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1. **Reference**
	1. **Documents**
		1. EPRO 150-8000-Manual-2020, “EPRO Small RO Series Operation and Maintenance Manual”
		2. Grundfos CRN1 Parts List, “Service and Parts List”
		3. Mettler M300 Transmitter, “Operation Manual, Conductivity/Resistivity, 2-channel Transmitter M300”
		4. Electromechanical Timer, “Pentair Fleck 3200 Series Electromechanical Timer Owner’s Manual”
		5. Mighty Pure MP22A, “Models MP16A, MP22A, MP36C & MP49C Owner’s Manual”
		6. PCB Drawing 74771, Aquasciences DI water system
		7. CR056, Aquasciences DI Water 20XX Data Log
	2. **Consumable Parts**
		1. PN 100-17360-50 Water softener salt, 40 pound bag
		2. PN 100-17360-60 0.2 µm cartridge filter 20”
		3. PN 100-17361-XX 0.2 µm cartridge filter 10”
		4. PN 100-17360-70 3 µm cartridge filter 20”
		5. PN 100-17360-80 5 µm cartridge filter 10”
		6. PN 100-17361-XX 5 µm cartridge filter 20”
		7. PN 100-17360-90 Water Hardness Test Strips
		8. PN 100-17361-00 Residual Chlorine Test Strips

Note 1: CR056 is located on TCS. Active and completed logs are saved to **R:\Facilities\Equipment Documentation\Depew\Aquasciences DI water system\Data Logs**

Note 2: All other reference documents are located at **R:\Facilities\Equipment Documentation\Depew\Aquasciences DI water system**

Note 3: Document convention: BOXED TEXT denotes labeled hardpoints on the DI system.

1. **System Processing Stages (defined in direction of water flow)**
	1. **Stage I: Pretreatment**
		1. Water softener- Incoming city water (copper pipe and valve) is filtered through the 5 µm sediment PREFILTER before processing. The softener is used to remove calcium and magnesium ions, which form scale. Those ions are replaced with sodium ions. The softener has a programmed/automated recharge, in which brine is pumped through the exchange tank. The recharge takes about sixty minutes. This removes the scaling ions, and replenishes the sodium consumed during ion exchange. The BRINE TANK stores a mixture of salt and water. The softener salt (see 1.2.1) is a consumable material for this process.
		2. Incoming city water pressure can be checked on GAUGE 1 whenever the RO system is idle.
		3. Carbon filtration- After softening, the water is passed through a carbon backwash bed. This is done to remove chlorine.
		4. The carbon bed is ‘refreshed’ on a programmed/automated cycle- this turns the carbon over, so the fresh carbon surface can capture more chlorine. Since this doesn’t recharge the media, this carbon bed is periodically changed. Call Aquasciences (716.695.1200) to schedule a carbon bed changeout.
		5. The carbon bed regeneration takes about 20 minutes.
		6. After the water is dechlorinated, it must be recirculated to prevent biofilm formation.
		7. After exiting the carbon filter bed, the water passes through the 5 µm RO PREFILTER into the RO system.
		8. At the time of this writing, the recharge cycles are staggered at six day intervals. Day six, the softener regenerates. Day 12, the carbon bed regenerates. Day 18, the softener regenerates, day 24 the carbon, etc. Reference 1.1.4 documents changing the intervals.
		9. IMPORTANT: The RO system cannot run during either of the regeneration cycles. The regeneration needs to be run during off-demand hours, so the RO system does not receive a ‘demand’ signal from the RO tank.
	2. **Stage II: Newterra EPRO 1500 Reverse Osmosis (RO) System**
		1. The EPRO 1500 system is designed to provide 1500 gallons/day of processed water. The RO system uses a semi-permeable, spiral wound, thin-film composite membrane as a filter media.
		2. The water is filtered at a pressure around 200 PSI. This intense pressure forces the small water molecules through the filter, while the larger molecules of dissolved contamination are left behind. The water, then, is filtered into two grades. ‘Permeate’ is the filtered, mineral free water sent to the holding tank, while the ‘concentrate’ is the unfiltered mineral-rich water.
		3. This system returns the concentrate for a second pass at filtration, to decrease the reject volume. After the second pass, the concentrate is sent to the sanitary drain.
		4. Adjustment of flow rates is made by the two valves (Valve 5: Recycle and Valve 6: Concentrate Control). Adjusting either valve will affect all three flow rates and possibly the water quality. When necessary, make slow adjustments, one valve at a time. Don’t adjust these unless you know what you’re doing.
		5. Permeate flow should be ± 15% of rated output. For this system, output is 1500 gallons per day; this puts the permeate flow 0.9 – 1.2 gallons per minute.
		6. IMPORTANT: DO NOT CLOSE ANY RO VALVES ON THE NEWTERRA SYSTEM. IF THE RO PUMP IS RUNNING, THAT WILL DESTROY THE PUMP.
	3. **Stage III: Deionizer System**
		1. The usual metric for DI water purity, resistivity (ρ), is measured in megohm-cm (MΩ\*cm) and is a bulk material property. Any ions not removed by the mixed beds will decrease ρ.
		2. The maximum attainable resistivity is 18.2 MΩ\*cm. Since the system uses polypropylene piping, it is realistic to expect water ρ ~ 17.5 MΩ\*cm.
		3. Upon exiting the RO system, the type of piping is changed. The ¾” schedule-80 PVC used during softening and pre-RO is inappropriate for purified water, as PCV releases chlorine into high-purity water. As a result, the piping used to transfer water from the holding tank onward is welded beige polypropylene.
		4. To equalize holding tank air pressure, a 10” 0.2 µm TANK VENT FILTER is located atop the tank. There is an overpressure valve installed as well.
		5. This system has two mixed-bed resin tanks; the first tank does the majority of the deionization, while the second deionizes what little may pass through the first tank. When it’s time to recharge the tanks, the second tank is reassigned to the first, and a newly recharged tank is assigned to the second.
		6. The first tank has an resistivity/LED indicator- green (ρ ≥ 1 MΩ\*cm) or red; once it turns red, the first tank needs to be recharged. Call Aquasciences (716.695.1200) and schedule a mixed bed changeout.
		7. After exiting the second tank, the water passes through a 5µm cartridge filter. This is to capture any stray resin particles that escape the mixed beds.
		8. After deionization, the water is passed through a bank of UV-C (253.7 nm) lamps. This photochemically destroys microorganism DNA. Rated lamp lifespan is 10,000 hours, and the recommended changeout is every 12 months. This lamp has a sight-port that indicates operation.
		9. Before sending the water into the recirculation loop, it passes through the final (0.2 µm) BIOFILTER in order to capture any now-dead microorganisms or fine particles.
		10. The resistivity meter is set to alarm when ρ ≤ 15 MΩ\*cm. It is located between the UV lamp and the BIOFILTER
		11. After exiting the BIOFILTER the water is sent into the loop. GAUGE 8 indicates recirculation pressure, and the FLOWMETER indicates volume.
		12. IMPORTANT: DO NOT RUN THE HOLDING TANK EMPTY. THIS WILL DESTROY THE DI PUMP.

**Appendix 1: Using the Data Log and Control Points**

A1.1 The data log template (CR 1072) is located on TCS.

A1.2 the colors of the columns correspond to the system. Gauge 1 displays city water pressure, so the column’s color is copper. Gauges on schedule 80 PVC are dark grey, polypropylene are beige, etc.

A1.3 Data is collected daily, and entered into the appropriate copy of the spreadsheet.

A1.4 Pressure drops across filters are automatically calculated; these are populated with zeroes until the gauge readings are entered.

A1.5 the pressure drops slowly increase. (Yes, the pun is deliberate) As a rule of thumb, a drop that increases 10% from the installation pressure drop indicates replacement. Any abrupt decrease indicates that the filter has been perforated and needs immediate replacement. Documentation on replacing filters is located at **R:\Facilities\Equipment Documentation\Depew\Aquasciences DI water system\Equipment Documents\Big Blue Filter Housings**

A1.4 For all analysis reports, the PDF should be hyperlinked in the comment for that day.

A1.5 Post-softened water hardness is tested daily at sample port 2, using hardness test strips (See 1.2.7 for PN).

A1.6 Should the strips show increased hardness, the softener regeneration interval will need to be shortened.

A1.6 Post-carbon chlorine is tested daily at sample port 3, using residual chlorine test strips (See 1.2.8 for PN). Each time a bottle is opened, perform the QC test pad procedure (included with the package) to verify a bottle is working correctly.

A1.7 Should the chlorine level exceed 0.5 ppm, call Aquasciences (716.695.1200) and schedule a carbon bed changeout.

A1.8 DI water samples drawn for lab analysis should be taken from Port 5. Port 5 should be sterilized with IPA after all other samples are drawn for analysis.

**Appendix 2: Valving for Isolation**

 A2.1 For all control points on the system, there are two ball valves that can be used to halt the flow of water.

 A2.2 In addition, there are sampling points that can be used to depressurize that isolated leg of the system.

 A2.3 **ALWAYS** turn the pump off **BEFORE** valving/isolating it.

 A2.3 Table 1, below, shows the valves and drain points for the system.

**Table 1: Valving, Drains, and Sampling Points**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Section** | **Inlet Valve** | **Outlet Valve** | **Sample/Drain** | **Sample** |
| City Water | Valve 1 | Valve 2 | Port 1 | City Water |
| Softener | Valve 1 | Valve 2 | Port 2 | Soft water |
| Carbon Bed | Valve 2 | Valve 4 | Port 3 | Dechlorinated Water |
| RO | Valve 4 | N/A | N/A | N/A |
| Tank | Valve 9 | Valve 7 | N/A | N/A |
| DI Pump | Valve 7 | Valve 11 | N/A | N/A |
| Mixed Beds | Valve 11 | Valve 12 | Port 4 | Unfiltered DI |
| Bed Filter | Valve 12 | Valve 13 | Port 5 | DI |
| UV Lamp | Valve 12 | Valve 13 | Port 5 | DI |
| Biofilter | Valve 12 | Valve 13 | Port 5 | DI |
| Resistivity Meter | Valve 12 | Valve 13 | Port 5 | DI |
| Flowmeter | Valve 13 | Valve 9 | Any DI faucet | DI |
| Loop | Valve 13 | Valve 9 | Any DI faucet | DI |

**REMINDER: SHUT OFF ANY PUMP(S) BEFORE ISOLATING.**

**Appendix 3: Annual Preventive Maintenance Scope- Done annually in April**

A3.1 This service is to be performed by Aquasciences.

A3.2 Change out carbon tank and distributor tube

A3.3 Clean RO filter with low and high pH solutions

A3.4 Ozone sanitization of system storage, distribution, and recirculation loops

A3.5 Change out 3 µm resin trap filter cartridge

A3.6 Change out 0.2 µm final filter cartridge

A3.7 Change out UV unit lamp, sleeve, O-rings, and nylon washers

A3.8 Calibrate M300 resistivity meter

A3.9 This work is performed during normal workweek hours.