NELSEN WATER SOLUTIONS Since 1954

Nelsen NRO 440 Commercial Systems

Installation, Operation & Maintenance Manual

Systems manufactured after May-2017





Including Models

NRO-1440-2500	NRO-2440-5000	NRO-3440-7500	NRO-4440-10000	NRO-5440-12500	NRO-6440-15000	NRO-8440-20000

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System Specifications

Nelsen Commercial Reverse Osmosis System Specifications							
Model:	**NRO-1440-2500**	**NRO-2440-5000**	**NRO-3440-7500**	**NRO-4440-10000**	**NRO-5440-12500**	**NRO-6440-15000**	**NRO-8440-20000**
Production GPD ***	2500	5000	7500	10000	12500	15,000	20,000
Membrane	4 X 40 (1)	4 X 40 (2)	4 X 40 (3)	4 X 40 (4)	4 X 40 (5)	4 X 40 (6)	4 X 40 (8)
Permeate GPM	1.73	3.47	5.2	6.94	8.68	10.4	13.8
Feed GPM **	6.0	7.0	10.0	12.0	17.0	20.0	25.0
% Recovery w/Recycle	19%-30%	50%-75%	50%-75%	50%-75%	50%-75%	50%-75%	50%-75%
Pump	1 HP	1 HP	1.5 HP	1.5 HP	3 HP	3 HP	3 HP
FLA 60HZ 1Ø 220	19.2/9.6	19.2/9.6	*/12	*/12	*/15	*/15	*/15
Circuit Size	15A	15A	15A	15A	20A	20A	20A
Inlet	3/4"	3/4"	3/4"	3/4"	1" Big Blue®	1" Big Blue®	1" Big Blue®
Permeate	1/2"	1/2"	1"	1"	1"	1"	1"
Concentrate	1/2"	1/2"	1"	1"	1"	1"	1"
Shipping Dims	34"x34½"x58½"	34"x34½"x58½"	34"x34½"x58½"	34"x34½"x58½"	34"x34½"x58½"	34"x34½"x58½"	34"x34½"x58½"
Weight - Pounds	124 lbs.	149 lbs.	158 lbs.	169 lbs.	211 lbs.	224 lbs.	248 lbs.
Max Operating Pressure	160 psi	160 psi	160 psi	160 psi	160 psi	160 psi	160 psi

WARNING: *Please carefully read the information contained in this Installation, Operation & Maintenance Manual (IO&M Manual) before starting or operating this reverse osmosis water purification system. Failure to do so may void warranty, cause equipment damage, bodily injury or potentially death.*

WARNING: *This Reverse Osmosis System is designed and produced for the purification of water only. Do not use this equipment for any other purpose without express written authorization from the manufacturer. Failure to follow these guidelines may result in serious bodily injury or death.*

WARNING: *The RO System should be shielded from the elements. Periodic rain and exposure to UV Rays will cause irreparable damage to the unit and will not be covered by warranty. Exposure to rain and high humidity environments may also cause damage to the pump motor and electronic controls. This damage will not be covered under warranty.*

Introduction

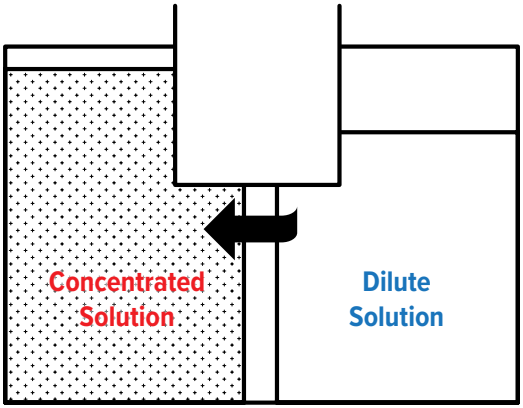
Nelsen Corporation's commercial reverse osmosis NRO systems produce high quality water. The system is durable and with proper care will last for many years. Components are of the highest quality on our reverse osmosis systems. This manual outlines installation, operation, maintenance and troubleshooting details vital to the sustained performance of your system.

Reverse Osmosis Water Filtration Process

Reverse Osmosis removes dissolved inorganic solids (such as salt) from water. The membrane allows only the permeate water, not contaminates, to pass through to Point of Use (POU). Reverse osmosis is considered to be the finest filtration process and was developed as a method for the desalination of seawater, but was later accepted by many manufacturing industries as a method of water purification. The process of reverse osmosis involves forcing water molecules through a semi-permeable membrane which is rolled up spirally around a hollow tube. High pressure exerted by the water, forces the water through the membrane, separating it from the impurities. This process removes unwanted particles that are as small as dissolved ions. The impurities are flushed to drain.

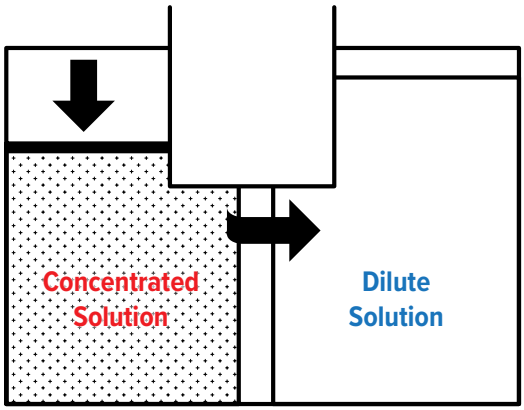
FIGURE 1

Osmosis



Water diffuses through semi-permeable membrane toward region of higher concentration to equalize solution strength. Ultimate height difference column is "osmotic" pressure.

Reverse Osmosis



Applied pressure in excess of osmotic pressure reverses water flow direction, hence the term "Reverse Osmosis".

Feed Water Requirements

Feed water quality has a huge effect on the performance of the reverse osmosis system. It is important to supply the reverse osmosis system with the feed water quality shown below. Pretreatment may be required if the parameters below are not met. Failure to meet feed water requirements may foul membranes, void the system warranty and effect the stated performance of the system.

Table 2: Recommended Feed Water Quality

Hardness	<1 grain (17.1 ppm)
Free Chlorine	0 ppm
T.D.S.*	<2000 ppm
Turbidity SDI	<5
Ph	3-11
Iron	<0.01 ppm
Silica	<1 ppm
Hydrogen Sulfide	0 ppm
Manganese	<0.05 ppm
Organics	<1 ppm
Flowing Pressure	35 - 60 psi
Temperature	40°F - 80°F 8°C - 27°C

*If TDS exceeds 2000 ppm, consult factory.

The RO feed water must be pretreated in order to prevent membrane damage and/or fouling. Proper pretreatment is essential for reliable operation of any RO system.

Pretreatment requirements vary depending on the quality of the feed water. Pretreatment equipment is sold seperatly. The most common forms of pretreatment are described below.

Media Filter - Used to remove large suspended solids (sediment) from the feed water. Backwashing the media removes the trapped particles. Backwash can be initiated by time or differential pressure.

Water Softener - Used to remove calcium and magnesium from the feed water in order to prevent hardness scaling. Softening is the preferred method of controlling hardness scale.

Carbon Filter - Used to remove chlorine and organics from the feed water. Free chlorine will cause rapid irreversible damage to the membranes.

The residual free chlorine present in most municipal water supplies will damage the thin film composite structure of the membranes used in this unit. Carbon filtration or sodium bisulfite injection should be used to completely remove the free chlorine residual.

Chemical Injection - Typically used to feed antiscalant, coagulant, or bisulfite into the feed water or to adjust the feed water pH.

Prefilter Cartridge - Used to remove smaller suspended solids and trap any particles that may be generated by the other pretreatment. The cartridge(s) should be replaced when the pressure drop between the inlet and outlet of the filter housing/cartridge combination exceeds 10 psi. The effect of suspended solids is measured by the silt density index (SDI) test. An SDI of five (5) or less is specified by most membrane manufacturers and three (3) or less is recommended.

Iron & Manganese - These foulants should be removed to less than 0.1 ppm. Special media filters and/or chemical treatment is commonly used.

pH - Lowering the feed pH results in a lower LSI value, which reduces the scaling potential for calcium carbonate. ***LSI - Langlier Saturation Index - is basically a way to determine if water is corrosive (negative LSI) or scale-forming (positive LSI).***

Silica - Reported on the analysis as SiO_2. Silica forms a coating on membrane surfaces when the concentration exceeds its solubility. Additionally, the solubility is highly pH and temperature dependent. Silica fouling can be prevented with chemical injection and/or reducing the recovery.

Reverse Osmosis Components

- Reverse Osmosis Unit: Required for the production of treated water, as per the daily requirements. Different capacities of the unit are available depending on the rate of production of purified water. For example, a 1600 gallon-per-day system produces purified water at the rate of 66 gallons per hour.
- Pretreatment Equipment: Filtration systems are necessary and should be installed along with the reverse osmosis system, especially if the water contains excessive mineral hardness.
- Storage Tank: Necessary for storage of permeate water. The storage tank stores the permeate water for later use.
- Re-pressurization System: Consists of a pump and bladder tank, which pressurizes water from storage tank and supplies water where there is a demand.

NOTES: *NRO Commercial Tap Water System Performance is based on 500 ppm TDS & 77°F temperature. Higher TDS or lower temperatures could affect permeate production.*

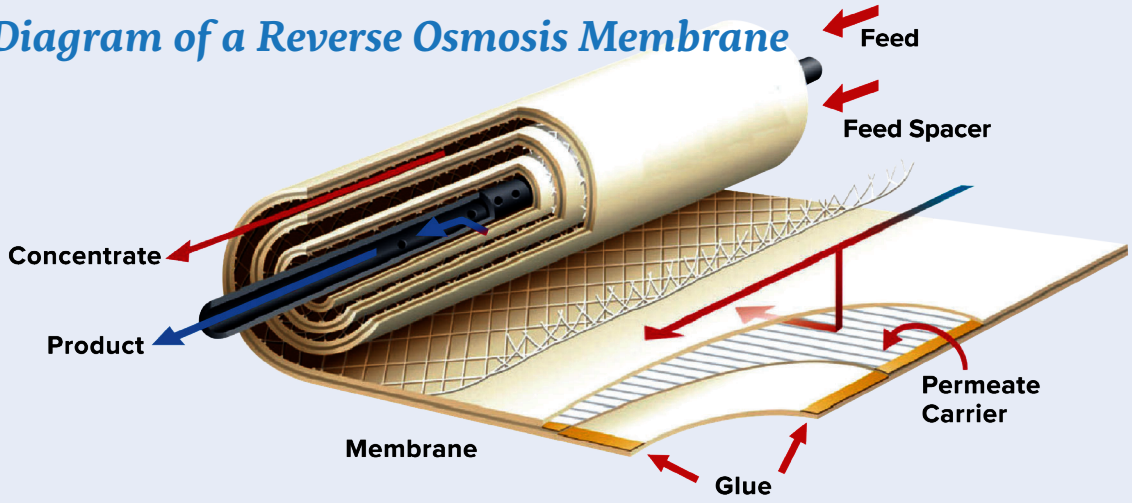
Table 3: Typical Rejection Characteristics of Reverse Osmosis Membranes[%]

Sodium	85-94%
Lead	95-98%
Sulfate	96-98%
Arsenic	92-96%
Calcium	94-98%
Magnesium	94-98%
Potassium	85-95%
Nickel	96-98%
Nitrate	60-75%
Fluoride	85-92%
Iron	94-98%
Manganese	94-98%
Zinc	95-98%
Cadmium	95-98%
Mercury	95-98%
Barium	95-98%
Selenium	94-96%
Cyanide	84-92%
Phosphate	96-98%
Chloride	85-92%

[%] May vary based on membrane type, water pressure, temperature, pH & TDS

FIGURE 2

Diagram of a Reverse Osmosis Membrane



Recovery & Rejection

Recovery is defined as the measure of the permeate flow to feed flow. A higher recovery rate means less concentrate going to the drain. A higher recovery can also cause soluble salts to precipitate out of the concentrate and onto the membrane surface.

$$\textbf{\% Recovery} = \frac{\text{Permeate flow rate}}{\text{Feed flow rate}} \times 100$$

Feed Flow = Permeate Flow + Concentrate Flow

Example: If permeate flow is 10 GPM and concentrate flow is 15 GPM, then

Feed Flow = 10 + 15 = 25 GPM

% Recovery = (10/25) x 100 = 40%

The amount of total dissolved solids (TDS) rejected by the membrane is expressed as a percentage (%). For example, a 99.6% rejection rate means that 99.6% of total dissolved solids do not pass through the membrane. To calculate the % rejection, use the following formula:

$$\textbf{\% Recovery} = \frac{\text{(Feed TDS - Permeate TDS)}}{\text{Feed TDS}} \times 100$$

Example: If feed water has 1500 TDS and permeate water has 20 TDS, then

$$\textbf{\% Recovery} = \frac{(1500 - 20)}{1500} \times 100 = 98.7\%$$

System Requirements & Operation Guidelines

Electrical

The pump used on the NRO system is a pump & motor combination. Each NRO system is equipped with a 6 foot electrical cord.

WARNING: *Ensure that all voltage supplies match the equipment being used. Failure to do so may cause death or serious injury. Proper breaker ratings must be used according to applicable local codes. Electrical service should be installed by a qualified, licensed technician. Ensure all ground connections are properly made to the complete system. All external connections to the RO System should be dry contact only. Float switches and pretreatment lockouts should not produce voltage applied to the electronic control box if so equipped. Ensure all electrical connections to float switches and pretreatment equipment are completed.*

Failure to do so may cause system damage, property damage or bodily injury including death.

Do not apply power to the RO unit at this time

NOTE: *Nelsen Corporation recommends that a licensed electrician install your unit in accordance to local and national codes.*

Plumbing

The high-pressure pump and membrane(s) require a continuous flow of water with a minimum feed pressure of 35 PSI, not to exceed 105°F. Run the concentrate piping to an open drain, with an air gap and free of blockage.

Pre-Filtration

NRO systems will filter most particles over 5 microns in size. Change the cartridge every month or when a 10 PSI pressure drop occurs. If pre-filter becomes clogged and flow to pump becomes restricted, cavitation in pump could occur.

RO Start-Up

Prior to installation of the RO system, flush the feed lines and pretreatment equipment first (especially the media filters) without allowing the feed water to enter the RO vessels. ***Verify that the pretreatment equipment is operating properly.*** If applicable, prepare chemical dosing tanks by mixing proper ratio of chemicals (anti-scalant reagents, sodium metabisulfite, etc.) with water. Check the operation of the chemical injection pumps and delivery lines.

Test the feed water to the RO membranes and verify that chlorine or chloramines are not present.

Pump

The pump must never run dry. Operating the pump without adequate feed water will damage the pump. Always supply pump with filtered water. Improper flow could cavitate the pump if it runs dry.

Mounting & Location

The NRO systems are free standing and should be bolted down in compliance to local regulation standards. If placed on an uneven floor, the system may vibrate. If this occurs, place the system on a rubber mat to reduce the vibrations.

WARNING: *The RO system should be located on a level surface in an area sheltered from sun, wind and rain. The temperature in this area should be maintained, and should not fall below 35°F, nor greater than 95°F. If these limits are exceeded, damage to components may result and the warranty may be considered void. It is important to allow sufficient space around the unit so maintenance can easily be performed.*

Installation

Carefully inspect the system before start-up. Check all plumbing and electrical connections. Connections may have become loose during shipment.

- Membrane installation - some RO's do not have membranes installed, if this is the case refer to page 10, Membrane Removal & Replacement
- Before installing the 5 micron prefilter cartridge into the filter housing, perfom the following steps:
  - Using the Filter Wrench, unscrew the housing; water may come out of the housing, so put a bucket under the area to catch any water that comes out
  - Inspect the inside of the filter housing for debris and rinse with water if necessary
  - Lubricate the o-ring around groove of housing with food grade lubricant and reinstall onto housing
- Install the 5 micron cartridge provided, then reattach the housing onto the cap and hand tighten, then bump tighten with the included wrench
- Locate the feed water inlet on the prefilter housing

CAUTION: *Piping for feed water to the RO system should be either copper or plastic, iron and carbon steel pipe will increase the iron content of the raw feed water and adversely affect the RO system's performance. Temperature of the feed water must not exceed 95°F.*

- Attach your feed water (source) inlet piping (not provided) to the inlet of the filter housing
- Always maintain a sufficient flow of feed water during operation @ 35psi minimum pressure

RECOMMENDATION: *Pre and post filer pressure gauges are advisable for monitoring feed water inlet pressure and pressure drop after the filter housing.*

RO Start-Up

- Locate the permeate outlet on the backside of the permeate flow meter and remove the dust cap, water/preservative may flow out of flow meter
- Attach your permeate piping (not provided) to permeate outlet and temporarily direct to the drain for start up
- Make sure the permeate water flows freely and that there is no back-pressure; back-pressure can cause damage to the membrane(s)

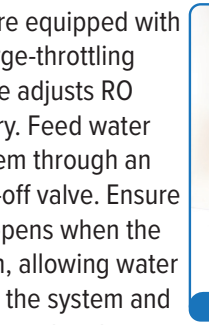
CAUTION: *The permeate line plumbing materials can contaminate the high quality water produced by the NRO system. Ensure that the components are compatible with the application. The pH of the RO permeate water will normally be 1-2 points lower than the feed water pH. A pH of 6.5 or lower can be very aggressive to some plumbing materials, such as copper piping.*



- Locate the Concentrate (waste) outlet on the backside of the Concentrate flow meter and remove the dust cap, water/preservative may flow out of flow meter
- Attach drain line (not provided) to the concentrate outlet
- Run the concentrate line to the drain; water should run freely, without any obstructions or debris
- Make sure no back-pressure exists on the concentrate drain line and that an air gap, which meets local codes, exists.
- Check to make sure the electrical power supply matches your NRO system power supply
- A level/float/control switch located in a storage tank typically controls NRO systems. The level/float switch turns the system on when water level in tank drops and off when tank is full.

If the NRO system is equipped with an NRO Controller, the level control is connected to the level control connections in box.

Do not exceed the level control's power rating. Level Switches can be obtained from original selling dealer.



NRO systems are equipped with a pump discharge-throttling valve. This valve adjusts RO desired recovery. Feed water enters the system through an automatic shut-off valve. Ensure that the valve opens when the system turns on, allowing water to flow through the system and closes when the system turns off, stopping water from flowing through the system. This saves water and prevents premature fouling of the RO membranes.

- The RO membranes are stored in preservative and the pressure vessels will need to be flushed out; redirect the permeate water to the drain for this procedure
- Fully open the concentrate control, permeate, and throttle valves; close the recycle valve if equipped
- Start water flow only and vent air from the pre-filter housing using pressure relief button
- RO's without a NRO controller may have two cords with plugs, or a single cord with a 220v plug. If you have two cords, plug in the 110v plug ONLY at this time to open the solenoid valve to allow water into the system to purge air from the RO at line pressure. If you have a RO with a single 220v plug Plug in the 220v plug. The solenoid will open and the pump will turn on. With the concentrate, permeate and throttle valves all wide open, the system will operate at reduced pressure to purge all air from the piping and membrane housing

- Flush the system for 30 minutes to remove the preservative from the membranes while inspecting the system for leaks

Systems with a NRO-Controller

- Plug in the system and turn on
- The system should start after a 10 second delay
- The system may shut down due to low pressure and you may have to manually turn the RO on several times to get water through the unit until it runs continuously
- The RO will attempt to re-start several times automatically until the air is purged and the unit runs continuously
- Systems equipped with a Permeate Flush, refer to the NRO-ROC manual for a start-up procedure

- After 30 minutes, while leaving the concentrate valve fully open, adjust the throttle valve to about 50% open (approximately 1-3/4 full revolutions)
- Plug in and start the high pressure pump
- Slowly adjust the throttle valve ramping up the pressure reading on the concentrate gauge to 150 PSI
- Locate the Permeate GPM for your system in the chart on page 3. Slowly close the concentrate valve until the permeate flow is equal to the permeate GPM value for your system.

NOTE: *The Permeate flow should not exceed the Permeate GPM for your system*

- On models with recycle valve, calculate the value that is 50% of the Permeate GPM. Slowly open the Recycle Valve and reduce the concentrate flow by the calculated value

EXAMPLE - The Permeate GPM found in the chart on page 3 for the NRO-6440 is 6.9 GPM
If your concentrate flow meter is reading 11.0 GPM prior to adjustment, slowly open the Recycle Valve until the Concentrate Flow Meter reads approximately 7.55 GPM (11.0 – 3.45 = 7.55)

- Make any adjustments to the throttle valve to the correct specific recovery and permeate production rates indicated on the chart on Page 3

Closely monitor the system for an hour adjusting the feed pressure and the concentrate valve as needed to maintain the design operating conditions while the system stabilizes. Verify that any additional equipment is operating properly by monitoring pH, ORP (Oxidation-reduction potential), etc.

- After running the system for an hour, shut down the system and redirect the permeate line to storage tank and allow the system to fill tank
- Record all operating measurements to a data sheet or operating log similar to the one at the back of this manual

NOTE: *It is imperative to keep track of the performance of the system on a regular basis especially during startup.*

Compare the data against the system design specifications and membrane performance projections as available. ***(Page 3 chart)***

If sample ports are available on each permeate vessel, check the conductivity/TDS readings of each vessel. An abnormal reading can point to a rolled or pinched o-ring allowing bypass of salts.

Record daily all operating data onto the operating log for one week then weekly thereafter. Again, compare the data against the system design specifications and membrane performance projections as available. Water samples should be taken from the feed, permeate and concentrate.

WARNING: *Never exceed maximum pressure rating of your membrane or pressure vessel.*

Operation & Maintenance

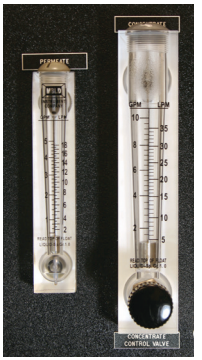
Check your feed water chemistry. Pre-treatment and/or reducing the system recovery may be required to reduce fouling and scaling on membranes.

RO process causes concentration of impurities in the concentrate stream to increase. These impurities may precipitate (come out of solution) when their concentration reaches saturation levels.

NOTE: *Precipitation can scale or foul membranes.*

Permeate & Concentrate Flow Meter(s)

These flow meters indicate flow rates of permeate and concentrate water. When added together indicate the feed water flow rate. On initial start up, set the permeate flow meter GPM at the design GPM and set the concentrate rate as the same Flow rate @150 psi for low energy membranes (up to 225psi for brackish membranes).



Waste Recycle Valve



This valve allows you to recycle some of the concentrate water back to the feed line ahead of the pump. This will increase the recovery rate of the RO. The amount of the wastewater recycled is limited by the TDS of the feed water. The drawback of using recycle concentrate water is an increase of TDS in permeate water. To increase the recycle rate, start with the recycle valve fully closed. Note the flow rate shown on the concentrate flowmeter. This is the total concentrate flow. Slowly turn the recycle valve counter clockwise until the concentrate flow comes down to the specified rate.

**Minimum 35psi Feed @ required GPM for system size*

Prefilter Pressure Gauges

These gauges measure feed water pressure when it enters and exits the prefilter housing. A pressure differential of 10% or more indicates the prefilter needs to be replaced.

Low Pressure Switch

The low-pressure switch shuts off the system when the feed water pressure drops too low for the system to function properly. This will prevent damage to the pump. When pressure is restored, the system will restart automatically. If pressure fluctuation is noticed, and system is cycling off and on repeatedly, turn the system off and ensure the proper feed flow* and pressure are available into the system.

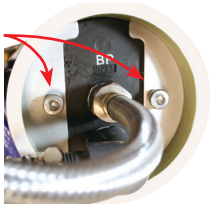
Membrane Removal & Replacement

Membrane changing can be an easy process if you have the proper tools and information on hand. Follow the below instructions when removing and replacing membrane(s).

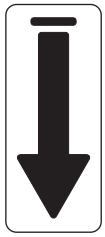
NOTE: *Always remove & replace the membrane in the direction of the FEED flow. This protects the brine seal from folding over. The brine seal should always be on the FEED end of the pressure vessel.*

WARNING: *Depressurize the system until all pressure gauges read zero before proceeding. Before attempting, disconnect the power from the system and bleed all water pressure from the system.*

- Remove the hoses and fittings from both ends of the pressure vessel
- Remove end caps from the pressure vessel. This is done by removing the crescent wedge(s), using properly sized allen wrench



- Thread a nipple and tee into the concentrate port. The nipple must extend past the end of the pressure vessel. Apply slight force to remove end caps. A "pickle fork" or ball joint separator can also be used to apply upward force on the end cap. Place a rag or towel between the tool and the edge of the vessel to prevent scarring and damage. Remove any fittings used to remove caps.
- After both ends are removed, membranes can be removed from pressure vessel. Note which side brine seal is on. All NRO RO units have flow indicator stickers on each vessel. The stickers indicate direction of feed flow and position of brine seal. The membrane must be removed and installed according to the arrow decal. The line on the decal references the position of the brine seal.



WARNING: *Do not pull membranes using permeate tube, this may cause damage.*

CAUTION: *Wear gloves for the following steps in order not to contaminate the membrane*

- Replace the new membrane(s). Feed in direction of feed water flow. Failure to do so may damage or "roll" the brine seal. Make sure brine seal is on feed end of pressure vessel.
- Replace any damaged brine seals or o-rings. Lubricate o-rings with food grade glycerin for proper lubricant.
- Re-install the end caps by gently twisting them while pushing onto vessel making sure to not pinch or damage any o-rings in the process. Make sure the outer diameter of the end cap is flush with the inner groove of the vessel.
- Replace crescent wedge(s) into the vessel grooves & tighten screws.
- Reattach any fittings that may have been disconnected in the process.
- Refer to start-up directions to start system.

CAUTION: *New or factory cleaned membranes are shipped in a preservative solution. Therefore the RO should be flushed at 50 PSI for 1 hour to remove the preservative from the membrane. See start up directions.*

NOTE: *Discard the permeate and concentrate water during this operation.*

CAUTIONARY REMINDERS

- Change the cartridge filters regularly
- Monitor the system and keep a daily log
- Run the system, as much as possible, on a continuous basis.
- Adjust the system recovery to the recommended value
- Always feed the pump with filtered water.
- **DO NOT** permit chlorine to enter or be present in the feed water.
- **DO NOT** shut down the system for extended periods.
- **DO NOT** close the throttle valve completely.
- **DO NOT** operate the system with insufficient feed flow.
- **DO NOT** operate the pump dry
- **Keep Records** - Record all operating data and onto a Operation Log. There is a log sheet on page 16-17.

Membrane Cleaning

Periodic cleaning of membranes can improve system performance. In normal conditions, mineral scale, biological matter, colloidal particles and organic substances can foul membranes.



WARNING: *Cleaning chemicals are dangerous and can cause injury and damage. Read and comply with all safety and disposal precautions. It is the user's responsibility to comply with all federal, state and local regulations that may apply.*

Inorganic anti-fouling cleaning

Use an acid cleaning solution to remove inorganic salts such as CaCO3, CaSO4, BaSO4 and metal oxides, such as iron from reverse osmosis membranes. Do not use sulfuric acid because it may cause calcium sulfate to precipitate on the membranes. Recommended cleaning solutions for inorganic cleaning include:

- Solution of 0.2% hydrochloric acid (HCL)
- Solution of 0.5% phosphoric acid (H3PO4)
- Solution of 0.2% sulfamic acid
- Solution of 1.0% sodium hydrosulfite

Organic anti-fouling cleaning

Use alkaline cleaning solutions to remove silica, bio films and organic matter from membranes. Acceptable cleaning solutions for organic cleaning include:

- Solution of 0.1% sodium hydroxide (NaOH)
- Solution of 0.1% sodium hydroxide (NaOH) and 0.1% of tetra-sodium salt of ethylene diamine tetraacetic acid (Na-EDTA)
- Solution of 0.1% sodium hydroxide (NaOH) and 0.05% sodium salt of dodecyl-sulfate (NaDDS)
- Solution of 1.0% sodium triphosphate (STP), 1.0% trisodium phosphate (TSP) and 1.0% Na-EDTA

The pH of the solutions above should be approximately 12 and temperature of the solution less than 86°F.

Membrane cleaning directions

To set-up a cleaning station, follow these directions:

1. Record the amount and TDS of the permeate with the system set at normal operating pressure.
2. Prepare approximately 15 gallons of inorganic cleaning solution (with a pH of approximately 2) in a polypropylene or fiberglass reinforced plastic tank with a removable cover. Use RO water for make up water if possible.
3. Connect a hose from the cleaning solution tank to the inlet of the pre-filter on the RO unit. Ensure there is a flooded inlet to the pump or positive feed pressure. It will be necessary to use a feed pump to generate enough pressure to overcome the RO pressure switch. If a feed pump is not used, the pressure switch can be disconnected as long as the RO pump is primed before use and sufficient flow is available to the pump. The switch must be reconnected after the cleaning process to ensure pump protection.
4. Feed the permeate and the drain tubes back to the cleaning solution tank so that the solution will recirculate during cleaning.
5. Turn on the reverse osmosis pump. Adjust the concentrate control valve (drain restrictor) to a concentrate pressure of 50 psi (3.5 bar). Run the pump for approximately thirty (30) minutes.
6. Turn the system off and reconnect to the feed water supply.
7. Turn the system on and flush at 50 psi (3.5 bar) for 15 minutes. Discard all of the permeate and concentrate water.

8. Adjust the system to normal operating pressure and record the amount and TDS of the permeate water after the acid cleaning to assess any improvements in the system's performance.
9. Repeat this procedure for organic cleaning solution (with a pH from 11 to 12).
10. Readjust the concentrate pressure to original operating pressure for normal operation. After the cleaning procedure is complete, check the amount and TDS of the permeate to evaluate the effectiveness of the cleaning process.

Disinfection

Hydrogen peroxide or renalin may be used for disinfection. Procedures are identical to the membrane cleaning directions described on page 12, with the following exceptions:



NOTE: *The prefilter cartridge should be replaced before AND after the cleaning is disinfection procedures.*

1. Remove deposits on membranes and other system parts with an alkaline cleaner prior to disinfection.
2. Clean the RO system with an acid cleaner to remove iron from membranes. (Iron or other heavy metals catalyze membrane degradation when peroxide is present.) Flush with water after acid cleaning.
3. Circulate a solution of 0.2%-0.25% hydrogen peroxide or renalin and RO product water for 20 minutes. The solution temperature must not exceed 77° F (25° C) to prevent damage to membranes. (A pH of 3-4 optimal results and longer membrane life.)
4. Soak membranes in a disinfecting solution 2 - 12 hours. (Two hours is needed to kill 90% and 12 hours is needed to kill 99% of the bacteria present.)

Spare Parts

Spare parts can be ordered through your original selling dealer.

- Prefilter Elements
- Inlet Solenoid Valve
- Concentrate Flow Meter with Valve
- Hose Washers
- Pressure Gauges, 0-100 and 0-300
- Pressure Switch
- Membranes
- Pump/Motor Combination
- Pressure Vessel
- Stainless Steel Braided Hoses

Table 4: Temperature Correction Factors*

Water temperature °F	Water temperature °C	Production Factor* (Using thin film membranes)
40	4	0.48
50	10	0.60
60	16	0.73
70	21	0.88
77	25	1.00
80	27	1.06
90	32	1.26

*Percent of rated production.

SYMPTOMS	POSSIBLE CAUSES	CORRECTIVE ACTION
Low Inlet Pressure	Low supply pressure <35 psi	Increase inlet flow pressure to >35psi
	Cartridge filter plugged	Change filters
	Solenoid valve malfunction	Replace solenoid valve and/or coil
	Leaks	Fix any visible leaks
	Motor may not be drawing correct current	Use clamp-on amp meter to check motor amp draw
	Concentrate valve might be damaged	Replace concentrate valve
	Pressure Loss across pretreatment	Check all pretreatment equipment
Low Permeate Flow	Low inlet flow	Adjust concentrate valve
	Cold feed water	See *Temperature Correction Table 4*
	Low operating pressure	See low inlet pressure
	Defective membrane brine seal	Inspect or replace brine seal
	Fouled or Scaled membrane	Clean membranes
High Permeate Flow	Damaged product tube o-rings	Inspect and/or replace
	Damaged or oxidized membrane	Replace membrane
	Exceeding maximum feed water temperature	See *Temperature Correction Table 4*
Poor Permeate Quality	Low operating pressure	See low inlet pressure
	Damage product tube o-rings	Inspect and/or replace
	Damaged or oxidized membrane	Replace membrane
	Recovery too high	Reduce amount of recovery
Membrane Fouling	Metal Oxide Fouling	Improve pretreatment to remove metals.
		Clean w/acid cleaners.
	Colloidal Fouling	Optimize pretreatment for colloidal removal.
		Clean with high pH anionic cleaners
	Scaling ($CaSO_4$, $CaSO_3$, $BaSO_4$, SiO_2)	Increase acid addition and anti-scalant dosage for CaVO3 & CaCO4.
		Reduce recovery.
		Clean w/acid cleaners

Nelsen Commercial NRO 440 Series Systems Troubleshooting

SYMPTOMS	POSSIBLE CAUSES	CORRECTIVE ACTION
Membrane Fouling	Biological Fouling	Shock dosage of Sodium Bi-Sulfate.
		Continuous feed of Sodium Bi-sulfate at reduced pH.
		Chlorination and De-chlorination.
		Replace cartridge filters.
	Organic Fouling	Activated Carbon or other pretreatment.
		Clean w/high pH cleaner.
	Chlorine Oxidation	Check chlorine feed equipment and dechlorination system.
	Abrasion of membrane by Crystalline Material	Improve pretreatment.
		Check all filters for media leakage.

OPERATION LOG

Model Number: Start-Up Date

Week of: Last Cleaning Date

Date						
Time						
Hours Of Operation						
Inlet Pressure						
Post Pre-Filter Pressure						
Pressure Differential						
Permeate Pressure						
Feed Pressure						
First Array Feed Pressure						
Differential Pressure						
Permeate Flow						
Concentrate Flow						
Percent Recovery						
Feed Flow						
Feed Conductivity						
Permeate Conductivity						
Percent Rejection						
Feed pH						
Permeate pH						
Scale Inhibitor Feed						
Acid Feed						
Sodium Bisulfite Feed						
Feed Water:						
Iron (ppm)						
Free Chlorine (ppm)						
Hardness (ppm, $CaCo_3$)						
Turbidity (Ntu)						

OPERATION LOG

Model Number: Start-Up Date

Week of: Last Cleaning Date

Date						
Time						
Hours Of Operation						
Inlet Pressure						
Post Pre-Filter Pressure						
Pressure Differential						
Permeate Pressure						
Feed Pressure						
First Array Feed Pressure						
Differential Pressure						
Permeate Flow						
Concentrate Flow						
Percent Recovery						
Feed Flow						
Feed Conductivity						
Permeate Conductivity						
Percent Rejection						
Feed pH						
Permeate pH						
Scale Inhibitor Feed						
Acid Feed						
Sodium Bisulfite Feed						
Feed Water:						
Iron (ppm)						
Free Chlorine (ppm)						
Hardness (ppm, $CaCo_3$)						
Turbidity (Ntu)						

NELSEN CORPORATION
NRO COMMERCIAL REVERSE OSMOSIS SYSTEM
LIMITED WARRANTY

Nelsen Corporation ("Nelsen") provides this limited warranty as described below (the "Limited Warranty").

Limited Warranty

Subject to the terms of this Limited Warranty, Nelsen warrants to the original buyer ("Buyer") of this Water Conditioner product (the "Product") solely from a Nelsen authorized dealer that the Product will be free from defects in material or workmanship for a period of one (1) year after the date of original installation. This Limited Warranty shall apply only if the Product is installed, operated and maintained in strict accordance with Nelsen's or the manufacturer's guidelines and other legal requirements. The Product is sold with the understanding that Buyer has independently determined the suitability and compatibility of such Product for Buyer's purposes. Any statements, technical information or recommendations concerning the Product or any parts therein by Nelsen are based upon data provided to Nelsen by its suppliers and believed to be accurate, but do not constitute a guarantee or warranty. This Limited Warranty shall not cover and shall be null and void if, in Nelsen's discretion, the Product, or any parts therein, are: (a) manufactured by a third party manufacturer; (b) modified after sale or use of replacement parts not specified by manufacturer requirements; (c) improperly installed, stored, used, operated, handled or maintained; or (d) abused, misused or otherwise damaged for any reason, including due to negligence, weather, fire, lightning, power surges or other acts of God or exposure to freezing or hot water or the effects of normal wear and tear.

Third Party Warranties

In lieu of the above Limited Warranty, the Product, or any parts therein, may be covered by a third-party manufacturer's warranty. Nelsen's authorized dealer will provide Buyer with a copy of any third-party manufacturer warranty prior to purchase. Nelsen shall transfer and assign to Buyer any and all third-party manufacturer's warranties on the Product, or any parts therein, subject to the conditions and exclusions in the manufacturer's warranty. Buyer's exclusive remedy under such third-party manufacturer's warranty shall be against such third-party manufacturer and not Nelsen. Buyer may need to register the Product with a third party manufacturer in order to obtain its warranty.

Additional Conditions

- This Limited Warranty does not cover any membranes or filters.
- This Limited Warranty shall not cover the Product if operated at water pressures or water temperatures or with water contaminants that exceed manufacturer's guidelines.
- The Product may include interconnecting piping that may have leaks, even if tested at the time of manufacture, due to pipe vibrations and handling. The installer of the goods is responsible for checking the system for leaks upon start-up and making any repairs if necessary.
- This Limited Warranty does not cover damage or failure of the Product, or any part therein, caused by friction, wear, chemical attack or debris build-up on wear parts. For purposes hereof, "wear parts" shall include, without limitation, end cap quad rings and parts requiring replacement under recommended maintenance procedures, including, without limitation, o-rings and gaskets.

Warranty Claims

All claims under this Limited Warranty shall be submitted by Buyer to the authorized Nelsen dealer who sold the Product in writing and shall include the Buyer's name, address, telephone number, date of purchase of the Product, receipt evidencing proof of purchase and a copy of this Limited Warranty. Nelsen or its authorized dealer will investigate the claim. Buyer must fully cooperate in investigating and evaluating the claim, including, without limitation, providing additional information upon request. TO BE ELIGIBLE FOR COVERAGE UNDER THIS LIMITED WARRANTY, BUYER MUST SUBMIT A CLAIM WITHIN SIXTY

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(60) DAYS OF THE DATE THAT THE ALLEGEDLY DEFECTIVE PRODUCT OR PART IS FIRST DISCOVERED BY BUYER AND, IN NO EVENT, LATER THAN SIXTY (60) DAYS AFTER THE WARRANTY PERIOD HEREIN.

Repair or Replacement/Credit

Subject to the conditions and limitations herein, if Nelsen determines that the Product, or any part therein, does not conform to this Limited Warranty, Nelsen will repair or replace the defective Product or part therein. Non-conforming Products or parts therein must be returned to Nelsen's authorized dealer at Buyer's cost. Any replaced Products, or any parts therein, shall be retained by and become the property of Nelsen. If Nelsen determines that the repair or replacement of the Product or part therein is not commercially practicable, Nelsen will issue a credit in favor of Buyer in an amount not to exceed the purchase price of the Product. Notwithstanding anything to the contrary herein, this Limited Warranty does not cover any cost or labor associated with the removal or re-installation of the replacement Product or part therein or any shipping costs associated with the returned Product or part therein, which remains the sole cost, risk and responsibility of Buyer, unless otherwise agreed in writing by Nelsen.

Eligibility/Non-Transferable

This Limited Warranty applies only to Buyer if the Product is purchased from a Nelsen authorized dealer. This Limited Warranty is personal to Buyer and may not be assigned or otherwise transferred by Buyer. Any attempt to transfer this Limited Warranty shall be null and void and not recognized by Nelsen.

Disclaimer of Other Warranties/Limitation on Liability

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IN NO EVENT SHALL NELSEN BE LIABLE TO BUYER OR TO ANY THIRD PARTY FOR CONSEQUENTIAL, INCIDENTAL, SPECIAL OR PUNITIVE DAMAGES, OR FOR LOST PROFITS OR LOSS OF USE, RESULTING FROM OR IN ANY MANNER RELATED TO THE PRODUCT, ITS DELIVERY, NON-DELIVERY, USE, OR INABILITY TO USE THE SAME, WHETHER SUCH DAMAGES BE CLAIMED UNDER CONTRACT, TORT OR ANY OTHER LEGAL THEORY.

NELSEN'S TOTAL LIABILITY UNDER THIS OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, IS LIMITED TO REPAIR OR REPLACEMENT OF, OR CREDIT FOR, THE PRODUCT OR ANY PART, AS STATED HEREIN.

Waiver of Class Action

ANY AND ALL CLAIMS ASSERTED BY BUYER OR ANY OTHER PERSON OR ENTITY SHALL BE RAISED IN AN INDIVIDUAL CAPACITY AND NOT AS A PLAINTIFF OR CLASS MEMBER IN ANY PURPORTED CLASS OR REPRESENTATIVE PROCEEDING, WHICH ARE HEREBY WAIVED.

Applicable Law

This Limited Warranty shall be interpreted and governed under the laws of the State of Ohio without giving effect to the choice of law rules thereof. Nelsen and Buyer irrevocably consent and submit to the exclusive jurisdiction and venue within the courts of Summit County, Ohio and/or the United States District Court for the Northern District of Ohio in connection with any litigation arising out of, or in any way relating to, this Limited Warranty or the Product, including, but not limited to, any and all claims for breach of warranty or products liability, and Nelsen and Buyer expressly waive any objection to the jurisdiction and/or venue of such courts.

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