

1. Before starting the cleaning process, record the current performance data as indicated on the Operating Log Sheet included in Appendix A.

2. Place the valves in the following positions:

OPEN:	BV02 – Raw Water Pump Suction
	BV03 – Raw Water Pump Discharge
	CV02 – Concentrate Recycle to Raw Water Tank
	CV01 – Raw Water Flow Control Valve
CLOSED:	CV03 – Concentrate to Drain
	BV07 – UF Filtrate to Filtrate Tank

3. Close completely the control valve on the flowmeter labeled UF CONCENTRATE TO DRAIN (CV03). Open completely the control valve on the flowmeter labeled UF CONCENTRATE TO RAW WATER TANK (CV02).

4. Fill the Raw Water Tank with fresh water (preferably RO permeate water).

5. Place the RAW WATER PUMP HAND-OFF-AUTO switch in the AUTO position.

   Confirm that all the water in the Raw Water Tank is circulating from the Raw Water Tank through the UF membrane and back into the Raw Water Tank. No filtrate flow should be indicated on the UF FILTRATE flowmeter.

6. Continue this rinse procedure for about 15-30 minutes, then stop the rinse procedure by placing the RAW WATER PUMP HOA switch in the OFF position. If desired, an additional 30 minute soak in permeate water can be performed.

7. Drain the contents of the Raw Water Tank. Drain the UF membrane modules by opening the Drain Outlet valve (BV06).

8. After the Raw Water Tank is emptied, close any Raw Water Tank Drain Valves..

9. Refill the Raw Water Tank with fresh or RO Permeate water.

10. Add the active cleaning chemical (acid for inorganic scale, caustic for organics, silt, and biofilms). If both acid and caustic cleaning are to be performed, it is recommended that the acid cleaning be performed first. Mix the chemical completely into solution.

11. Place the RAW WATER PUMP HAND-OFF-AUTO switch in the AUTO position. Confirm that all the cleaning solution in the Raw Water Tank is circulating from the Raw Water Tank through the UF membrane and back into the Raw Water Tank. No filtrate flow should be indicated on the UF FILTRATE flowmeter.

12. Continue this cleaning procedure for about 30-60 minutes, then stop this cleaning procedure by placing the RAW WATER PUMP RUN switch in the OFF position.

13. Drain the contents of the Raw Water Tank. Drain the UF membrane modules by opening the Drain Outlet valve (BV06).

14. If both acid and caustic cleaning are to be performed, perform a rinse procedure, then clean with caustic by repeating steps 7-13 above.

15. Perform a final rinse procedure by repeating steps 4-8 above.

16. Restore all valves to their normal operating position as described elsewhere in this manual. Place the REFILL VALVE HAND-OFF-AUTO switch in the AUTO position and refill the Raw Water Tank with untreated water.

17. Place the UF SYSTEM HAND-OFF-AUTO switch in the HAND or AUTO position. Confirm that filtrate is being produced and all flows and pressures are in the recommended ranges.

18. Record the current performance data as indicated on the Operating Log Sheet included in Appendix A

Membrane Preservation

The recommended solution for preservation of UF and membranes is sodium bisulfite (Na2SO3). The concentration is typically 1% by weight, but concentrations can vary depending on the membrane manufacturer. Refer to the Appendix for the UF membrane manufacturer's recommendation. To introduce the preservative solution, a process similar to the membrane cleaning is performed.

Once the membranes have been preserved using the bisulfite chemical, before the system can be restarted normally, the preservative solution should be rinsed out. It is recommended that all UF filtrate produced for the first hour after preservation be dumped to drain.

The procedures for preserving the membranes are as follows:

UF Membrane Preservation:

1. Place the valves in the following positions:

OPEN:	BV02 – Raw Water Pump Suction
	BV03 – Raw Water Pump Discharge
	CV02 – Concentrate Recycle to Raw Water Tank
	CV01 – Raw Water Flow Control Valve
CLOSED:	CV03 – Concentrate to Drain
	BV07 – Filtrate Outlet to Filtrate Tank

2. Close completely the control valve on the flowmeter labeled UF CONCENTRATE TO DRAIN (CV03). Open completely the control valve on the flowmeter labeled UF CONCENTRATE TO RAW WATER TANK (CV02).

3. Fill the Raw Water Tank with fresh water (preferably RO permeate water).

4. Add the sodium bisulfite chemical (about 1 lb. per 50 gallons water) and mix completely.

5. Place the RAW WATER PUMP HAND-OFF-AUTO switch in the AUTO position. Confirm that all the water in the Raw Water Tank is circulating from the Raw Water

Tank through the UF membrane and back into the Raw Water Tank. No filtrate flow should be indicated on the UF FILTRATE flowmeter

6. Continue this recirculation procedure for about 10-15 minutes, then stop the procedure by placing the UF SYSTEM RUN switch in the OFF position.

7. Drain the contents of the Raw Water Tank. Drain the UF membrane modules by opening the UF membrane drain valve (BV06).

8. After the Raw Water Tank is emptied, close any Raw Water Tank Drain Valves.

Troubleshooting

If the system production declines or the unit stops working check the mechanical components for any visual problems. Listed below are the items to check for two of the most commonly encountered problem conditions: LOW SYSTEM PRESSURE and ABNORMAL FILTRATE FLOW. Refer to the membrane manufacturer's recommendations for troubleshooting as found in the Appendix.

Low System (Feed) Pressure

Low system pressure occurs when sufficient feed water pressure and flow are not obtained. This may cause any of the pumps installed on the UF system to cavitate. Failure to provide the proper feed flow and pressure will result in lower system pressure that may result in low production and poor rejection. Check the following components:

SUCTION VALVES: Check the isolation valve between the tanks and the Raw Water and UF Filtrate Pump suction. These valves must be open for the pumps to operate.

PUMP: Isolate the pump and determine how much pressure can be achieved. This can be determined by checking the pump discharge pressure gauge at this point. The pressure of the pump should reach at least 2 bar (20 psi) when the flow is restricted.

PRE-FILTERS: Check the differential in the pressure gauges corresponding to the micron filter (PI01 and PI02) to determine if this filter is restricting the flow from the pump.

ELECTRIC: Check to ensure that there are no electrical fuses blown or breakers tripped and that all electrical connections are secure. Use a voltmeter to verify that the motor is getting sufficient power. Refer to the electrical schematic supplied for required electrical power.

PRESSURE GAUGES: Check for foreign matter on the gauge fittings. Remove any visible matter and replace the fitting. Verify that the tube is not pushed too far inside the fitting. This could restrict flow and cause an inaccurate display. If the fitting and tube are fine and the pressure gauge is still malfunctioning, the gauge should be replaced.

FLOW CONTROL VALVES: The flow control or concentrate control valves may be defective, thereby prohibiting the system from achieving any backpressure. Remove the valve, inspect the internals, and replace if necessary.

MOTOR: The motor may not be drawing the correct current or may be wired improperly. Use a clamp-on ammeter to check the current draw. If the three-phase legs are reversed, the motor rotation will be reversed and the pumps will not generate the specified discharge flow or pressure.

LEAKS: Check the system for leaks, as this can result in low pressure.

Abnormal Filtrate Flow

Filtrate and permeate flow should be within 15% of the rated production, after correcting for feed water temperatures above or below 25° C. Check the filtrate flow meter to confirm the flow rate. If the flow meter is not working or your suspect it is inaccurate, measure the time it takes to fill a 5-gallon container then calculate the filtrate flow rate at gallons per minute.

Causes of Low Filtrate Flow

COLD FEED WATER: Ultrafiltration membranes achieve optimal performance at a feed water temperature of 77F (25C). The exact change in membrane performance, as a function of temperature is specific to each membrane type and manufacturer. In general, the production of the membrane increases by 2% for each degree C above 25C and declines by about 2% for each degree C below 25C. For example, at 10C feed water temperature, the typical UF membrane will operate at about 50% of its specified flow rate at 25C. Increasing the concentrate pressure (to the extent permitted by the capacity of the Raw water pump and maximum recommended pressure ratings of the membrane module will increase the filtrate flow when feed water is cold.

LOW OPERATING PRESSURE: The filtrate flow and the concentrate (operating) pressure are directly related. Increase the operating pressure by closing the concentrate valve slightly. If the pressure does not increase, check the mechanical devices as indicated previously.

FOULED OR SCALED MEMBRANE: Accumulation of foulants or mineral scale on the membrane surface will reduce the filtrate or permeate flow. In most cases, membrane cleaning will be required. Refer to cleaning instructions in this manual and the Appendix for more information on determining the type of membrane cleaning required. A short-term alternative should membrane cleaning not be feasible is to perform and automatic flush or to feed filtrate water through the system and soak the membranes in filtrate or permeate by leaving the filtrate or permeate water in the system overnight.

Causes of High Filtrate Flow

DEFECTIVE PRODUCT O-RING: If the filtrate o-ring(s) or seals are damaged, out-of-position, or missing, concentrate water may be able to enter the filtrate or permeate piping and cause a dramatic increase in filtrate flow and decline in filtrate quality. Remove the fitting connections from the modules and examine the product-tube o-rings to ensure they are in position and free of nicks, cuts, debris and separations. (Note that the physical configuration of UF membranes vary, and some membrane modules may not use seals or o-rings)

DEFECTIVE OR OXIDIZED MEMBRANE: If the membrane has been exposed to certain solvents or oxidants the membrane may suffer irreversible damage, evidenced by high filtrate flow and low solids rejection. UF membranes are made of an inert material (PVDF) that is highly chemical-resistant. In most cases, membrane replacement will be required to restore filtrate flow. Before replacing membranes, determine the source of the oxidation or other contaminant and install the proper pre-treatment. In addition, the UF membrane fibers can break, thereby allowing the feed water to enter the filtrate water. If the cause of the failure is unknown, obtain a return authorization from the membrane supplier and return the defective membrane for a destructive test and failure analysis.

Causes of Poor Filtrate Quality

LOW OPERATING PRESSURE: The filtrate quality and the concentrate (operating) pressure are directly related. Higher operating pressures typically result in greater solids removal. Increase the operating pressure by closing the concentrate valve slightly. If the pressure does not increase, check the mechanical devices as indicated previously.

DEFECTIVE OR OXIDIZED MEMBRANE: If the membrane has been exposed to certain solvents or oxidants the membrane may suffer irreversible damage, evidenced by high filtrate flow and low solids rejection. In most cases, membrane replacement will be required to restore filtrate flow. Before replacing membranes, determine the source of the oxidation or other contaminant and install the proper pre-treatment. In addition, the membrane fibers can break, thereby allowing the feed water to enter the filtrate water. If the cause of the failure is unknown, obtain a return authorization from the membrane supplier and return the defective membrane for a destructive test and failure analysis.

Appendix

A - Operating Log Sheet

B - Component Specifications and Manuals

C - Electrical Schematics

D – General Arrangement and Process & Instrumentation Drawings