Operation & Maintenance Manual

Arviat Water Treatment Plant

Arviat, Nunavut Project #2999

Rev. 03

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REVISION AND APPROVAL RECORD

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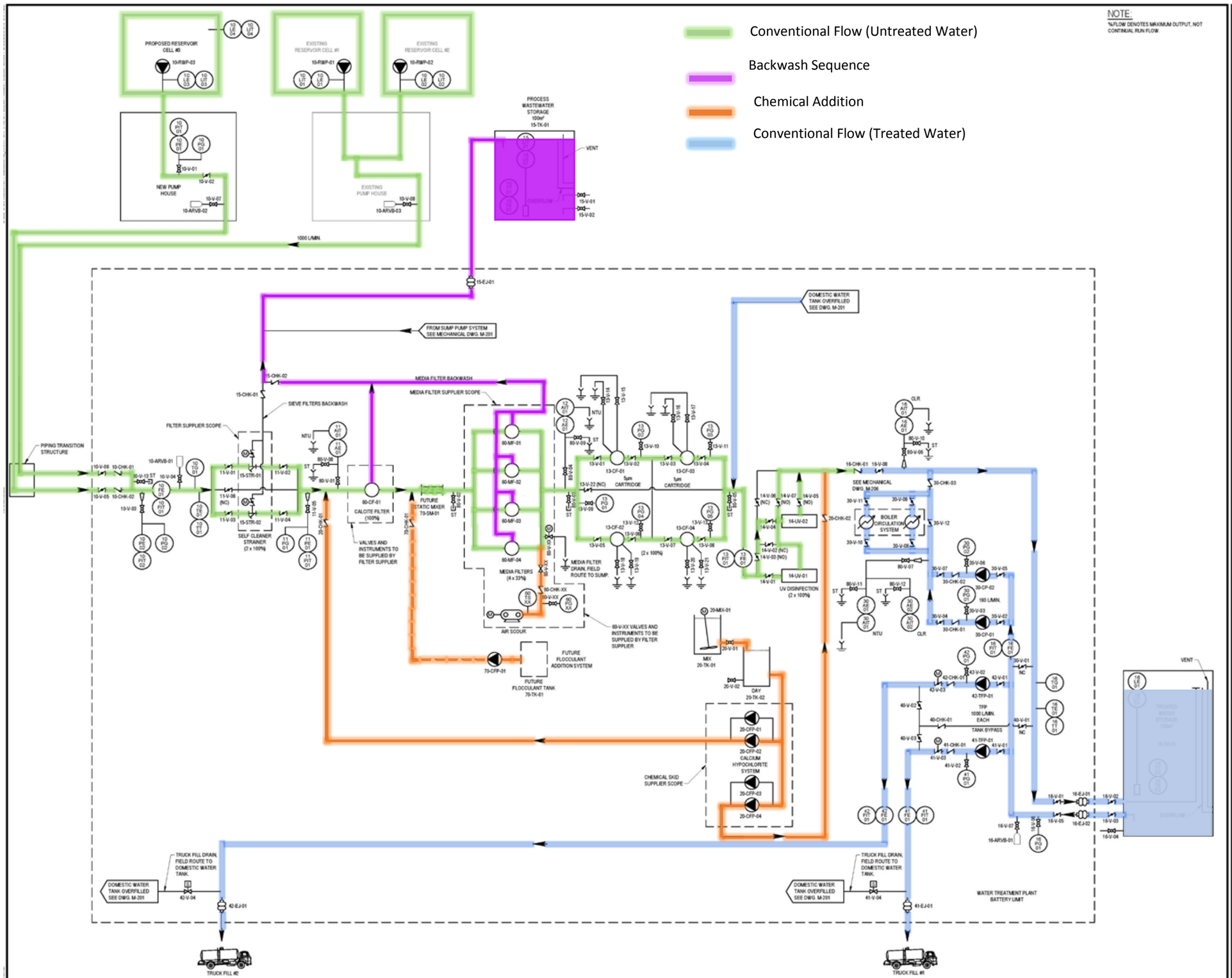

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Rev. No. 1

1 General Specifications

1.0 Safety

It is very important that installers, operators and maintenance personnel read this manual and become thoroughly familiar with the modules. Pay close attention to applicable warnings, cautions and notes to protect your safety and maintain the proper functioning of the units.

(1) When servicing, follow the manufacturer's procedures to protect the integrity of the water treatment system.

(2) If any questions arise with respect to any portion of this manual, or if any error or discrepancy is found, please contact the manufacturer.

IMPORTANT – READ THIS MANUAL

This document contains important start-up, operational, and maintenance procedures, that must be followed in order to keep the water treatment plant and its individual components operating at the design level.

Failure to follow these procedures can result in damage to equipment and/or decreased water treatment function.

1.1 Security

As this WTP treats water for human consumption, the system should be secured. Entry should be restricted to authorized and qualified persons only. Unauthorized and unqualified persons should be escorted and supervised by an authorized person.

In the event of a break-in, vandalism, or other suspect activity that may have compromised the safety of the water, the appropriate section of the Emergency Response Plan should be activated. The Emergency Response Plan should be developed by the owners, operators, and community officials to deal effectively with issues that may constitute an emergency with respect to the water safety and water treatment plant operations.

WARNING	**Hearing protection is recommended for entering the water treatment plant**

1.2 Introduction

Over the construction seasons of 2018 and 2019, Tower Arctic and BI Pure Water with EXP engineering undertook the construction of the #3 Storage Reservoir, Water treatment plant, Potable water storage tank and dual truck fill stations. This document addresses the work done during this time frame and is limited in scope to operations and maintenance to the equipment utilized for this upgrade work.

1.3 Background Design Data (Water Quality)

The design goal for the water treatment plant is to provide water that meets or exceeds the CDWQG (Canadian Drinking Water Quality Guidelines). The water is supplied from Wolf Creek during the summer season and is stored over winter in the 3 cells as the plant treats this water to meet the CDWQG. The primary functions of this plant include filtration and disinfection.

The filtration aspect is for treatment of turbidity to less than 1.0 NTU and to achieve 3.0 log removal of Cryptosporidium/Giardia and 4.0 log removal for viruses.

Further to treatment for turbidity and disinfection, the plant includes flexibility for water quality improvements such as pH adjustment, increasing hardness (reducing aggressive corrosion tendencies), manganese reduction, colour reduction and taste and odor mitigation. Most of these water quality conditions have been seen only occasionally, as such the turbidity and disinfection requirements are the primary treatment requirements.

1.5 Schematic Functional Data (Delivery)

The water delivery and storage requirements for this project have been developed from the Northern Engineering Design standards. Key points for these deliverables include a consistent truck fill rate of 1000 litres per minute for each truck. Further to that water storage requirements are to include equalization storage (408m^3), fire storage (60m^3) and emergency storage (282m^3) for a total storage of 750m^3.

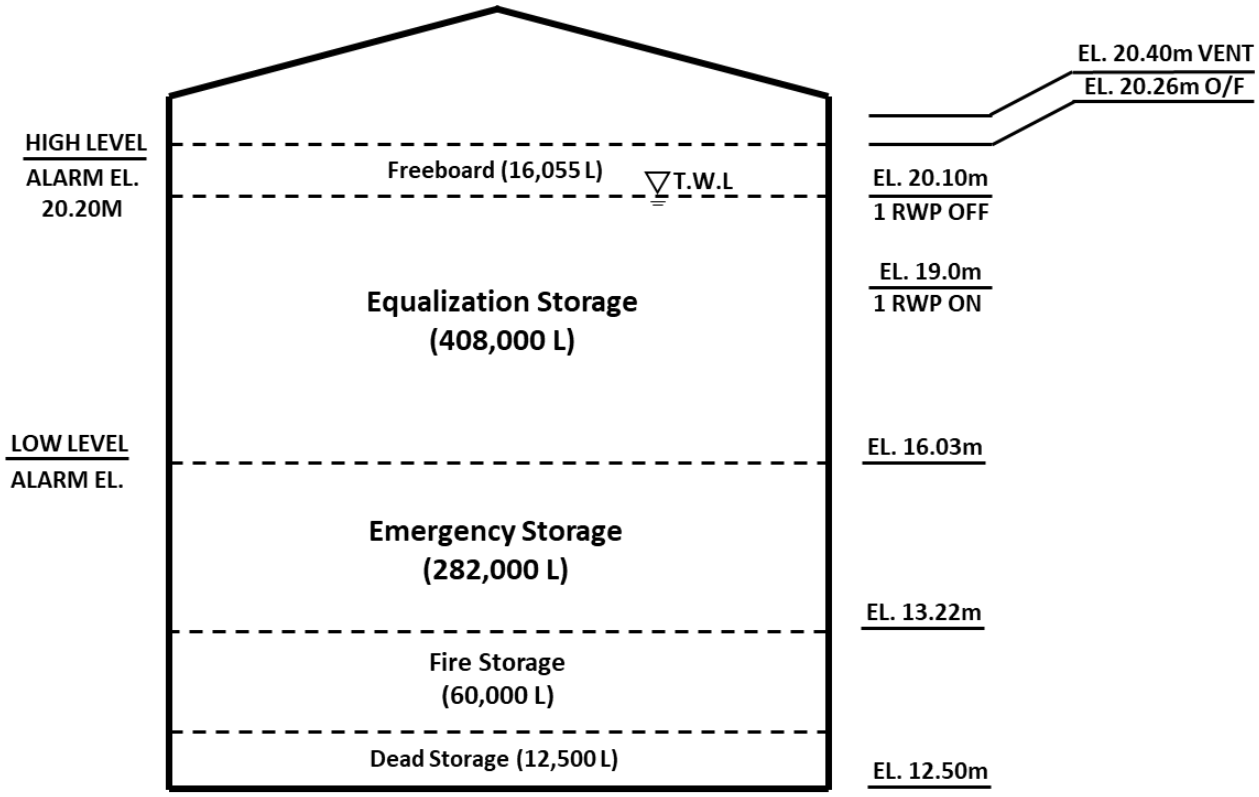


Figure 2 Treated Water Tank level schematic

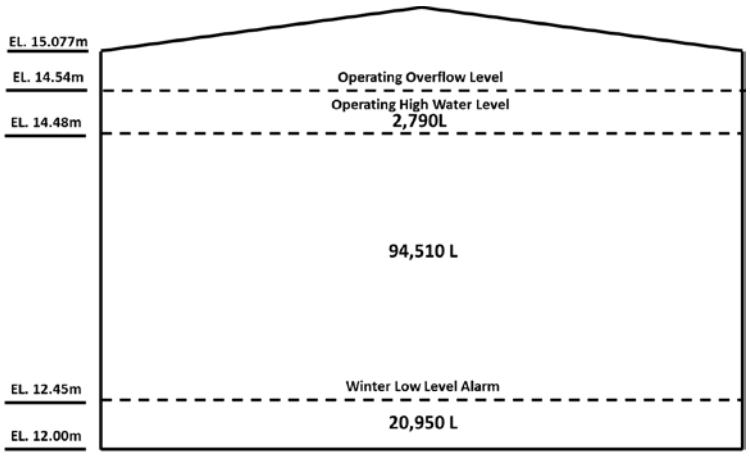


Figure 3 Backwash Storage Tank level schematic

1.4 General Description

The new water treatment plant (WTP) supplies drinking water to the community of Arviat, Nunavut with a population of 2,657 (2016). The water treatment plant will replace the current cartridge filtration plant with a new WTP building. A third reservoir is added in addition to two existing reservoirs.

Raw water enters the new treatment plant from either of the two pump houses and an operator-adjustable flow volume is delivered. The operator chooses a single pump to maintain 500 L/min, or two pumps to achieve "high flow" of 1000 L/min.

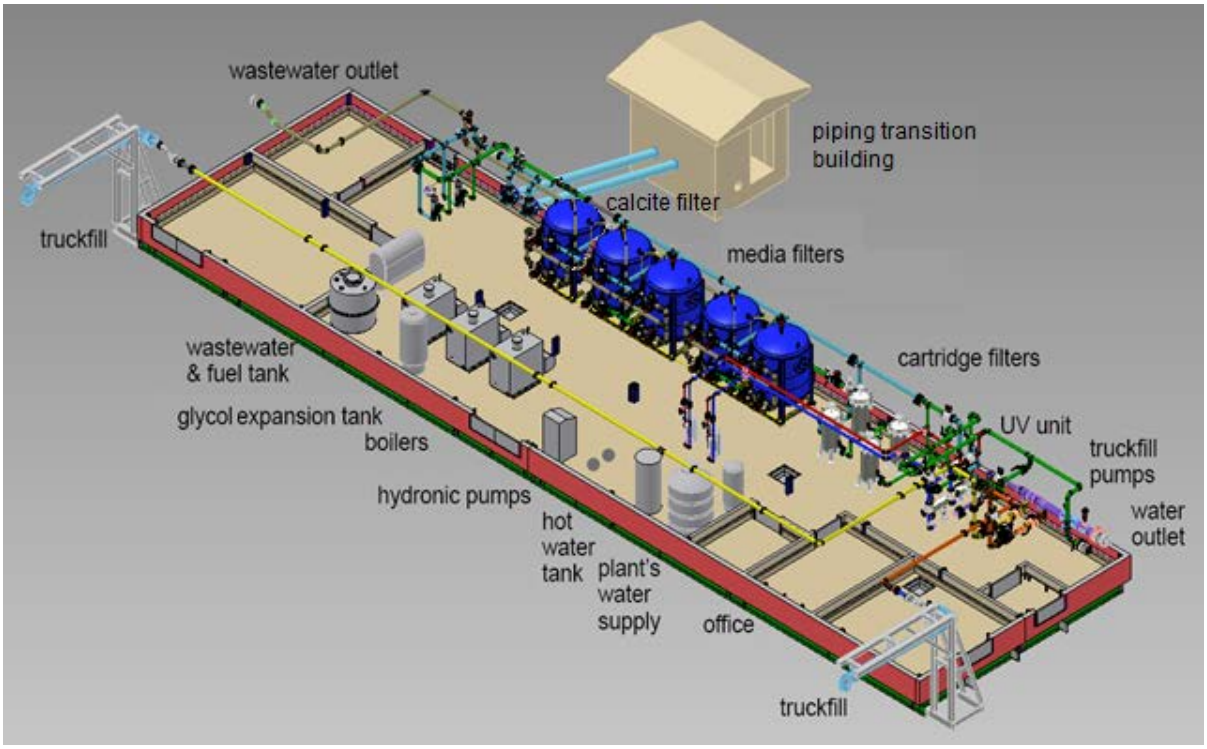


Figure 4 Major components of water treatment system

1.5 Process Description

The design Peak Flow Rate is 1000 L/minute (264 US gpm). The operating pressure is regulated to not exceed 150 psi. Backwash flow to the media filters is 1115+ LPM.

Submersible raw water feed pumps 10-RWP-01, -02 and -03 located in reservoir cells 1, 2 and 3 start when a low water level in the treated water storage tank 16-TK-01 as indicated by the level transmitter 16-LIT-01. Water is pumped from the Reservoir through the pump house and transition buildings into the Water Treatment Plant (WTP) at valve 10-V-05.

When full flow 1000 L/min is required, two raw water pumps are operated to deliver the required flow rate.

The raw water first passes through two self-cleaning strainers in parallel configuration to capture larger particles. The pressure is again measured after the filters; if pressure is too high an automatic backwash is triggered.

One-two ppm Chlorine is injected into the pipe at 20-CHK-01. Turbidity is measured by 11-AIT-01. Water then enters the first tank for a chlorine contact time. From the contact tank, four media filters, in similar vessels, filter the particles from the water, in parallel configuration. The four media filters are filled with gravel, sand and anthracite layers. Backwash of the media filters is triggered when the turbidity measured by meter 12-AIT-01 either (1) has not been reduced to the setting, (2) after the filter's production period, or (3) as set manually by the operator. When a single filter is in backwash, it is being supplied with filtered water from the other filters which are remaining in service mode.

A media backwash consists of 5 stages:

1. Drain approx. 1 minute;
2. Air scour approx. 5 minutes;
3. Settling time approx. 15 minutes;
4. Backwash for approx. 10 minutes;
5. Fast rinse approx. 2 minutes.

The contact tank is not backwashed.

In an Emergency the treatment systems may be bypassed to supply water.

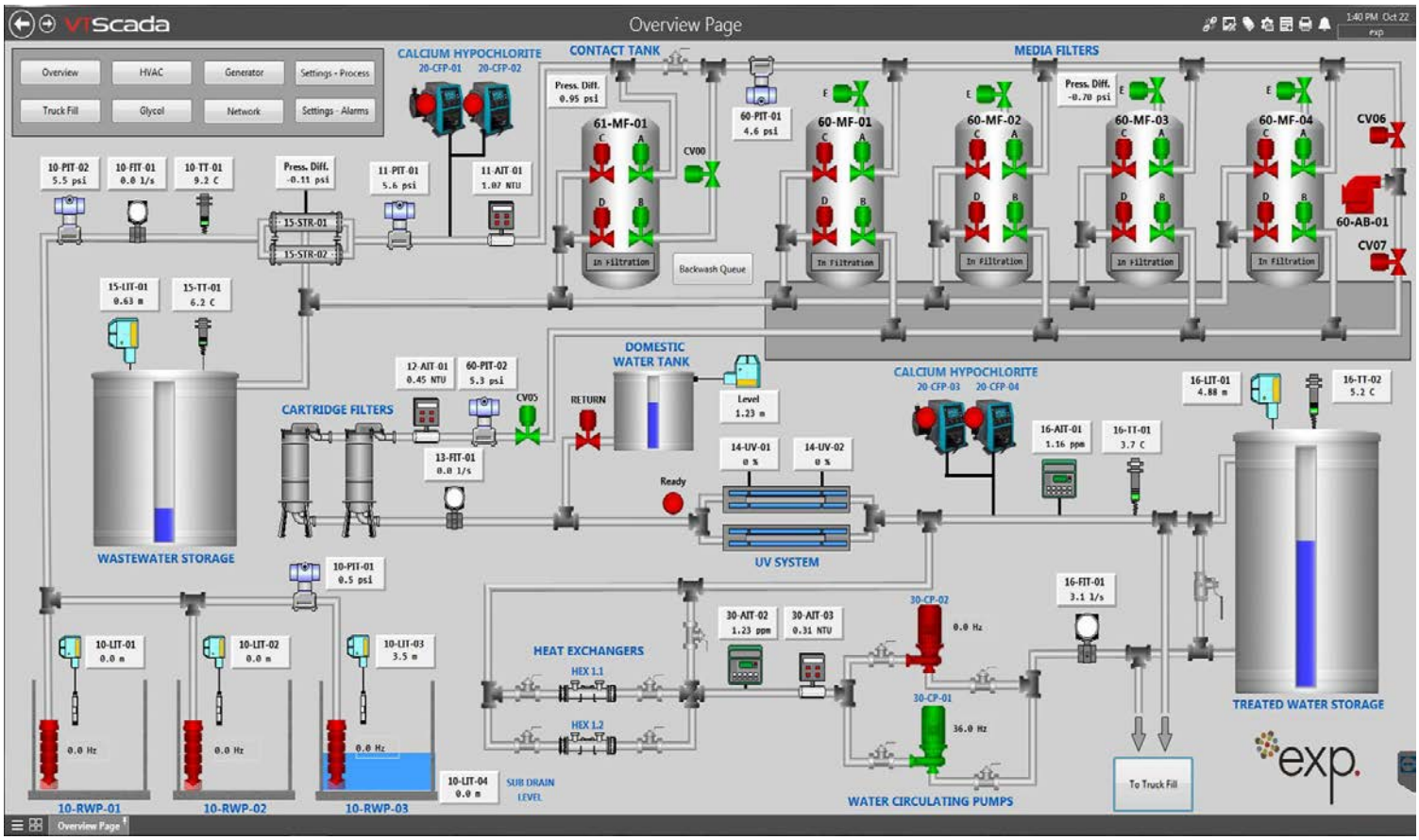


Figure 5 Home screen on HMI control panel

After the media filters, the filtered water flows to cartridge filters which prevent any of the sand media from entering the UV unit. Cartridge filters are two 5 micron in parallel configuration, followed by two 1 micron (can be absolute or nominal). Pressure transmitters measure the pressure differential so that the operator knows when to clean or change out the filters.

After the cartridge filters, the water enters two parallel UV units for sterilization of microorganisms. After the UV, calcium hypochlorite is injected into the water pipe through an injector for disinfection. The turbidity is again measured at 16-AIT-01 and the potable water line exits the treatment plant at valve 16-V-01 where it is piped to the 735 m^3 treated water storage tank.

1.6 System Interface

a) Physical Interface – Raw water from Reservoir 1 and 2, through the existing pump house, enters the treatment plant at 10-V-06/10-CHK-01. Raw water from Reservoir 3 via the new pump house enters at 10-V-05 / 10-CHK-02.

b) Power Interface: Utility Power 575 Vac, 200A, 3-phase, 60 Hz. Backup power is a diesel generator. There is a transfer switch in the WTP electrical room that automatically switches power from utility to generator when there is a power outage.

Figure 6 the main control panel inside the Motor Control Centre (MCC room).
Power Auto Transfer Switch on the right

c) Operational Interface:
The main control panel is located in the Electrical room (MCC room).

Control panels A, B & D have alarm indicators. If the alarm is illuminated, the main control panel Alarms and screen should be pressed for more information. Control Panel C is for local control of the boiler pumps and start/stop boiler operation.

The emergency stop button will cut all power to the treatment system and pumps.

d) Communications Interface
Internet: A high speed internet connection will be available to allow operators and service technicians to remotely operate and monitor the WTP. A computer in the office also has the plant software control with the same HMI control screen as the panels.

Consult "Drawings" in this binder for schematics and electrical details.

2 Main Components

1) Building
2) Electrical room
3) Fuel system and back-up generator
4) Hydronic heating system
5) HVAC system
6) Domestic Water system
7) Water treatment process

See Appendix A for a detailed list of components.

3 Plant Operation and Troubleshooting

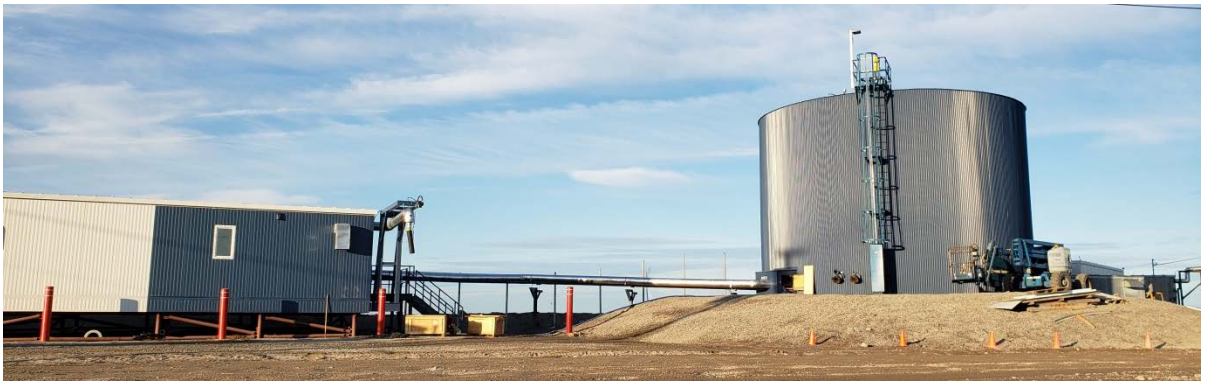


Figure 7 Treated Water Tank

3.1 Filling the Treated Water Storage (TWS) Tank

Submersible raw water pumps 10-RPW-01, 02, 03 will be started when a low water level, as sensed by level transmitter 16-LIT-01 in the treated water storage tank, is triggered. The low level is set at 4.2m (above bottom of tank). Note: These pumps can also be started/stopped from the PLC control panel by the operator or on a timer.

There are two (2) modes of operation, regular flow and high flow. Regular flow will adjust a single pump to maintain 500 L/min from 10-FE-01. High flow will run two pumps to achieve a flow of 1000 L/min, or an operator adjustable amount.

Each pump's hours of operation can be viewed and reset on the HMI Settings screen. The operator chooses the duty pump and backup pump and the triggers that prompt

pumps to alternate such as run time, or pump fault, or alternation every time the pumps start up. The pumps should be on a schedule for each pump to receive equal duty time.

Figure 8 Raw Water Pump Popup Screen

The raw water pump 10-RWP-03 is currently not the duty pump and not on. It will display green when running.

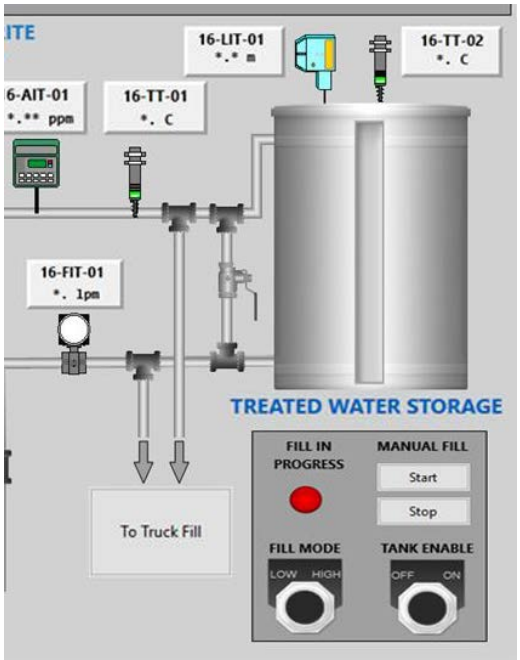


Figure 9 Treated Water Tank Level (16-LIT-01) and Tank water temperature (16-TT-02) and on the flow into the tank (16-TT-01)

Figure 10 Tank fill controls
See touchscreen notes at the end of this manual for details

3.2 Plant Start-Up Operation

- Verify that the treated water storage tank 16-TK-01 level is sufficient to receive treated water.
- Verify that all controls are set to AUTO and all manual isolation valves are in the open position and sample taps are closed.
- Cartridge filters should be installed in the Harmsco filter housings
- Sufficient Calcium hypochlorite solution should be mixed and transferred into the dosing tank.
- The turbidity and chlorine monitoring system should be operational and within calibration.

Operating Condition	**Cause / Remedy**
Typical Problems Eg. Plant won't start	• Treated water tank is too full. Drain some water out of the tank. • Control panel not on auto • Restart the control panel from the office computer
Equipment failure	• Bypasses are designed into the system to bypass the equipment, eg UV, cartridge filters, EXCEPT the chlorination system • Media Filters can be isolated by manually closing the actuated valves of a single filter
Power issue	A loss of power will automatically initiate a switch to generator power after a 3 minute delay. There is also a generator warm-up delay.

3.3 Self-Cleaning Strainers

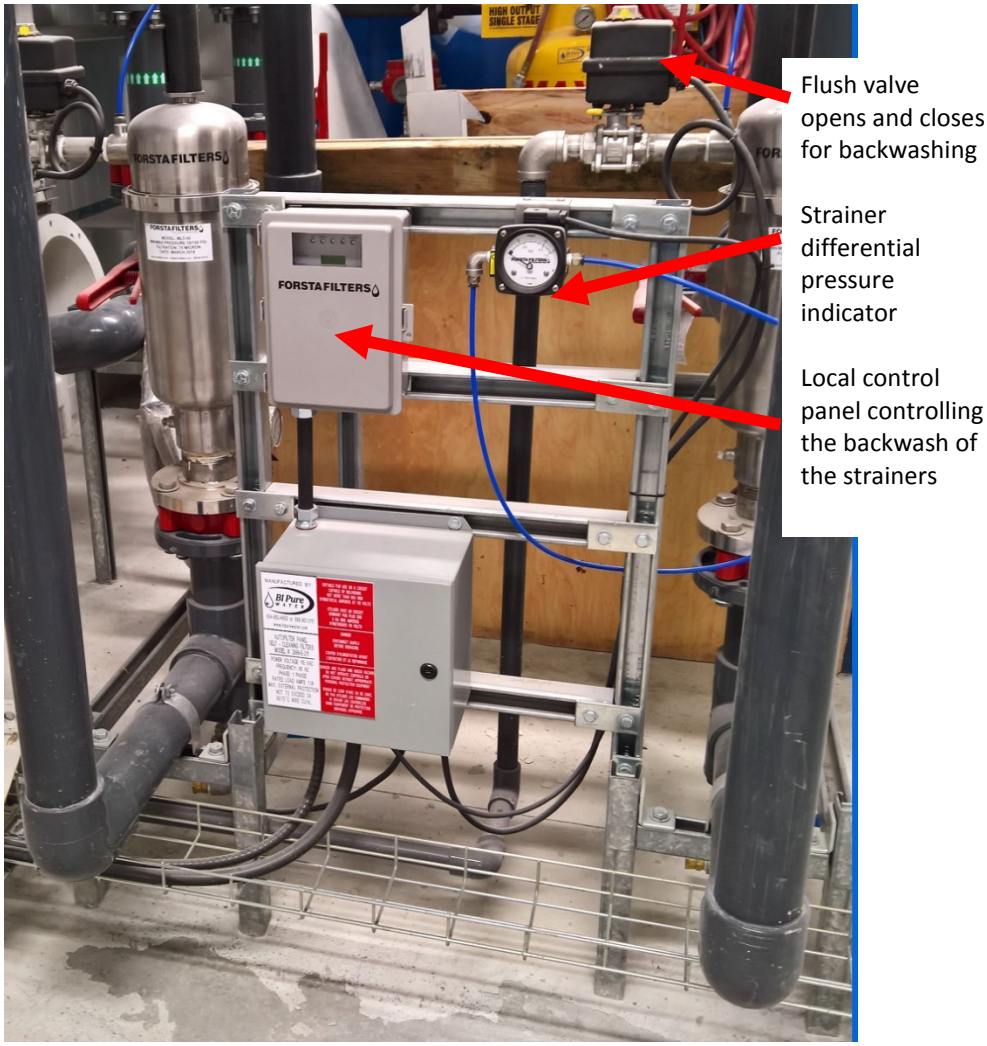


Figure 11 Self-cleaning strainers

Two self-cleaning strainers screen out large particles and operate in parallel. Each strainer is capable of filtering 756 lpm with a 100 micron screen and 500 lpm with a 75 micron screen – these strainers come equipped with a 75 micron screen. The strainers are backwashed periodically after a timed period or due to pressure differential set point. Backwash is controlled by the local control panel and they should not backwash at the same time. If there is an issue with operation an alarm will be reported on the main HMI. If one unit is down for maintenance the other unit is capable of hydraulically filtering regular and high flows.

The controller receives an open/closed signal via terminals P and D. This signal is from the differential pressure gauge, and means that the gauge has reached a preset value. Reaching the preset value (7 PSID) tells the controller that debris has collected on the

screen element, and that an automatic backwash will activate. The controller allows the user to adjust the flush duration, dwell time between backwashes, and the specified periodic backwash. As well the operator can conduct a manual backwash from the controller.

If the screen becomes clogged over time and the cleaning process is cycling too frequently, one strainer at a time the strainer can be isolated and the screen removed for replacement or more thorough cleaning. Refer to the self-cleaning strainer manual for detailed instructions on screen removal.

3.3.1 Self-Cleaning Strainer Operating Conditions

Operating Condition	Cause / Remedy
Typical strainer backwash schedule as set at time of commissioning, Oct 2019	Pressure differential reaches 7 psi approx. every 15 minutes
In the spring the turbidity will be higher	Backwashes will occur more frequently; allow the strainer to operate by pressure differential or set a more frequent backwash

3.3.2 Self-Cleaning Strainer Troubleshooting

Symptom	Cause / Remedy
Filter clogged / Mechanical filtration issue	• Isolate one unit at a time, open the filter and inspect the components as per the strainer manual in this binder. • Remove the screen for cleaning or replace the screen with a new one. Refer to the self-cleaning strainer manual for detailed instructions on screen removal.
Flow through the system is lower than expected	• Is Strainer flushing fully? • Is the flush valve operating? • Check settings and alarms in HMI • Is the cleaning sequence in AUTO? • Is the pressure at the outlet between 40 and 60 psi? • Are the strainers clogged? • Is there a closed valve?
Strainer is fouling too quickly or flushing all the time	• Adjust the timing of the flushing. If the water is particularly dirty, the strainers may need to flush frequently • There is not sufficient flushing flow/pressure. There must be at least at least 20 GPM at 40 psi during backflush for the filter to flush properly.
No filtration	• Conduct manual backwash of filter from filter control panel, “Manual Start/Advance” button or modify the length of backwash or rinse time

3.4 Calcite Tank

Figure 12 Contact tank, followed by 4 filters containing sand media

3.4.1 Chlorine Contact Tank

The calcite tank is used currently as a chlorine contact tank. Chlorine is injected before the filters to aid in the filtration process. The contact tank is not backwashed.

3.4.2 Calcite Tank

The contact tank may be used as a calcite filter. The first filter is loaded with calcite, a crushed and screened white marble media which inexpensively neutralizes acidic or low pH waters to a neutral, less corrosive effluent. The calcite is backwashed periodically, however it cannot be backwashed when the filters are making water – when the treated water tank is being filled. An operator/PLC initiated backwash can be triggered based on run time duration or manual (operator select). Tank fill is not available during a filter backwash.

The calcite filter operation is completed in 1 stage, with raw water entering the bottom valve CV-01D and exiting the top valve CV-01C to the drain when the filter is not making water.

3.5 Sand Media Filters

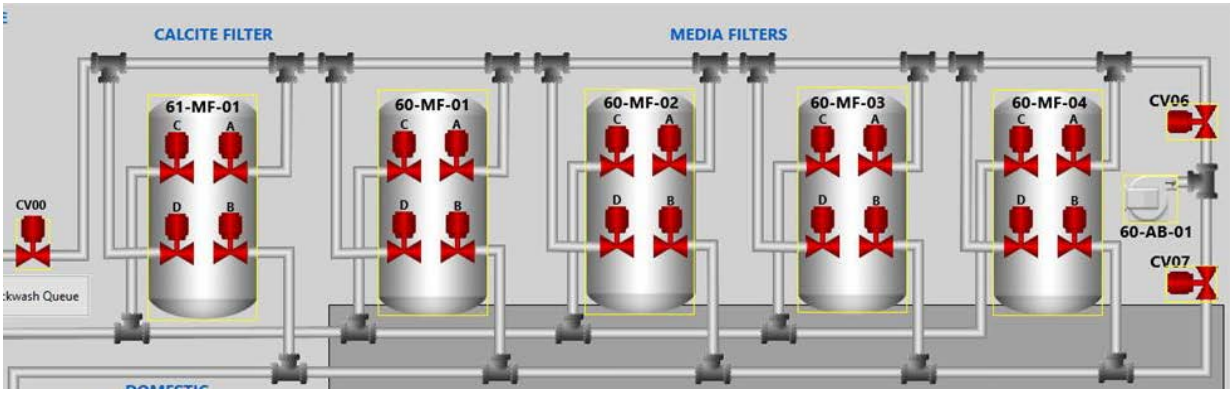


Figure 13 Media filter configuration on the HMI

The media vessels 60-MF-01, -02, -03, and -04 are filled with sand media for reducing turbidity and separating particulates. The bottom half to two thirds of each tank is filled with layers of 16 ft^3 of gravel, silica sand 0.45-0.55 mm, and anthracite 1.0-1.2 mm E.S. The filters must be backwashed periodically to rinse the filter bed, which allows the media to be reused.

Each of the media vessels can be controlled independently through the HMI. Each vessel is capable of filtering 333 LPM. Only one vessel can be backwashed at a time while the other three vessels are in service. Treated water is supplied by the three service vessels for backwashing the remaining vessel at 1115+ LPM.

Each filter vessel can be backwashed individually or all filters can be backwashed in sequence. The automatic backwash is triggered based on filter outlet turbidity (12-AIT-01) or the water production run time. A flow totalizer (13-FIT-01) is used by the PLC to record and total the run time of the filters between backwashes. With the backwash initiated, the tank fill will be interlocked to be unavailable until the backwash is complete.

A media backwash consists of 5 adjustable-time stages: drain approx. 1 minute; air scour 5 minutes; settling time 10 minutes, backwash for 10 minutes; fast rinse 2 minutes. The drain outlet is in the floor draining to sumps. Backwash water exits to the backwash tank outside.

In an Emergency, the bypass valves CV-06 will open and the CV-0XE valves to each of the filters will close, bypassing the filter unit, to supply water.

3.5.1 Media Filters Operating Conditions

Figure 14 Media filter with fluid direction labels

3.5.2 Valve Operation – Sand Media Filters

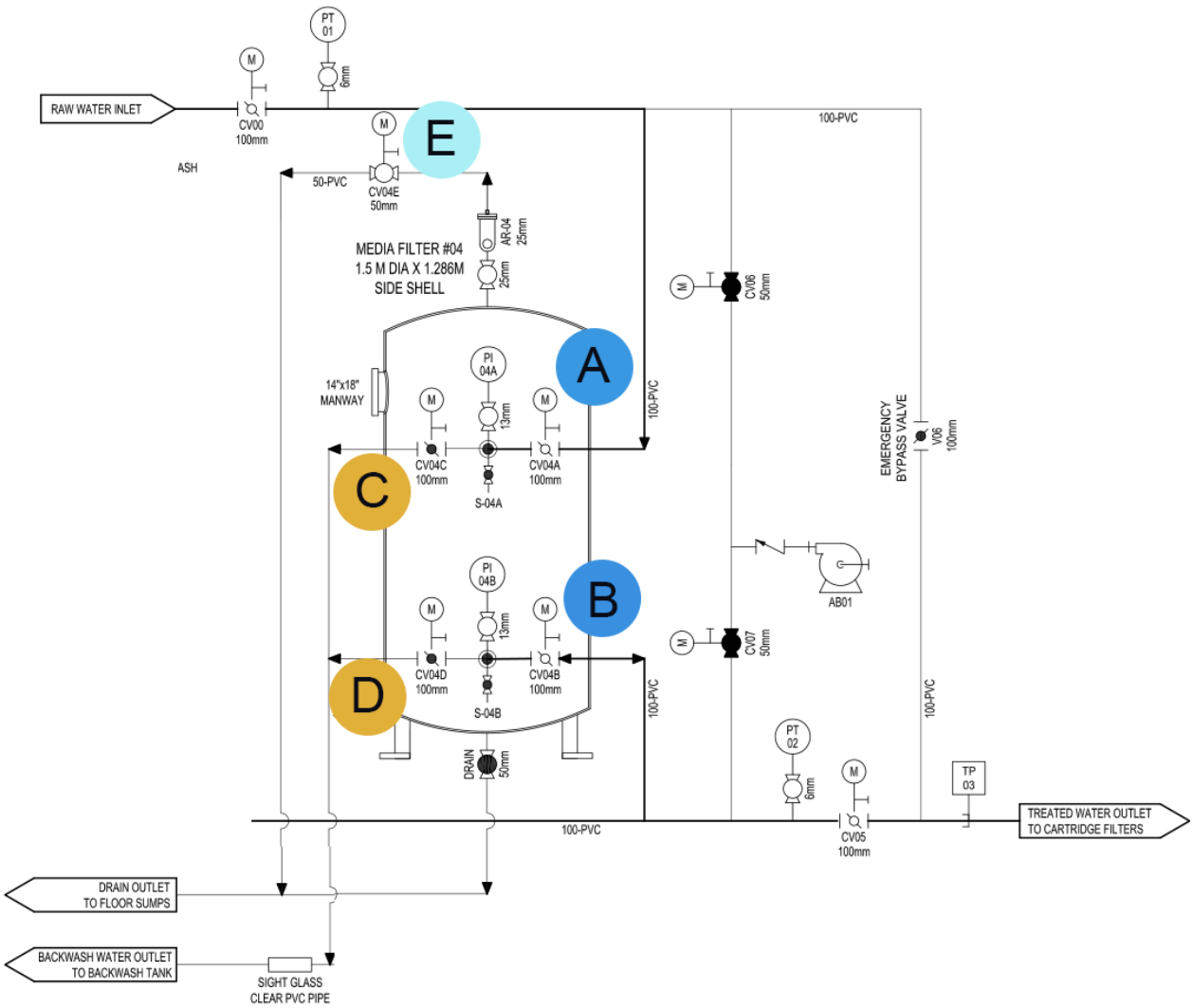


Figure 15 Sand Media Filter Process Diagram

When the filter is in service and filtering water, the skid inlet CV00 will be open allowing raw water flow. Each vessel's Valves A and B will be open, and top air valve E will be open. System outflow valve CV05 will also be open. Backwash outlet valves C and D will be closed. As well the air blower AB01 valves are closed.

When a single filter is in backwash, it is being supplied with filtered water from the other filters which are remaining in service mode. During the air scour mode, which assists the backwash, all the valves close except Backwash Inlet "B" and backwash outlet "C".

For the backwash operation, the inlet is open and "B" and "C" are open. All other valves are closed.

Valve Position – Parallel Flow										
"Flow Sequence"	**"Time (min)"**	**CV00**	**CVxxA**	**CVxxB**	**CVxxC**	**CVxxD**	**CVxxE**	**CV05**	**CV06**	**CV07**
Service	N/A	O	O	O	X	X	O	O	X	X
Drain	3	X	O	X	X	O	X	X	O	X
Air Scour	3	X	X	O	O	X	X	X	X	O
Settling Time	2	O	X	O	O	X	O	X	X	X
Backwash**	8	O	X	O	O	X	O	X	X	X
Fast Rinse	2	O	O	X	X	O	O	X	X	X
Shutdown	N/A	X	X	X	X	X	O	X	X	X

Figure 16 - Media Filter Valve Sequencing Table

**Valve operation shown represents the (1) filter vessel being backwashed at the moment. Since the backwash supply water is being supplied by the other remaining filters, the other vessels will be operating in "service mode" to provide the treated water for backwash.

CVxxE is closed during drain down and air scour for all tanks when a single filter is being backwashed.

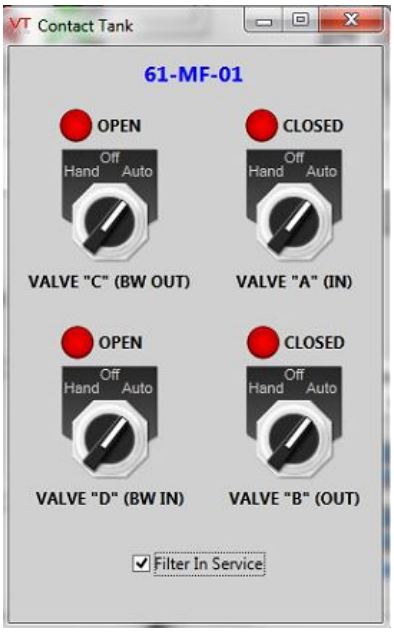


Figure 17 – Individual Sand Filter Valve Controls on HMI

If green the valve is activated to open or close depending which flow sequence the filter is in.

3.5.3 Media Filter Troubleshooting

Symptom	Cause / Remedy
No reduction in turbidity or not enough, objective: <1 NTU	Verify turbidity analyzer is within calibration. Initiate a manual backwash or perform an extended backwash
Inlet Pressure < 100 psi	Check for closed valves
Differential Pressure >10psi	Initiate a manual backwash of single filter or all filters sequentially
Differential pressure after backwash is below 4 psi	Media may be loading with heavier materials such as sand and may need to be replaced. Contact BI Pure Water
Equipment failure	Each filter's actuated valves can be manually closed to isolate and take the filter offline. See the video for filter valve operation.

3.6 Cartridge Filters

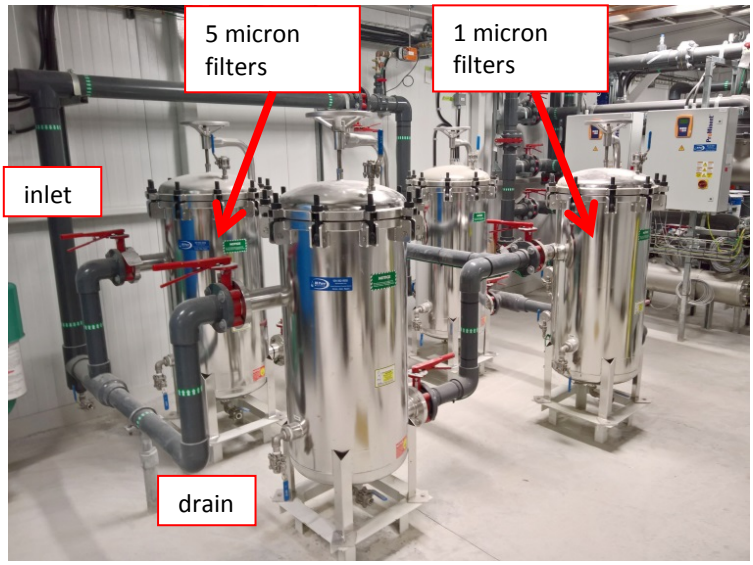


Figure 18 Cartridge Filter Housings

Two cartridge filter trains operate in parallel. Each train consists of Harmsco Hurricane filter cartridges inside each of the housings. Five micron filters are inside the first two housings followed by the 1 micron filters in the following two housings, filtering increasingly small particles and providing a measure of disinfection. One micron filters can potentially provide disinfection log removal credits if certified 1 micron absolute cartridges are used.

With one train down for maintenance the other unit is capable of filtering regular and high flows. The cartridge filters prevent sand particles from entering the UV and increase the clarity (UV transmittance) of the water before it enters the UV unit.

During operation, the pressure reading on the gauge installed before the cartridge filters will gradually decrease as the filters are used and fill with particles.

The operator should monitor the differential pressure across each set of 2 filters, (13-PG-02, 13-PG-04 minus 13-PG-01 and 13-PG-03, 13-PG-05 minus 13-PG-01) and clean or change the filter inside the housing when the max differential pressure of 15-20 psi is reached.

There are no automatic controls for cartridge filters. The filters can be bypassed by simply not installing a cartridge or manually activating the filter bypass valves.

3.6.1 Cartridge Filters Operating Conditions

Operating Condition	Cause / Remedy
Cartridge filters pressure differential Sept 27, 2019	2-5 psi
Seasonal variation eg. Feb, 2020	(Operator record for troubleshooting)

3.6.2 Cartridge Cleaning Instructions for 5 Micron Filter

*See the Harmsco filter manual in the parts binder. Filter cartridges (5 micron and up) are washable and reusable. 1 micron cartridges must be replaced. Clean cartridge and filter with pressure nozzle using standard hose. Direct spray at an angle to remove particulates. If organic matter or deposits are difficult to remove, a cartridge can be soaked in a solution of chlorine and water one hour or longer until surface is no longer "slippery". Rinse after bath. For calcium or mineral deposits on the filter, one part muriatic acid to twenty parts of water may be used. Rinse cartridge thoroughly afterward with water.

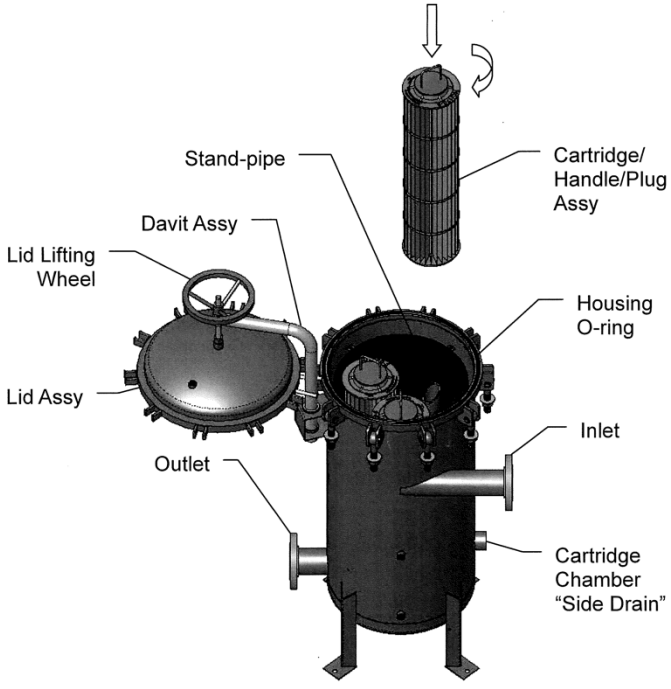


Figure 19 Filter Housing components

3.6.3 Filter Preparation

To prepare the cartridge filters for startup, complete the following tasks:

1. Open the cartridge filter housings
2. Load the appropriate cartridges into the filter housings
3. Set the O-rings in place and tighten the filter housings hand tight.
4. Check for leaks when pressurized and release air trapped in the housing.

3.6.4 One Micron Absolute Cartridge Filters (CF230, CF235)

The purpose of the 1-micron absolute cartridge filter if used is to provide 2 log removal for crypto and giardia. If a 1 micron nominal filter cartridge filter is used, the purpose is to polish for turbidity. The cartridges should be changed out when the pressure differential between PG234 and PG224 exceeds 10 psi.

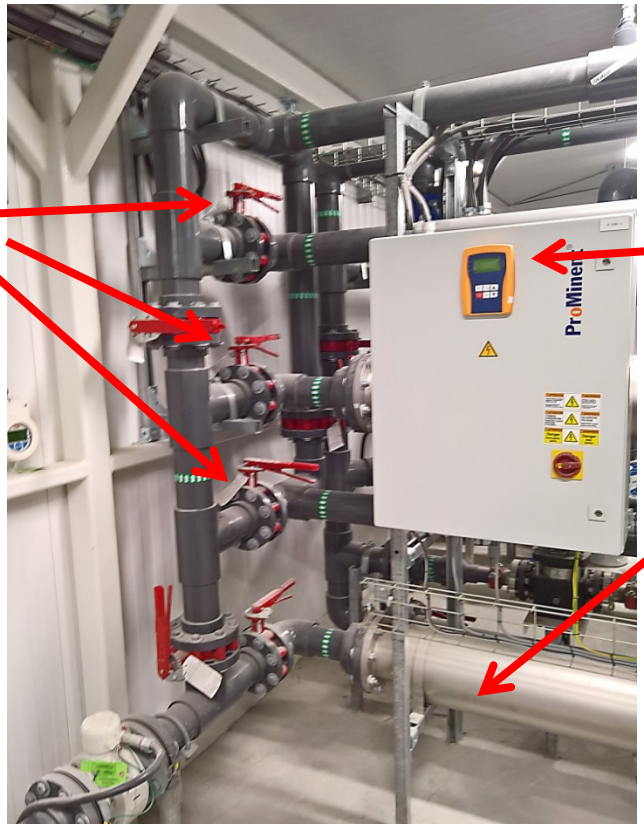


Figure 20 UV unit with local control panels

3.7 UV Units

Each of 2 ProMinent Dulcodes Type LP UV: 2 x350-LP UVs treats up to 500 L/min each. They can be operated in parallel, or in series with both UVs in operation. The PLC /Operator setting will be able to disable the UV, one unit at a time to avoid shutting down the water production, if desired for maintenance. Manual shutoff valves on the inlet and outlet of the UV units allow the operator to isolate each unit one at a time for maintenance. With one unit down for maintenance the other unit is capable of disinfecting regular flows only. Both UV units can be bypassed, if required.

When the call for water has been initiated by the operator or by the tank level, the UV units will start to warm up the lamps 90 seconds before the command to the raw water pumps is given. The local controller will have lamp hours log (life of and UVT efficiency counters). The lamp life is 14,000 hours, or approx. 18 months. The local PLC will receive/report operational status and error codes.

This UV's dynamic lamp heating feature adjusts the lamp output to varying flows and water temperatures. The starting UVT (UV light transmittance) is 81.0%/1cm. The minimum UV dose of this system is = 40 mJ/cm2 = 400 J/m2. When the UV dose drops below this value, the system alarms and it is time to replace the lamp.

3.8 UV Bypass

UV may need to be bypassed if there is an equipment failure or emergency water required.

UV Valve Operation							
	14-V-01	**14-V-02**	**14-V-03**	**14-V-04**	**14-V-05**	**14-V-07**	**14-V-06**
Single UV in service 14-UV-01	O	X	X	X	X	X	O
Single UV in service 14-UV-02	X	X	O	O	O	X	X
Series Operation	O	O	X	O	O	X	X
Parallel operation	O	X	O	O	O	X	O
Bypass	X	X	O	X	X	O	X

3.8.1 UV Maintenance

UV maintenance should be conducted by a trained operator. See UV manual in the system Parts binder. An annual cleaning of the UV lamp protection tubes when replacing the UV lamp is usually sufficient.

Caution: Care must be taken when handling the quartz sleeves and UV lamps as they are fragile and will easily break.

Spare parts include: 300 W UV Lamp Opti-flux, 350 LP Lamp Protection Quartz Tube, 2x350 LP Set of O-rings.

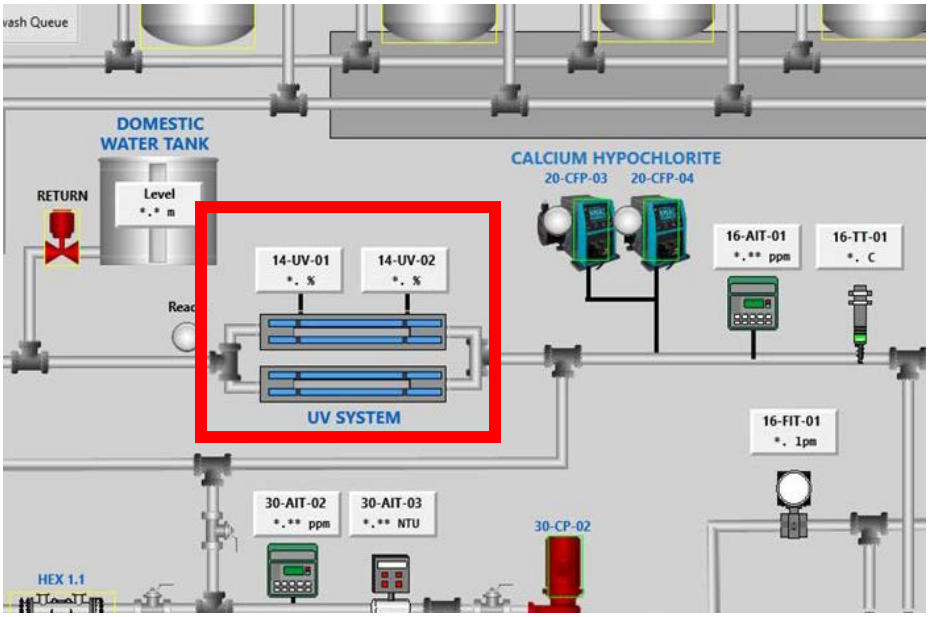


Figure 21 UV transmittance data displayed on the homepage HMI

Figure 22 UV controls on the HMI

3.8.2 UV Operating Conditions

Symptom	**Cause / Remedy**
Inlet UVT Sept, 2019	81%
Equipment failure Power failure	Close off valves to the UV unit and open the bypass valve. Disinfection is conducted by cartridge filtration and chlorination only.

The UV units require 2 minutes to warm up before startup of the plant is permitted.

3.8.3 UV Troubleshooting

Symptom	**Cause / Remedy**
UVT (light Intensity): less than 60% will trigger an alarm	Replace the lamp if worn out or clean the sleeve.
The UV will not turn on / the UV is in fault mode	• Check the UV's control panel for alarm info. There may be insufficient power in the lamp and the lamp needs to be changed. • The water temperature is too warm • The UV needs to warm up for 2 minutes before operation is permitted
Error #	Check the Prominent UV pump manual for further info on error numbers

3.9 Chlorination

The chlorine room is separate from other equipment because of the corrosive effect of chlorine fumes on pumps and equipment. The ventilation of the room is important and also in the room is a safety eyewash and shower in case of chlorine spills or exposure.

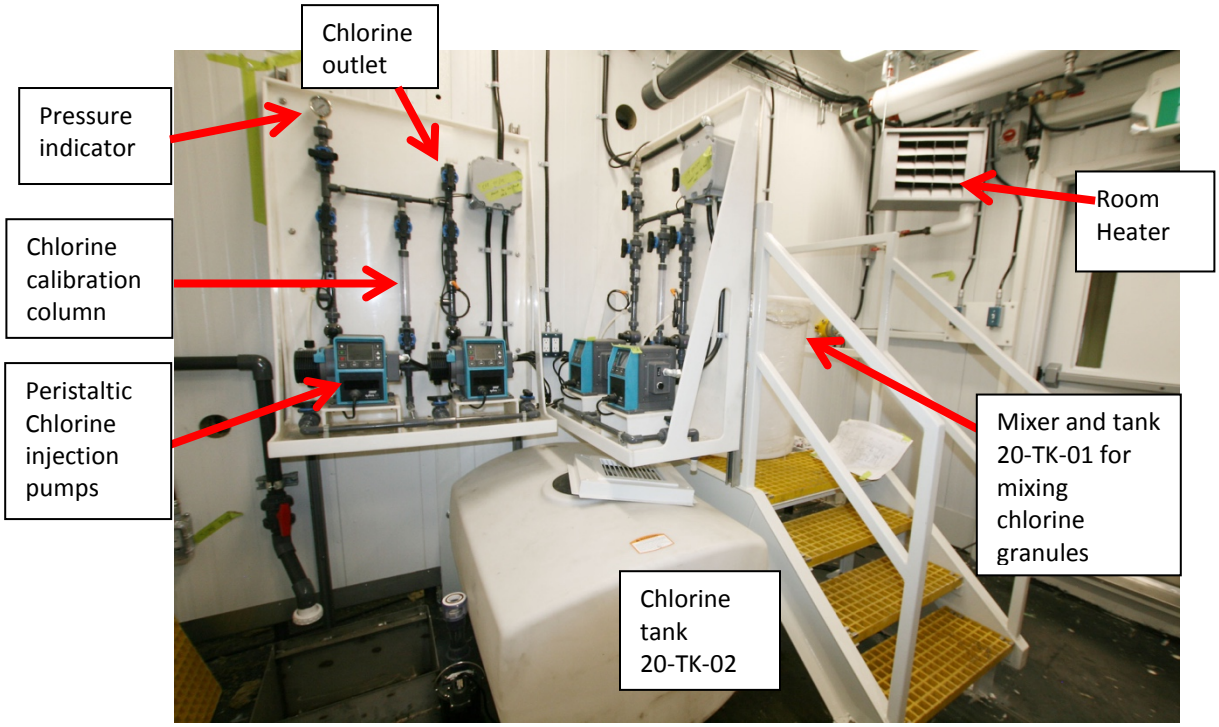
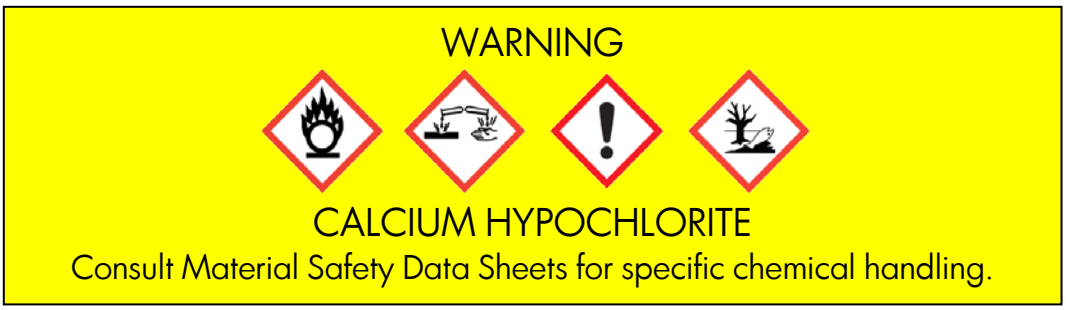


Figure 23 Chlorine room



3.9.1 Chlorine Mixing

Procedures for handling and dispensing calcium hypochlorite should be carefully read and reviewed before commencement (see calcium hypochlorite MSDS section 8 of the Manual/Treatment Plant Parts/MRB). The solution tank for the calcium hypochlorite should be monitored for fill level. Do not let the tank run empty as the resulting air in the line will have to be purged before chlorination can resume.

Mixing setup – The use of powdered calcium hypochlorite for drinking water disinfection requires premixing and storage of the hydrate calcium hypochlorite. The Axiall powder is NSF approved for use in drinking water. The solution is mixed by the operator in a 204 L mix tank (20-TK-01), allowed to settle, and then the operator manually transfers the solution to the 454 L day tank (20-TK-02). A small mixer is clamped to the mixing tank to assist the operators in dissolving and maintaining the calcium hypochlorite solution.

The day tank is sized to provide a 9% calcium hypochlorite solution for up to 7 days.

Recipe: 2.37 L (80 oz = 10 cups) of 65% granular calcium hypochlorite with 140 L of water = 8788 mg/L
Mixing tank: 200 L

Use the 8 oz rectangular scoop that comes with each pail of calcium hypochlorite to fill the tank.

Safety Precautions:
Calcium hypochlorite in a liquid form can result in spills and splashes. Before using calcium hypochlorite for disinfection, a protective apron, rubber gloves, goggles, and a face shield are recommended. Procedures for handling and dispensing calcium hypochlorite should be carefully read and reviewed before commencement (see calcium hypochlorite material safety data sheet (MSDS) in this manual.

3.9.2 Safety Shower/Eyewash

For user safety, an emergency shower and eyewash is installed in the chlorination room. The emergency shower is serviced with tepid water that uses hot and cold water flowing through a mixing valve to ensure user is not scalded with hot water or sent into hypothermic shock with cold water.

The emergency shower and eyewash station is available in case there's a chlorine chemical spill or splash on the operator. The operator presses the handle on the lower right for the eyewash or pulls the large shower lever down. The shower is supplied with lukewarm water from the water tank, as cold water may exacerbate a chemical injury.

The shower and eyewash should be tested monthly to ensure there is flow of the appropriate temperature.

Figure 24 Safety shower and eyewash

A hot water tank and thermostatic mixing valve mixes hot water to 29 degrees C with treated water supply coming back from the treated water tanks. It has a failsafe to deliver cold water if no hot water is available.

Figure 25: Mixing valve

Figure 26: Domestic water balancing valve

3.9.3 Room Ventilation

The fan EF-1 in the Chemical room has two speeds. Low speed is signalled with the light switch in the off position. High speed is signalled with light switch in the on position.

3.9.4 Adjusting the Chlorination

The operator should read and become familiar with the Watson-Marlow Chemical Feed pump Manual in this binder (Section 4. Process System/4B. Pumps/page40-). Six chemical dosing systems are provided with the treatment plant. Each system has a redundant chemical pump that will alternate automatically if a pump fault is detected.

Figure 27 Peristaltic chlorine pumps

The pump will start and stop as (water flows to the treatment system, to the truckfill, or treated water tank). Typically the pumps are flow paced to the process flow, i.e. the speed will increase / decrease with the process flow.

If the pump is running the display will be blue. If there is an alarm the display will be red. Pumps have a digital display of flow rate, pump speed and % of max speed.

A manual flow check of chlorine can also be conducted with the calibration column by noting the amount of chlorine that fills the column in one minute (open and close the appropriate valves first). See the video: *BI Pure Water channel: Sodium hyopochlorite injection with a peristaltic pump*

<u>Manual dosing pump settings</u>
See calculations below. Pump speed should be 20% @ 68 mL/min service flow.

Default Dosing Rate

Full strength cal hypo: 8788 mg/L
Desired dosing rate: 0.5 mg/L
Expected flow rate: 500 L/min (132 gpm)
Dosing rate required for flow: (0.5 / 8788 *500 * 1000) = 28.4 mL/min
Dosing pump – max flow rate: 333 mL/min
Dosing pump – Speed: 28.4 / 333 = 8.5 %
The treated water tank has been sized to provide the desired Contact Time (CT).

Figure 28 Chlorine pump display on the HMI

3.9.5 Chlorine Injection Operating Conditions

Symptom	**Cause / Remedy**
Less than 0.2 More than 4.0	Increase or decrease the flow multiplier in the Process Settings Screen

3.9.6 Chlorine Pump Troubleshooting

Check and clear any alarms on the HMI.

Symptom	**Cause / Remedy**
Pump is not running	• Check settings in HMI • Check for faults • Is there a leak in the tubing? • Run pump in HAND mode • If the fluid monitoring is enabled on the pump controller, when the pump estimates zero fluid level in the tank the pump will stop
Pump is running all the time	• Check that pump is not in HAND mode (icon on top left on the pump display) • Check the mode setting. There are 5 possible modes; Manual, Flow Calibration, Analog 4-20 mA, Contact, Fluid Recovery, and Cancel. • Possible glitch in PLC
The residual chlorine value takes a while after starting to come up	• The chlorine in the dosing line is off-gassing and creating air pockets • The dosing line has lost prime • The backpressure valve close to the injector is not working properly

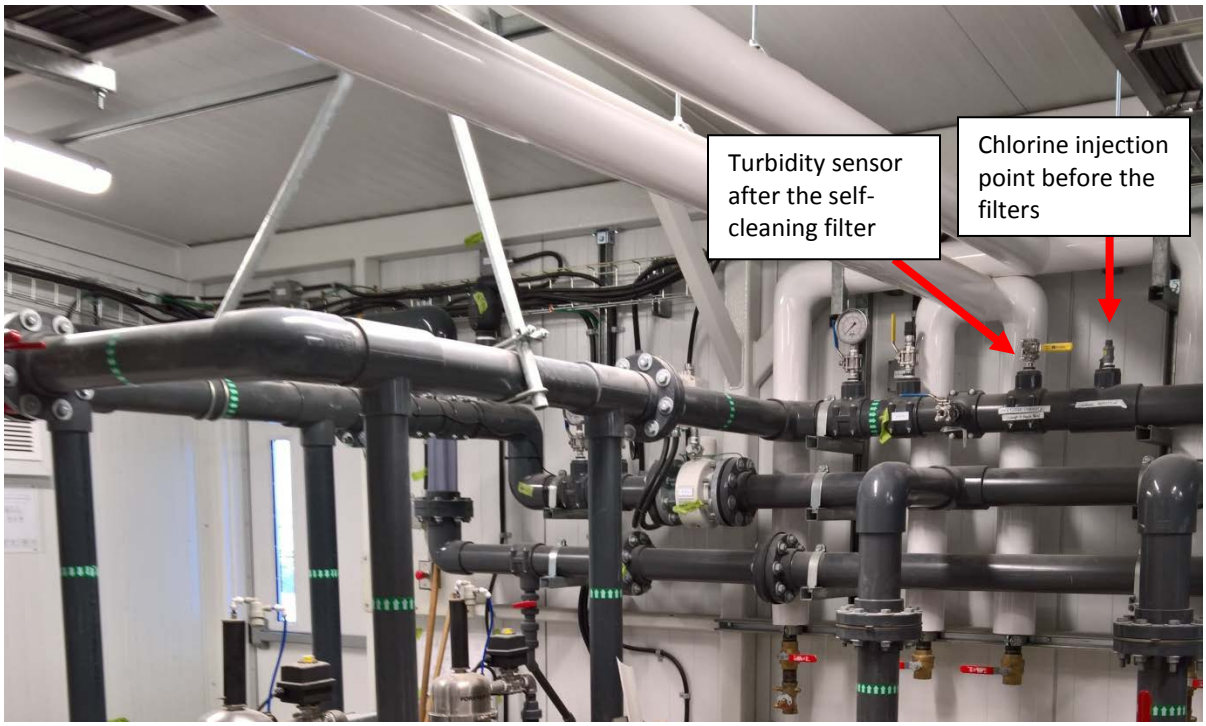


Figure 29 Chlorine injection point preceding the filters

3.9.7 Chlorine Injection

Flow paced operation and quill location – There are two chlorine chemical injection points, 20-CHK-01 and 20-CHK-02 (see drawings P-205, P-206 and P-214). Injection point 20-CHK-01 is to inject a trace amount of chlorine into the raw water prior to the calcite vessel and media filtration. This is done to oxidize the manganese and inhibit biological growth in the media filters. The concentration will be set by the operator and controlled based on the flow from 10-FE-01.

Injection point 20-CHK-02 is to add a residual amount to the treated water before it enters the storage tank 16-TK-01 for disinfection. The concentration will be set by the operator and controlled by 13-FE-01.

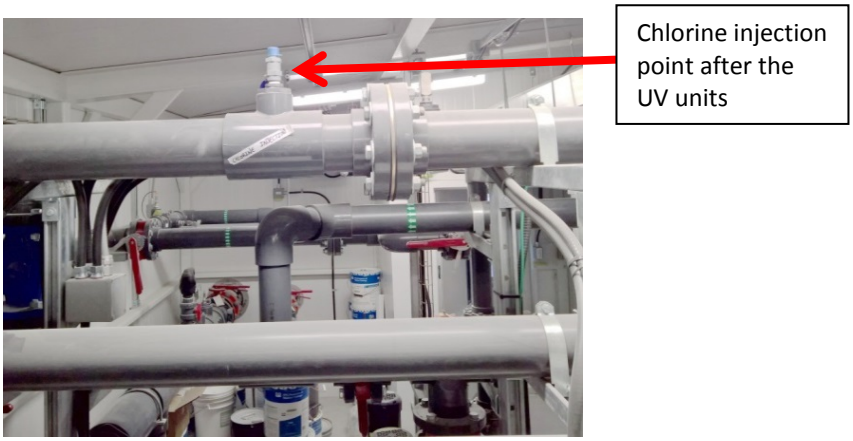


Figure 30 Chlorine injection point on the outlet

3.9.8 Chemical Injection Maintenance & Troubleshooting

Scaling and blockage can occur in the injector. The solution tube and check valve internals should be inspected regularly to ensure that scaling/build up is not impeding operation. Scale can be cleaned by soaking solution tube in warm water and then working the scale free, or using a rod or brush. Do not use rod or brush on units with Tips. See SAF-T-Flo manual in the Parts binder.

Symptom	**Cause / Remedy**
No chlorine flow or high flow	Failure of chlorine injection valve/point. Try cleaning or replacing the injection valve. Verify the dosing pump is operating correctly. Verify the solution tank is sufficiently full.

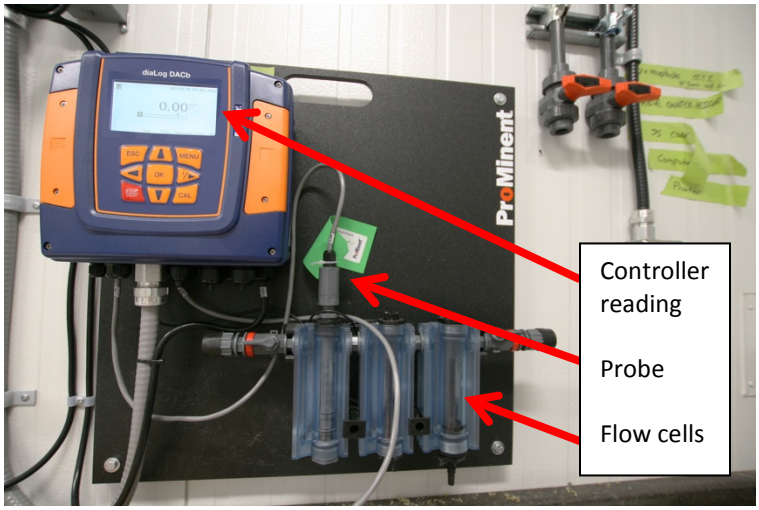


Figure 31 Chlorine analyzer

3.9.9 Chlorine Analyzers

Chlorine analyzers check the chlorine level within the tank circulation loop. 30-AE-02 will be able to read the concentration of chlorine in the treated water tank (16-TK-01), it will also be indicative of the chlorine concentration going into the trucks if the plant is bypassing the tank. 16-AE-01 should read the same as 30-AE-02 when just the circulation pumps are in operation. However, when the treatment train is in operation 16-AE-01 indicates chlorine levels left over from injection point 20-CHK-01. The operator can then adjust the concentrations of chlorine at the injection points as required.

Treated water samples flow into the free chlorine and pH cells pictured here and are sampled by the probes. pH and chlorine levels are shown on the controller.

There is a calibration log in the analyzer, writing calibration and event data every 10 seconds to an SD card, with a capacity of 20 years. This is not used / required during normal operation as the PLC is data logging.

3.9.10 Analyzer Maintenance

The surfaces of the instruments should be kept clean and dust free. The pH analyzer and chlorine analyzer can be calibrated to verify its functioning. The following Youtube videos may be helpful:

- *ProMinent Tutorial – Zero Point Calibration for a chlorine sensor on a DULCOMARIN® 3*
- *Metering System DULCODOS® Pool Comfort: Calibrating the pH sensor*

3.9.11 Analyzer Troubleshooting

Symptom	Cause / Remedy
Error #	Check p128- of the Prominent chlorine analyzer manual in the O&M manual.

3.10 Turbidity Meters

Turbidity levels and historical data can be read on the main HMI. There are four turbidity meters, three are located in the computer office. Each has a controller located above it and a sensor located on the water pipe. 30-AE/AIT-01 has a sensor located on the tank circulation line and will receive sample water continuously as long as the circulation pumps are running.

Figure 32 Turbidity meters -01, -02, -03 in the computer room

Turbidity meter sensor 11-AE/AIT-01 is located just after the self-cleaning strainers and it measures the turbidity before the calcite tank. 12-AE/AIT-01 is located after the media filters (60-MF-01/02/03/04). 30-AE/AIT-01 is located on the tank circulation line and will receive sample water continuously as long as the circulation pumps are running. 30-AE/AIT-01 reads the turbidity in the treated water tank (16-TK-01), it also indicates turbidity going into the truckfills.

Reading turbidity on the HMI
Keep a record of turbidity levels as this can assist with troubleshooting.

3.10.1 Turbidity Meter Maintenance

The surfaces of the instruments should be kept clean and dust free. The instruments come with maintenance kits including special tools.

The vials need to be checked and cleaned every 1-3 months depending on water quality. Every 1-2 years the vials and desiccant cartridge need to be replaced. The tubing may need to be replaced if leaking.

The following Youtube video may be helpful:

- *TU5 Series Turbidimeters - Routine Maintenance*

3.10.2 Troubleshooting Turbidity

Symptom	**Cause / Remedy**
High turbidity	Verify Turbidity meter is within calibration and operating correctly. Conduct a manual backwash of filters
Unusually low turbidity reading.	Verify Turbidity meter is within calibration and operating correctly. Follow the calibration procedure, if required. Compare reading with hand-held unit.

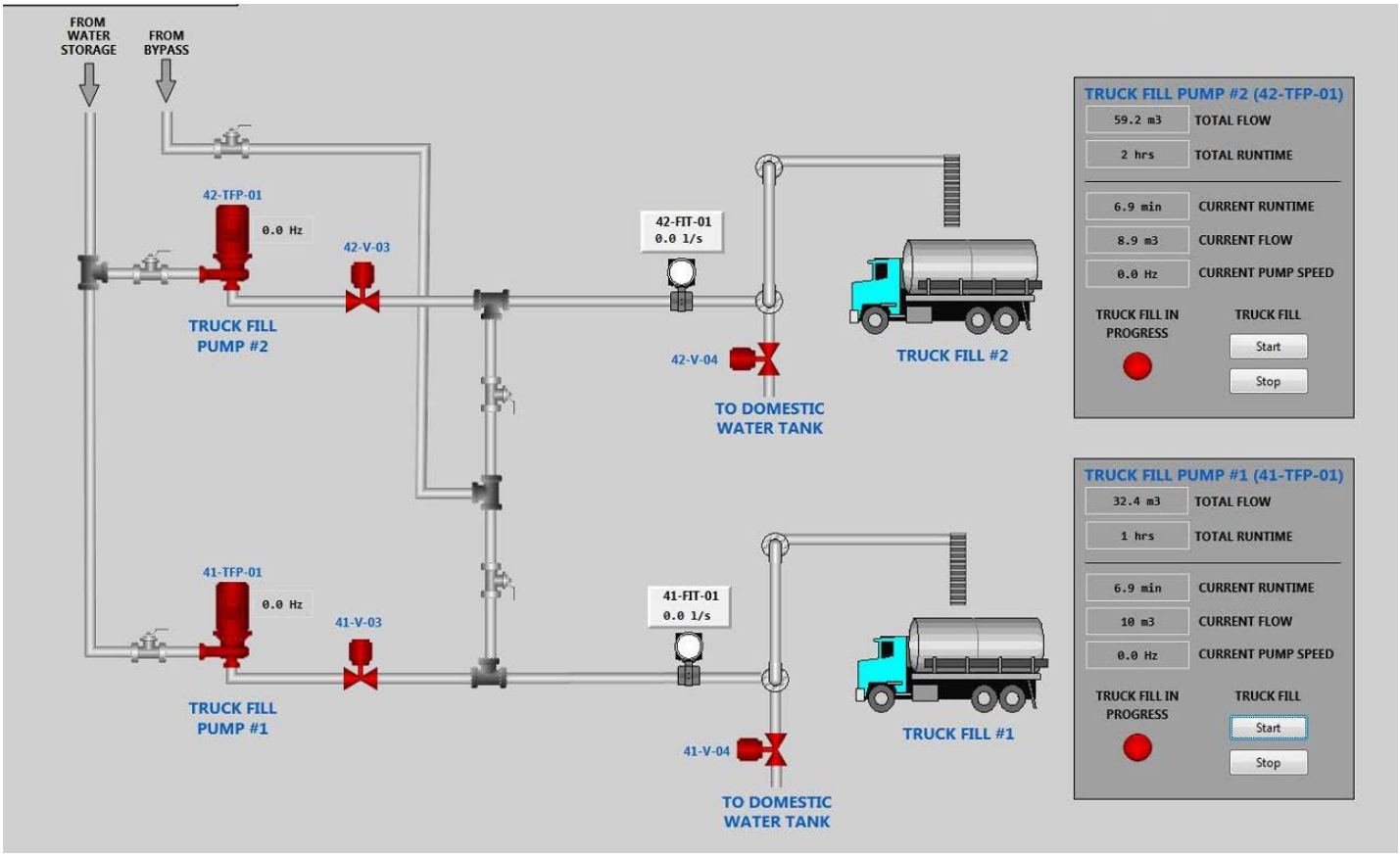


Figure 33 Truckfill display screen

3.11 Truckfill

Truck Fill Sequence
There are two dedicated truck fill pumps, 41-TFP-01 and 42-TFP-01. Once the call for water is initiated by the truck fill start button (TFP1-PB1 or TFP2-PB2) the corresponding electrically actuated valve will open (41-V-03 or 42-V-03) and the corresponding truck fill pump will turn on.

The operator can check how long the pump has been operated, and reset the pump hours, in the PLC.

Drain down timer – Once a truck is filled, the water left over in the exterior portion of the truck fill arm will be drained via solenoid valves 41-V-04 and 42-V-04. These valves will open for a time as set during commissioning. The valves will drain into the domestic water tank. Once the domestic water tank reaches a high water level it pumps the excess water into the sumps.

Figure 34 Truckfill pumps

3.11.1 Truckfill Operating Conditions

Symptom	**Cause / Remedy**
Truckfill flow, pumps speed, Sept 2019	
Outside fill buttons not working	Truckfill can be Started/Stopped from the office computer or any of the HMI control panels

Figure 35 Two reservoir cells with new reservoir #3 under construction; miniature level transmitter

3.12 Reservoir Cells

Four level transmitters are associated with the reservoir cells. Transmitters are located in the pump suction intakes and read the amount of vertical hydraulic head (depth) of water above them. 10-LIT-01, 10-LIT-02 and 10-LIT-03 will transmit the volume of water, of reservoir cells 1, 2 and 3 respectively, to the main PLC.

Reservoir cell 3: Level transmitter 10-LE-04 is located in the sub-drain. If water is present during shoulder seasons, generators should be connected to the heat traced sub-drains. This level will be transmitted to the PLC and will notify operators.

Process wastewater storage tank 15-TK-01: Level transmitter 15-LIT-01 will transmit the volume of process wastewater to the PLC and will have a low water level alarm sent when the level reaches 0.45m above the floor of the tank. The tank holds 100 m^3 and has a temperature sensor/transmitter. It also has a vent and overflow valve.

Figure 36 Backwash (process wastewater storage) tank with exterior fuel tank beside it

3.13 Support Systems ~ Water Treatment Plant

3.13.1 Diesel Fuel System

An outside double-walled, 35,000L diesel storage tank (FST-1) supplies diesel fuel to the 1383L day tank (DT-1). DT-1 supplies fuel to the boilers and emergency generator. The tank's level gauge should be monitored for refilling. The day tank has an integrated pump and level controls to draw fuel from the external fuel tank.

The boilers and generator will draw fuel from the bottom of the day fuel tank (DT-1) by separate supply lines. The storage tank has low and low-low level float switches that will inform the transfer pump when fuel is required. The overflow of the day tank will return to the top of FST-1. The day tank has 110% spill containment construction.

The glycol fill pump is located near the hydronic expansion tank. The expansion tank allows for heated expansion of the glycol lines without causing pipe damage. The glycol feeder should be monitored for level and refilled when necessary.

3.13.2 Power and Generator

The current building is fed with 575V 3 PH 60Hz, 200A utility power with a 575V 100A 3PH 60 Hz backup generator. See "2999-E-100 Electrical Distribution" drawing.

In the event of a power failure, an automatic transfer switch (ATS) will automatically switch to generator power. ATS mode and generator running / fault signals will be sent to the main PLC.

The ATS will feed Panel PA, Panel PB, the MCC and the existing Pumphouse 1 via the Transformer XFM#1000 or voltage regulator VR#1000, then two transformers 40 KVA (XFM#1100) and 5 KVA (XFM#1200).

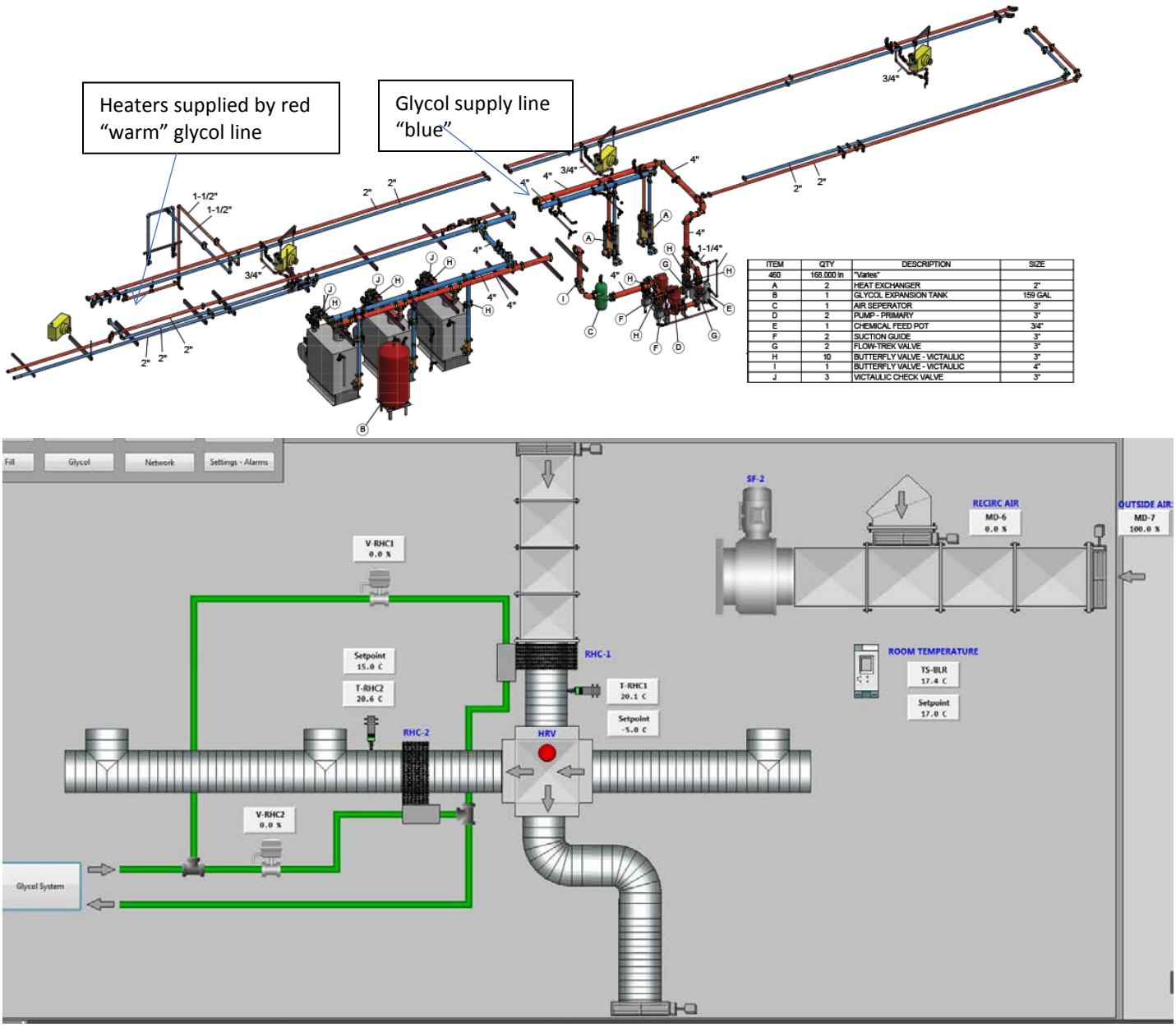


Figure 37 Boiler, glycol pumps and heat exchanger diagram

3.13.3 Heating and Hydronic System

Primary heating is provided by a hydronic heating system. The schematic for this system is found in drawing # 2999-M-206. Boilers heat a 50/50 propylene glycol solution and circulation pumps send the solution to various hydronic unit heaters as well as Pumphouse #1 and #2, and the tank heat exchangers for Treated Water Tank and Backwash Tank. A propylene glycol fill system (GFS-1), pressure or expansion tank (ETK-1), and circulator pumps (P-1, P-2, P-3) are part of this hydronic heat system.

A Call for Heat signal is used to start the boiler system. This signal is sent to the Tekmar controller. There is a Boilers Start Hand-Off-Auto (HOA) switch on the boiler control panel.

- Hand will turn on the Call for Heat signal
- Off will stop the Tekmar controller and reset the boiler startup sequence
- Auto, will turn on the Call for Heat signal based on a signal from the main plant PLC

The main PLC will send a Call For Heat signal if the Outside Air temperature drops below a set point (e.g. 7 deg C) and resets when the outside temperature goes above a set point (e.g. 17 deg C).

Figure 38 Glycol components

Pumps P-4.1 and P-4.2 supply the treated water tank heat exchanger HEX 1.2 and HEX 1.2 and backwash tank heat exchange HEX-2 and pump houses.

3.13.4 Circulation Pumps (P-1, P-2, P-3)

Two circulation pumps for the hydronic system operate in duty with a third on standby. The circulation pump operation, sequencing and alternation are controlled by the Tekmar controller.

Each circulation pump has a Hand-Off-Auto (HOA) switch on the boiler control panel.

- Hand will turn on the pump
- Off will disable the pump

- Auto, the pump will be controlled by the Tekmar controller
- **Pumps need to be alternated manually on a weekly basis.

Backup electrical baseboard heaters prevent freezing of equipment.

Additional HVAC items in the building are:

- Dampers for the generator operation and cooling
- Tempered water heating for the water storage reservoir
- Ventilation for the Process room
- Electric heat trace for
    - Intake pumps
    - Overland discharge pipe
    - Truckfill arm, exterior piping
    - Drain to intake, exterior piping

Drawing References:

EXP, Heating Schematic, Ref#: M-206
EXP, Fuel Oil Piping Schematic, Ref#: M-204

3.13.5 Temperature Control and Monitoring

There are multiple temperature sensors to monitor and control temperature, plus provide alarms. Gas detectors in the Chemical and Generator rooms are provided and monitored by the PLC.

The main plant PLC receives analog temperature readings for Outside Air, Generator Room, Process Room, Storage Building, Glycol Supply, and Glycol Return. The OA air temperature is used to start/stop the boiler system. The other temperatures are used to trigger alarms.

The Tekmar receives glycol supply and return temperatures to control boiler operation. These sensors are separate from the ones feeding information to the main plant PLC.

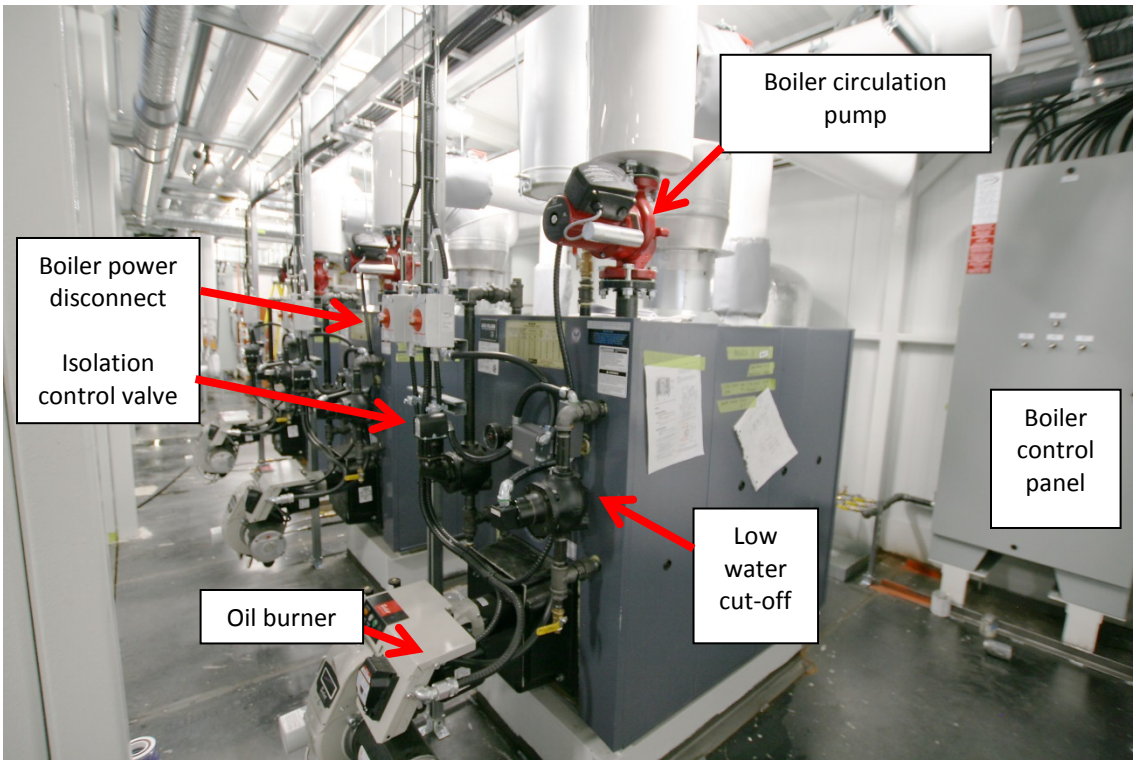


Figure 39 Boiler heating system

3.13.6 Boilers (B-1, B-2, B-3)

The boiler plant is equipped with a local control system for boiler operation, including the glycol circulating pumps. The main PLC system can enable the boiler to operate and will display if there is a trouble alarm from the boiler controller.

Two of the three diesel fired boilers can be used if required, with the third boiler on standby. Only two of the three boilers are required for the facility's heating requirements with the third on standby. The third standby boiler should be cycled into the rotation on a weekly basis so the boilers receive equal duty.

The boiler operation, sequencing and alternation are controlled by the Tekmar boiler controller.

Each boiler has a Hand-Off-Auto (HOA) switch on the boiler control panel, described in the previous section.

To protect the boilers, each boiler has a high-temperature cutoff and a low water cutoff. These cutoffs are wired directly to the respective burner and operate separately from the Tekmar controller and HOA controls.

An emergency stop switch, to cut power to the boiler burner is installed next to each boiler.

Combustion air for the boilers is provided through the combustion air intake duct in the main Process Room. The combustion air damper must be open to enable the boilers.

Figure 40 Tekmar controller inside the boiler control panel

3.13.7 Tekmar Controller

The Tekmar controller is a dedicated boiler and pump controller for hydronic heating systems. The controller will start the hydronic system based on an external Call for Heat signal. The controller will start the boiler(s) to maintain a boiler return temperature.

The Tekmar controller will start the lead boiler, then after a few minutes if the target temperature is still not met, the lag boiler is activated. The lag boiler, then the lead boiler will be stopped after a few minutes once the target temperature is reached. The Tekmar controller will also stop the boilers if the max temperature (82.2°C (180°F) is reached. Also, note that each boiler has a high limit temperature cutoff that operates separately from the Tekmar.

The lead and lag boiler are swapped after a set amount of hours. Factory default settings can be found in the Tekmar operating manual.

Note: Boilers must alternate at least weekly

3.13.8 Alarms

The Tekmar controller will send an Alert signal to the main control panel PLC and the alarm dialer if there is an issue with heating system. The Tekmar IOM will provide details on what errors will trigger an alert, but include circulation pump flow proof fault and failure to reach boiler target temperature after a set time (factory default: 20 minutes).

The boilers can be turned off using the PLC touch screen. If the glycol temperature is lower than 45°C for more than 60 minutes and the boilers are turned on, there will be an external alarm.

3.13.9 Hydronic Unit Heaters

There are 5 hydronic unit heaters in the water treatment system; 1 unit heater in the generator room, 2 unit heaters in the process room, and 2 unit heaters in the water storage building.
There are also 2 heaters in each of the pumphouses. The heaters are controlled by individual wall mounted thermostats, typically set to 5 deg C.

3.13.10 Backup Heating

To protect the plant in case of an issue with the hydronic heating system, a back up electric heater is provided in the electrical room.

3.13.11 Generator

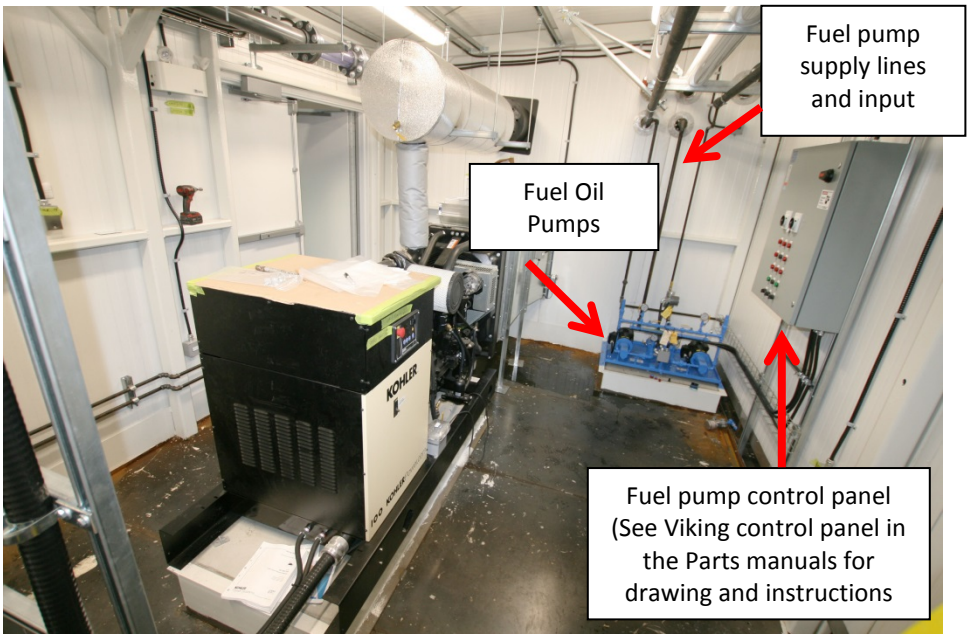


Figure 41 Generator room

The generator is water cooled. Fuel oil pumps supply the generator and boilers from the generator room, with the diesel day tank on the other side of the wall. Fuel pump control panel will assist in testing and alternating fuel pumps.

The generator is not designed to run continuously but only during an emergency power outage. The generator is fuelled with day tank inside the building which is in turn fed by the outside diesel tank. The fuel pumps have lines that pump diesel to the boilers and generator.

The generator automatically starts when there is an electrical power interruption.

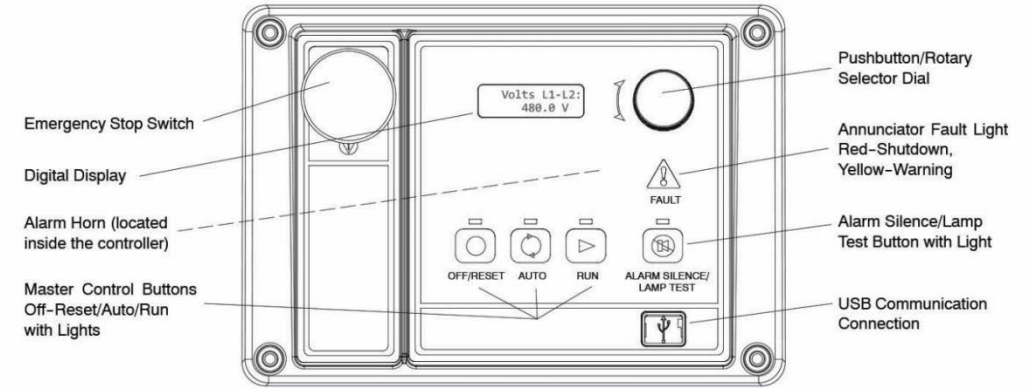


Figure 42 Generator display panel

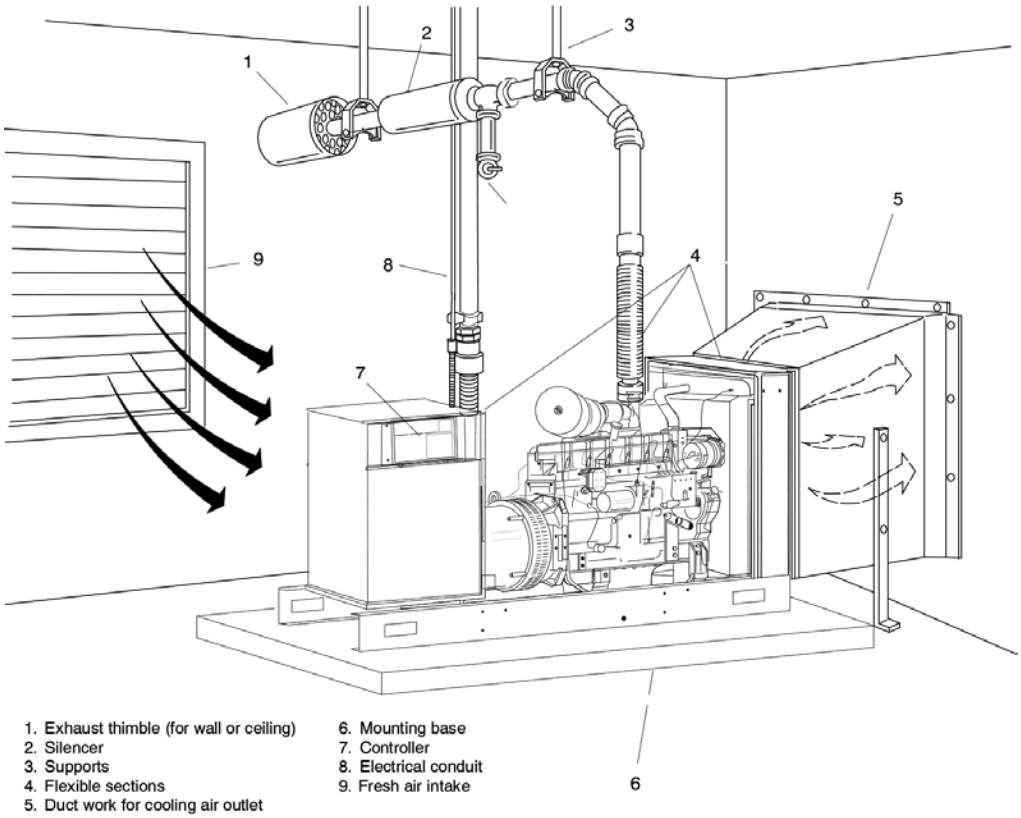


Figure 43 Typical generator setup

The generator should only be operated by trained personnel.

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

Do not smoke or permit flames or sparks near fuels or the fuel system.

Exhaust System

⚠ WARNING

Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Fuel System

⚠ WARNING

Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

3.13.12 Ventilation

The fan in the Chemical room EF-1 has two speeds. Low speed is signalled with the light switch in the off position. High speed is signalled with light switch in the on position.

The Nitrogen Dioxide Detector in the generator area triggers a visible and audible alarm on the main PLC when a Nitrogen Dioxide level of 1.0 ppm is detected.

Ventilation: Outdoor air make-up is tempered by heating coil V-RHC-1 to prevent the exhaust air from dropping below 0°C. Supply air is tempered by heating coil V-RHC-2 to maintain a 15°C setpoint. The HRV runs by timer switches in office and bathroom. Upon starting of HRV-1 the outside air MD-9 and exhaust damper MD-8 need to open. Upon shutting down of the plant the dampers need to close.

Figure 44 outside air hoods

Process/Boiler room cooling is controlled by supply fan SF-2, space temperature sensor, supply air temperature sensor, return air damper MD-6 and outside air damper MD-7. The ventilation unit modulates outside air and return air dampers to maintain supply temperature of minimum 10°C and to maintain room temperature at 22°C. The fan turns on and the dampers operate when room temperature exceeds 24°C. Fan turns off when room temperature drops to 20°C.

3.13.13 Building Water Supply – Domestic Supply

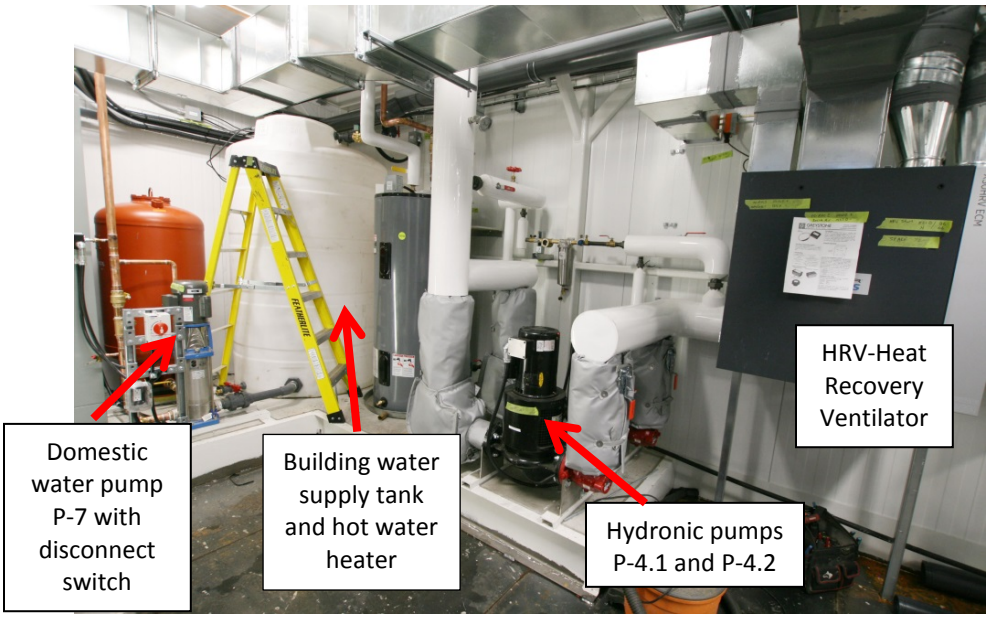


Figure 45 Domestic water supply

See Drawing #M-201 for more details

Domestic water for the building, including the eyewash, is provided by a pump with built-in pressure tank and pressure switch. This pump will draw from the building water supply tank. The pump will operate independently based on the pressure switch to maintain a minimum supply pressure of 40-60 psi.

A tempering system with heat exchanger (HE-1) and circulation pump (P-4) will draw domestic water from the truckfill pump header and return it to the treated water feed to the storage tanks. The circulator pump will be manually activated by the operator. A temperature control valve (FV-19), modulates the glycol feed to the heat exchanger and is controlled by a PID temperature controller (TC-19) to maintain a set outlet temperature on the tempered water side of the HE.

Hot water for the sink and the emergency eyewash will be provided by the hot water tank (DWH-1).

3.13.14 Heat Trace

Heat trace is required to keep external pipes from freezing. A heat trace control panel is installed in the WTP to control the exterior piping heat trace circuits.

3.13.15 Heat Exchangers

There are two systems to warm and recirculate the water in the treated water storage tank. These systems consist of recirculation pumps and a heat exchanger. Refer to the mechanical system manual provided by the mechanical contractor for specific information on the boiler or heat exchanger operation.

Figure 46 Treated water tank heat exchangers

Figure 47 Backwash tank heat exchangers

3.13.16 Motor Control Centre (MCC) Room

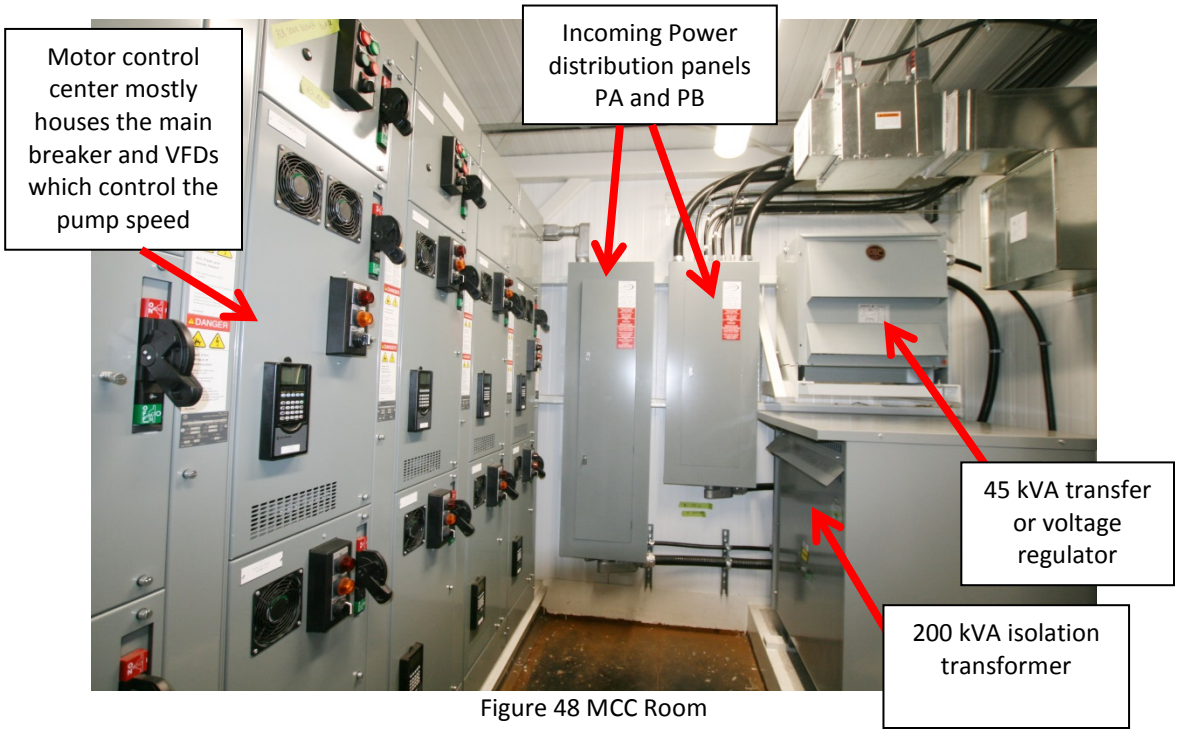


Figure 48 MCC Room

3.13.17 Variable Frequency Drives for the pumps (VFD)

Figure 49 Panel housing the VFD (variable frequency drive) for each pump, in the MCC room

For complete MCC drawings, see part number *2999-G100-81- Motor Control Centre* in the parts manual, Section 7, Electrical and control components.

VFD CONTROL PANEL INDICATORS AND SWITCHES		
ID	**DESCRIPTION**	**TYPE**
Pump RUN	Pump is running when light on (DISPLAY)	LIGHT
Pump FAULT	Investigate Pump issue on HMI/local	LIGHT
Pump OPERATION	Pump (HAND-OFF-AUTO)	SWITCH
Power Disconnect	Power to pump (ON-OFF)	SWITCH
Login Panel	Control panel	Keypad

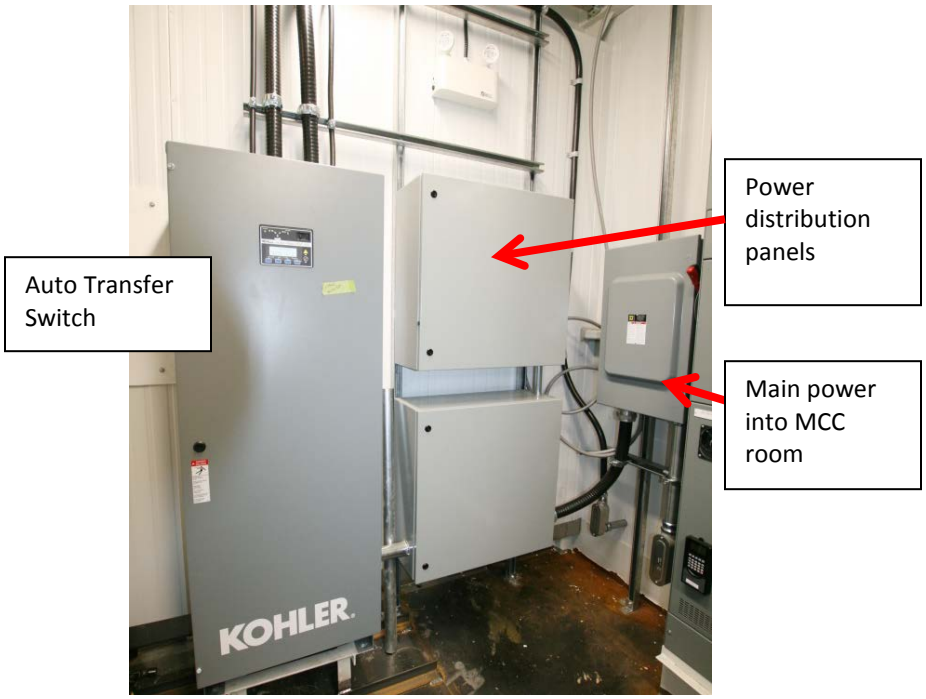


Figure 50 MCC Room components

3.13.18 Auto Transfer Switch

Figure 51 ATS screen

When there is a power failure the Automatic Transfer Switch will automatically switch treatment plant power source to Emergency – Generator power, and the E button

display on this panel will be highlighted red. There may be a short delay while the generator powers up. In "normal" mode "N" the WTP is powered by outside electrical sources.

4 Main Control Panels

Three control panels, A, B & C have HMI touch screen interfaces and they are the main plant controls with info on alarm history, alarm delays and means for entering set points. Keep the home screen on as default to be updated on all system alerts. Admin access is required to make any changes to the control panel.

4.1 Main Control Panel A&B&C

Figure 52 Main Control Panel B

MAIN HMI CONTROL PANEL INDICATORS AND SWITCHES		
ID	**DESCRIPTION**	**TYPE**
E-STOP	Emergency Stop (OFF-ON)	Button

MAIN HMI CONTROL PANEL INDICATORS AND SWITCHES		
ID	**DESCRIPTION**	**TYPE**
GENERAL ALARM	Indicator and Reset	Button & light
HMI	Plant software control	touchscreen

4.2 Boiler Control Panel - C

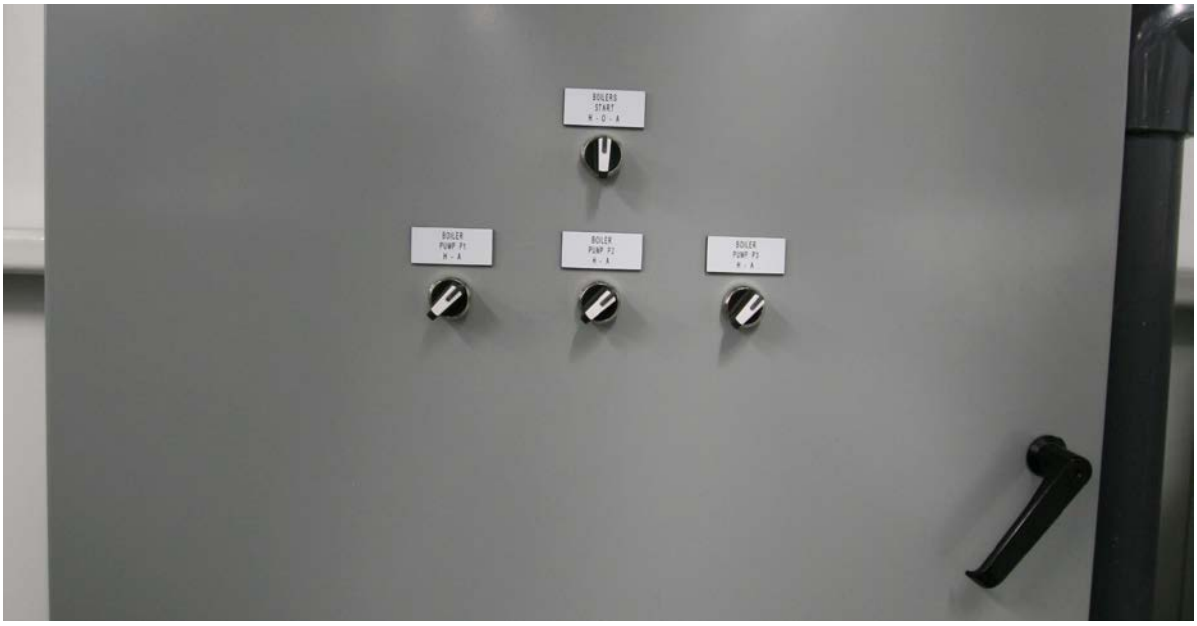


Figure 53 Boiler Control Panel C

BOILER CONTROL PANEL INDICATORS AND SWITCHES		
ID	**DESCRIPTION**	**TYPE**
Boilers Start	Boilers start (HAND-OFF-AUTO)	SWITCH
Circ Pump P-1	Boiler pump P1 (HAND- AUTO)	SWITCH
Circ Pump P-2	Boiler Pump P2 (HAND- AUTO)	SWITCH
Circ Pump P-3	Boiler Pump P3 (HAND- AUTO)	SWITCH

Top Switch - Boilers Start *(HAND-OFF-AUTO)*

- Hand will turn on the Call for Heat signal
- Off will stop the Tekmar controller and reset the boiler startup sequence
- Auto, will turn on the Call for Heat signal based on a signal from the main plant PLC

Bottom Switches

Boiler Pump P1 *(HAND- AUTO)*
Boiler Pump P2 *(HAND- AUTO)*
Boiler Pump P3 *(HAND- AUTO)*

- Hand will operate the boiler pump manually for testing or other
- Auto, will be operated by the Tekmar controller

4.3 Boiler Control Panel – C - Inside

Figure 54 Interior of Boiler Control Panel

The open panel show the wiring, Tekmar controller and other components

4.4 Control Panel – D

Figure 55 Control Panel D

TRUCKFILL CONTROL PANEL D - INDICATORS AND SWITCHES		
ID	**DESCRIPTION**	**TYPE**
E-STOP	Emergency Stop (OFF-ON)	Button
GENERAL ALARM	Indicator and Reset	Button & light
HMI	Plant software control	touchscreen

4.5 HMI Touch Screens

The control panel touch screen indicates system status and provides means for complete operator control as well as alarm indicators, alarm history, alarm delays and means for entering set points. Keep the home screen on as default to be updated on all system alerts.

Note the Default Factory Values in the screenshots' settings in case any of the equipment needs to be reset from changed.

1. There are eight (8) primary screens associated with the VTScada-based SCADA system, each accessible via the Main Menu buttons in the upper left corner of each screen. These eight screens can be seen in Figures 1 through 8. The screens are as follows:
    1. Overview
    2. Truck Fill
    3. HVAC
    4. Glycol
    5. Network
    6. Generator
    7. Settings – Process
    8. Settings – Alarms

2. Except for the Settings screens, each of these screens listed in item 1 also has several popup and sub-screens that provide operator access to controls and additional status information.
3. All motors and valves are animated such that "green= on" and "red= off".
4. All general status pilot lights (running, duty, remote, etc.) are animated such that "green= on", while either grey or red can represent "off".
5. All fault pilot lights are animated such that "red= on" and "grey= off".

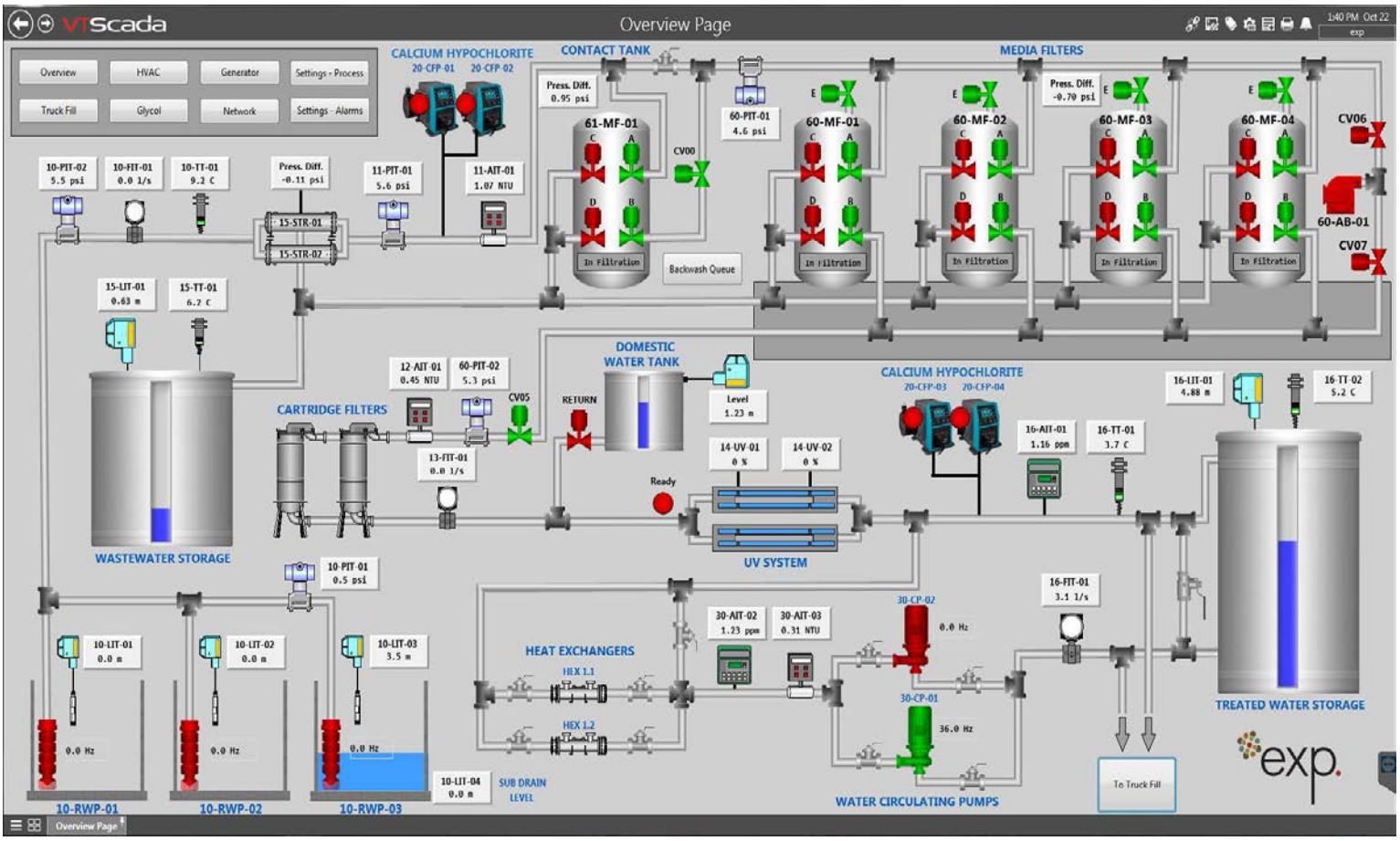


Figure 1 – Overview Screen

Notes:

1. This screen provides an overview of the water treatment process. It is considered the main screen of the SCADA system.

2. Several popup screens can also be accessed via the Overview screen by clicking on the device of interest. The popup screens allow the operator to control the associated devices. Devices with an associated popup menu are as follows:

    - Raw water pumps 10-RWP-01 through 10-RWP-03.
    - Chlorine pumps 20-CFP-01 through 20-CP-04.
    - Contact tank 60-MF-01.
    - Filters 61-MF-01 through 61-MF-04.
    - UV system components 14-UV-01 and 14-UV-02.
    - Treated water storage tank.
    - Circulating pumps 30-CP-01 through 30-CP-02.
    - Scour blower 60-AB-01.
    - Valves CV00, CV05, CV06 and CV07.

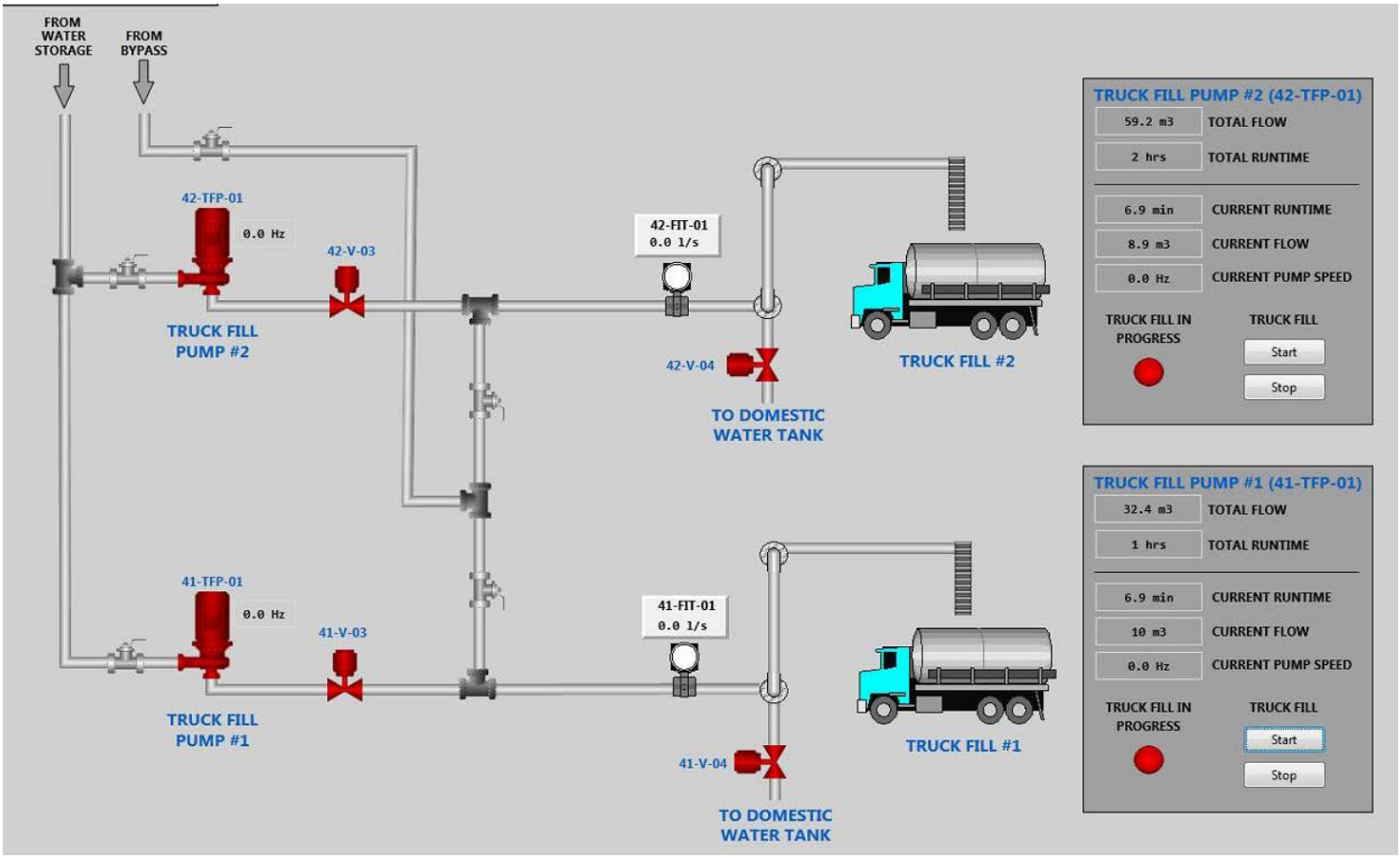


Figure 2 – Truck Fill Screen

Notes:

1. This screen provides an overview of the Truck Fill system. It can be accessed by clicking on "Truck Fill" in the Main Menu. It can also be accessed by clicking on the "To Truck Fill" button in the lower right corner of the Overview screen of Figure 1.

2. Click on the icon for an associated popup menu:
   - Truck fill pumps 41-TFP-01 and 42-TFP-01.
   - Truck fill supply valves 41-V-03 and 42-V-03.
   - Truck fill drain valves 41-V-04 and 42-V-04.

3. There are two (2) independently operating truck fill systems, each with a pump, supply valve and drain valve.

4. For each truck fill system, this screen provides start and stop push buttons that allow the operator to start and stop, respectively, the truck fill sequence for that system. The pilot light beside the buttons indicates when a truck fill sequence is in progress.

5. For a given truck fill sequence to operate properly, each of the respective control switches for the truck fill pump, supply valve and drain valve must be in the "Auto" position.

6. For each truck fill system, this screen provides the total runtime (hrs) and total flow (m3).

7. For each truck fill sequence, this screen provides the total flow (m3), runtime (minutes) and current pump speed (Hz).

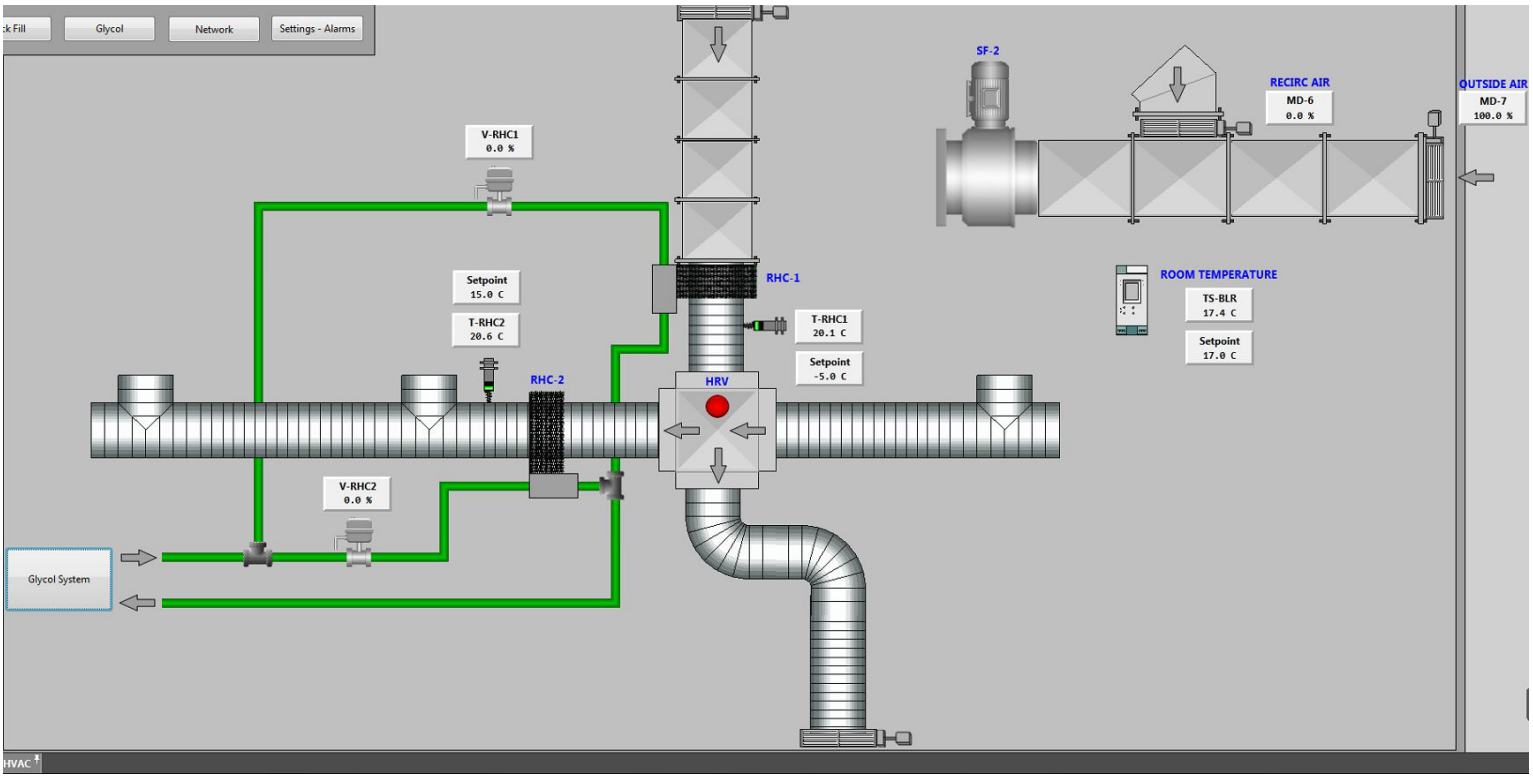


Figure 3 – HVAC Screen

Notes:

1. This screen provides an overview of the primary parts of the HVAC system that are controlled by the PLC. It can be accessed by clicking on "HVAC" in the Main Menu. It can also be accessed by clicking on the HRV Heating Coils button on the Glycol screen of Figure 4.

2. Several popup screens are associated with the HVAC screen. These can be accessed by clicking on the graphic of the device of interest. Devices on the HVAC screen with an associated popup menu are as follows:
   - Heating coil control valves V-RHC1 and V-RHC2.
   - Modulating dampers MD-6 and MD-7.

3. When in "Auto", dampers MD-6 and MD-7 will modulate automatically to maintain a room temperature setpoint in the boiler room.

4. When in "Auto", control valve V-RHC1 will modulate automatically to maintain an outside air temperature setpoint as given by TD-RHC1. Similarly, control valve V-RHC2 will modulate automatically to maintain an air temperature setpoint as given by TD-RHC2.

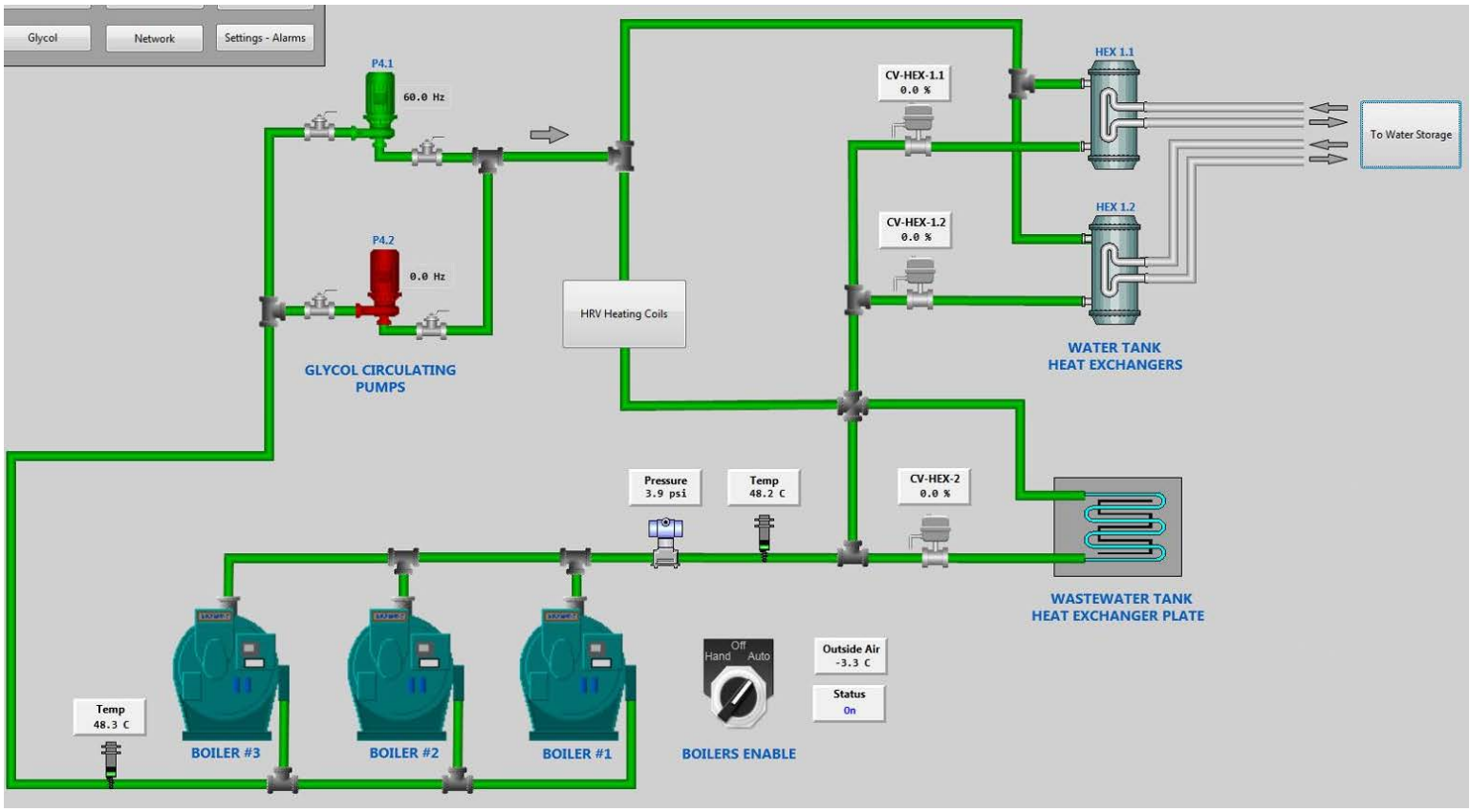


Figure 4 – Glycol Screen

Notes:

1. This screen provides an overview of the Glycol system. It can be accessed by clicking on "Glycol" button in the Main Menu. It can also be accessed by clicking on the heat exchangers graphic on the Overview screen of Figure 1 or by clicking on the "Glycol System" button on the HVAC screen of Figure 3.

2. Access the popup by clicking on the icon for:
   - Glycol circulating pumps P4.1 and P4.2.
   - Heat exchanger control valves CV-HEX-1.1, CV-HEX-1.2 and CV-HEX-2.

3. When in "Auto", the heat exchanger control valves CV-HEX-1.1 and CV-HEX-1.2 will modulate automatically to maintain a water temperature setpoint in the

treated water tank, as given by temperature transmitter 16-TT-02. Similarly, control valve CV-HEX-2 will modulate automatically to maintain a water temperature setpoint in the wastewater tank, as given by temperature transmitter 15-TT-01.

4. When in "Auto", the glycol circulating pumps P4.1 and P4.2 will operate in a duty / standby configuration. The duty pump will run continuously, and its speed will modulate to maintain a glycol pressure setpoint as given by the glycol return pressure transmitter.

5. The boilers HOA selector switch allows the operator to control a run signal sent to the boilers. When in the "Auto" position, the boilers will run whenever the outside air temperature drops below 15C.

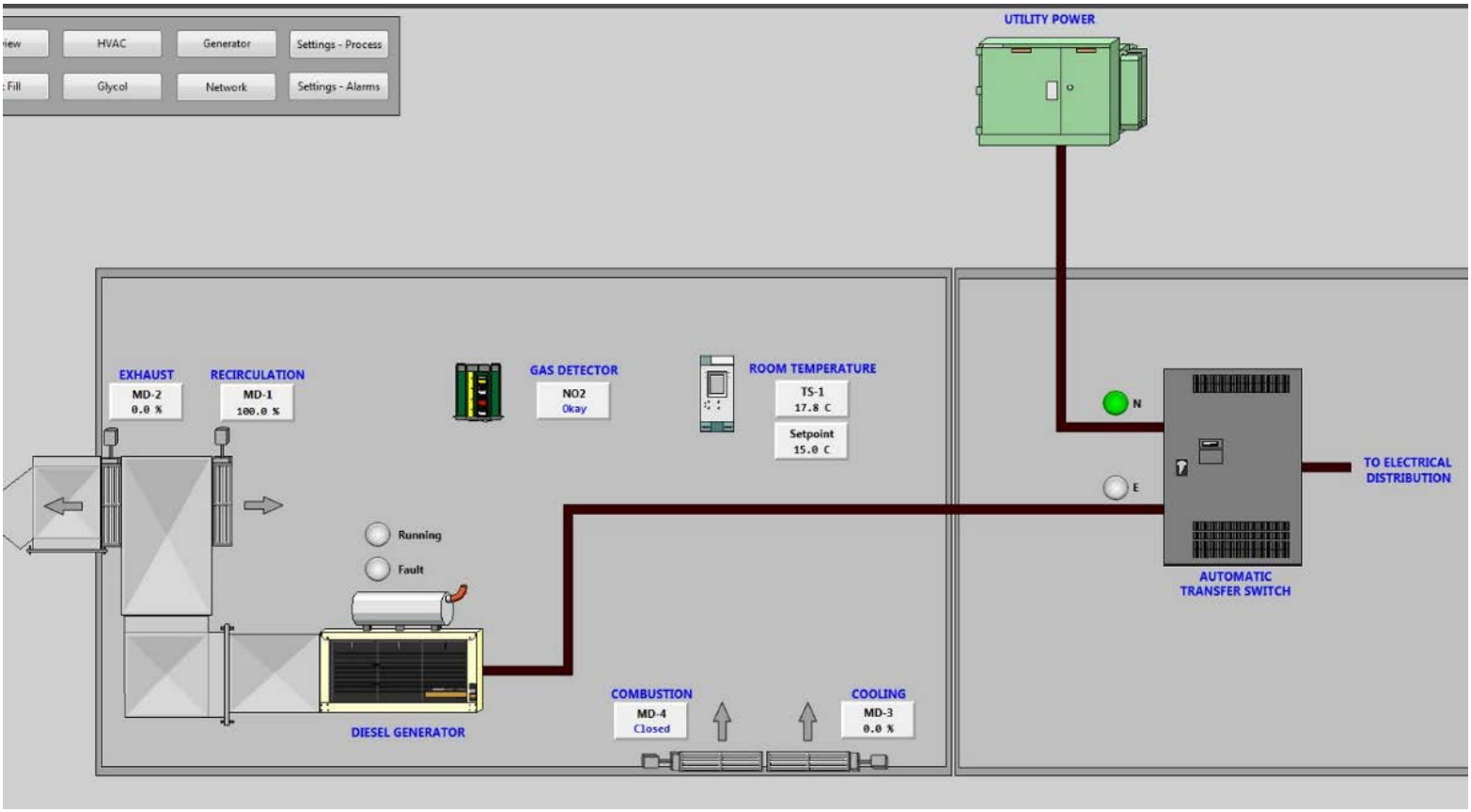


Figure 5 – Generator Screen

Notes:

1. This screen provides an overview of the Generator system. It can be accessed by clicking on "Generator" button in the Main Menu.

2. Click the icon for a popup menu for:
   - Modulating dampers MD-1, MD-2 and MD-3.
   - Combustion damper MD-4.

3. This screen provides status information for the automatic transfer switch (ATS), the generator and all other generator related systems, including the generator dampers as well as the generator room temperature and NO2 sensors.
4. When in "Auto", the generator dampers will operate as follows:
    - When the generator is not running, MD-2 will open and all other dampers will close.
    - When the generator is running, the combustion damper MD-4 will open and all other dampers will modulate their positions to maintain a room temperature setpoint in the generator room.
5. The display for the NO2 sensor on this screen is binary. When the alarm is not tripped the display will read "Okay". When tripped, it will read "Alarm".

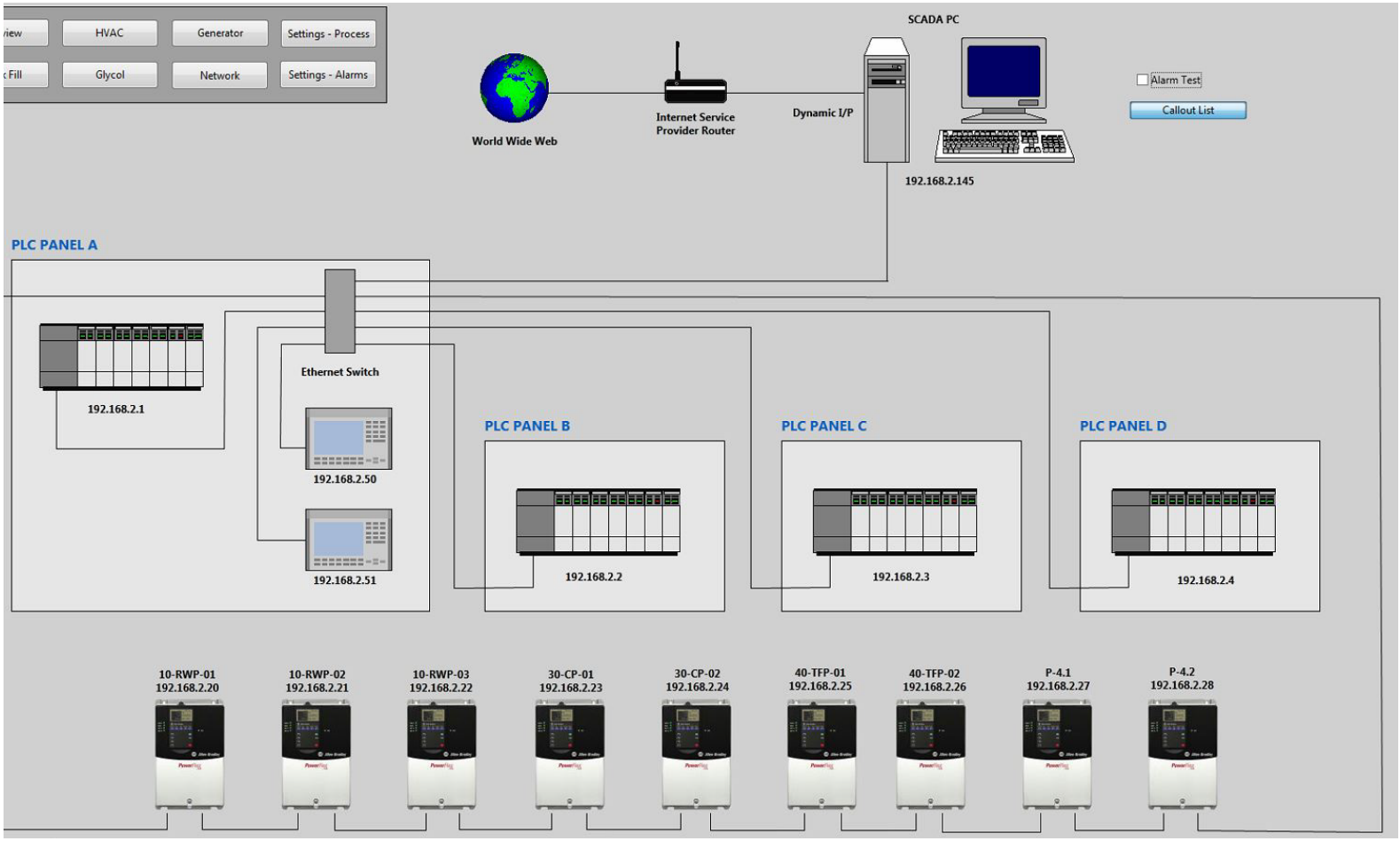


Figure 6 – Network Screen

Notes:

1. This screen provides an overview of the control system network. It can be accessed by clicking on "Network" in the Main Menu.
2. The Network screen provides a graphical layout of all the control system components, along with their network IP addresses.
3. There are no controls or popup screens associated with the Network screen. Everything on this screen is for information only.

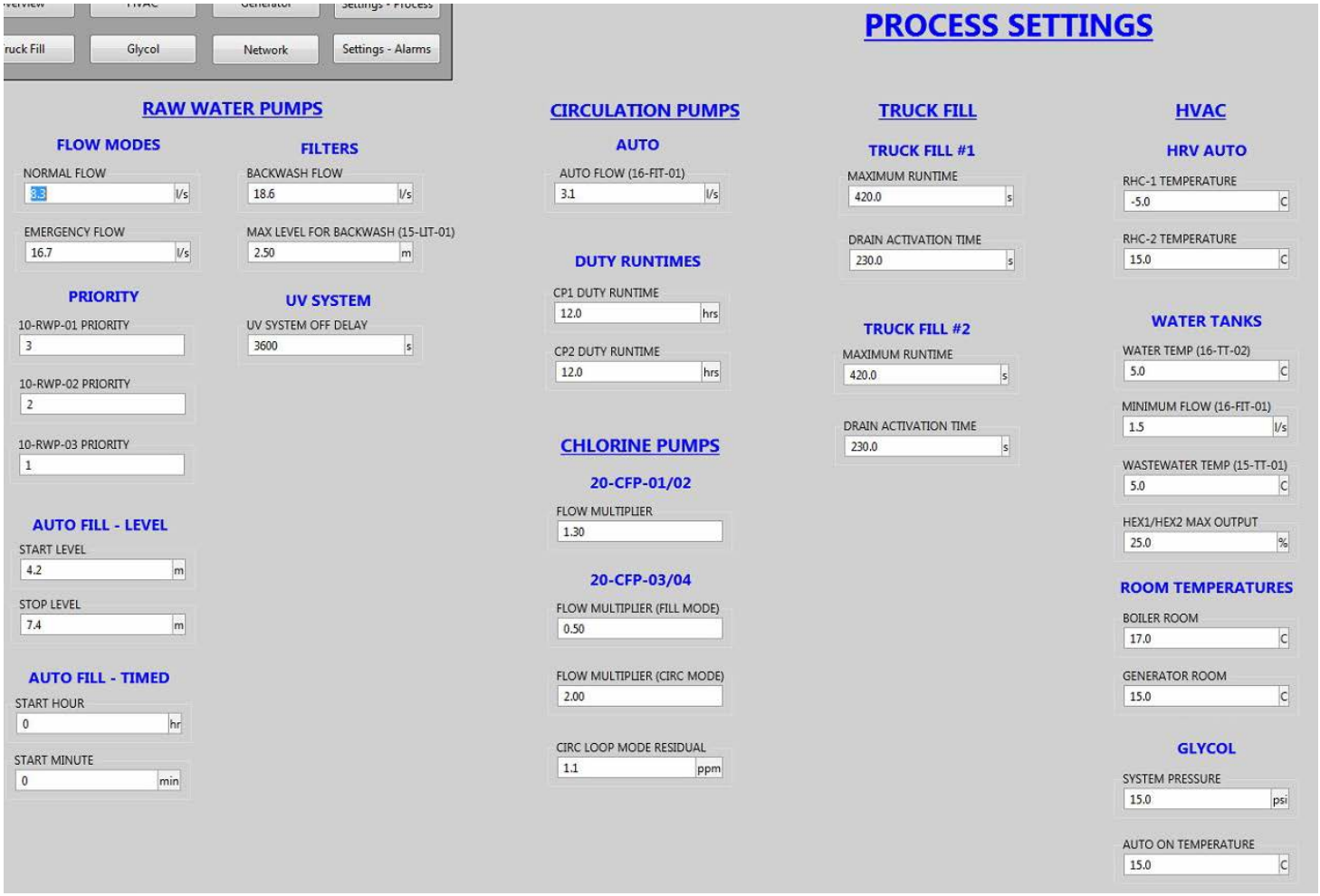


Figure 7 – Process Settings Screen – left side of screen
(screen cropped for visibility, see below for right side of this screen)

Notes:

1. This screen provides access to the WTP process settings. It can be accessed by clicking on "Settings - Process" in the Main Menu.
2. This screen allows the operator to adjust all the analog setpoints.

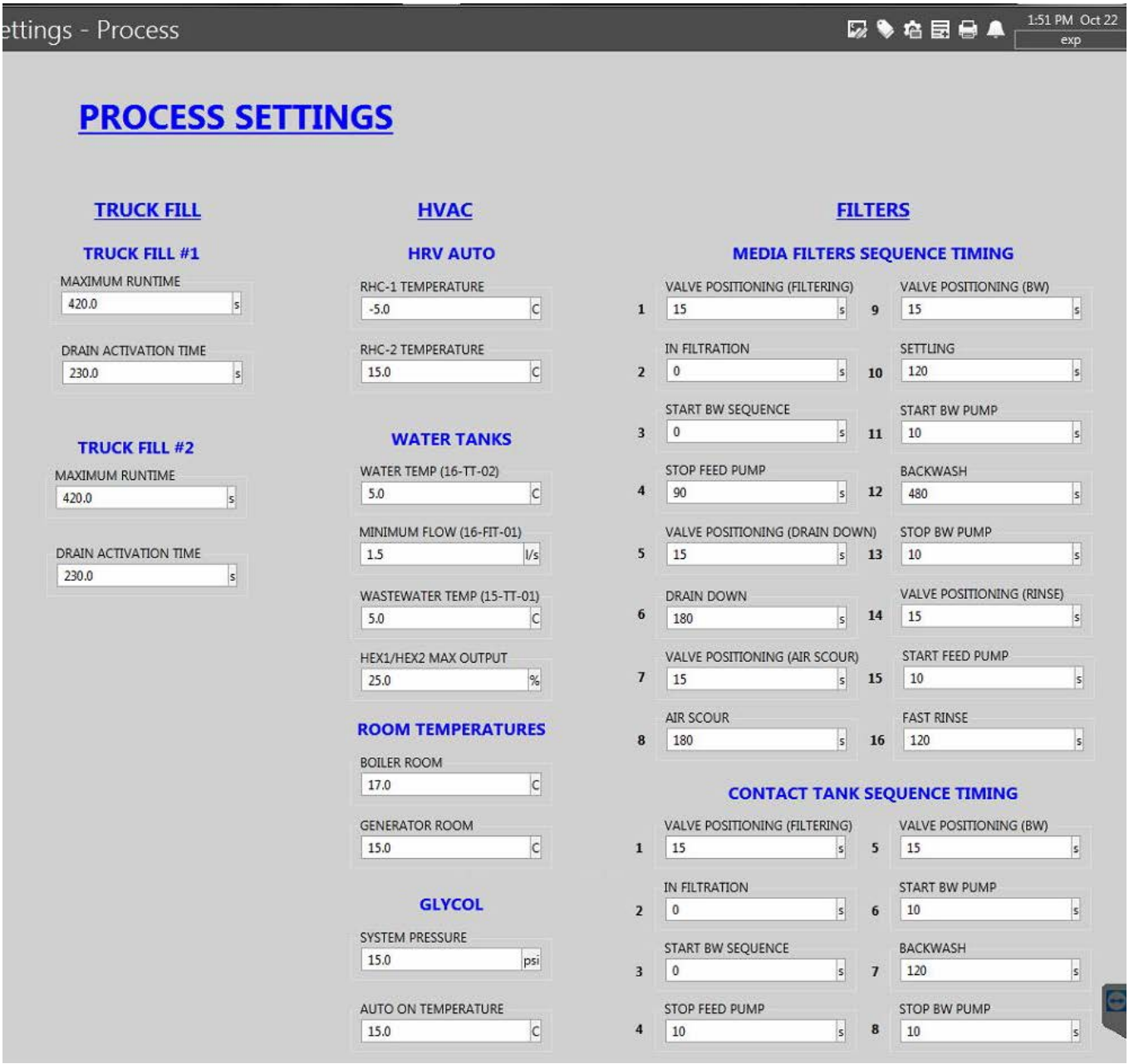


Figure 8 – Process Settings Screen – right side of screen
(screen cropped for visibility, see above for left side of this screen)

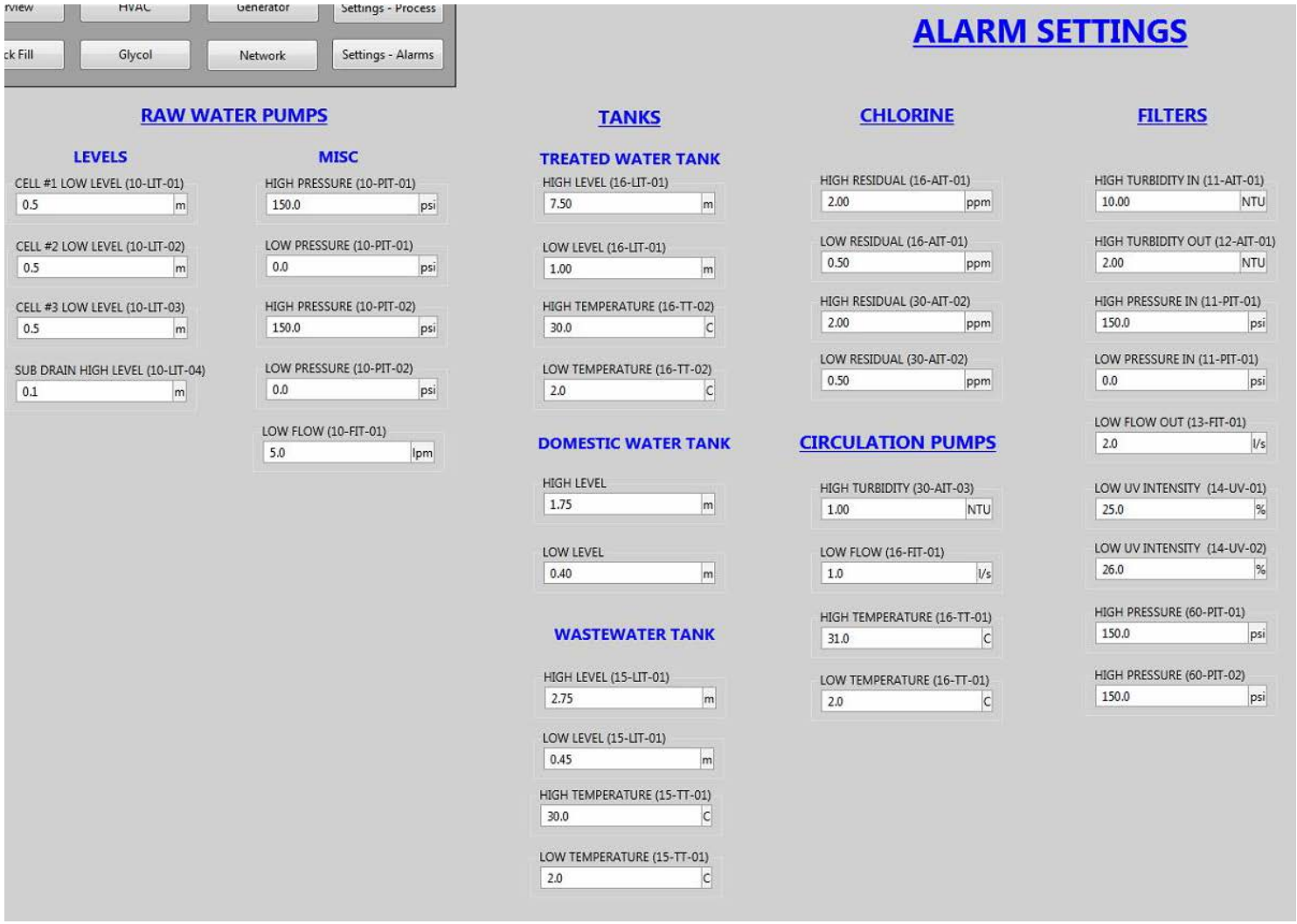


Figure 9 – Alarm Settings Screen – left side of screen
(screen cropped for visibility, see below for right side of this screen)

Notes:

1. This screen provides access to the WTP alarm settings. It can be accessed by clicking on "Settings - Alarms" in the Main Menu.
2. This screen allows the operator to adjust all the analog alarm setpoints associated with the Arviat WTP.

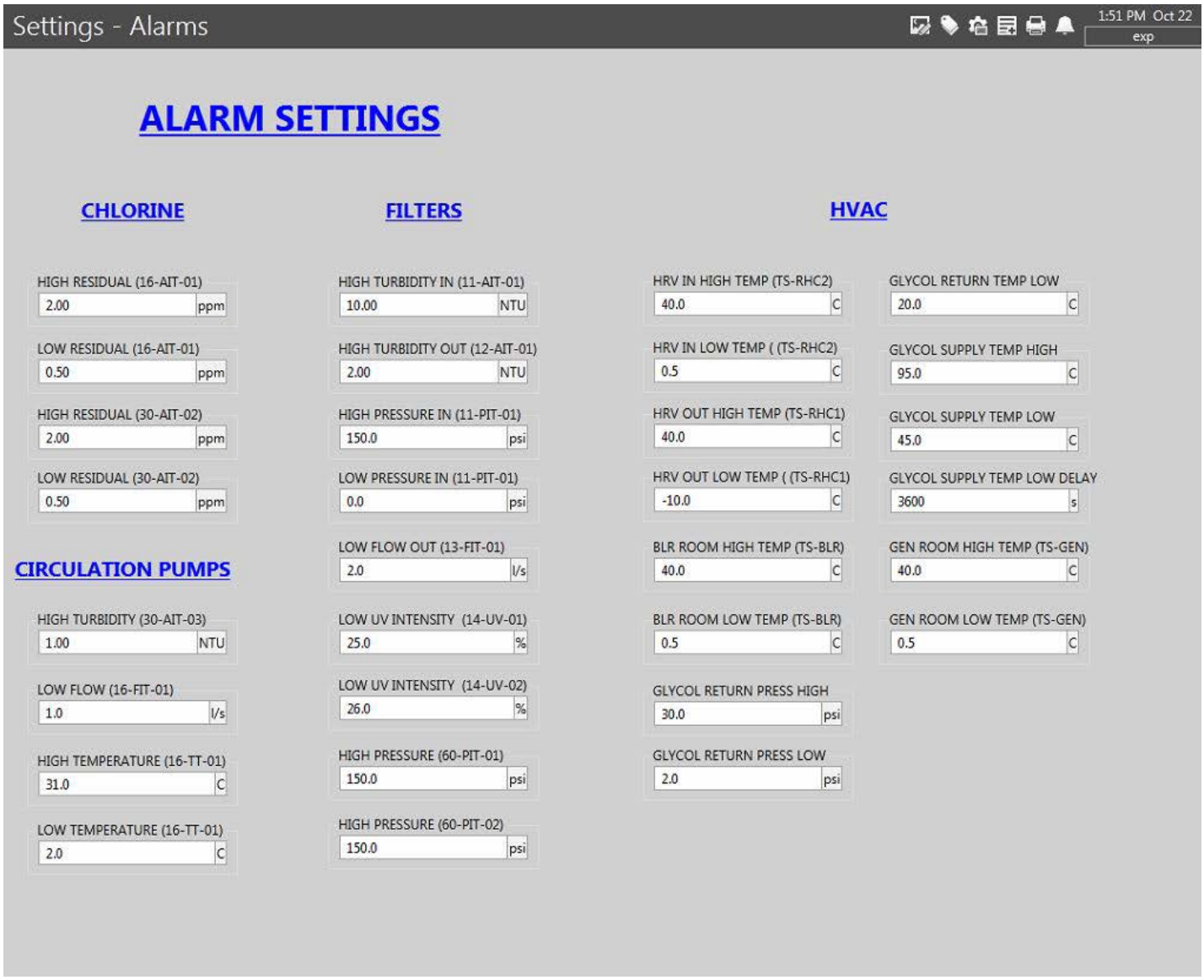


Figure 9 – Alarm Settings Screen – right side of screen
(screen cropped for visibility, see above for left side of this screen)

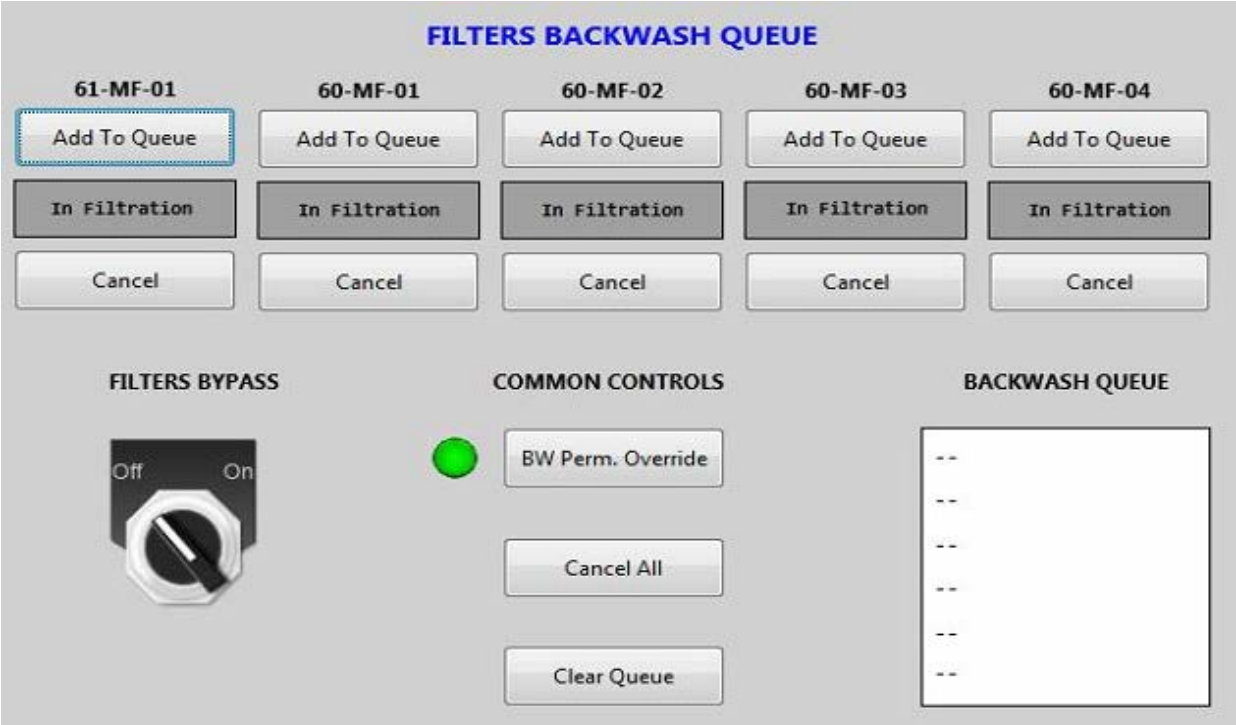


Figure 9 – Backwash Queue Popup Screen

Notes:

1. This screen provides access to the filters backwash queue controls. It can be accessed by clicking on the "Backwash Queue" button on the Overview screen of Figure 1.
2. The Backwash Queue box lists the filters currently waiting to be backwashed.
3. Any filter can be added to the backwash queue by clicking on its respective "Add To Queue" button. Similarly, any filter can be removed from the backwash queue by clicking on its respective "Cancel" button.
4. There are several common controls for the backwash queue. The Clear Queue button clears the backwash queue. The Cancel all button cancels all backwashes in progress. The "BW Perm. Override" bypasses any sequencing and executes any pending backwashes immediately.
5. The "Filters Bypass" switch bypasses the operation of the contact tank filter and media filters if switched to the "On" position. When in the "On" position, the system will not filter water and no backwashes will occur. In addition, a banner will appear on the Overview screen warning the operator that the filters have been bypassed.

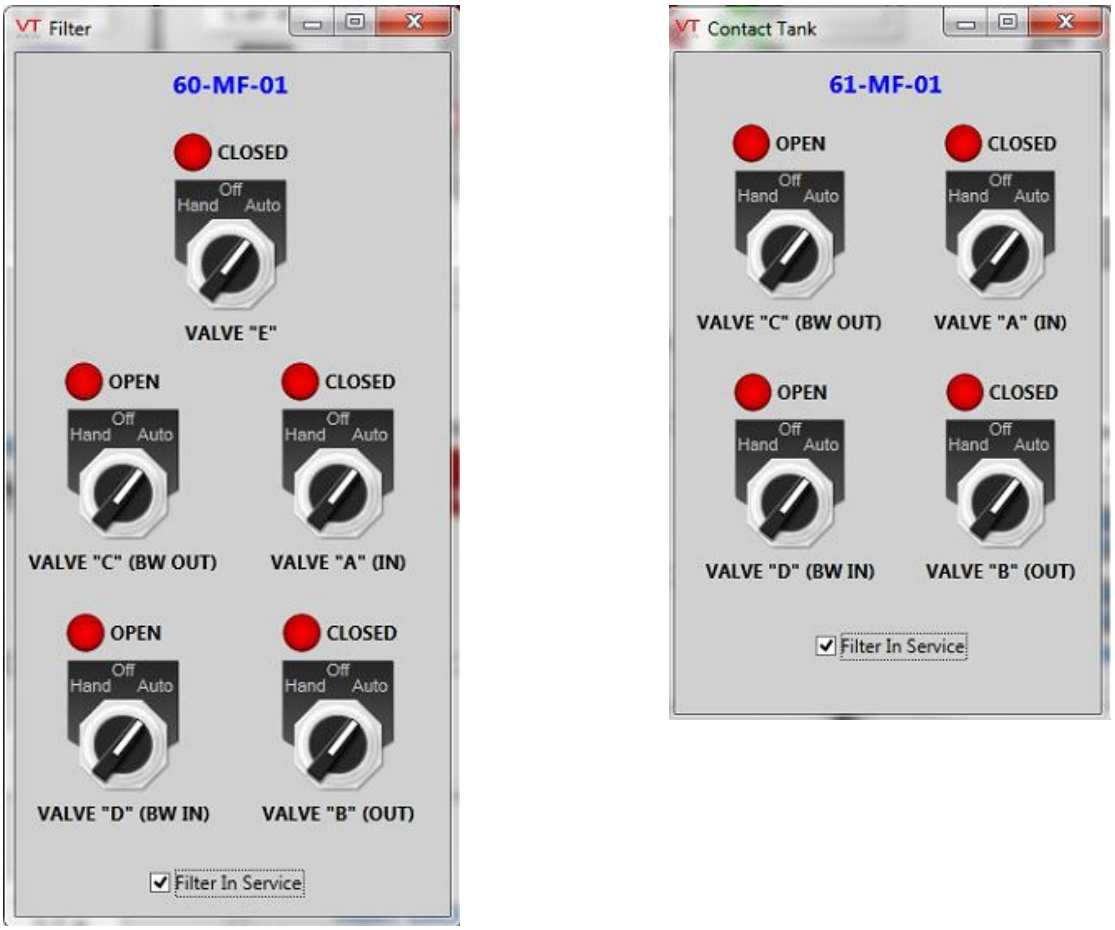


Figure 10 – Filter Controls Popup Screen

Notes:

1. These popups give the operator access to the filter operation controls for the contact tank filter 60-MF-01 (on the left) and the media filters 61-MF-01 through 61-MF-04 (typical of which is shown on the right). They can be accessed by clicking on their respective graphics on the Overview screen of Figure 1.
2. Each valve of a given filter can be manipulated using its respective HOA switch. When any switch is in the "Hand" position, its respective valve will be in the position corresponding to the pilot light indication over the switch. In the "Off" position, the valve position will be the opposite of that. Typically, these switches are used for maintenance purposes only. For the filter to operate properly, all these switches should be in the "Auto" position.
3. The "Filter In Service" checkbox allows the operator to put the filter in and out of service.

Figure 11 – Treated Water Tank Fill Controls

Notes:

1. This popup gives the operator access to the treated water tank fill controls. It can be accessed by clicking on the water tank graphic on the Overview screen of Figure 1.
2. The "Fill In Progress" pilot light indicates when the treated water tank is being filled.
3. The Manual Fill start and stop buttons allows the operator to manually start or stop a tank fill sequence.
4. The Fill Mode selector switch allows the operator to select the rate the treated water tank will be filled. In the "Normal" position, the system will use one (1) raw water pump to fill the tank. It will run at a speed that modulates to maintain a programmable flow tied to this switch position (see Figure 7). In the "Emerg" position, the system will use two (2) raw water pumps to fill the tank. The pumps will run at a speed that modulates to maintain a programmable flow tied to this switch position (see Figure 7).
5. The level fill selector switch allows the operator to engage automatic filling of the tank based on level. Setpoints for this mode are accessible via the Settings – Process screen.
6. The timed fill selector switch allows the operator to engage automatic filling of the tank based on time. The fill sequence will start based on time and stop based on level. Setpoints for this mode are accessible via the Settings – Process screen.

7. The tank bypass selector switch allows the operator to bypass the tank. In this mode the raw water pumps are used whenever a truck fill is requested (i.e. truck fills are serviced directly from the reservoirs).

Figure 12 – Raw Water Pump Popup Screen

Notes:

1. Popup access to the raw water pump controls. The controls for 10-RWP-01 and 10-RWP-02 are identical. Each pump control screen can be accessed by clicking on its respective pump graphic on the Overview screen of Figure 1.

2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.

3. The Reset Fault push button allows the operator to manually reset any pump VFD faults. A pump fault is indicated when the fault light turns red.

4. Each raw water pump has a corresponding HOA selector switch. In the “Hand” position, the pump will run continuously at a speed given by the Manual Speed setpoint in the lower left corner of the popup screen. In the “Auto” position, the pump will run automatically as required by the system. In the “Off” position, the pump will not run.

Figure 13 – Chlorine Pump Popup Screen

Notes:

1. Popup window for chlorine pump controls. The controls for 20-CFP-02 and 20-CFP-04 are identical. Each pump control screen can be accessed by clicking on its respective pump graphic on the Overview screen of Figure 1.
2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.
3. Each chlorine pump has a corresponding HOA selector switch. In the “Hand” position, the pump will run continuously at a speed given by the Manual Dosing Rate setpoint at the bottom of the popup screen. In the “Auto” position, the pump will run automatically as required by the system. In the “Off” position, the pump will not run.

Figure 14 – Circulating Pump Popup Screen

Notes:

1. Popup screen access to the circulating pump controls. The controls for 30-CP-02 and 30-CP-01 are identical. Each pump control screen can be accessed by clicking on its respective pump graphic on the Overview screen of Figure 1.
2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.
3. The Reset Fault push button allows the operator to manually reset any pump VFD faults. A pump fault is indicated when the fault light turns red.
4. Each raw water pump has a corresponding HOA selector switch. In the "Hand" position, the pump will run continuously at a speed given by the Manual Speed setpoint in the lower left corner of the popup screen. In the "Auto" position, the pumps will run in a duty / standby configuration. The duty pump will run continuously and at a speed that maintains a programmable flow setpoint as measured by 16-FIT-01. In the "Off" position, the pump will not run.

Figure 15 – Scour Blower Popup Screen

Notes:

1. Popup screen for Scour blower controls. This screen can be accessed by clicking on the scour blower graphic on the Overview screen of Figure 1.
2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.
3. The scour blower HOA selector switch allows the operator to control the operation of the blower motor. In the “Hand” position, the blower will run continuously. In the “Auto” position, the pump will run called upon during the backwash sequence of the contact tank filter or any one of the media filters. In the “Off” position, the scour blower will not run.

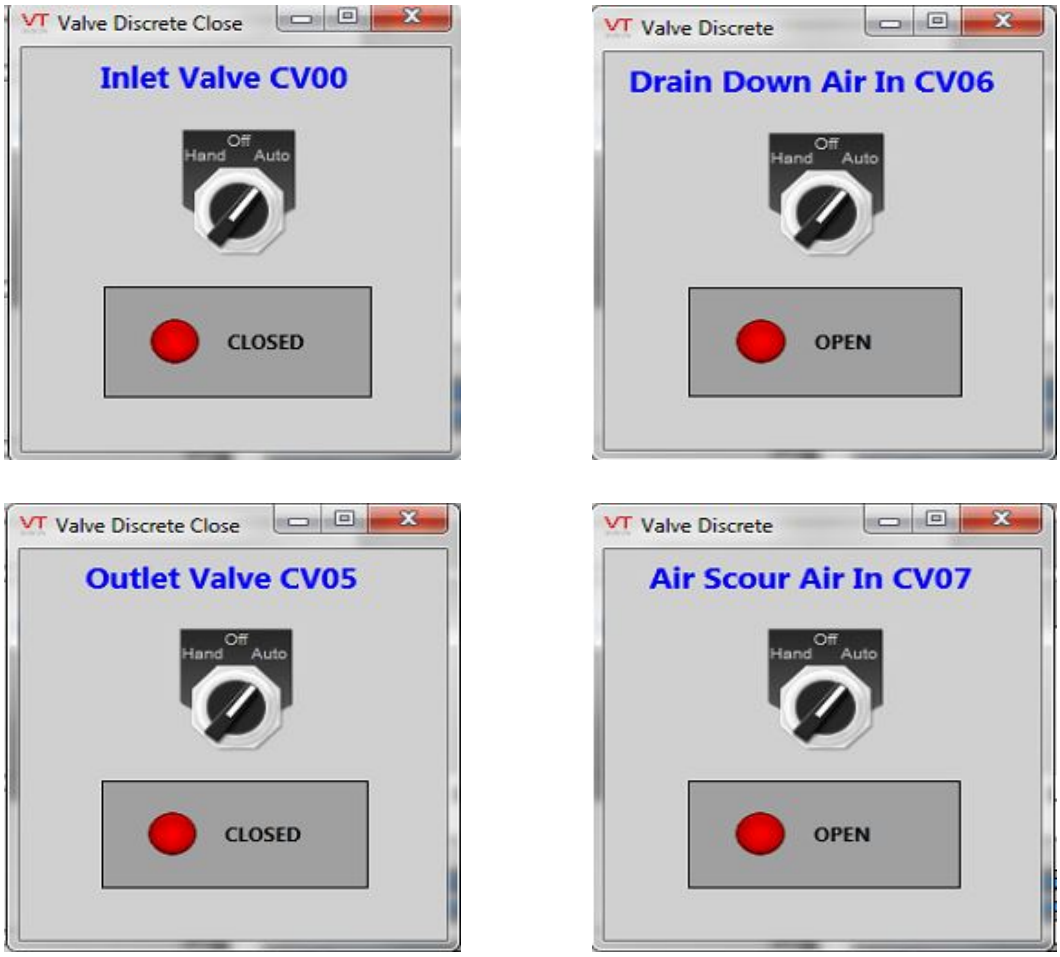


Figure 16 – Filter Common Valves Popup Screens

Notes:

1. Popup screen access to the common valve controls for all filters. They can be accessed by clicking on their respective graphics on the Overview screen of Figure 1.
2. Each valve of a given filter can be manipulated using its respective HOA switch. When any switch is in the "Hand" position, its respective valve will be in the position corresponding to the pilot light indication over the switch. In the "Off" position, the valve position will be the opposite of that. Typically, these switches are used for maintenance purposes only. For the treatment process to operate properly, all these switches should be in the "Auto" position.

Figure 17 – UV System Popup Screen

Notes:

1. Popup access to the UV controls. The controls for 14-UV-01 and 14-UV-02 are identical. The UV control screens can be accessed by clicking on their respective UV graphics on the Overview screen of Figure 1.
2. The UV HOA selector switch allows the operator to control the operation of each UV system. In the “Hand” position, the UV system will run continuously. In the “Auto” position, the UV will run whenever a treated water tank fill sequence is in progress. Once a UV system is running, it will stay on for 60 minutes after the treated water tank fill sequence has ended. This is done to prevent frequent start/stops of the UV systems, which reduces the life of the UV lamps.

Figure 18 – Truck Fill Pump Popup Screen

Notes:

1. Popup access to the truck fill pump controls. The controls for 42-TFP-01 and 41-TFP-01 are identical. Each pump control screen can be accessed by clicking on its respective pump graphic on the Truck Fill screen of Figure 1.
2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.
3. The Reset Fault push button allows the operator to manually reset any pump VFD faults. A pump fault is indicated when the fault light turns red.
4. Each truck fill pump has a corresponding HOA selector switch. In the "Hand" position, the pump will run continuously at a speed given by the Manual Speed setpoint at the bottom of the popup screen. In the "Auto" position, the pump will run at full speed whenever called upon by the truck fill sequence. In the "Off" position, the pump will not run.

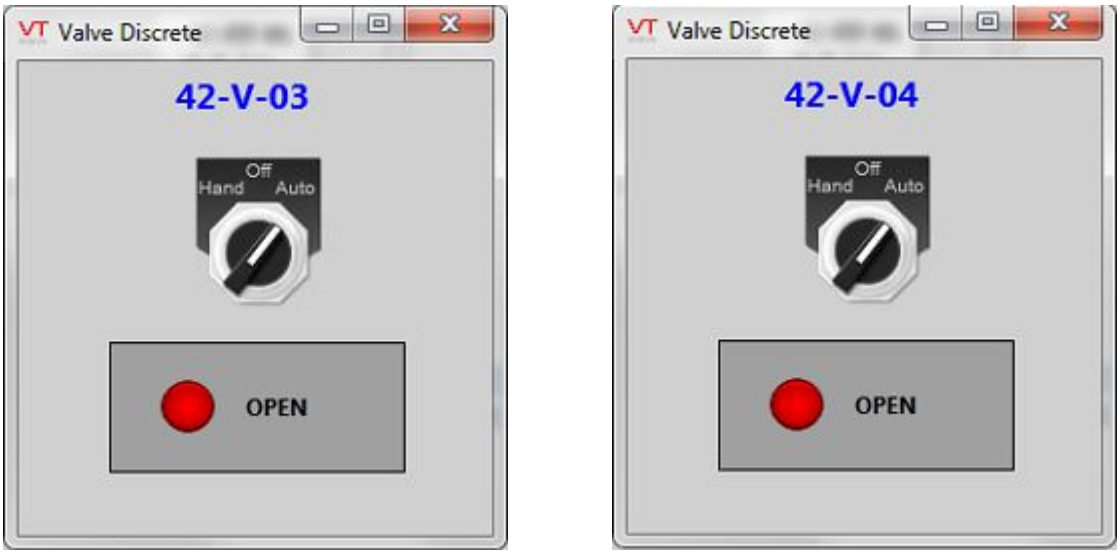


Figure 19 – Truck Fill Valve Popup Screens

Notes:

1. These screens give the operator access to the truck fill valve controls. Figure 19 shows the controls for valves 42-V-03 (supply valve) and 42-V-04 (drain valve). The controls for 41-V-03 and 41-V-04 are identical. They can be accessed by clicking on their respective graphics on the Truck Fill screen of Figure 2.
2. Each valve can be manipulated using its respective HOA switch. When any switch is in the "Hand" position, its respective valve will be in the position corresponding to the pilot light indication under the switch. In the "Off" position, the valve position will be the opposite of that. Typically, these switches are used for maintenance purposes only. For the treatment process to operate properly, all these switches should be in the "Auto" position.
3. When in the "Auto" position, the supply valves (41-V-03 and 42-V-03) will open whenever a truck fill sequence is in progress. They will close when the truck fill sequence is complete.
4. When in the "Auto" position, the drain valves (41-V-04 and 42-V-04) will open for a programmable period at the end of every truck fill sequence. This allows water still in the truck fill arm to drain back into the domestic water tank.

Figure 20 – DWT Return Valve Popup Screen

Notes:

1. This screen gives the operator access to the domestic water tank (DWT) return valve controls. It can be accessed by clicking on the valve graphic on the Overview screen of Figure 1.
2. The return valve can be manipulated using its respective HOA switch. In the "Hand" position, the valve will be open. In the "Off" position, the valve position will be closed. In the "Auto" position, the valve will open and closed based on programmable DWT level setpoints. Typically, this switch is used for maintenance purposes only and is for the most part left in the "Auto" position.

Figure 21 – Glycol Circulating Pump Popup Screen

Notes:

1. Access to the glycol circulating pump controls. The controls for P4.1 and P4.2. are identical. Each pump control screen can be accessed by clicking on its respective pump graphic on the Glycol screen of Figure 4.
2. The Reset Runtime push button allows the operator to manually reset the pumps accumulated runtime.
3. The Reset Fault push button allows the operator to manually reset any pump VFD faults. A pump fault is indicated when the fault light turns red.
4. Each glycol pump has a corresponding HOA selector switch. In the "Hand" position, the pump will run continuously at a speed given by the Manual Speed setpoint at the bottom of the popup screen. In the "Auto" position, the pumps will run in a duty / standby configuration. The duty pump will run continuously and at a speed that maintains a programmable glycol return pressure. In the "Off" position, the pump will not run.

Figure 22 – Glycol Control Valve Popup Screen

Notes:

1. Popup access to the glycol control valve controls. Figure 22 shows the controls for valves CV-HEX-1.1. The control for valves CV-HEX-1.2, CV-HEX-2, V-RHC1 and V-RHC-2 are identical. They can be accessed by clicking on their respective graphics on the HVAC and Glycol screens of Figures 3 and 4.
2. Each valve can be manipulated using its respective HOA switch. When any switch is in the "Hand" position, its respective valve will be in the position corresponding to the Manual Position setpoint at the bottom of the popup screen. In the "Auto" position, the position of the supply valves will modulate automatically to maintain a programmable temperature setpoint.
3. Please note that all HVAC damper controls have the same format as that for the glycol control valves. Refer to the notes for HVAC screens 3 and 4 for a description of the operation of these dampers.

Appendix A Main Components

A.1 Process System Components

ID/Tag #	Description	Make	Model #	Serial No.	Size
15-TK-01	Process Wastewater storage tank	Parr Metal	J0256-02		108 m^3
16-TK-01	Treated water storage tank	Parr Metal	J0256-01		735 m^3
20-TK-01	Chlorine mix tank	Century Plastics	OT-45-L		200 liter
20-TK-02	Chlorine day tank	Norwesco	150 gallon PCO		450 liter
10-RWP-01 10-RWP-02 10-RWP-03	Submersible raw water pumps	Goulds	160L15/6F155		15 HP 600/3/60
30-CP-01 30-CP-02	Circulator pumps	Grundfos	CR10-02 A-GJ-A-E-HQQE	0002 0005	1.5 HP 600/3/60
41-TFP-01 42-TFP-02	Truck fill pumps	Grundfos Paco	16N6-4070-13010X-2662P	1971144285-6 1971144285-2	3 HP 600/3/60
20-CFP-01 20-CFP-02 20-CFP-03 20-CFP-04	Chemical feed pumps	Watson-Marlow	Qdos 20	180112-147106 180112-147107 180112-147108 180112-147109	120/1/60
SP-1 SP-2 SP-3	Sump Pumps	Liberty	257 VMF-2	10J517 10J518 107ZZN	1/3 HP 115/1/60
60-AB-01	Air Blower	Greatech	SdB65	167904	5 HP 600/3/60
15-STR-01 15-STR-02	Self-cleaning strainer	Forsta Filters	ML3-90		
	Self-cleaning strainer differential pressure gauge	Forsta Filters		09170942	0-1.0 bar
	Calcite filter	Quick Tanks	BIP6060-B		
60-MF-01 60-MF-02 60-MF-03 60-MF-04	Media filters	Quick Tanks	BIP6060 BIP6060-A	56283 56284 56285 56286	
14-UV-01 14-UV-02	UV system	Prominent	Dulcodes 2x350LP	2018025113 2018025114	
20-MIX-01	Chlorine Mixer	Dynamix	MMX-2105D-7	71135-1	
10-FE/FIT-01 13-FE/FIT-01 16-FE/FIT-01 41-FE/FIT-01 42-FE/FIT-01	Flowmeters	ABB Water-master	FEW325100H1S1A1B1A1A2P2B3A1M5	3K620000244716 3K620000244717 3K620000244718 3K620000242125 3K620000242126	100 mm
16-AE/AIT-01 30-AE/AIT-02	Chlorine analyzer	Prominent	DACA006140200010010EN	2018014087	
XX-PG-XX	Process pressure gauges	Winters	PFQ1547		0-160 PSI/kPa

10-PE/PIT-01 10-PE/PIT-02 11-PE/PIT-01	Process pressure transmitter	Wika	A-10		
10-LE/LIT-01 10-LE/LIT-02 10-LE/LIT-03 10-LE/LIT-04	Reservoir level transmitter	Dwyer	BLT-2SB-IVEM-30-50		
15-LE/LIT-01 16-LE/LIT-01 15-TE/TT-01 16-LE/TT-02	Exterior water storage tank temperature and level transmitter	Impress Sensors	IMSTL-G1000-5A2-AAV-010-5-D-000	506891 506892	
11-AE/AIT-01 12-AE/AIT-01 30-AE/AIT-01	Turbidity Meters	Hach	TU5300sc With SC200 Controller	1791683 1787769	
10-TG-01 16-TG-01	Process temperature gauges	Winters	TBM32040-B5		-5 deg C to 50 deg C
10-TE/TT-01 16-TE/TT-01	Process Temperature transmitter	IFM	TA2343		
	Chlorine dosing flow cell	IFM	SF2405		
	Butterfly valves	Bray	Series 31		Sizes 75-200 mm
	Valve Actuator	Bray	Series 70		
10-CHK-01 10-CHK-02 16-CHK-01 40-CHK-01 41-CHK-01 42-CHK-01	Check valve	Tideflex	Waterflex WF-3		100 mm
15-CHK-02	Check valve	EVR	CPI		100 mm
41-V-04 42-V-04	Truck fill drain valve	Asco	8210G035		19 mm
10-ARVB-02 10-ARVB-03	Air/vacuum valve	Valmatic	101S, 102S		25-50 mm
10-ARVB-01 16-ARVB-01	Combination valve	Bermad	C30		50 mm
30-CHK-01 30-CHK-02 30-CHK-03	Swing check valve	Valmatic	503A	M931220	75 mm
80-V-01 80-V-04 80-V-06 80-V-07	Needle valve	Hamlet	H-99-SS-SS-V-1/2		12 mm
15-V-01 15-V-02	Process wastewater tank plug valve	Dezurilk	PEC,4,F1,CI,NBR,NBR*GS-6-HD8		100 mm
	Pressure relief valve – pump houses	Cla-Val	50-01		38 mm
	Injection quill	Saf-t-flo	IQ-50-V-5-3-C-H		

	SS ball valves	NVC	V3		6 mm to 50 mm
41-EJ-01 42-EJ-01 16-EJ-01 15-EJ-01	Expansion joint	Mercer Flexmore	Style 452E		100 mm, 200mm
	PVC ball valve	Praher	S6 series True Union		
	Check valve	Praher	S4 series		
	Calibration cylinder	Griffco	CC0100S		
	Vented ball valve	Hayward	TBZ		
	Pressure relief valve	Griffco	BPM050PVS		12 mm
	Pressure gauge isolator	Hayward	GG120x50		
	Robar couplings	Robar	1506		50 mm to 200 mm
	Process Victaulic couplings	Victaulic	#77		Various
	Air scour check valve	Moygro	W15A-66A		
	Air scour control valves	Belimo	B254+AFRBUP		50 mm
	Media filter air relief control valves	Belimo	B225+LRB120-3		25 mm

A.2 Mechanical System Components

ID/Tag #	Description	Make	Model #	Serial No.	Size
	Exterior fuel tank	Regal tanks	5702		35,000 L
DT-1	Interior fuel day tank	Westeel	S602	671800866	1,100 L
TK-1	Hydronic expansion tank	Amtrol	AX-260V	375011	600 L
P4.1 P4.2	Primary Hydronic pumps	Grundfos Paco	25709 VLSC	1971144285-1-A1 1971144285-1-B1	3 HP 600/3/60
P1 P2 P3	Boiler pumps	Grundfos	UP53-46 F	96635423	½ HP 115/230/1/60
P-6A P-6B	Fuel pumps	Viking	SG-0510X-DUP-O	8196840105 8198680135	½ HP 115/1/60
	Automatic air vents	Honeywell	EA79A1004		19 mm
AP-1	Air purger	Bell & Gossett R-36	5-360-03-G12-003	270525 01 CRN: OH12878.51	75 mm
GFS-1	Glycol feeder	Axiom	SF100	18-11588-SF	
	By-pass chemical pot feeder	Neptune	VTF-2HP		
	Side stream filter	Axiom	SFP-10		
HEX1.1 HEX1.2	Plate heat exchanger	AICO	AT70X-1G1-47/16-DW	24695 24696	
HEX2	Tank heat exchanger	Tranter	Style 50D		
UH-4, UH-5, UH-7A, UH-7B, UH-8A, UH-8B	Hydronic unit heater	Rosemex	H26		
UH-1, UH-2, UH-3	Hydronic unit heater	Rosemex	H50		
UH-6	Electric heater	Ouellet	OAS03008		3kW/ 208V/1ph
FF-1 FF-2	Forced flow heater	Rosemex	F-200		
BB-1 BB-2	Baseboard heater	Rosemex	EM-RV18		
HRV-1	Air to Air heat recovery ventilator	Venmar	AVS X30HRVE X30HRV ECM	XB04170901523	HRV-1: 250 cfm (118L/S) @ 1.25” (in. wg.) E.S.P
B-1 B-2 B-3	Boilers	Weil Mclain	BL-780	801801986 801801987 801801988 CRN: L8978.512346789N0TY	

B-1 B-2 B-3	Boiler Burners	Beckett	CF1400		
RHC-1	Reheating coil	Trane	DTTB12012G0AA144BABA00B		
RHC-2	Reheating coil	Trane	DTTB12012G0AA080BABA00B		
	Arctic Vent	Arctic Vent	AV120-03GFC		
EF-1	Chlorine room fan	Greenheck	SQ-70-VG		114 L/s (242 cfm) @ 75.0 Pa (0.3")
SF-1	Boiler room fan	Greenheck	SQ-90-VG		225 L/s (477 cfm) @ 75.0 Pa (0.3")
SF-2	Electrical room fan	Greenheck	SQ-70-VG		90 L/s (190 cfm) @ 50.0 Pa (0.2")
	Dampers	Tamco	9000 EC		
	Fire dampers	Price Industries	FDD-B, FDD-C		
	Boiler low water cut--off	McDonnell & Miller	Series 64		
	Pressure gauges	Winters	PFQ803		
	Temperature Gauges	Winters	TBM32040		
	Temperature transmitter	IFM	TA2333		
	Viking pump skid pressure switch	ASCO	SC10D		
	Viking pump skid flow switch	Flotech	V6 series		
	Day tank Fuel oil level switch	Gems Sensors	LS-700-3C-SPST-020V-GR1-5PT		
	Exterior tank fuel oil level switch	Ktech	FS301		
	Fuel tank levelometer	Midget	277		
	Vacuum Pressure Switch	United Electric	J120-15878		Set @ 8" HG Vac Fall
	Overfill prevention valve	Franklin Fueling Systems	Defender Series		
	Hydronic Victaulic couplings	Victaulic	#107N		
	Hydronic butterfly valve	Victaulic	#761 VIC300		
	Hydronic circuit balancing valve	Victaulic	#789		

	Hydronic circuit balancing valve	Bell and Gossett	LF Series		
	Hydronic check valve	Victaulic	#716		
	Brass ball valves	MA Stewart	B3		
	Boiler pressure relief valve	Watts	Series 740		
	Oil de-aerator	Tigerloop Plus	58915		
	Oil Safety Valve	Webster	150 OSVA 38		
	Suction diffuser	Bell & Gossett	DC-3X		62 mm x 75 mm
	Flo-trex valve	Armstrong	FTV-F		75 mm
CV-HEX2	Heat exchanger control valve	Belimo	B220+LF24-SR US		19 mm
V-RHC1	HRV Outside Air Valve Command	Belimo	B209+TFRB24 -SR		12 mm
V-RHC2	HRV Inside Air Valve Command	Belimo	B207+TFRB24 -SR		12 mm
CV-HEX1.1 CV-HEX1.2	Heat exchanger control valve	Belimo	B231+AFRB24 -SR		31 mm
V-BB1	Baseboard heater control valve	Belimo	B209+LF120 US		12 mm
V-BB2	Baseboard heater control valve	Belimo	B208+FL120 US		12 mm

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A.3 Domestic Water System Components

ID/Tag #	Description	Make	Model #	Serial No.	Size
	Domestic Wastewater tank	Progressive Yard Works	48BTC300		1360 L
TK-3	Domestic water tank	Norwesco	500 imp gallon		2275 L
TK-2	Domestic expansion tank	Well-X-Trol	WX-448		300 L
DHW	Hot water tank	Rheem	CELD-120-208	A491715975A	450 litres
P-7	Domestic Water Pump	Goulds	10SV9TC7L20	B1806481	1 HP 208/1/60
EEW	Eye/face wash	Haws	7260BT-7270BT		
TM-1	Mixing valve	Haws	9202E		
EEW/S	Emergency shower	Haws	8300-8309		
CS-1	Office sink	Kindred Franke	LBD6410/316PCB-1/4		
	Office faucet	Delta	2497LF		
CL-1	Lavatory sink	American Standard	Cadet Everclean		
	Lavatory faucet	Delta	21C142		
WC-1	Toilet	Liberty	AscentII-ESW		
	Domestic water pressure switch	Eaton	CHWPS3050D		
LT	Domestic water tank level transmitter	Dwyer	BLT-2SB-IVEF-20-X		
	Waste tank level transmitter	MDI	SNF-5426R015		
	Circuit balancing valve	Bell & Gossett	LF Series		25 mm
V-DCW-1	Control valve	Belimo	B229-LF120US		32 mm
	Pressure reducing valve	Zurn	NR3XL		32 mm
	Vacuum relief valve	Watts	N36-M1		19 mm

A.4 Electrical and Control Components

ID/Tag #	Description	Make	Model #	Serial No.	Size
GEN	Generator	Kohler	100REOZJF	SGM32M9PV	100 kVA
	ATS	Kohler	KCS-ANTA-0230A	SGM32M625	
	MCC	Allen Bradley	Centreline 2100 P Series	6503792466/300	
	MCC VFDs	Allen-Bradley			
	Moulded Case Circuit Breaker (MCCB)				

	TVSS for MCC	Allen-Bradley	2100-BK05		
	VFD Ethernet Switch	Allen-Bradley	20-COMM-E		
	MCC Line Reactor	Allen-Bradley	1321-3R4-B		
	Fused Disconnect Switch	Square D	CH364RB		
	45 kVA Transformer	Marcus	MTWP45A1		
	200 kVA Transformer	Beaver	TVR200T-T44C	18C23030	
	Boiler Controls	tekmar	Boiler Control 284	24411 0008	
	Boiler Sensor	tekmar	Universal Sensor 082		
	Panel board (Type NF)	Square D	NC50S		
	Circuit Breaker	Square D	H-/J-Frame		
	Panel Board (Type NQ)	Square D			
	Circuit Breaker	Square D	QB/QD/QG/QJ		
	PanelView 800 HMI	Allen Bradley	2711R-T10T	GF0RS3CQ GF0AM4B Q	
	Stratix 2000 unmanaged switch	Allen Bradley	1783-US16T		
	Power Supply	Allen Bradley	1769-PA4		
	Ethernet distributed I/O	Allen Bradley	1769-AENTR		
	Logix 2 MB Memory	Allen Bradley	1769-L33ERM		
	Digital input	Allen Bradley	1769-IA16		
	Digital output	Allen Bradley	1769-OA16		
	Analog input	Allen Bradley	1769-IF8		
	Analog output	Allen Bradley	1769-OF8C		
	Interior lights	RAB	FW4-LED60		
	Exterior lights	RAB	SLIM26 /PC		
	Flood lights	RAB	FL2-LED30		
	UPS	Always On	GES-152N	10019541 612	
	Power Supply	Phoenix Contact	Quint Power		
	Emergency Exit lights	Thomas & Betts	L50-2LD1-UTP12W, L50-2M6-ULT13W		
	Beacon lights	Banner	SG-TL70, B-TL70		
	Chlorine sensor	Honeywell	XNX-UTAE-RNNNN, XNXXSL1SS	14187464	
	Nitrogen Dioxide sensor	Honeywell	E3SAH E3NO2	SA181700 053	

	Outdoor temperature sensor	Tekmar	Universal Sensor 070		
MD-4-LS	MD4 Open Limit Switch	Greystone	DES-100		
TS-GEN	SF-2 Fan Duct Temperature	Greystone	TE500FDB12C1A6		
	Duct Temperature Sensor	Greystone	TE500FDB12A1A6		
	Duct Temperature Sensor	Greystone	TE200FDB12B1A6, TE200FDB12C1A6		
PS-GR	Glycol Supply Pressure Sensor	Greystone	PGS100A12A1A		
TS-RHC1	HRV Outside Air Temperature	Greystone	TE500F121A6		
CS1	HRV Outside Air Pump CT	Greystone	CS-652-R1		
CS2	HRV Inside Air Pump CT	Greystone	CS-652-R1		
TS-BLR	Boiler Room (102) Temperature	Greystone	TE500AS121A2		
MD-1	Generator Recirc Air Damper Actuator	Belimo	LF-24-SR-US		24VDC
MD-2	Generator Exhaust Air Damper Actuator	Belimo	LF-24-SR-US		24VDC
MD-3	Generator Outdoor Air Damper	Belimo	NFB24-SR		24VDC
MD-4	Generator Combustion Air Damper	Belimo	TFB120		120V
MD-6	Boiler Recirc Air Damper	Belimo	TFB24-SR		24VDC
MD-7	Boiler Outdoor Air Damper	Belimo	TFB24-SR		24VDC
MD-8	HRV Exhaust Air Damper Open	Belimo	TFB120		120V
MD-9	HRV Outside Air Damper Open	Belimo	TFB120		120V
MD-10	Chemical Room EF-1 Damper Open	Belimo	TFB-121		120V
	Fuel pump control panel	Viking	CPPA05-DEFGMNOPRWZ3	1831873.00	
	Relay	Finder	46 Series		
	Thermostat	Honeywell	T4051A, T4051B		

Appendix B Warranty

B.1 Authorized component policy

1. BIPW only authorizes the use of genuine BIPW spare parts, which meet stringent engineering design specifications and quality standards, and have traceability to having been procured and certified to these specifications by the BIPW Quality Assurance System.

2. The use of any non-BIPW authorized parts, or any parts not having been submitted to the BIPW Quality Assurance System will invalidate any and all factory warranties.

B.2 Factory service

1. To return the WTP components to an authorized service depot, perform the following steps:

    a. Have the unit's serial number and service requirement details ready. BIPW can be reached by telephone at (604) 882-6650 or fax at (604) 882-6659.

    b. A return authorization number is required before returning any components.

    c. Securely package the unit in the foam covering and a box similar to the one it was shipped in.

    d. Insure the package with your shipper.

    e. Write the return authorization number on the package.

    f. Unless otherwise instructed, ship to;
    BI Pure Water (Canada) Inc.
    #2, 9790 – 190th Street
    Surrey, BC, V4N 3M9

The parts are under warranty by the manufacturer for a period of 12 months from the date of shipping. The Warranty covers the cost of any part that is proven defective in material or workmanship with the exception of parts outlined in "Conditional Terms."

B.3 Conditional Terms

- The Warranty does not cover the cost of labor or service calls to examine, remove or replace a proven defective part.

- A part can only be determined to be defective by an authorized service representative or the manufacturer.

- Except as agreed to in writing by BIPW, packing and shipping costs for warranty inspection and/or repairs are not the responsibility of BIPW.

- The Warranty does not apply to damage resulting from accidents, alteration, misuse, tampering, or abuse. Examples of the foregoing, without limitation, are:

    1. Damage to the exterior or interior finish as a result of any of the above.
    2. Use of inadequate or defective wiring or improper voltage; loose or blown fuses or open circuit breakers; or improper connections to electrical service.
    3. Use with inadequate or defective plumbing, water supply or water pressure.
    4. Improper use of controls.

Appendix C Maintenance Schedule Checklist

Description	Task	Maintenance Frequency												
		Daily	Weekly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overall visual inspection	Complete overall visual inspection to be sure there are no alarms, all equipment is operating to design, there are no leaks, and safety systems are in place. Check HMIs for alarms.	X													
Overall audio inspection	Complete overall audio inspection to be sure all equipment/pumps sound normal when in operation.	X													
	Pumps														
Sub pump	Being inaccessible, monitor the sub pumps through its electrical connections. Measure & record operating current and voltage.														
Air Scour Blower	Check for normal discharge pressure, check for abnormal noise or vibration, check oil level. Monthly check air filter element and for oil leakage, see manual in Parts	X	X												

	Instruments	Daily	Weekly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chlorine Gas Detector	Functional check every month as per manual. Calibrate as per manual every 6 months.			X	X	X	X	X	X	X	X	X	X	X	X
Turbidity Analyzers	Recommended re-calibration every 3 months. Use calibration kit.			X			X			X			X		
Eyewash	Test shower and eyewash flow, check temperature.			X	X	X	X	X	X	X	X	X	X	X	X
	Chlorination System														
Chemical Dosing System	Check tubing and replace if necessary				X		X		X		X		X		X
Chemical tank level	Check level in the chemical tanks and fill if necessary.	X													

	Building Support Systems	Daily	Weekly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water heater	Lift and release the lever handle on the temperature pressure relief valve, located near the top of the water heater, to make certain the valve operates freely. Allow several litres to flush through the discharge line to an open drain.												**X**		
Heat Link Panel	Yearly operation check as per manual.												X		
Heat Recovery Ventilator	System operation check. Refer to control mode Sequence of Operation in manual.												X		
Heat Recovery Ventilator	Wash air filters every 2 months. Drain pans and interior of unit.				X		X		X		X		X		X
Heat Exchanger	Heat exchangers are subject to fouling which can cause pressure drops, low temp differential in the heated medium, or higher exit temperature. Check and clean with solution recommended in manual.						X						X		
Air Heating Coil	Keep coils clean to maintain maximum performance as per manual. Winterize: drain water from the coil before the heating season and add antifreeze to prevent freezing of any water left standing in the coil.				X			X			X			X	
Boiler	Check the boiler operating pressure of steam or water boilers: usually will not exceed 5 PSIG. Check safety valve and open at 15 PSIG. Open boiler drain cock to remove impurities that have settled to the bottom of the boiler. Refill to the correct working pressure. Refer to water boiler control/manuals for more info.		X												
Boiler low-water cutoff	Blow down weekly during heating season. Open up float chamber and clean annually. Replace control every 10 years.		X												
Avtron Load bank	**Daily** remove any restriction to airflow through. Check screens for debris or blockage. Verify the airflow is in proper direction. Assure that there is no recirculation of the exhaust air through the load bank. **Every 3 months** remove access panels and screens and inspect for mechanical breakdown, loose connections, corrosion of magnetic contactors. ***Use eye protection and follow warnings in manual. Annually** the blower motor can be lubricated.	X			X			X			X			X	

	Water Treatment System	Daily	Weekly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Self cleaning strainers	Isolate one unit at a time as per Self Cleaning Strainer manual in this binder. Every six months to a year, or during scheduled down-time it is recommended to open the filter and inspect the components. Access to the internal components can be gained by removing the clamp and top section. Lift the particle remover and plate straight out of the filter housing and separate the two. Inspect both for wear. See manual for instructions and warnings.						**X**						**X**		
UV Lamps	The UV lamp must be replaced after 9,000 hours of continuous operation (approx one year). The controller will indicate lamp hours. As a measure of safety, this should be done even if the HMI indicates that the intensity of the lamp is still in a safe region. Refer to the Prominent UV manual in this binder for instruction on changing the lamp.												**X**		
UV Quartz Sleeve and Sensor Window	Keep the quartz sleeve and sensor window clear and clean. See UV manual for details. Clean the UV lamp protection tube and replace the wiper when necessary.			X											
	Filtration System														
Pressure Vessels	Visually Inspect Integrity						X						X		
Pressure Gauges	Verify Proper Function											X			
Backwash Face pipe	Visually Inspect Integrity											X			
Media sampling	Annually or as required											X			
Media level check	Annually or as required					X						X			

Appendix D Maintenance by outside contractors

Generator	Yearly	Contact dealer for recommended generator maintenance: Frontier Power Products Ltd. 7983 Progress Way Delta, BC Canada V4G 1A3 Tel: (604) 946-5531 Craig Einarson ceinarson@frontierpower.com
Boiler	Yearly	Contact installer for recommended boiler maintenance: Boiler Installer: Zack Krvavac BC Boiler Service Ltd. #10-11538 132A St, Surrey, 604-580-3252 Dan Webber, email: bcboiler@shaw.ca
Overall Plant	Yearly	Yearly check/training/maintenance by BI Pure Water can avoid costly last minute visits: Toll free: 888-901-3111 #2 - 9790 190th Street Surrey, BC, Canada
Heating System	Yearly	Yearly cleaning and inspection of heating system, including horizontal steam and hot water units. BI Pure Water, Inc. Toll free: 888-901-3111 #2-9790 190th Street Surrey, BC, Canada
Yearly pump maintenance		Yearly lubrication of all pumps and check

Appendix E Key Contacts

Owner	Government of Nunavut	ᐋᔅᐅᐊᓂ ᔮᕐᒪ/ Ashwani Sharma Project Manager, Infrastructure - Kivalliq Region ᐊᔅᐅᐊᓂ ᔮᕐᒪ ᐱᓕᕆᐊᒃᓴᓄᑦ ᐊᖏᔫᑎᓄᑦ ᐊᐅᓚᑦᓯᔨ, - ᑭᕙᓪᓕᕐᒥ Gestionnaire de projet, Infrastructure – région du Kivalliq Havaakhamut Atan'nguyaq, Aulapkaidjutikhanut – Kivalliq T: (867) 645-8180 Eš: ASharma@GOV.NU.CA
Engineers	EXP	Boris Allard, FEC, P.Eng. EXP | Manager - Water and Wastewater Services T : +1.506.451.7470 | E : boris.allard@exp.com Jack Piercy, P.Eng. Design Engineer - Municipal Infrastructure T : 506.452.9000, local 7475 E : jack.piercy@exp.com Fredericton, NB
Construction Supervisor	Tower Arctic Ltd	1502 Federal Road Iqaluit, NU T: 844-636-3550 Gord Paterson, E: gpaterson@towergroup.ca
Programmer/Plant Software Control	EXP	Greg Hatchard, P. Eng. EXP | Senior Engineer T : 506-452-9000 | e : Greg.Hatchard@exp.com 1133 Regent Street, Suite 300 Fredericton, NB E3B 3Z2
Treatment System Support	BI Pure Water	Jim Tam, P.Eng E : jimt@bipurewater.com T : 604.882.6650 | TF : 888.901.3111 # 2, 9790 - 190th Street, Surrey, BC V4N 3M9. Fax 604.882.6659
Service Trips Scheduling and Parts Replacement	BI Pure Water	Theresa Rendl, Inside Sales e : insidesales@bipurewater.com T : 604.882.6650 local 224 | TF : 888.901.3111 # 2, 9790 - 190th Street, Surrey, BC V4N 3M9. Fax 604.882.6659 OR www.shopbipurewater.com
Local source for parts		Unknown at time of commissioning

Appendix F Parts & Service Order Form

See next page

PARTS AND SERVICE ORDER FORM

Email: insidesales@bipurewater.com
Phone: 604-882-6650
Fax: 604-882-6659

Ordered by:
Contact phone number:

Contact fax number:

Ship to address:

Contact email address:

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Comments

If you don't know the answer please call, email or fax -- we would love to help.