Operators' Manual for Palm Beach County Water Treatment Plant No. 9

OVERVIEW

The Palm Beach County Plant 9 water treatment plant is a Reverse Osmosis (RO) based system. The plant has several support systems to feed, process, and distribute drinking quality water. Over all plant startup and volume can be either manual or automatic control based upon storage tank level. Raw water is provided from 24 local wells and an Aquifer Storage and Recovery (ASR) well.

Treatment Process

The raw water is first passed through a sand strainer to remove particles greater than XXXX. Sulfuric Acid is then injected to bring down the pH of the water to facilitate and protect the membrane filtration. After acid addition, the water is sent through a static mixer and then a bank of cartridge filters to remove sediment. The water pressure is next boosted by a bank of membrane feed pumps and regulated at an elevated pressure for the RO membranes. This is sent through a common header to the feed valves of the eight membrane trains. Excess pressure and flow are diverted through a tune up valve to the concentrate system.

Each train consists of a feed valve, first stage membranes, first stage permeate and concentrate, second stage membranes, second stage permeate and concentrate, and a final concentrate valve. The positions of the feed and concentrate valves are controlled to produce the target flow and recovery ratio.

The concentrate of the first stage is fed directly to the second stage membranes. The permeate of both the first stage and second stage are then combined together and sent to post processing. The concentrate is sent to the concentrate disposal system. The permeate produced is actually softer (less minerals) than what can be sent to distribution. Raw water is next blended back with the permeate to achieve the proper hardness blend.

After blending, the water passes through an odor control system to remove unwanted odor causing sulfur dioxides and iron. Next, the permeate is channeled to the clearwell where the first disinfection process occurs.

Sodium Hypochlorite (Chlorine) is injected at the front of the clearwell. The permeate and chlorine combine and mix through the baffles in the clearwell. At the end of the mixing chamber, Ammonia (to produce chloramines) and Sodium Hydroxide (to raise the pH) are injected. Corrosion inhibitor and Fluoride are

also available to be added at this point, but are currently not used.

The finished water is next sent via a bank of transfer pumps to the ground storage tanks. Supplementary Chlorine addition is available at this point if needed. From ground storage, finished water is pumped to the distribution system via a bank of high service pumps. Again, Supplementary chlorine addition is available here.

SYSTEMS

All of the systems are controlled by the WTP9 Overview Screen shown in figure 1 below.

(pic)
Figure 1, WTP9 Overview Screen

Plant Demand and Auto Control
In order to start the plant in either auto or manual modes, the plant must first be enabled from the Startup Screen (figure 2).

(pic)
Figure 2, Startup Screen

Plant startup/shutdown and volume can be either manually or automatically initiated. In auto mode, the plant will startup, add membrane trains, subtract membrane trains, and shutdown based upon tank levels.

(pic)
Figure 3, Star and Stop Skid Setpoints

The figure above shows these setpoints. This is available from the Storage and Distribution Screen (figure 4) shown below.

(pic)
Figure 4, Storage and Distribution Screen

Also on the Screen is the Tank Select. This determines which of the three-storage tank's level is used for this control. In addition to having the plant enabled, to run the train startup/shutdown in auto, individual membrane trains must be selected in auto, along with enough well capacity, sulfuric acid capacity, booster pump capacity, etc.

Whether started in manual or auto, there are ten (10) criteria that can immediately shut down the plant or keep it from starting. These can be individually enabled or disabled and are listed and controlled on the Shutdown Override Screen as shown in figure 5 below. The Screen is available from the WTP9 Overview Screen.

(pic)
Figure 5, Shutdown Override Screen

All measured analog values can be manually overridden to directly control any process. The following is an example of this override.

(pic)
Figure 6, Override Example

Only authorized users can initiate override and only after Override is selected from the Train Detail Screen (figure 7).

(pic)
Figure 7, Train Detail Screen

If enabled through the shutdown overrides, the plant can be quickly shut down through an Emergency Stop (figure 8). This is available on all main system screens as E-Stop.

(pic)
Figure 8, Emergency Stop

Also available on all main screens is a Reset All. This clears all latched alarms in the PLC. Some screens have specific resets that only affect a particular alarm. An example of this is on the Train Detail Screen that has both a Reset All and individual Reset Fails on each train.

Raw Water

Raw water wells are individually controlled through a radio telemetry system operated from the Wellfield Screen (figure 9). This shows the current status of all 24 wells.

(pic)
Figure 9, Wellfield Screen

From here, any individual well can be chosen and controlled as shown in figure 10.

(pic)
Figure 10, Individual Well Window

The number of wells brought on by the auto system is determined by a combination of the capacities of each well, the plant demand, and the capacities of each membrane train. Each well and membrane train is individually assigned a capacity. The Well Flow Rate Screen (figure 11) is available from the Wellfield Screen.

(pic)
Figure 11, Well Flow Rate Screen

The Membrane Train Flow Rate Screen (figure 12) is available from the Train Detail Screen.

(pic)
Figure 12, Membrane Train Flow Rate Screen

In auto, when bringing on a train, wells are started in a First On First Off sequence. Enough wells are initiated to supply the demand of the specific membrane train. During operation, wells are also added or subtracted based upon raw water pressure. After a settable delay, on low pressure an additional well is called for. On high pressure, the tune up valve is incrementally opened to limit the maximum pressure. If it is opened 2% or greater for another settable time, a well is called off.

The pressure setpoints for both starting a well on low pressure and opening the tune up valve on high pressure is on the Wellfield Screen. From this Screen, the timer setpoints for the on and off delays are also available (figure 13).

(pic)
Figure 13, On/Off Timer Setpoints

There are several alarms associated with the raw water wells. An overall water pressure alarm is available as shown in figure 14.

(pic)
Figure 14, Raw Water Pressure Alarm

Additionally, each well is configured with a fail to start alarm (figure 15). If the

well does not respond to a run command with a running status within a settable period of time, the well is considered failed. It is removed from being called and another well is called in its place. Its failed status is displayed on each of the well status screens. The timer setpoints for the delay before determining failure is reached from the well startup/shutdown timer Screen.

(pic)
Figure 15, Fail to Start Screen

In addition to the raw water wells, an ASR well can be used in conjunction. During recharge operation, additional wells are called for to supply the demand of the ASR well. During recovery, the ASR well flow is added to the raw water well flow.

PART 2. PRETREATMENT

[recommend numbering the different parts]

??? [recommend some sort of intro paragraph like this...]
Pretreatment of the water consists of Sand Strainer and Cartridge Filters, Sulfuric Acid, and the AntiScalant.

I. Sand Strainer and Cartridge Filters

The sand strainer is an automatically self-cleaning system. It has its own dedicated control system and only a status is reported to the HMI system of whether it is backwashing or not (figure 16). During this backwash cycle, raw water flow is diverted to flush the screen. This water is discharged in the settling lagoon. During backwash, raw water pressure falls. Depending on plant dynamics at the time, an additional raw water well may be call. After backwash is completed and no longer using water, the pressure will come back up. If it exceeds the high limit, the tuneup valve will open and initiate a well shut down.

(pic)
Figure 16, Sand Strainer & Cartridge Filters Screen

II. Sulfuric Acid

Sulfuric acid is delivered to the raw water after the sand strainer and before the cartridge filters. A software PID controller in the PLC controls acid addition. The system must detect raw water flow in order to enable the acid pumps to operate. The pumps are variable speed variable stroke positive displacement pumps**.**

Note: Great care must be taken when in or near the acid room. Severe injury can result from exposure to sulfuric acid.

1. Auto

[example of third level of headings I recommend to better organize/find info]
When in auto, a pump will start when a membrane train is called for and raw water flow is detected. The number of trains called for controls the stroke. The speed is both proportional and integral controlled and adjusts to bring the pH of the raw water to the desired setpoint.

2. Manual

In manual, both the stroke and speed are based upon manual setpoints. The two pumps operate in an alternator arrangement with only one pump operating at a time. The pump alternation can be triggered manually or left to trigger automatically based on a timer and preset.

3. pH

Membrane longevity is significantly impacted by pH. Exposure to too high of pH leads to fouling. It is essential that the pH of the raw water be under control before opening the feed valves to the membranes.

To accomplish this, the pH is constantly monitored both during startup and during operation. During startup, the raw water is allowed to bypass through the tuneup valve during pH stabilization prior to operation. During this time, the PID control is adjusting to bring the pH into range. The time allowed to reach within .2 pH is operator adjustable. The pH must then stay within that range for another settable period of time to ensure stability. If it goes out of range, high or low, the out of range timer starts again. If at any time the out of range timer times out, and the related shutdown criteria is enabled, the plant will go into emergency shutdown.

The pH is monitored before the cartridge filters with a pair of instruments. Either can be selected to be the source of the feedback to the PID control. The raw water pH setpoint is on the Sulfuric Acid Feed Screen (figure 17).

(pic)
Figure 17, Sulfuric Acid Feed Screen

The setpoints for the timers are also available from that screen (figure 18).

(pic)
Figure 18, Timer Setpoints

Various pH alarms are configurable (figure 19). These setpoints are also available from the Sulfuric Acid Feed Screen.

(pic)
Figure 19, pH Alarm Setpoints

Both high and low pH on both transmitters are plant shutdown criteria and available to be enabled/disabled.

III. AntiScalant

??? [why is this in here if it's not in use? Recommend move to end]
This system is currently installed, programmed and tested, but the plumbing was not completed due to the decision to not use it. (figure 20) The plumbing would need to be finished before putting the system in service.

(pic)
Figure 20, AntiScalant System

IV. Cartridge Filters

??? [wouldn't it make more sense for this to be below the Sand Strainer section]
The seven cartridge filters trap fine sediment that can foul the RO membranes. The differential pressure across the filters rises with filter obstruction. This is monitored and one of the shutdown criteria. The alarm points are settable from the Sand Strainer & Cartridge Filters Screen.

Also the turbidity in the post filter water is another shutdown criteria and again settable from this Screen. Additional parameters are monitored including temperature, Conductivity, ORP, and pressure.

TREATMENT

Treatment of the water consists of ... ???

Membrane Feed Pumps

The membrane feed pumps boost and maintain a constant pressure to the membrane feed valves. A combination of both fixed and variable speed pumps is used. There are two fixed speed and four variable speed pumps. Whenever a train is in operation, a feed pump is called for. As a train is added, an additional pump is called for. Pumps are also called for by pressure. Pumps are shut down by a train going off line or the VFD drives reaching a minimum speed.

In auto, pumps are operated in a specific sequence of calling in all available VFD driven pumps, then if needed, the fixed speed pumps. Within a group, VFD or fixed, the pumps are selected in a first-on-first-off sequence.

Pumps in manual mode are considered when calculating pump demand. In manual, the speed of VFD pumps is set from the Membrane Feed Screen (figure 21).

(pic)
Figure 21, Membrane Feed Screen

Fail Alarms

Each pump has both a fail and a fail to start alarm. The fail alarm is generated from the pumps drive (either VFD or soft start), the fail to start is generated in the PLC and resetable with other alarms. The fail alarm can only be cleared at the respective drive. Once a drive is failed (either fail or fail to start), it is removed from being called and the next available drive in the sequence is called for.

PID Control

The pumps are PID controlled using discharge pressure. Two pressure transmitters are used and either one can be selected as the source of feedback. The target pressure is set from the Membrane Feed Screen.

The setpoint for shutdown on minimum speed is available from the VFD SP icon (figure 22).

(pic)
Figure 22, VFD Setpoint

While in manual, a manual speed setpoint display is visible by each VFD pump (figure 23). Auto/manual selection and manual start/stop are available through screens reached from each individual pump icon. Individual pump fail to starts can be reset here also.

(pic)
Figure 23, Manual Speed Setpoint Display

As with numerous other analog values, the membrane feed pressure reading can be overridden for manual intervention to the PID control (figure 24).

(pic)
Figure 24, Membrane Feed Pressure Override

Membrane feed pressure is monitored and multiple alarms are triggered from it (figure 25). These alarm setpoints are available from the Alarm SP's icon on the Membrane Feed Screen.

(pic)
Figure 25, Membrane Feed Pressure Alarm Setpoints

Tuneup Valve

The auto/manual operation of the tuneup valve is controlled from the Membrane Feed Screen and others. In auto a PID using raw water as feedback controls the valve. The setpoint for the valve is on the Wellfield Screen. The valve remains shut unless the raw water pressure rises beyond the "Open tuneup valve" setpoint. The valve will open to bleed off excess raw water pressure. If the valve opens greater than 2% for a settable time, (accessed from the Wellfield Screen), the system will shut off a well. This reduces pressure and the valve closes.

In manual, the valve will transition to the manual setpoint. If this is greater than 2%, well shutdown will be initiated after the delay.

Membrane Skids
Each of the eight membrane skids consists of a feed valve, stage 1 membranes, stage 2 membranes, and a concentrate valve.

(pic)
Figure 26, Skid Screen ???

Feed Valve
Raw water flow is controlled by the feed valve and introduced to the first stage. The result is either permeate, (clean water) or concentrate (dirty water). The permeate is sent on to post treatment. The concentrate from stage 1 is sent to the feed of stage 2. It is again split into permeate and final concentrate. The stage 2 permeate is combined with the stage 1 permeate and also sent to post treatment. The final concentrate is sent through the concentrate valve to the concentrate disposal system.

Concentrate Valve
Final concentrate is controlled by the concentrate valve. Feed pressure after the feed valve and concentrate pressure ahead of the final concentrate valve are both electronically monitored.

The difference of these two values yields the overall differential pressure of the skid. The differential of each stage is available from mechanical gauges on local monitor panels. Feed and concentrate electronic readings are available here also. Permeate pressure is mechanically monitored on the panel and a permeate pressure switch is used to shut down the individual train in the event of high pressure. Flows are electronically monitored at each permeate and the final concentrate and available on the panel. There is no monitor of the raw water flow, but it is calculated by the sum of permeate 1, permeate 2, and final concentrate.

Recovery Rate
The recovery rate is the percent of total permeate (stages 1 and 2) to raw water. The recovery rate is critical to membrane longevity. Whenever a skid is operating, the recovery rate is monitored. Alarm setpoints are configured for each membrane skid for multiple alarm points (figure 27). The skid is shut down on either high-high or low-low recovery. This is available from any of the Skid Screens. ???

(pic)

Figure 27, Recovery Rate Alarm Setpoints

Feed pressure after the feed valve is another alarm and shutdown of a skid criterion (figure 28). Each skid is set individually and available from the Skid Screen.

(pic)
Figure 28, Feed Pressure Alarm Setpoints

Skid Operation
Each of the eight skids are individually controlled. There are four operating conditions. Off, Preflush, Operation, and Postflush.

An All Skid Screen provides the operator with an overview of dynamic operation of all of the skids at once. ??? [is there a figure for this?] All electronically monitored values from all skids are displayed. All calculated recovery ratios, calculated skid differential, current mode of control, and current auto/manual status for each train is also shown. The only direct control is from an icon to reset a failed train

(pic)
Figure 29, All Skid Screen

Off mode
In the Off mode, both the feed and concentrate valves are fully shut. The permeate is isolated via a check valve from other skid's permeate. All alarm criteria is ignored. In manual operation, any mode of operation can be selected at any time. Alarm conditions are monitored and will shut down the skid if any are met.

Skid Auto Startup – First Skid
In auto, the skid will be called for from the demand logic of the ground storage tanks. The elevation in the ground storage tanks causes a train to be added. There is a difference in the startup of the train as to whether the train is the first to start or not. If it is the first to start, the system will call for enough wells on to supply the demand of the skid. Each skid's demand is settable (figure 30). The Skid Demand Screen is access from the All Skid Screen ???.

(pic)
Figure 30, Skid Demand Screen

Tuneup Valve
Flow into the plant is bypassed through the tuneup valve to the concentrate system. Concentrate booster pumps are started as concentrate pressure rises. When flow into the plant is detected, sulfuric acid addition begins. The stroke and speed of the pump is based upon known starting points for one skid. After the pH has been stabilized, the feed and concentrate valves to the train will open to their respective auto setpoints and the tuneup valve closes. The tuneup valve begins automatic control based on raw water pressure.

Preflush
The intention of the preflush is to allow a low pressure flow into the membranes to fill any evacuated areas and turn over the water in the membranes while sending a minimal flow out as permeate. The duration of the preflush is settable from the individual membrane skid screens. The preflush timer does not start till the feed valve opens. The feed valve does not open till flow and pH are established.

After the preflush period, the train is sequenced into operation. Feed and concentrate valves transition to their operation setpoints. A membrane feed pump is started and a PID and its setpoint control the membrane feed pressure. Pressure builds in the feed header and flow increases.

Skid Auto Startup – Additional skids
The only difference between first skid startup and successive skids is the initial pH settling is skipped and the header pressure is already at setpoint when the feed valve opens. The stroke of the sulfuric acid pump in operation is incremented to a known value for an additional skid. The timing of the opening of the feed valve is dependent on enough wells being started to cause the tuneup valve to open in order to limit the raw water pressure. The train will wait before going into preflush till the tuneup valve opens 2%. Alarms associated with pH are still active and if the pH goes out of limit for too long, the plant will shut down.

Skid Auto Shutdown – Other than Last Skid
When the demand of ground storage determines that a skid is no longer

needed, it initiates a skid shutdown. The skid controls sequence to postflush where setpoints open up the concentrate valve and the feed valve reduces flow. This is to allow a purging of the membranes prior to being put idle. At the end of the postflush time, settable from the Skid Screen, the feed and concentrate valves close, enough wells turn off to only supply the remaining skids, the stroke of the sulfuric acid pump is decremented, and a membrane feed booster pump shuts off.

Skid Auto Shutdown – Last skid

The last skid shutdown is almost the same as previous skids except that at the end of the postflush time, all wells shut off, all membrane feed pumps shut off, the sulfuric acid feed pump shuts off and the tuneup valve opens fully. Due to possible delays in the telemetry and the shutting down of wells, while in auto, the concentrate booster pumps will continue to operate to dispose of the raw water till it quits flowing. The lack of pressure in the concentrate line will then signal the shutdown of any remaining concentrate booster pumps.

Skid Manual Modes

If a skid is selected into any mode other than off, the system will determine if additional wells, acid, or feed pumps are required and bring them online as needed. The skid will remain in whatever mode selected until the operator changes the mode, a skid shutdown alarm occurs, or a plant shutdown is initiated. The auto/manual status is selected from the individual skid Screen and while in manual, one of the four modes can be selected also.

Feed and Concentrate Valves

Both the feed and concentrate valves are automatic actuating with feedback. Each valve has both manual and auto operations. In auto the valve will automatically change opening to individual setpoints for Off, Preflush, Operation, and Postflush (figure 31). In manual, the valve stays at the manual setpoint regardless of skid operation. Manual/auto and manual setpoints are available on the Skid Screen for each skid. The auto setpoints are available through respective auto setpoint icons on the Skid Screen.

(pic) (pic)

Figure 31, Feed and Concentrate Valve Setpoints

The auto setpoint for off for both valves is 0% or fully closed.

Operator Document
A Help Screen is available from the Skid Screen to explain the auto/manual effects of valves and skids (figure 32). This Screen has no status or control. ??? [what's the document that's mentioned here and where is it?]

(pic)
Figure 32, Help Screen ???

Tuneup Valve
The auto/manual status and manual setpoint of the tuneup valve is available on each Skid Screen as well as the Membrane Feed Screen.

Flow Totals
Several running flow totals are available. For each skid a current daily total is shown on each Skid Screen (figure 33). Available from there is a Previous Day, Current Month, and Previous Month flow totals for the skid.

(pic)
Figure 33, Skid Flow Totals

Other flow totals showing combined skid and overall plant operation are available from the All Skid Screen.

(pic)
Figure 34, Combined Skid And Plant Operation Flow Totals

These totals automatically update current day, previous day, current month, and previous month based upon the PLC internal clock/calendar.

POSTTREATMENT

Posttreatment consists of...

Concentrate Disposal

The concentrate disposal system consists of three pumps and a deep injection well. The pumps draw down the concentrate pressure from the membranes to maintain a constant pressure exiting the membranes and overcome the natural artesian pressure of the deep well. A pump is called for any time the concentrate pressure exceeds the high-pressure limit for a period of time.

A PID loop using concentrate pressure ahead of the pumps as feedback controls the speed of the pumps. A pump is shut down when the minimum speed causes the concentrate pressure to go below the low-pressure setpoint. The high and low pressure setpoints are automatically calculated from the PID setpoint. The PID setpoint is set from the Concentrate Disposal Screen (figure 35).

(pic)
Figure 35, Concentrate Disposal Screen

All three pumps are VFD driven and have similar popup controls ??? [what is this new reference for- you mean like other smaller screens?] as the membrane feed pumps. There are also controls to put all pumps in either auto or manual without using the individual popups. The pumps also have an automatic rotation feature similar to the feed pumps. Pumps will rotate through the first-on-first-off based either on a preset time or by the operator control. The ORP of the concentrate is monitored and available on the Concentrate Disposal Screen ??? [figure?] also. Like other pumps, each has both a fail and fail-to-start alarm. The fail alarm is generated from the VFD drive. The fail-to-start is determined in the PLC.

Raw Water Blend

The hardness of the permeate coming from the membranes is too soft to send to distribution. To raise the hardness back up, a raw water blend is used. This allows raw water to mix with the permeate to raise the hardness. The

conductivity is monitored at the raw water, permeate, and blended water as a measure of hardness.

Blending is controlled either automatically by flow pacing or manually by setting a specific valve position. In auto, the total permeate, calculated by summing all of the individual permeate flows, is compared to the raw water being blended to calculate the ratio. A dedicated flow meter is used for the raw blend water. These flows are shown also. The auto/manual, manual setpoint, and auto blend ratio setpoint are all on the Raw Water Blend Screen (figure 36). A cartridge filter is used in the raw water blend line and its differential pressure is monitored and displayed.

(pic)
Figure 36, Raw Water Blend Screen

Odor Control
After blending, the mixed water is sent to the odor control system. The odor control system is comprised of two identical systems that can be independently operated. Under conditions of low plant flow, half of the odor control system and the later clearwell can be valved off using only the remaining half. They are shown on the Odor Control Screen (figure 38) ???.

[insert graphic]
Figure 37, Odor Control Screen

Each system has two degasifier towers, each with their own dedicated blower, and a scrubber tower. Each blower has a popup control ??? similar to the other systems allowing auto/manual selection and, while in manual, on/off selection. In auto, the blower comes on whenever a membrane skid is not off. Like other systems, each blower has a fail and fail-to-start alarm. Each system has an independent local control panel used to monitor the scrubber and control chemical addition.

Local Control Panel
The local control panel ??? [where? figure?] is enabled from the PLC system any time one of the two blowers associated with that system is running. The local control panel monitors the pH and ORP of the scrubber water and calls for

Sodium Hydroxide and Sodium Hypochlorite as necessary. These signals are sent to the PLC where it controls the on/off status and speed of the dedicated pumps supplying the chemicals. The speed signal from the local control panel is passed to the respective pump controller through the PLC. Both the pH and ORP signals from each scrubber are sent to the PLC and available on the Odor Control Screen. The local common alarm generated in each control panel is enunciated on the Screen as well. This alarm can only be cleared at the local panel. See the Odor Control System O&M for further details on the operation of the scrubber system.

Primary Disinfection

Primary disinfection occurs after odor control. The blended water drops through the degasifier blower into the front end of the clearwell. The clearwell is split into two separate contact chambers that can be used independently. Sodium Hypochlorite is injected at the front end of the clearwell (figure 38).

(pic)

Figure 38, Sodium Hypochlorite Screen

The Sodium Hypochlorite flow to the clearwell is split from a common pump. Back pressure valves at the injection points are adjusted to the same pressure. Both valves should open and close at the same pressures resulting in a division of flow. When only one side of the clearwell is used, the idle side's injection point can be valved off.

The pump supplying flow to the clearwell uses the same arrangement of auto/manual control as other systems. In auto, a PID loop and flow pacing control its speed. The flow pacing is given major control while the PID is used for tuning over longer periods of time. An online chlorine residual monitor at the end of the clearwell is the source of the feedback.

Flow pacing ratio factor and chlorine residual setpoint are both on the Sodium Hypochlorite Screen. This Screen also has the controls for the pumps feeding the scrubbers. In auto, their on/off control and speed are sent from the local odor control panels.

Two additional pumps supply Sodium Hypochlorite. One is injected at the line exiting the transfer pumps from the clearwell. The other is injected just before the high service pumps. Both of these are manually controlled both on/off and

speed. Like all other pump controls, each pump has a fail and fail-to-start alarm. The fail is generated from the pump drive, the fail-to-start is determined in the PLC.

Ph Correction

The pH of the water must be brought back up before being sent to ground storage or distribution. Sodium Hydroxide is injected at the end of each side of the clearwell just prior to the transfer pump chamber to accomplish this (figure 39).

(pic)
Figure 39, Sodium Hydroxide Screen

A single flow line is split using backpressure valves. By setting the valves to match, they should open and close together splitting the flow. If only one side of the clearwell is used, the other injection point can be valved off. The pumps have auto/manual control. In auto, the pump speed is controlled by a combination of flow pacing and PID control like the Sodium Hypochlorite addition. Major control is assigned to the flow pacing while the PID trims the speed based upon pH feedback from samples taken from the middle of the transfer pump chamber. Flow pacing ratio factor and pH setpoints are on the Sodium Hydroxide Screen.

The pumps feeding the odor control scrubbers are on the same screen. These two pumps currently have a different control than any other pumps. Auto/manual and start/stop have not been provided as yet. All other aspects are the same as other systems. All Sodium Hydroxide pumps have both fail and fail-to-start alarms. Fail alarms are generated by the pump's drive and the fail-to-start alarms are generated by the PLC.

Disinfection Residual

To maintain a disinfection residual, remaining free chlorine from the Sodium Hypochlorite addition is fixed with Ammonia to form Chloramines. The ammonia is injected at the end of the clearwell before the transfer pump chamber (figure 40). Ammonia, like the other chemicals injected at the clearwell, is split to both sides of the clearwell. Instead of using backpressure valves, natural water pressure is used against the low pressure ammonia. When using only one side of the clearwell, the unused ammonia injection can be valved off.

(pic)
Figure 40, Ammonia

The ammonia system consists of two ammoniators. Only one is selected at a time. A rate signal is sent from the PLC system to local controls on each ammoniator. This rate signal is a combination of a flow pacing ratio setpoint and total permeate flow. There is no feedback for this system. The Ammonia Screen has the ammoniator selector and flow pacing ratio setpoint. The rate signal to the ammoniators is also displayed.

Corrosion Inhibitor
Corrosion inhibitor can be injected at the end of the contact chambers. Two pumps in an alternator control supply to a common line that is split by backpressure valves. The pump speed is controlled by permeate flow and a flow pacing ratio factor. The pumps have similar controls to other pump systems. Auto/manual, manual speed, and manual start/stop are all on the Corrosion Inhibitor Feed System Screen (41).

(pic)
Figure 41, Corrosion Inhibitor Feed System Screen

Clearwell and Transfer Pumps
The clearwell serves as both the chemical contact/mixing chamber and buffer for the transfer pumps. It is separated into two independent contact chambers and a common transfer pump chamber. Lowering gates to restrict or stop flow can isolate either contact chamber. Final water quality is monitored. Turbidity, Conductivity, pH, and chlorine residual are all recorded and available on the Clearwell and Transfer Pumps Screen.
(pic)
Figure 42, Clearwell and Transfer Pumps Screen

Finished water from the clearwell is sent to ground storage and distribution via the transfer pumps. The transfer pumps are all fixed speed. Pumps are called on by level in the clearwell. The setpoints for the pumps (figure 43) is available from the Clearwell and Transfer Pumps Screen.

(pic)
Figure 43, Transfer Pumps Setpoints

Transfer pumps cycle on and off as the level in the clearwell rises and falls. Controls for the pumps are similar to other controls. Each pump has a popup ??? available from the Clearwell and Transfer Pumps Screen in addition to controls that change all pumps to either manual or auto.

Several level alarms are associated with the clearwell (figure 44). Both a level transmitter and a high-high level float are used. The Level transmitter has alarm points configured from it. These are available from the Clearwell and Transfer Pumps Screen.

(pic)
Figure 44, Clearwell Level Alarm Setpoints

Both the high-high float and the high-high level alarms are shutdown criteria and can be independently enabled or disabled.

Finished Water Secondary Disinfection

Additional Sodium Hypochlorite injection is available following the transfer pumps. A dedicated Sodium Hypochlorite pump feeds an injection point in the line between the transfer pumps and ground storage. The pump is manually controlled, both on/off and speed, from the Sodium Hypochlorite Screen. This is available if additional disinfection is needed.

STORAGE AND DISTRIBUTION

Storage and Distribution consists of... ???

Ground Storage Tanks

The system has three ground storage tanks, two 5 MG and one 2.5 MG. Each tank level is monitored and shown on the Storage and Distribution Screen.

A selected tank controls skid operation. Each tank has a selector and choosing one clears any other that may be selected. The level in the selected tank controls the automatic starting and stopping of the membrane skids. A tank level/skid startup setpoint screen (figure 45) is available from the Storage & Distribution Screen.

(pic)
Figure 45, Tank Level Setpoints

Tank level alarms are available for each tank. High-high, high, low, low-low are all settable from the GST SP's icon.

Distribution Disinfection Addition

Additional Sodium Hypochlorite can be injected prior to distribution. Chlorine concentration is monitored before and after the high service pumps. If additional residual is needed, a dedicated Sodium Hypochlorite pump can be used. This pump injects chlorine after the sample point and before the pumps. On/off and speed are both manually controlled. The addition is blended through the pumps and the result is indicated on the monitor after the pumps.

High Service Pumps

There are six high service pumps supplying the distribution system. Three are VFD driven and three are fixed speed. The speed of the VFD pumps is controlled by a PID loop with distribution pressure as feedback. Pumps are called on and off as demand changes in order to maintain distribution pressure. The order of pumps being called is; VFD, VFD, FIXED, FIXED, FIXED, VFD.

Contingencies are built in such that pumps running in manual are considered in the auto pump selection logic. Also, if a pump is unavailable, the sequence

compensates for an unavailable pump. For example, if a fixed pump is unavailable, the system will bring on the VFD as the fifth pump. The controls will ramp VFD speed to compensate for changes in distribution pressure. If the pump speed falls too low, it's check valve will close. When the system detects a closed check valve, after a delay, it will shut down a pump in the sequence. Additionally, if the VFD speed falls below a minimum setpoint, for a delay time, a pump is shut off. If the VFD speed is at or above 99% for a delay time, a pump is called on.

To protect the pumps, a minimum VFD speed can be set (figure 46). The VFD shutdown criteria will be overridden if the minimum speed is set higher than it. Both the minimum VFD speed and the VFD shutdown setpoints are available from the Storage & Distribution Screen.

(pic)
Figure 46, VFD Speed and Shutdown Setpoints

Within the group of VFD pumps and the group of fixed, the pumps will rotate based upon time or operator trigger. All pumps have popup control for auto/manual and manual on/off controls. Controls for all pumps in manual or all pumps in auto are available on the Storage & Distribution Screen. Each pump has a pump fail and pump fail-to-start alarm. The pump fail is generated in the pump drive, the pump fail-to-start is generated in the PLC.

SUPPORT SYSTEMS

Support Systems consists of... ???

Sodium Hypochlorite Generators

Three sodium Hypochlorite generators produce sodium Hypochlorite from brine solution for disinfection (figure 47). Each generator has a local control panel and supervisor control from the PLC. Refer to the Sodium Hypochlorite Generator O&M Manual for further details on operation.

(pic)
Figure 47, Hypochlorite Generators Screen

Emergency Power

Two standby generators provide emergency power to the facility. The second generator supplies power to the sodium Hypochlorite generators and the wastewater lift station. Operating status along with buss voltage, current, and power are displayed (figure 48).

(pic)
Figure 48, Emergency Power Screen

The main generator supplies the plant including the clearwell building and high service pumps. The main generator supplies power to two distribution busses. Each buss monitors voltage, current, and power being supplied from the generator. The generator status, and tie breaker status are shown. A popup control is available to start/stop the generator, enable/disable peak shaving, manual load transfer between FPL and the generator, and set whether to return to FPL on power being resumed (figure 49).

(pic)
Figure 49, Generator Popup Control

Eye Washes

Each of the eye wash stations at the facility are monitored (figure 50). If water is detected flowing in one, its local alarm will sound and an alarm will activate in the PLC.

(pic)
Figure 50, Eye Wash Screen

The status of all eyewashes is displayed on the Eye Wash Screen available from the WTP9 Overview Screen ???.

Liftstation
The plant waste water liftstation is controlled by the plant PLC (figure 51). On/off operation and rotation is controlled automatically. Local manual switches override automatic controls. Floats in the wetwell determine the starting and stopping of the pumps.

(pic)
Figure 51, Liftstation Screen

Historical Trending
Trends of values collected can be displayed as a line graph (figure 52) by selecting historical from any of the main screens. Trends can be created on any value configured in the database. Multiple values can be configured on the same trend. Trends configurations can be saved for recall later.

(pic).
Figure 52, Trend Values Line Graph Example