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CONTROL STRATEGIES

1.1 General Monitoring Requirements

All analog signals (flows, levels, pressures, conductivity, chlorine residual, pH, turbidity, etc.) connected to PLC I/O modules shall be displayed on appropriate HMI graphic screens. Displays shall be in engineering units. High and low alarms for analog signals shall be displayed on the appropriate graphic screens.

All analog signals shall be trended on HMI trend displays as real-time and historical trends.

All discrete signals (on/off, open/close) connected to PLC I/O modules shall be displayed on appropriate HMI graphic screens.

Discrete alarm signals (fail, high, low, tripped, etc.) transmitted to the HMI via PLC I/O, or generated by the PLC shall be displayed on the appropriate HMI graphic screens. All alarms shall be maintained in the Historical Server with time and date stamp.

All pumps, Fe/Mn filter trains, RO trains, blowers, and miscellaneous equipment RUN times shall be calculated and updated in the PLC system and transmitted to the HMI.

All timer settings, setpoints, and miscellaneous adjustments shall be determined during application software development or plant startup. All settings and adjustments shall be easily made through the HMI.

1.2 General Control Modes

Select equipment controlled by the PLC shall have field-mounted selector switches that can be set for LOCAL or REMOTE operation. The REMOTE status of the selector switch shall be an input to the PLC. In LOCAL mode, the operator shall be able to control the equipment manually at the equipment location. This switch contact shall be hardwired to the final control element and bypasses the HMI and PLC action. In REMOTE mode, the PLC shall control the equipment in one of the two selected modes, MANUAL or AUTOMATIC via HMI faceplate graphics.

In REMOTE MANUAL mode, the operator shall be able to operate the equipment manually from the HMI. There shall be no PLC algorithm interlocks in effect, except for hardwired safety interlocks. In REMOTE AUTOMATIC mode, the equipment shall be controlled by the PLC control algorithm interlocks.

If a final control device is called to operate in the REMOTE mode and the local switch is not in remote, a “NOT IN REMOTE” alarm shall occur at the HMI.

If a final control device is called to operate in the REMOTE mode and the local switch is in remote, and the status input does not change for an adjustable preset time, the PLC subsystem shall generate a “FAILED TO START” alarm and transmit to HMI.

1.3 Overall Control: Local vs. Remote

The Operator shall have the capability of selecting whether the system is being controlled locally or whether the facility shall be controlled from PDF I. This shall be done by a “System Local/System Remote” selection pushbutton at the PDF II HMI.

“System Local” shall allow controls and changes only from PDF II SCADA System. “System Remote” shall allow only from PDF I. If both trains have been down, the system shall only be allowed to start locally. The IOC SCADA shall have the capability to shut down plant.

1.4 Plant Control Strategies

PDF II shall be composed of several parts that work together to provide a final product water that goes into the EMWD distribution network. The following sections summarize basic control strategies for the plant facilities. All control shall be exercised through the plant PLC with operator interface through the HMI. All well control shall utilize the Kingfisher RTU. The major components are the raw water well pumping system, Fe/Mn removal system, RO feed, two RO membrane trains, decarbonator, clearwell (CCT), finished water pump station, membrane cleaning and flushing systems, Fe/Mn backwash and reclaimed water systems, concentrate pump station, and the chemical storage and feed systems.

These descriptions include the functional requirements for the instruments, LCPs, and SCADA system. Refer to the process flow diagram and P&IDs when reading the loop descriptions for a better understanding of the system.

1.4.1 Starting Production (Drawings I-3, I-5)

The filtration system shall be designed to treat water from a combination of desalination wells numbered 76, 77, 81, 82, 83, 84, 86, 87, 88, and 89.

The desalination facility PLANT PLC shall control the operation of the desalination facility and interface with the wells, Fe/Mn removal system, RO membrane trains, and all support systems. Desired plant flow and LEAD RO train are entered at the Operators HMI. Depressing an “Initiate Production” transmits the desired flow rate to the Fe/Mn removal system master control panel (MCP) and gets the RO system ready for production by ensuring all equipment and valves necessary for the system to run are in auto, and by setting the valves in their correct positions. Initially, PCV-90511, PRV-90610, FCV-10151, FV-10211 and FV-10221 are fully closed (see Drawing I-5). The operating RO trains are selected by the operator.

The MCP shall determine the required number of Fe/Mn filters necessary to provide the desired flow rate as well as the flow rate per Fe/Mn filters and transmit the information to the PLANT PLC.

Based on the number of Fe/Mn filter vessels required, the MCP shall verify the operating status of each filter vessel as follows: READY, NOT READY, and STANDBY. Each filter is provided with a HAND/OFF/AUTO (HOA) hand switch, which must be in the AUTO position. After determining that the required number of filter vessels is READY to operate, the MCP shall check the status of all remaining filtration system alarm signals. If, after a preset adjustable time period, no alarm conditions exist, the MCP shall transmit a “Filtration System Ready to Operate” signal to the PLANT PLC. If an alarm condition exists, the MCP shall transmit a “Filtration System Not Ready to Operate” signal to the PLANT PLC for further operator action.

Upon receipt of the “Filtration System Ready to Operate” signal from the MCP, the PLANT PLC shall transmit staggered start signals to the required number of desalination wells to achieve the desired desalination facility flow rate.

1.4.2 Fe/Mn Filtration System Pressure (Drawing I-2)

Prior to starting the Fe/Mn system, PVC-90101 on the raw water purge line shall divert (waste) flow water flow to the pond and maintain an operating pressure of 80 psi. Should the pressure rise to 85 psi, the high-pressure relief valve (PRV-90102) shall open, discharging the raw water to the pond.

Once well flow and pressure are established, the PLANT PLC shall force PCV-90511 open while holding PRV-90610 closed. Then the PLANT PLC shall send a start signal to the MCP. As flow enters the Fe/Mn system, it shall be diverted through PCV-90511

1.4.3 Fe/Mn Filtration System Filters (Drawing I-3)

There are three Fe/Mn filters in the system. The tag numbers used below are for filter F-91100; the controls for F-91200 and 91300 are typical.

When the desired total rinse flow rate is achieved from the wells, the MCP shall energize the “rinse/purge” solenoid valve (opening valve FV-91150) until the flow rate as measured by FIT-91110 reaches the supplier’s preset minimum rinse rate for a preset minimum time period. After each required filter vessel has been adequately rinsed, the MCP shall position the filter vessel valves to the “filtration” mode by de-energizing the purge valve solenoid and energizing the filter effluent valve (FV-91140).

Note: Each filter vessel shall be “rinsed” before the filter vessel effluent is conveyed to the desalination facility, regardless of whether the filter vessel was “parked dirty” or “parked clean” after the previous plant operating cycle. Rinsing the filter vessels shall ensure that the filter bed has been settled prior to initiating filtration and conveyance of effluent to the desalination facility.

An effluent rate-of-flow-control valve (FCV-91160) and effluent flowmeter (FIT-91110) on each filter vessel shall be used to maintain the flow through the filter. The effluent flowmeter analog signal shall input to a position controller (ZC) electronic control system (ECS), located at the MCP, for the rate of flow control valve. Based on the measured effluent flow rate and the flow rate setpoint, the ECS shall cause the rate-of-flow-control valve to open/close (modulate) as necessary to achieve the desired filter vessel flow rate setpoint. The ECS setpoint shall be adjustable locally at the ECS keypad or remotely by the MCP PLC. The flowmeter signal shall be retransmitted by the ECS to the MCP PLC for monitoring and data storage.

Initially, when the required filter vessels are operating in the filtration mode, the flow rate from the desalination wells shall increase gradually as additional wells are brought online. During this time, the effluent rate-of-flow-control valves shall not be modulating to balance flow between the operating filter vessels. Once the MCP receives a signal from the PLANT PLC that all required desalination wells are operating, the effluent rate-of-flow-control valves shall begin modulating to balance flow between the operating filter vessels. The balanced flow setpoint shall be determined by the MCP based on the flow rate from the influent flow meter to the Fe/Mn removal facilities and the number of operating filter vessels. An adjustable deadband shall be provided for achieving the balanced flow setpoint via the

ECS for the effluent rate-of-flow-control valve. As floc builds up within the filter, the ECS modulates the FCV-91160 to maintain flow within the deadband. If after a preset adjustable time delay, the flow signals from one or more filter vessels do not fall within the preset adjustable deadband, the MCP PLC shall cause the filtration system to shut down and an alarm condition to be activated (“Effluent Rate of Flow Control Fail”). Manual reset shall be required.

1.4.4 Fe/Mn Chemical Feed (Drawings I-2, I-3)

The raw water feed to the Fe/Mn filtration system shall be monitored for chlorine residual (AE/AIT-90210), and the filter effluent flow is monitored for ORP (AE/AIT-90310). These signals, along with the filter system discharge flow (FE/FIT-90111) shall be used to pace the injection of sodium hypochlorite to ensure proper generation of an Fe and Mn floc for removal by the filter.

The effluent shall also be monitored by a “zero center” analyzer (AE/AIT-90410) that measures both sulfur dioxide residual and total chlorine. This signal, along with the filter system discharge flow (FE/FIT-90111) shall be used to pace the injection of sodium bisulfate to ensure that the RO feed flow is free of any chlorine residual that could damage the RO membranes.

If free chlorine is detected in the Fe/Mn filter system effluent, the flow shall be diverted to the pond by opening the treated-water-to-waste valve (PCV-90511) and closing the treated water valve (PRV-90610) if open, and initiating a shutdown of the operating RO train(s).

1.4.5 Fe/Mn Filter Backwash (Drawing I-3)

Filter backwash shall be based on a preset maximum time of operation or preset maximum pressure drop across the filter as measured by a differential pressure switch (PDSH-91170) or manually at the MCP. Once any of these conditions occurs, a “standby” filter shall be brought online (“rinse then “filtration”), and the filter shall automatically begin the backwash cycle by closing the filter feed inlet valve (FV-91110)and effluent valve (FV-91140) and opening the backwash supply (FV-91130) and return (FV-91120) valves. The filter shall be backwashed for a preset adjustable time. At completion of the backwash, the filter shall be placed in the “standby” mode.

If backwash is required on multiple filter vessels, their backwash cycles shall be staggered. The effluent flow rate established by the PLANT PLC from the Fe/Mn removal facility shall be maintained at all times.

The signal from PDSH-91170 shall be provided with an adjustable time delay to prevent unnecessary backwash. Filter controls shall incorporate provisions to allow the filter to backwash only one time on headloss. If backwash does not correct the condition (high headloss), the MCP shall shut down the respective filter vessel and an alarm condition shall occur at the HMI. Manual reset shall be required. Upon satisfactory completion of backwash, the elapsed time shall reset.

Filtration ON, filtration OFF, backwash, backwash on headloss, backwash on time, rinse (purge), elapsed run time (since last backwash), inadequate backwash, effluent flow rate, and effluent rate-of-flow-control fail status shall be controlled and displayed on the HMI. Raw water influent flow rate, treated water effluent flow rate, raw water free chlorine residual, treated water free chlorine residual, treated water total chlorine residual, and

treated water sulfur dioxide residual values shall be recorded on an MCP digital chart recorder.

An “emergency stop” push button on the MCP shall initiate a plant shutdown sequence; that is, filter valves shall be closed, chemical feed pumps shall be stopped, and backwash supply and recycle water pumps shall be stopped.

1.4.6 Fe/Mn Backwash Supply Tank and Pump System (Drawing I-12)

A backwash supply tank containing filtered effluent from the Fe/Mn Filters and/or treated effluent from the desalination facility (W2), and the backwash pumps shall be utilized to provide backwash water to the filter vessels. The flowmeter signal shall be transmitted to the MCP for display and then retransmitted to the MCP PLC for monitoring, control action and data storage.

The backwash supply tank shall be equipped with a level monitoring system to provide an analog level signal to the MCP PLC. Based on the tank analog level signal, the MCP PLC shall be programmed to provide adjustable level setpoints as follows: Open Fill Valve Level (on falling tank level), Close Fill Valve Level (on rising tank level), Inhibit Backwash Level (on falling tank level), Low Water Level (on falling tank level), and High Water Level (on rising water level). An adjustable time delay shall be provided for each tank level setpoint. Using the above-level setpoints, the MCP shall provide the following monitoring and control:

LOCAL/REMOTE and OPEN/STOP/CLOSE selector switches shall be provided to operate backwash supply tank fill valve on the treated water pipeline. A manual valve shall be provided on the W2 water line to permit use of W2 water if treated water is not available.

With the switch in “REMOTE” Position – when tank water level falls to “Open Fill Valve Level,” the MCP shall close a dry contact to open the valve (start filling tank). When the tank level rises to “Close Fill Valve Level,” the MCP PLC shall open the dry contact to close the valve (stop filling tank). The open/close fill valve status shall be displayed on the HMI.

“Inhibit Backwash Level” shall cause the MCP to prevent backwash cycles and the backwash supply pumps from starting due to insufficient level in the tank. The MCP shall activate an alarm condition. Manual reset of the alarm display shall be required, but the pump shall be allowed to start when the tank level rises above the “Inhibit Backwash Level.”

“Low Water Level” (LWL) (alarm and stop pump level) shall cause the MCP to activate an alarm condition and prevent the start of the backwash supply pumps or, if the filter is in backwash mode, shall shut down the backwash supply pumps, backwash cycle, and respective filter. LWL alarm condition shall require manual reset.

“High Water Level” (HWL) shall cause the MCP to activate an alarm to indicate a malfunction of the tank fill valves. HWL also shall cause the MCP to close the supply valves. Manual reset shall be required.

Backwash supply pumps (one duty and one standby) shall be provided with Local/Remote switches. In REMOTE, they shall be interlocked with the backwash supply tank levels and pump discharge flowmeter (FE/FIT-94130). The backwash flowmeter signal shall be transmitted to the MCP for display and retransmitted to the PLC for monitoring and control action. In REMOTE, the MCP shall call the duty backwash pump to start when backwash is required. Duty and standby shall be selectable via the PLC HMI.

If after a preset adjustable time delay, the flow rate measured by the flowmeter is not within acceptable limits, the MCP shall stop the backwash pump and activate an alarm condition (Backwash Rate-of-Flow-Control Fail) and shut down the respective filter in backwash mode. Manual reset shall be required.

1.4.7 Reclaim Tank and Reclaim Pumps (Drawing I-12)

The reclaim tank shall be monitored by a level transmitter that transmits a signal to the MCP for display and use by the MCP PLC. The MCP PLC shall utilize the level signal to enable control of the reclaim pumps.

The reclaim pumps (two duty and one standby) shall be provided with VFDs, each provided with a Local/Remote (L/R) switch. The discharge flow from each pump shall be monitored and the signal transmitted to the MCP for display and MCP PLC control panel. The total reclaimed flow shall be limited to 10 percent of the total plant flow.

In REMOTE, with the Fe/Mn filter in the filtration mode, a “Start Reclaim Pump(s)” level shall cause the MCP PLC to start the required reclaim pumps after a preset adjustable time delay (0 to 8 hours) from completion of the last backwash cycle (to allow settling of solids). The pump speed shall be adjusted to maintain the required flow rate. The MCP shall provide pump stop signals if the filtration cycle stops or when the reclaim tank “Stop Reclaim Pumps” level is reached.

If the total plant flow rate changes during the filtration cycle, the MCP shall start/stop the reclaim pumps accordingly. The pumping unit shall be selected via the PLC HMI as “lead,” “lag,” or “standby.”

Once the reclaim pumps are in operation, the MCP PLC shall transmit a “Reclaim System Start” signal to the PLANT PLC. The PLANT PLC shall adjust the total raw water flow rate to 90 percent (minimum). The MCP shall then transmit speed control signals to the reclaim pump VFDs to vary the pump speed until the desired flow rate is achieved (0 to 10 percent of the total plant flow rate, adjustable via the MCP. When two reclaim pumps are operating simultaneously, the MCP shall transmit matching speed signals to both VFDs. The minimum and maximum speed for all pumps shall be adjustable. These values shall be adjusted in the field based on actual operating conditions and actual pumps furnished.

If after a preset adjustable time delay, the flow rate from the respective reclaim pump flowmeter is not within acceptable limits, the MCP PLC shall stop the reclaim pump(s) and generate an alarm “Reclaim Water Pump No. X, Rate of Flow Control Fail” and shut down the duty reclaim pumps. Manual reset shall be required.

When the reclaim pumps are off, the PLANT PLC shall return the total raw water flow rate to 100 percent of the desired plant flow rate.

1.4.8 Starting RO Production (Drawings I-3, I-5)

When the Fe/Mn effluent flow reaches the setpoint flow for one train and is chlorine-free as sensed by AE/AIT-90410, the bypass valve PCV-90511 shall be allowed to close (remove forced open command), and the dechlorinated treated water valve (PRV-90610) shall be opened and hydraulically controlled to maintain a constant downstream pressure of 55 psi. This flow shall be diverted to the ponds through the RO waste valve (FCV-10151), until the

addition of the TI or sulfuric acid (if needed) target dosing rate is reached. Once the TI or sulfuric acid (if needed) target dosing rate is stabilized, the RO feed pump suction valves shall start to open and the FCV-10151 shall start to close.

1.4.9 Membrane Feed Bypass or “Blend Control” (Drawings I-4, I-10)

A certain volume of pretreated water shall be blended with membrane permeate before it goes to the clearwell. This control loop shall automatically maintain a preset “blend” using a PLC-programmed proportional-integral-derivative (PID) controller (AIC-70015). The PID algorithm shall control the conductivity of the raw water/permeate blend by modulating valve FCV-10046. The PID process variable shall be the blended water conductivity measured by AE/AIT-70015. The conductivity setpoint shall be entered by the Operator based on water quality data. The output of controller AIC-70015 shall be used to modulate valve FCV-10046. If the conductivity measured by AE/AIT-70015 is lower than the preset value, the PID algorithm shall increase flow through the bypass by increasing the opening of FCV-10046.

There is a maximum bypass flow that shall be allowed, as a percentage of total finished water flow. If the flow measured at FIT-10045 is equal to this maximum flow, the control for FCV-10046 shall not be allowed to open more. If the flow measured at FIT-10045 is greater than the maximum flow, the control for FCV-10046 shall modulate bypass flow to the setpoint. A plant shutdown shall force FCV-10046 fully closed.

The controller faceplate, process variable, controller output, setpoint and AUTO/MANUAL status shall be displayed at the HMI

1.4.10 Raw Water pH Control (Drawing I-3, I-4, I-18)

A PID controller (AIC-10048) shall control the speed of the selected sulfuric acid metering pump to maintain the preset raw water pH. The measured value for the PID loop comes from pH analyzer AE/AIT-10048. If the pH measured by AE/AIT-10048 is higher than the preset value, the selected sulfuric acid pump shall increase the feed rate until the preset pH value is reached. If the pH measured by AE/AIT-10048 is lower than the preset value, the selected sulfuric acid pump shall decrease the feed rate until the preset pH value is reached.

This pH control loop shall be augmented to compensate for raw water flow changes. The speed of the metering pump shall be adjusted to correspond to the treated water flow. The treated water flow shall be measured by FE/FIT-90111 minus the bypass flow (FE/FIT-10045). Controller faceplates and all other associated variables shall be displayed at the HMI.

1.4.11 Pretreatment Threshold Inhibitor (TI) Feed Control (Drawing I-3, I-4)

The speed of the selected scale inhibitor pump shall be controlled proportional to the treated water flow measured by FE/FIT-90111 minus the bypass flow (FE/FIT-10045).

Measure flow rate of threshold inhibitor. If plant is ON and TI flow rate is low for present time delay, then shutdown the plant.

1.4.12 Cartridge Filter Differential Pressure (Drawing I-4)

The cartridge filter differential pressure shall be computed in the PLC by using the upstream and downstream pressure transmitters (PIT-10050 and PIT-10122). The differential pressure shall be displayed on the HMI and an operator-adjustable high differential pressure setpoint shall result in an alarm at the HMI.

1.4.13 Membrane Feed to Waste Control (Drawing I-4, I-5)

During the initial first membrane startup, FCV-10151 shall be controlled by FIC-10151 to maintain a flow equal to single-train rated flow. When the chemical feed has stabilized, and an RO Feed Pump has started in AUTO mode, then modulate FCV-10151 closed. When starting a second train, open FCV-10151 and modulate the flow as described in Article 1.4.8. Once the chemical feed is stabilized and the second RO Feed Pump has started in AUTO mode, then modulate FCV-10151 closed.

During train operation, if the feed pump suction pressure (PIT-10122) exceeds an adjustable preset HIGH-HIGH pressure limit, the controller shall OPEN valve FCV-10151 until the pressure is back to NORMAL value. The operator shall generate an alarm indicating, “Feed to Waste Valve open due to High Suction Pressure” and modulate the valve to maintain NORMAL pressure. After an adjustable time (0 to 60 minutes), the operator shall close the valve.

The controller faceplate, process variable, controller output, setpoint and AUTO/MANUAL status shall be displayed at the HMI.

1.4.14 RO Feed Pumps (Drawing I-5)

There are two RO feed pumps (P-10210 and P-10220) driven by adjustable frequency drives VFD-10210 and VFD-10220. The tag numbers used below are for pump P-10210; the controls for P-10220 are typical.

Manual Operation

A START/LOCK-OUT-STOP switch shall be provided near the pump to stop the drive. This shall only be a control stop and shall not be used as a safety lock-out. For maintenance purposes, standard lock-out/tag-out procedures at the MCC shall be followed. The START/LOCK-OUT-STOP switch shall be hard wired into the drive control circuits.

Manual operation of feed pumps shall require certain prerequisite conditions, and the operator shall have to ensure all safety interlocks. Similar safety interlocks shall be programmed for the PLC start command.

When the switch is in LOCAL position, field STOP is not pushed and the drive is in MANUAL mode, the pump could start and stop and the speed shall be manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, then the soft switch at the HMI shall be used to start and stop the feed pump manually from the HMI. The speed could be controlled manually by putting controller FIC-31107 in MANUAL and using the cursor on the face plate to control speed to maintain a desired total feed flow as measured by the sum of permeate flowmeters FE/FIT-31206, FE/FIT-31107, and concentrate flowmeter FE/FIT-31209.

Automatic Operation

The feed pump shall always be manually started from the HMI when all prerequisite safety interlocks are satisfied and the sequence calls for starting the pump. Once started at the preset minimum speed, the PLC controller (FIC-31107) shall be put in AUTO mode to control the speed to maintain the preset flow. EMWD shall have the capability to operate the system from a remote location.

1.4.15 Interstage Turbocharger (IT-32150) and Auxiliary Nozzle Valve (ANV-32151) - (Drawing I-6)

There shall be a turbocharger provided on each RO process train. The turbocharger, consisting of a pump and a turbine coupled together, is located between the two stages of a membrane train. The turbocharger boosts the pressure of the first stage concentrate by utilizing the pressure in the second stage concentrate. The turbocharger output shall be controlled by an auxiliary nozzle valve that is an integral part of the turbocharger. The auxiliary nozzle valve and controller assembly are stand-alone systems that do not interface with the facility SCADA system.

1.4.16 Membrane Permeate/Concentrate Flows and Recovery Control System (Drawing I-5; Drawing I-6, Train 1; Drawing I-7, Train 2)

The SCADA system programmer shall provide displays to allow membrane system parameter configuration, such as acceptable recovery range for each train, minimum concentrate flow, etc. This display shall be password-protected to allow access to supervisory personnel only.

The operator shall enter a TARGET percent recovery (Y) at the SCADA HMI. If the entered value of Y is out of the preset recovery range, it shall generate an alarm and prompt the operator to select a value within the range. The operator shall enter a percent TARGET permeate flow setpoint (Qp) at the SCADA HMI. Again, if the value is outside the range, it shall generate an alarm and prompt the operator to re-enter a value within the range.

The operator shall enter a minimum acceptable value of concentrate flow (Qc min) in the RO configuration display at the SCADA HMI.

Percent recovery is defined as follows:

$Y = [Q_p/(Q_p+Q_c)]*100$

Where Y = Percent Recovery

Q_p = Permeate Flow

Q_c = Concentrate Flow

Q_{ct} = Target Concentrate Flow

Q_{cm} = Minimum Concentrate Flow

Based on entered TARGET values of Y and Qp, targeted (maximum allowable) concentrate flow shall be computed by the PLC algorithm as follows:

$Q_c = Q_p\ (100-Y)/Y$

If $Q_c < Q_{cm}$,

THEN use Q_{cm} as the concentrate flow setpoint.

1. Use PLC algorithm FIC output to modulate RO feed pump speed via VFD-10210 to maintain permeate flow Q_p setpoint. This control shall be similar for

both trains. Should a High-High pressure limit be reached, the operator shall have to initiate train shutdown. Similarly, the operator shall have to initiate train shutdown if the RO feed pump suction pressure drops below an operator-adjustable preset value.

2. Concentrate flow control shall be achieved primarily by modulating FCV-31210 to keep the concentrate flow at target flow (Q_{ct}). The valve shall open more if the Q_c measured by FIT-31209 is less than Q_{ct}. The amount of opening shall be proportional to the variance (Q_{ct} - Q_c). On the other hand, if the concentrate flow is higher than the target value, the control valve shall close proportional to the variance (Q_c - Q_{ct}).

3. The second stage flux ratio (SSFR) shall be controlled by the first stage permeate control valve (FCV-31106). The SSFR is defined as follows:

   SSFR = Ratio of Second Stage Permeate Flow as measured by FE/FIT- 31206 to total flow as measured by the sum of FE/FIT-31206 and FE/FIT-31107.

   Operator shall select a SSFR setpoint range by inputting minimum SSFR (SSFR min) and maximum SSFR (SSFR max). If the SSFR is within the range, no action shall be initiated. If SSFR falls below SSFR min, then FCV-31106 shall start closing to hold the SSFR at SSFR min. While modulating, the FCV shall open if the SSFR rises above SSFR min. Once the FCV is back to a fully open position, it shall be disengaged (an adjustable time delay of 0 to 60 seconds shall be used). The FCV shall not modulate until the SSFR falls below SSFR min again. If the SSFR increases above SSFR max, an alarm shall be generated. FCV position, fully closed status, and fully open status shall be indicated.

4. Controller faceplates, all setpoints, process variables and AUTO/MAN status, target recovery and actual recover shall all be displayed at HMI.

1.4.17 Permeate to Waste Controls (Off-Spec Permeate) (Drawing I-6, Train 1; Drawing I-7, Train 2)

The capability to manually purge off-spec permeate to waste shall be provided. This capability shall be used mainly during initial commissioning, but can be used at any other time. Manual isolation valves (HV-31131 and HV-31132) shall be provided on each side of a spool piece in the permeate to waste line. These valves shall be normally closed. The spool piece shall be provided with a tap and manual valve (HV-31130) to drain the contents of the spool when the isolation valves are closed. This permeate to waste line shall be provided with an air gap at the pond.

1.4.18 Decarbonator Bypass (Drawing I-9)

Some RO permeate can be set to bypass the decarbonator. This is done to stabilize the pH and to minimize chemical usage. RO permeate has a low pH, and going through the decarbonator may raise the pH (alkaline) by removing CO_2. The operator shall enter the desired flow for the bypass, measured by FE/FIT-40030, and the PLC controller FIC-40030 shall adjust the decarbonator bypass valve FCV-40031 to maintain the desired flow setpoint.

1.4.19 Post-Treatment Corrosion Inhibitor Feed Control (Drawing I-6, I-7, I-22)

The speed of the selected metering pump shall be controlled proportional to the total of the permeate water flowmeters (FE/FIT-31107, FE/FIT-31206, FE/FIT-32206 and FE/FIT-32107).

1.4.20 Clearwell/ Finish Water Off-Spec Water (Drawing I-10)

During the initial startup of the facility, water quality in the CCT may not satisfy criteria for delivery into the distribution system. Similar situations may occur during the maintenance, such as after cleaning of the CCT and/or finished water pump station clearwell. For those instances, operators shall have the capability to discharge the off-spec water to the pond.

1.4.21 Post-Disinfection Sodium Hypochlorite Feed Control (Drawing I-11, I-17)

The objective of the post-disinfection sodium hypochlorite system is to provide minimum residual chlorine in the finished product water before it is delivered into the distribution network. The sodium hypochlorite feed rate shall be proportional to the total flow of finished water as measured by FE/FIT-70211.

1.4.22 Post-Treatment Ammonia Feed Control (Drawing I-11, 1-19)

The ammonia dosage is a fixed ratio of the sodium hypochlorite dosage. Once the sodium hypochlorite per gallon of finished water flow is determined based on AIT 70013, the PLC shall compute the ammonia dosage as a fraction of the hypochlorite dosage. The fraction “f” shall be adjustable (from HMI), normally set in a range between 0.25 and 0.33. Using this relationship, the ammoniator pacing ratio, K, shall be computed and used for ammoniator pacing.

1.4.23 Post-Treatment Fluoride Feed Control (Drawing I-11, I-23)

The objective of the post-fluidization is to provide a minimum residual fluoride in the finished product water before it is delivered into the distribution network. The hydrofluosilicic acid solution feed rate shall be proportional to the flow of the finished water (FE/FIT-70211) and the fluoride concentration as measured by AE/AIT-70223.

1.4.24 Final Metering (Drawing I-11, I-23)

Plant finished water is monitored by a magnetic flowmeter (FE/FIT 70211) to be used in the chemical feed pump pacing for the post-treatment chemical addition. Plant W1 and W2 are withdrawn from the discharge header going to the plant distribution system. Plant use shall be monitored by FE/FIT-70214.

1.4.25 Membrane Cleaning System (Drawing I-13)

The chemical preparation for the cleaning process shall be a manual process performed in the field via LCP-50010, LCPs-65210 (Drawing I-20), and LCP-68210 (Drawing I-24) located adjacent to the CIP tank (TK-50010). LCP-50010 shall be used to control and monitor the CIP cleaning operation, while LCP-65210 and LCP-68210 shall be used to manually control the sodium hydroxide and citric acid transfer pumps and monitor the flow of chemical added to the CIP tank.

If dry chemicals are to be used, the operator shall manually load the chemical bag contents into the CIP hopper during the mixing stage of the chemical preparation process.

The CIP tank (TK-50010) is used for the cleaning of RO membranes. The cleaning operation shall be a manual operation with control capability from

the HMI provided the associated control valve hand switches are in the REMOTE position.

Cleaning Cycles

The cleaning cycle shall be performed manually and shall consist of acid and caustic chemical wash/flush cycles. Each cycle shall consist of a chemical wash followed by a permeate flush. The train shall be sequentially washed, initially with a citric acid solution, then with a sodium hydroxide solution. Each cycle shall require solution preparation, solution circulation, a membrane soak period, solution recirculation, then a permeate flush.

Solution Preparation and Cleaning

Operator opens valve FV-50005 on the permeate makeup supply line.

1. When the desired level is reached, operator STOPS permeate makeup water addition.
2. Operator shall ensure that the manual valve (HV-50043) to membrane system is CLOSED, manual recirc valve (HV-50044) is OPEN, and HV-50048 is CLOSED isolating the CIP tank from the permeate flush tank and creating a recirculation path for chemical mixing.
3. The operator transfers the desired amount of chemical to be added to the CIP tank and starts the membrane cleaning pump (P-50020) using HS-50020; operator adjusts the speed utilizing SHK-50020 to provide mixing of the added chemical. Operator observes pump status on LCP-50010.
4. Operator turns electric heater (TE 50010) on and monitors the pH and temperature on AE/AIT-50023 (pH) and TIT-50022 (temperature), respectively on the LCP. The operator shall continue the recirculation until complete mixing of the chemical is achieved and preset cleaning solution temperature is reached.
5. Operator makes sure that all manual valves related to membrane cleaning for the selected train and stage are in proper position and verified/logged, in a standard operating procedure checklist.
6. Operator Opens the valves to feed cleaning solution to membranes, CLOSES the recirculation valve, and adjusts pump speed to provide the required flow through the membrane.
7. Operator observes temperature of the circulated chemical and stops the pump (P-50020) when the temperature is again at the desired level and leaves membranes to be soaked with the cleaning solution for a predetermined period of time.
8. After soaking time expiration, the operator shall start pump P-50020 to recirculate cleaning solution through the membrane system for a predetermined period of time that shall constitute completion of the chemical treatment portion of the cleaning cycle.
9. The above-described cycle may be repeated two more times.
10. After the cleaning operation is complete, the operator shuts down the cleaning system by stopping the cleaning pump, closing valves to membranes, opening the recirculation valve, closing the permeate makeup supply, and closing HV-50043 to isolate the CIP tank for the permeate flush.

11. Used cleaning solution shall be discharged either into the concentrate pump station by opening HV-50047, or returned back into TK-50010 and discharged into the sewer by opening the drain valve.
12. The cleaning cycle shall be finished by flushing fully one volume of permeate water through the stage. This is done manually via LCP-50010 as described below.
13. The above process shall be repeated for both chemicals and for both stages of the RO train.
14. The operator positions the valves on the train and prepares the train for operation again.
15. All data related to the cleaning system pH, temperature, cleaning solution flow, cleaning tank level, equipment status, water volume, quantity of chemicals used, alarms, and others are displayed on the HMI.

CIP Permeate Flush

1. The CIP tank is filled with permeate by OPENING FV-50005. When the desired level is reached, operator STOPS permeate water addition.

2. Operator shall ensure that the manual valve (HV-50043) to membrane system is CLOSED, manual recirc valves (HV-50044 and HV-50045) are OPEN, and HV-50048 is CLOSED isolating the CIP tank from the permeate flush tank and creating a recirculation path.

3. The operator starts the membrane cleaning pump (P-50020) and adjusts the speed to purge the recirc line. Operator observes pump status on LCP-50010.

4. Operator makes sure that all manual valves related to membrane flushing for the selected train and stage are in proper position and verified/logged, in a standard operating procedure checklist.

5. Operator Opens the valves to flush the membranes, CLOSES the recirculation valves, and adjusts pump speed to provide the required flow through the membrane.

6. After one volume of water of pressure vessels and piping water pass through, the operator stops the pump and repositions the manual valves to permit an out-of-service flush to occur automatically, if required.

7. After the flushing operation is complete, the operator shuts down the system by closing valves to membranes, opening the recirculation valves, stopping the cleaning pump, closing the permeate makeup supply, and closing HV-50043 to isolate the CIP tank.

8. Used flushing solution shall be discharged either into the concentrate pump station by opening HV-50047, or returned back into TK-50010 and discharged into the sewer by opening the drain valve.

1.4.26 Membrane Flushing (Drawing I-14)

The membrane out-of-service flushing process shall be an automatic process. It shall be used when taking a train out of service. Flushing with permeate shall be controlled from LCP-55010. The flushing system for taking a train out of service shall be a two-step process: an initial flush with RO feedwater, then a final flush with permeate water.

RO Flush Tank T-55010 shall be used in flushing operations for the RO membranes. The flushing operation shall be an automated operation with manual control capability from the HMI, provided the associated control valve hand switches are in the REMOTE position.

Out-of-Service Flushing Operation (Train 1, Typical for Train 2)

1. Initial flushing shall be done using raw water after the RO treatment system is stopped for a preset period of time. Final flushing shall be done using permeate water immediately after initial flushing.
2. Before flushing starts, adjust RO feed pump to the preset flush water flow rate.
3. Valves FCV-31106, FV-31205, FV-31214, FV-31110, FV-31215, FV-31111, FV-31216, and FV-31104, shall fully close. Keep valves FV-31103, FCV-31212, and FCV-31210 fully open. That shall divert all flush water flow to the ROC line to the concentrate pump station sump in the RO building.
4. After two volumes of the pressure vessels and piping water pass through, initial flushing is completed and final flushing shall proceed.
5. The RO feed pump is OFF and the RO inlet valve (FV-10211) is CLOSED.
6. Train 1 flushing valve FV-10215 is OPENED and pump P-55020 is STARTED. This shall flush the RO feed pump and RO train with permeate and discharge the flow to the CCR line to the concentrate pump station. After two volumes of pump can, pressure vessels, and piping water pass through, the pump shall be shut OFF and all the valves shall return to their normal positions for operation.

1.4.27 Permeate Transfer Between Permeate and CIP Tanks (Drawings I-13,I-14)

Manual valves shall have to be positioned to perform this transfer. The operator shall have to inhibit a flushing operation from automatically being initiated by the system by either inhibiting it at the HMI or by placing hand switch 50010A, CLEANING MODE/ NORMAL OPERATION (C/N) on the CIP LCP in the “C” position. The manual valves just prior to the cartridge filter for each pump system (HV-50043 and HV-55043) must be closed. Proper positioning of manual valves HV-50044, HV-50045, HV-55044, and HV-55045 shall create a direct line between the two tanks. To transfer permeate from one tank to the other, the operator must manually START the appropriate pump and monitor the tank levels at the HMI or in the field and shut off the pump when the tank level has reached the desired value. At the completion of the transfer, the operator must reset the valves to their prior positions.

1.4.28 Finished Water Pump Station (Drawing I-10)

The finished water pump station pumps shall transfer product water from the clearwell to the distribution network based on EMWD’s requirements (operator input). The VFD-driven pumps shall operate within a preset range of maximum and minimum water levels in the clearwell.

Manual:

When the switch is in LOCAL position, and field STOP is not pushed, the pump shall be started and stopped and the speed manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, and field STOP is not pushed, then the soft switch at the HMI can be used to start and stop the feed pump manually from the HMI.

Automatic:

When the local switch is in REMOTE position, and field STOP is not pushed, when the soft M/A switch at the HMI in AUTO, the pumps shall be controlled based on the PID control algorithm in the PLC, with pump sequence logic as follows:

1. At a preset minimum level, start LEAD variable speed pump at 60 percent speed. PID controller measures level, compares to a setpoint, and based on error generates an output to control pump speed.
2. Note that the level setpoint shall be an adjustable level band 6 inches to 12 inches, instead of a single value. This dead band shall allow reduced cycling of pumps.
3. When the speed of the LEAD pump has reached 100 percent and the level is higher than the set level band, start LAG variable speed pump at 60 percent speed. Ramp down LEAD pump and ramp up LAG pump such that both pumps are working at a common speed.
4. When both pumps are running at 100 percent speed and the level is rising above the set band, generate a HIGH-HIGH alarm at the HMI. Advise operators to shut down a train or reduce the product water flow.
5. On falling level, follow the sequence in reverse.
6. When level drops below cut-off level and both pumps are running at 60 percent speed, stop the LAG variable speed pump. On the low level in the clearwell, stop all pumps.
7. Provide high and low level alarm, and pump status at HMIs. Provide controller faceplate for display of process variable, setpoint, controller output, AUTO/MANUAL status.
8. Provide alternation of pumps using a 1/2/3 sequence following each cycle of operation and based on 24-hour pulse.
9. When any of the local switches are not in REMOTE position, those pumps shall be considered out-of-service and the sequence shall bypass these pumps.
10. At HMIs, provide means for modifying PID turning constants, changing set level band.

When at least one pump is running, provide downstream sodium hypochlorite and ammonia feed control. Provide controller faceplates for PID loops and ratio control. When any of the local switches are not in REMOTE position, those pumps shall be considered out-of-service and the sequence shall bypass these pumps.

1.4.29 Concentrate Pump Station (Drawing I-15)

The VFD pumps transfer RO concentrate from the concentrate pump station wet well to the TVRI. There are three concentrate pumps.

Manual:

When the switch is in HAND position, and field STOP is not pushed, the pump can be started and stopped and the speed manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, and field STOP is not pushed, then the soft switch at the HMI can be used to start and stop the feed pump manually from the HMI.

Automatic:

When the local switch is in REMOTE position, and field STOP is not pushed, and the soft M/A switch at the HMI is in AUTO, the pumps shall be controlled based on the PID control algorithm in the PLC, with pump sequence logic as follows:

1. Level is controlled over a set control band, nominally 12 inches. Over this level band, provide a flow setpoint that changes proportionally with level. Flow setpoint shall range from approximately 400 gpm at bottom of band to 2,000 gpm at top of band. Use this flow setpoint in a PID flow controller, with PID output used to adjust pump speed. Set VFD minimum speed to deliver the minimum flow setpoint at maximum head, approximately 80 percent of full speed.
2. Provide a clamping function on the flow setpoint based on number of pumps running. For one pump running, limit the flow setpoint to approximately 1,000 gpm. For two pumps running, limit flow setpoint to approximately 2,000 gpm. Select flow limit based on pump curves to prevent pump run-out at any operating speed.
3. Provide for pump sequence selection at HMI: LEAD, LAG, and STANDBY.
4. Start LEAD pump when level rises to bottom of control band.
5. Start LAG pump when level rises to top of control band.
6. Stop LAG pump when flow setpoint has fallen below 85 percent of upper limit for one pump (approximately 850 gpm).
7. Stop LEAD pump when level falls 6 inches below bottom of control band.
8. Provide high and low level alarm, and pump status at HMI. Provide controller faceplate for display of process variable, setpoint, controller output, AUTO/MANUAL status.
9. At HMI, provide means for adjusting level control band, PID tuning constants, flow setpoint range, and flow limits

When any of the local switches are not in REMOTE, those pumps shall be considered out-of-service and the sequence shall bypass these pumps.

1.5 Chemical Systems for Desalination Facility

There are typically two chemical feed pumps provided for each chemical application. Duty assignment selection shall be operator adjustable from the HMI. Each pump shall be driven by a VFD for effective speed control. The pump output rate may be further fine-tuned by manual adjustment of the stroke length. Fe/Mn pumps shall be provided with an automatic stroke length adjustment. The hard-wired VFD signal interfaces are shown on Drawings I-16 through I-25.

Each pump can be isolated using manually operated hand valves.

Local Manual Operation of Metering Pumps

When the VFD Local/Remote switch is in LOCAL position, the pump can be started locally with local speed control. When the switch is in REMOTE, the PLC

control shall take over. The operator shall have to ensure that all manual valves on the system are properly set for manual and automatic controls.

LOCAL-Manual operation shall be used only for testing. For safety reasons, this shall not be the normal or preferred mode of operation.

Automatic Operation of Metering Pumps

When the VFD switch is in REMOTE, the drive shall respond to RUN command and speed and stroke, if applicable, control signal(s) from the PLC. The operation of the metering pumps from the PLC and HMI shall be based on control requirements defined above.

All motor/drive RUN times shall be computed in the PLC and reported to the HMI.

All digital inputs connected to the PLC shall be reported to the HMI.

All analog inputs connected to the PLC shall be converted to engineering units and reported to the HMI.

Safety Interlocks/Alarms

A pump discharge HIGH pressure shall shut down the associated feed pump and provide an alarm at the HMI. A tank level switch low low (LSLL) condition shall shut down the associated feed pump and provide a shutdown alarm to the PLC for control action and display on the HMI.

1.5.2 Sodium Hypochlorite System (Drawings I-16, I-17)

This system shall consist of an onsite sodium hypochlorite generation system. This system shall be a complete package as shown on Drawing I-16. PLC-300, supplied as part of the package, shall control and monitor the hypochlorite generation system. PLC-300 shall communicate with the main plant PLC using a Ethernet data link. The data exchange requirement between the main PLC and PLC-300 shall be coordinated by the Contractor to ensure orderly plant operation. The package system shall generate sodium hypochlorite and store it in storage tank TK-61020 (Drawing I-16).

Hypochlorite Metering Pump Control – Hypochlorite addition for Fe/Mn raw water (Drawing I-2): Hypochlorite shall be added to increase the chlorine residual level required by the filtration process. Pumps P-61150 and P-61160 shall be controlled as described in Section 1.4.4.

Hypochlorite Metering Pump Control – Primary Disinfection (Drawing I-9) for Permeate, Pumps P-61110 and P-61120: The pre-carbonator feed shall be a manual operation. All hand valves shall be normally set for feed to pre-chlorine contact tanks.

Hypochlorite Metering Pump Control – Final metering (Drawing I-11): This feed point shall be used as a measure to boost the chlorine level prior to going to distribution if necessary. Feed pumps P-61130 and P-61140 shall be controlled as specified in Section 1.4.21.

When FLOW PACED mode is selected, the automatic flow paced addition of sodium hypochlorite solution shall be provided to the chlorine injection point, based on the following relationship to calculate the required sodium hypochlorite feed pump rate S:

Rate = [Flow * Dose * (60) * (74.5/71)] / [1,000,000 * Conc * SG]

Where:

Rate = Target NaOCl pump metering rate (gph)
Flow = Finished Water Flow (gpm)
Dose = Sodium Hypochlorite Dosage Setpoint (mg/L)
Conc = Sodium Hypochlorite Solution Concentration (percent)
SG = Sodium Hypochlorite Solution Specific Gravity

The sodium hypochlorite solution concentration is approximately (0.008 percent); its specific gravity is approximately 1.03 (may vary slightly). The 74.5/71 is a conversion factor from NaOCl to CL2.

The pump speed can be calculated using the equation below:

Speed (percent) = 100 * (Rate / NaOCl Pump Capacity at Max. Speed in gph)

All the above parameters shall be operator-adjustable on a setup display.

1.5.3 Truck Loading Indication and Alarm Panel (Drawings I-18 through I-25)

Provide a truck loading panel (LCP-60010) near the chemical truck fill connections, for all chemicals. For each chemical system, display the chemical tank level, to be observed by the operator when filling the tank. Retransmit each tank level signal to the PLC/HMI.

Monitor each chemical tank for HIGH level and provide a HIGH level indicating light for each tank. Relay the HIGH level alarm condition to the PLC/HMI.

At LCP-60010, provide one horn and one beacon, to be activated if any chemical HIGH level alarm is present. Provide a SILENCE pushbutton for each chemical tank, which will silence the horn when pressed. If another tank is filled to HIGH level, the horn shall sound again. The beacon shall remain activated until all chemical tanks do not have a HIGH level alarm.

1.5.4 Sulfuric Acid Storage, Transfer and Metering System (Provision for Future) (Drawing I-18)

Sulfuric Acid Storage

Sulfuric acid shall be stored in tank TK-64010 located in the chemical storage area. Acid shall be brought in by truck and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps.

Sulfuric Acid Metering Pumps

There are two acid-metering pumps (P-64110 and P-64120). These pumps shall be controlled as described in Section 1.4.10.

1.5.5 Aqueous Ammonia Storage and Feed System (Drawing I-19)

Aqueous ammonia shall be stored in tank TK-62010 located in the chemical storage area. Aqueous ammonia shall be brought in by truck and loaded in the

storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps.

Aqueous Ammonia Metering Pumps

There are two aqueous ammonia metering pumps (P-62110 and P-62120). These pumps shall be controlled as described in Section 1.4.22.

Ammonia scrubber system: A package scrubber system shall be provided with the ammonia system. A low water level in the scrubber shall be alarmed at the HMI.

For aqueous ammonia (NH3) injection:

Rate = [Flow * Dose * Ratio * (60)] / [1,000,000 * Conc * SG]

Where:

Rate = Target NH3 pump metering rate (gph)
Flow = Finished Water Flow (gpm)
Dose = Sodium Hypochlorite Primary Disinfection Dosage Setpoint (mg/L)
Ratio = Ammonia to Chlorine Addition Weight Ratio
Conc = Aqueous Ammonia Solution Concentration (percent)
SG = Aqueous Ammonia Solution Specific Gravity

The aqueous ammonia solution concentration is approximately 19 percent, and its specific gravity is approximately 0.926. The ammonia to chlorine addition weight ratio is an operator-adjustable value; the value is typically 0.2 to 0.25 (equivalent to a range between 5-to-1 and 4-to-1).

The pump speed can be calculated using the following equation:

Speed (percent) = 100 * (Rate / NH3 Pump Capacity at Max. Speed in gph)

1.5.6 Sodium Hydroxide (NaOH) Storage Transfer and Metering System (Drawing I-20)

NaOH Storage System

The operation and monitoring of the NaOH storage system is similar to that described for acid storage. Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps.

RO Post-Treatment NaOH Metering Pumps

Two VFD-controlled metering pumps (P-65110 and P-65120) shall be dedicated for feeding NaOH to the finished water clearwell.

RO Cleaning Transfer Pumps

The NaOH transfer pumps (P-65210 and P-65220) shall be controlled manually from LCP-65210 as specified in Section 1.4.25. The operator shall select the desired pump to run by selecting it for AUTO mode. The pump discharge shall be measured by a flowmeter (FE/FIT-65203) for display and totalized at the panel. The operator shall set the desired total flow of chemical to be added

to the RO cleaning tank on the totalizer and start the pump. The pump shall run until the desired totalized flow is loaded into the cleaning tank. A contact from the totalizer shall stop the pump. The operator must manually reset the totalizer before starting the pump. The NaOH and citric acid pumps shall be interlocked to prohibit operation of the other.

1.5.7 Threshold Inhibitor (TI) Storage and Metering System (Drawing I-21)

Threshold Inhibitor Storage

TI shall be stored in tank TK-63010 located in the chemical storage area. TI shall be brought in by truck and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps.

RO Pretreatment TI Metering Pumps

Two VFD-controlled metering pumps (P-63110 and P-63120) shall be dedicated for feeding TI to the cartridge filters. The operation of these pumps shall be as described in Section 1.4.11.

1.5.8 Corrosion Inhibitor Storage and Metering System (Drawing I-22)

Corrosion inhibitor shall be stored in tank TK-66010 located in the chemical storage area. Corrosion inhibitor shall be brought in by truck and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps..

RO Post-Treatment Corrosion Inhibitor Metering Pumps

Two VFD controlled metering pumps (P-66110 and P-66120) shall be dedicated for feeding corrosion inhibitor to the clearwell.

1.5.9 Hydrofluosilicic Acid (F) Storage, Day Tank, and Metering System (Drawing I-23)

Hydrofluosilicic acid shall be stored in tank TK-67010 located in the chemical storage area. The acid shall be brought in trucks and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure storage tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the transfer pump.

The day tank shall be used to hold the volume of acid to be utilized in 1 day. The tank shall be provided with a sight gauge and level switches to monitor and control the daily filling of the tank. A transfer valve (FV-67100) and transfer pump (P-67020) shall be used to transfer the acid to the day tank. The pump shall be controlled from LCP-67020. In AUTO, the transfer valve and pump shall be operated to fill the day tank to the HIGH level (LSH-67020). LOW level shall be alarmed at the HMI and relayed to shutdown the metering pumps.

Two VFD-controlled metering pumps shall be dedicated for feeding hydrofluosilicic acid to the facilities finished water header. The operation of these pumps shall be as described in Section 1.4.23.

1.5.10 Citric Acid Storage and Transfer System (Drawing I-24)

Citric acid shall be stored in tank TK-68010 located in the chemical storage area. Acid shall be brought in by truck and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps.

The citric acid transfer pumps (P-68210 and P-68220) shall be controlled manually from LCP-68210 as described in Section 1.4.25. The operator shall select the desired pump to run by selecting it for AUTO mode. The pump discharge shall be measured by a flowmeter (FE/FIT-68111) for display, and totalized at the panel. The operator shall set the desired total flow of chemical to be added to the RO cleaning tank on the totalizer and starts the pump. The pump shall run until the desired totalized flow has been loaded into the cleaning tank. A contact from the totalizer shall stop the pump. The operator must manually reset the totalizer before starting the pump. The NaOH and citric acid pumps shall be interlocked to prohibit operation of the other.

1.5.11 Sodium Bisulfate Storage, Transfer, and Metering System (Drawing I-25)

Sodium bisulfate shall be stored in tank TK-69010 located in the chemical storage area. Sodium bisulfate shall be brought in by truck and loaded in the storage tank. A 2-inch truck connection shall be provided for connection to the tank.

Measure tank level and transmit level signal to LCP-60010. Monitor the tank for HIGH level alarm and send to LCP-60010. Monitor the tank for LOW level and send to PLC/HMI for alarm, and relay LOW level signal to shutdown the metering pumps..

There are two metering pumps (P-69110 and P-69120). These pumps shall be controlled as specified in Section 1.4.4.

1.5.12 All Chemical Storage Tanks (Drawings I-16 to I-25)

For each chemical tank, provide Remote AUTO and MANUAL control of the tank outlet valve. In Remote MANUAL, provide manual OPEN and CLOSE control from the HMI. In Remote AUTO, close the valve when no associated pumps are called to run, and open the valve when a pump is called to run. Alarm valve FAIL if feedback position does not match control state, after a time delay.

-- END OF SECTION --