
City of Raymond

Water Treatment Plant Operation Manual



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CH2MHILL®

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Acronyms and Abbreviations

°C	degrees Celsius
µg/L	micrograms per Liter
AC	alternating current
ATS	automatic transfer switch
MRI O&M Manual	Meurer Research Incorporated Plate Settler Operations & Maintenance Manual
CV	control variable
CT	Chlorine Residual x Contact Time
DC	direct current
EGU	engineering generic units
EPA	Environmental Protection Agency
GFI	ground fault indicator
g	grams
gal	gallons
gpm	gallons per minute
HMI	human-machine interface
KW	kilowatt
LT2	Long Term 2 Enhanced Surface Water Treatment Rule
mgd	million gallons per day
mg/L	milligrams per liter
mg-min/L	milligram – minutes per Liter
MRI	Meurer Research Incorporated
MSDS	Material Data Safety Sheet
NIOSH	National Institute for Occupational Safety and Health
NTU	Nephelometric Turbidity Unit
OSHA	Occupational Safety and Health Administration
PID	proportional-integral-derivative
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PV	process variable
RIO	Remote Input/Output
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
UPS	Uninterruptible Power Supply
WDOH	Washington State Department of Health

SECTION 1

Introduction

This Operations Manual presents a summary of the design criteria, system description, and operational strategies for the City of Raymond Water Treatment Plant (WTP). Additional design and operational details are contained in the contract drawings and the Meurer Research Incorporated Plate Settler Operations & Maintenance Manual (MRI O&M Manual) and other equipment manuals.

The City of Raymond obtains its source water from the South Fork of the Willapa River. The water flows from an intake in the river to a wetwell located in the Pump Room of the treatment plant. The water is pumped through a mixer where coagulant and hydrogen peroxide are injected. The water then flows to two package flocculation and sedimentation tanks and then to two granular media filters. After filtration, the water is fluoridated and chlorinated and pumped to the clearwell. After the clearwell, soda ash is added for pH adjustment and the water is pumped again into the distribution system. The maximum flow through the treatment plant is 1,400 gpm. The average daily demand is 375 gpm.

The water treatment system consists of coagulation, flocculation, sedimentation, filtration, fluoridation, chlorine disinfection, and soda ash addition.

- Flocculation, settling, and filtration are used for turbidity reduction and *Giardia* and *Cryptosporidium* removal.
- Free chlorine is used for additional *Giardia* inactivation, virus inactivation, and distribution system residual.
- Soda ash addition increases the water's pH to minimize the potential of lead containing items in the water distribution system and household plumbing from leaching into the delivered water.
- Fluoride is added for dental benefits.

The City of Raymond performed upgrades to the Water Treatment Plant in response to high disinfection byproducts in the distribution system. Disinfection byproducts are regulated by the Stage 2 Disinfectants and Disinfection Byproduct Rule (Stage 2 DBP Rule). The rule addresses the public health risk from high levels of disinfection byproducts in drinking water.

The installed treatment plant upgrades provide the following benefits to City of Raymond customers:

- Reduced exposure to disinfection byproducts.
- Reduced pathogen risk from improved settling.
- Improved public health protection.

SECTION 2

Water Quality Goals

Operating Raymond's water treatment system requires that certain water quality goals be achieved. These goals are necessary in order to maintain regulatory compliance, corrosion control, and aesthetic water quality. Table 2-1 summarizes these water quality goals.

TABLE 2-1
Water Quality Goals Summary

Water Quality Requirement/Goal	Target Value	Allowable Target Value Range	Adjustment Method
Virus and Protozoa Control			
<i>Giardia</i> Removal/Inactivation	2.5 log (99%) removal through settling & filtration 0.5 log inactivation via chlorine contact	Minimum 3.0 log total removal/inactivation	Optimize settling and filtration performance to meet turbidity requirements Maintain chlorine dose
<i>Cryptosporidium</i> Removal/Inactivation	2.0 log removal	Minimum 2.0 log total removal/inactivation	Optimize settling and filtration performance to meet turbidity requirements
Virus Inactivation	4.0 log inactivation	Minimum 4.0 log inactivation	Maintain chlorine dose
Disinfectant Residual			
Total chlorine residual entering distribution system	The residual leaving the plant will most often be controlled by the residual needed to meeting <i>Giardia</i> inactivation. The minimum is 0.2 mg/L.	As needed to maintain distribution system residual and meet <i>Giardia</i> inactivation	Adjust pre-clearwell chlorine dose.
Turbidity Criteria			
Settled Water	<1 NTU when raw water turbidity less than 10 NTU < 2NTU when raw water turbidity less than 10 NTU		Modify cationic polymer and/or ACH dose
Combined Filter Effluent	< 0.1 NTU 95% of the time.		
Corrosion Control			
pH after soda ash addition	7.2 pH units	7.0 – 8.0 pH units	Check pH probe calibration and Soda Ash pump controller

NOTES:

CT = disinfectant residual x contact time

PLC = Programmable Logic Controller

SCADA = Supervisory Control and Data Acquisition

SECTION 3

Treatment Processes

A process flow diagram for the treatment system is shown in Figure 3-1.

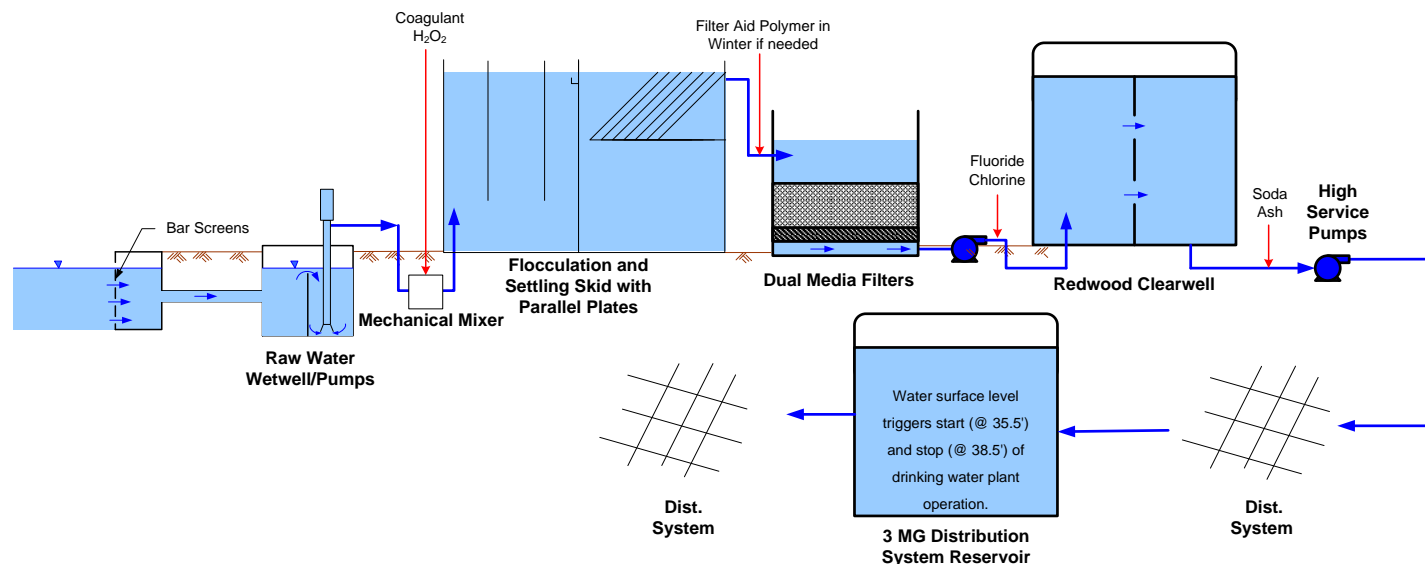


FIGURE 3-1
Process Flow Diagram

3.1 Raw Water Pumping & Chemical Mixing

Raw water is pumped from the wet well to the plate settlers. There are three raw water pumps (two duty and one standby) that are controlled by adjustable frequency drives. Each pump is sized for a maximum of 700 gpm.

A mechanical mixer is located between the raw water pumps and the plate settlers. Aluminum chlorohydrate (ACH), cationic polymer, and hydrogen peroxide are added in the mixer. Hydrogen peroxide is used to control algae formation in the plate settlers and filters. ACH and cationic polymer are used for coagulation.

3.2 Flocculation & Sedimentation

Two package units provide flocculation and sedimentation of solids in the water. The flocculation portion of each unit provides slow mixing to allow floc to form. Particles are then settled out as the water flows up through inclined parallel plate settlers. Water flows by gravity to the filters.

3.3 Filtration

There are two dual media filters. A filter aid polymer is injected prior to filtration during storm events. The filters are equipped with air scour for backwash.

3.4 Disinfection

Disinfection is accomplished by injecting chlorine into the water prior to the clearwell. Disinfection is monitored by calculating the contact time in the clearwell and measuring the pH just after chlorine addition, the chlorine residual as the water enters the distribution system, and the temperature of the finished water.

3.5 Finished Water Pumping

Finished water is pumped from the clearwell to the distribution system. There are three finished water pumps (two duty and one standby) that are controlled by adjustable frequency drives. Each pump is sized for a maximum of 700 gpm.

SECTION 4

Water Quality Monitoring

The City of Raymond WTP continuously monitors water quality throughout the treatment process to ensure the facility's goals and treatment requirements are met.

Flow is measured as the water is pumped to the settling tanks and as the treated water leaves the plant. The flow into the distribution system is used in the calculation of chlorine CT for *Giardia* and virus inactivation.

Streaming Current is measured after coagulant addition. It is used to monitor the charge on particles in the water. The coagulant dose can be increased or decreased to neutralize the charge on the particles for optimum coagulation.

Chlorine residual is monitored after chlorine injection upstream and downstream of the clearwell. The measurement after injection is used to control the chlorine dose. The measurement after the clearwell tank is used in the Chlorine Contact Time x Chlorine Residual calculation to determine *Giardia* and virus inactivation and to ensure the distribution chlorine residual requirements are met.

Fluoride residual is monitored after fluoride addition. The measurement is monitored to ensure that fluoride is dosed into the system at the appropriate level.

pH is monitored downstream of the clearwell. The measurement is used in the CT calculation for *Giardia* and virus inactivation and to adjust the soda ash injection dose in order to maintain an optimum pH for lead and copper corrosion control.

Turbidity measured in NTUs is measured at the raw water coming into the facility, the water after settling, after each filter, and the combined filter effluent. Turbidity is a measure of the clarity of the water. Turbidity measurements are collected to monitor settling and filtration performance.

Temperature is monitored as the water leaves the treatment plant. Temperature is used in the Chlorine CT calculation for *Giardia* and virus inactivation.



FIGURE 4-1
Raw and Finished Water Analyzers

The water quality analyzers are mounted together in two locations. The raw and finished water analyzers are mounted on the wall of the Pump Room, and the streaming current and turbidity analyzers are mounted in the filter room. Figure 4-1 is a picture of the raw water sample station, and Figure 4-2 shows the turbidity analyzers in the filter room. It is important to maintain an adequate flow rate through the analyzers to obtain a representative water sample. The flow rate through each of the analyzers should be recorded for reference.

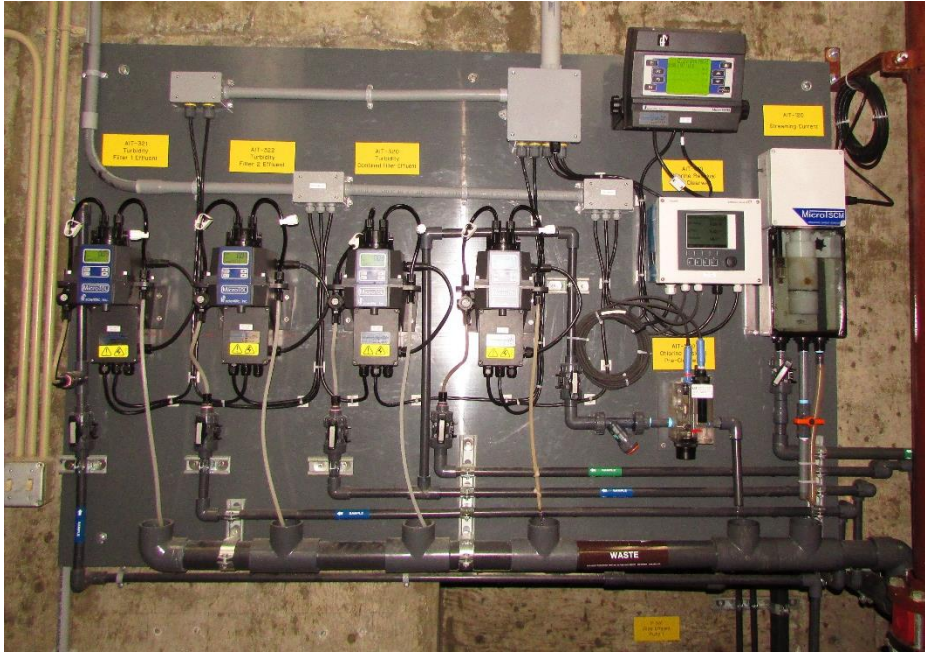


FIGURE 4-2
Filter Influent & Effluent Analyzers

A description of the monitoring water quality analyzers and how they are transmitted to the SCADA system can be found in Section 5.3.18.

Facility Operation and Control

5.1 Control System Configuration

The facility control system consists of SCADA computers and PLC panels. The main control panel CP-01 is located in the Pump Room of the treatment plant. CP-01 is the master facility control panel and contains PLC-01 which coordinates the operation of the treatment plant. CP-201 and CP-202 are located on the side of the package flocculation and plate settlers. These panels control the function of each plate settler. These systems share information through an Ethernet (fiber) network cable. The SCADA server computer is installed in the new office of the treatment plant building. The SCADA system also logs water quality data.

Reference Drawing I-10 in Appendix A for control system block diagram that illustrates how the various components of the process control system are connected to one another.

5.2 Level of Control

There are two primary monitoring and control levels, Local and Remote.

Local: Functions which are located near the equipment for controlling the local equipment. Local control functions typically involve manual equipment or package system operation. Local or remote control mode selection is provided locally at the equipment to transfer control between the two modes of operation. In the local mode, SCADA control is disabled. Local controls are independent of SCADA.

Remote: Functions are implemented by a programmable controller. The controller is either part of the package system, or a PLC controller. This includes most control functions from the SCADA/HMI system including remote manual and remote automatic control.

Remote control is accomplished through the SCADA/HMI. This is the normal system control level. In SCADA **auto control**, the SCADA system will automatically control the treatment equipment according to the established control strategy, for example, flow rate. Any equipment automatically controlled by the SCADA is also provided with a **SCADA manual control** mode. This allows individual equipment to be manually controlled from the HMI by establishing a constant operating value, for example, pump speed.

5.3 Human Machine Interface (HMI)

The HMI is the operator's interface with the facility control system. It is comprised of a series of graphical screens where the operator can input operating parameters, monitor operating status, review alarms, and start or stop the facility and individual equipment components. The screens, navigation, and control strategy are described in more detail in this section.

5.3.1 HMI Layout and Navigation Menu

The HMI screen layout contains a menu, body, and a footer. The menu bar along the left side of the screen provides operator interface to navigate to each HMI screen. The body displays the HMI screen in the center, and the footer shows a concise alarm summary.

There are 15 main screens; each has a corresponding navigation button on the left side menu bar. Each screen can be accessed from any other screen by clicking the appropriate button on the side panel. The buttons are defined below.

1. **Overview** screen: The Overview screen gives the operator a full facility view with key parameters shown.
2. **Raw Water** screen: The Raw Water screen shows and overview of the raw water system (wet well, pumps, flow, chemical mixing) and the plant flow control (level or flow).
3. **Plate Settler** screen: This screen provides monitoring information about the Plate Settler system, as well as the streaming current and settled water turbidity. The SCADA screen provides primarily monitoring and alarming features for the plate settlers.
4. **Filters** screen: This screen shows the status of the filters including level, head loss, filter effluent pump status, and provides a link to the backwash sequence. It also shows the filtered water turbidity and the status of the automatic valves.
5. **Finish Water** screen: The finished water screen shows the clearwell, distribution pumps, and distribution system level. It also provides a snapshot of finished water quality and the chemical injection status of the chlorinator, fluoride pumps, and soda ash pumps.
6. **Misc** screen: The miscellaneous screen shows the status of the generator, ATS, UPS, Air Compressor, and Emergency Eye Wash
7. **Backwash** screen: The backwash control screen shows the backwash sequence and the setup for the backwash duration and flow. It is also the locations where backwashes are started.
8. **ACH** screen: The ACH screen shows the chemical metering pump status and allows for dose adjustment.
9. **H2O2** screen: The H2O2 screen shows the chemical metering pump status for the perox ide pumps and allows for dose adjustment.
10. **CAT** screen: The Cationic Polymer screen shows the chemical metering pump status and allows for dose adjustment.
11. **FAP** screen: The Filter Aid POLymer screen shows the chemical metering pump status and allows for dose adjustment. It also shows the status of the filter aid carrier water system.
12. **Soda Ash** screen: The Soda Ash screen shows the chemical metering pump status and monitoring. The pumping rate is controlled locally based on the pH reading.

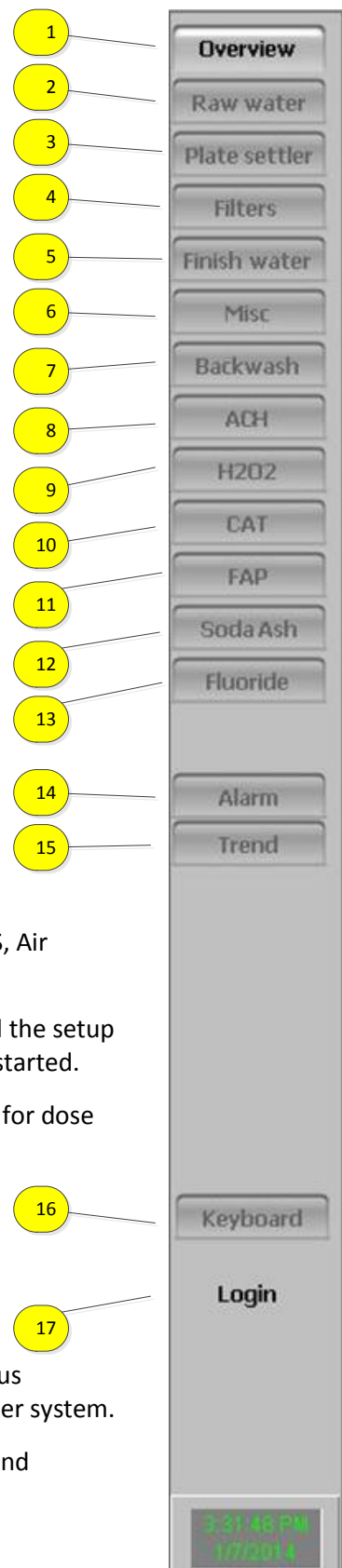


FIGURE 5-1
HMI Navigation Menu

13. **Fluoride** screen: The Fluoride screen shows the chemical metering pump status and allows for dose adjustment.
14. **Alarm** screen: This screen provides the complete list of active alarms and indicates which ones have been acknowledged by an operator.
15. **Trend** screen: Click on the Trend button to open the screen showing the trending historical data
16. **Keyboard** screen: Shows a keyboard.
17. **Login/Logout** buttons: The login controls the level of access to the SCADA controls and is password-protected. The default login allows the user to view each of the screens, but does not allow control of the facility. Logging in as an operator allows general control of the facility.

5.3.2 Standard Conventions

The control system uses a set of standard conventions for each HMI screen. For example, a standard set of colors, symbols, and navigation are used throughout the HMI control screens. The following describes the standard conventions used throughout the HMI screens:

1. Valves: Valves are color coded to indicate status.
 - Green = open
 - Grey = close
 - Red = fail
 - Yellow = transition
2. Motorized equipment: Motorized equipment is color coded to indicate status.
 - Green = on/running
 - Grey = off/not running
 - Blinking red = fail
3. Instrument Readings: The alarm status is indicated by a HIHI, LOLO, HI, or LO Textbox and a red box surrounding the reading. A blinking red box around the value indicates the signal failure status.
4. Tank water levels: Tank water levels are visually simulated by a showing an approximation of the water surface within the tank symbol.
5. Availability to SCADA: A box with red background and the letter M indicates the device is in manual and therefore not Ready/Available to control in SCADA auto. For example, a pump in manual mode is not available to the SCADA. It is recommended to take devices out of service before putting them in manual mode.
6. Alarm Lights animation: Alarms Lights are animated with blinking red for the alarm condition and Green for the normal condition.
7. Selected object: A green box surrounding the object indicates the currently selected/active object.
8. Keypad entry: Clicking a set point entry box will initiate a keypad pop-up. This keypad is used to enter numeric values. Click ok to transfer entered value to the SCADA system.

5.3.3 Facility Overview Screen

The facility overview screen displays an overview of the Water Treatment Plant. The Figure 5-2 illustrates the major components of the plant following the water flow through the facility. More information on individual systems can be found on the system screens, including Raw Water, Plate Settlers, Filters, Distribution, and the chemical dosing screens. These screens are reached by clicking in their general area in the overview screen, or on the individual screen tab on the left side of the window.

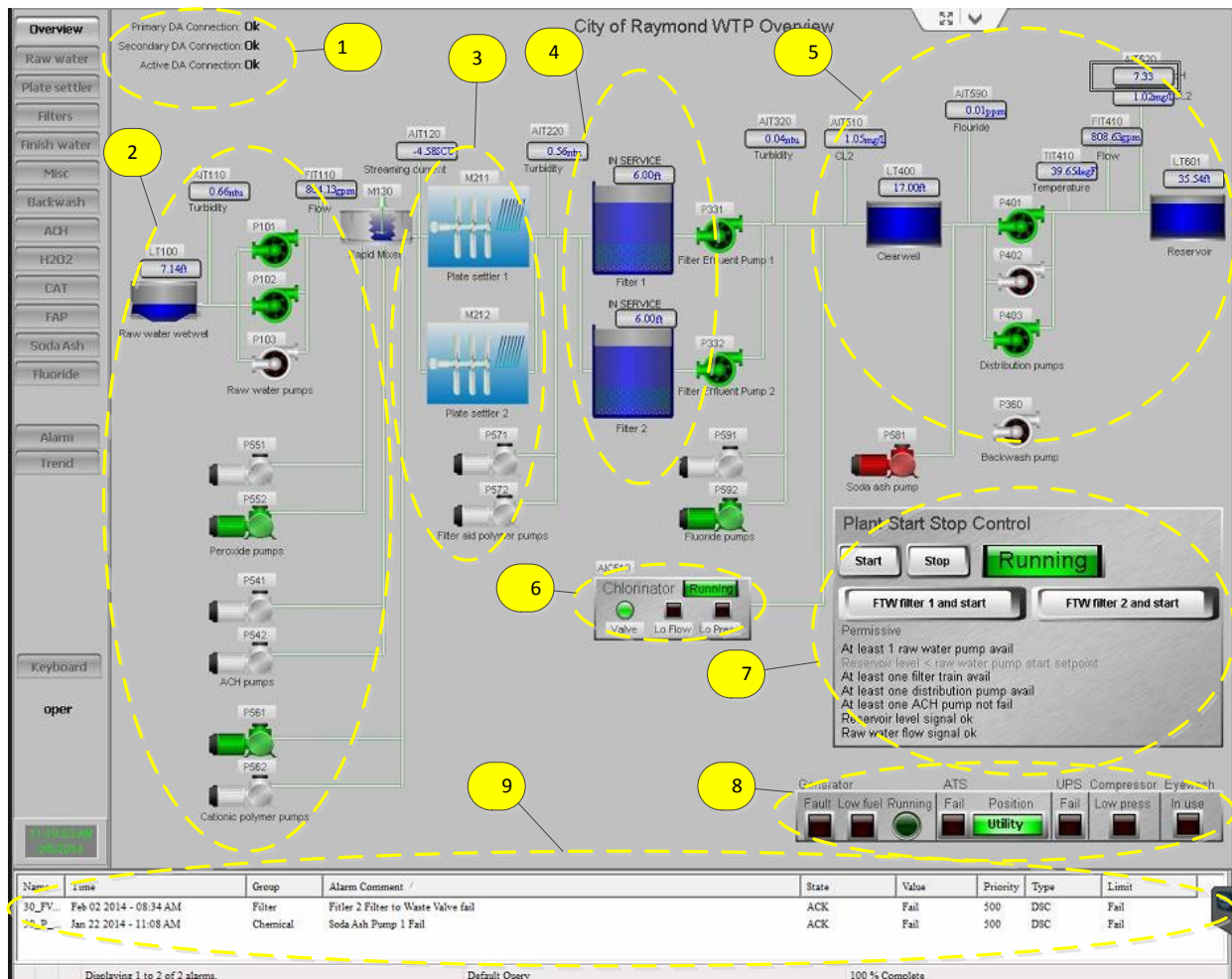


FIGURE 5-2
HMI Facility Overview Screen

An explanation of the features identified by yellow number circles is provided below.

1. SCADA Communication Status – DA indicates the data access server status. The Primary DA server is installed on the control panel operator interface and the secondary is installed on the HMI.
2. Raw Water – Shows the raw water system. Clicking in this area will open the raw water control screen.
3. Plate Settlers – Shows the plate settler area. Clicking in this area will open the plate settler control screen.

4. Filters – Shows an overview of the filters. Clicking in this area will open the filter control screen.
5. Finished Water – Shows an overview of the finished water system. Clicking in this area will open the finished water control screen.
6. The chlorinator and current inactivation ratio are shown near the Stop/Start control on the overview screen.
7. Plant Start/Stop – This area allows the plant to start or stop and displays the running status. There are options to filter one of the filters to waste prior to starting the plant. The list of permissives listed below these buttons must be all in black text before the plant start button will work.
8. Miscellaneous – Shows the status of the miscellaneous systems.
9. Alarms – Summarizes all active and acknowledged alarms.

5.3.4 Raw Water Screen

Water is supplied to the treatment plant through the Raw Water Pumps. The pump wetwell is connected to the South Fork Willapa River by a screened intake. Plant flow is controlled by the speed of the raw water pumps. The flow rate into the plant can be regulated through SCADA in three ways:

1. Remote-Manual to set the speed of each individual pump,
2. Level Control to maintain an operator selected level in the distribution system reservoir, or
3. Flow Control to maintain an operator entered flow rate

The actual starting and stopping of flow through the WTP is accomplished by starting and stopping the raw water pumps. The pumps are controlled by variable frequency drives that operate in a lead/lag mode to meet the flow needs of the plant. When in Auto, the plant flow or the start/stop of the plant is controlled by the level of the distribution system storage tank. The selected flow control regime will then begin modulation of the raw water pump speed to maintain the entered set point.

Flow Control

Flow control may be used to operate the plant at a constant flow rate. It will turn the plant on and off based on the level in the distribution system storage reservoir. To set the on/off levels of the reservoir, select the Reservoir Start and Stop level shown as (1) in the figure below. To control the flow automatically using a desired flow rate, click on the Flow button on the top center of the screen. Both the Flow button and the Flow Control box will be highlighted in green as shown in the figure below. Then click on the Auto button within the Flow Control box item (2) in the figure below. Enter the desired flow set point as gallons per minute (gpm). The control system will adjust the speed and number of raw water pumps in service to maintain the entered flow set point. If the reservoir level reaches the Stop Level, the plant will be shut down until the reservoir level reaches the Start Level.

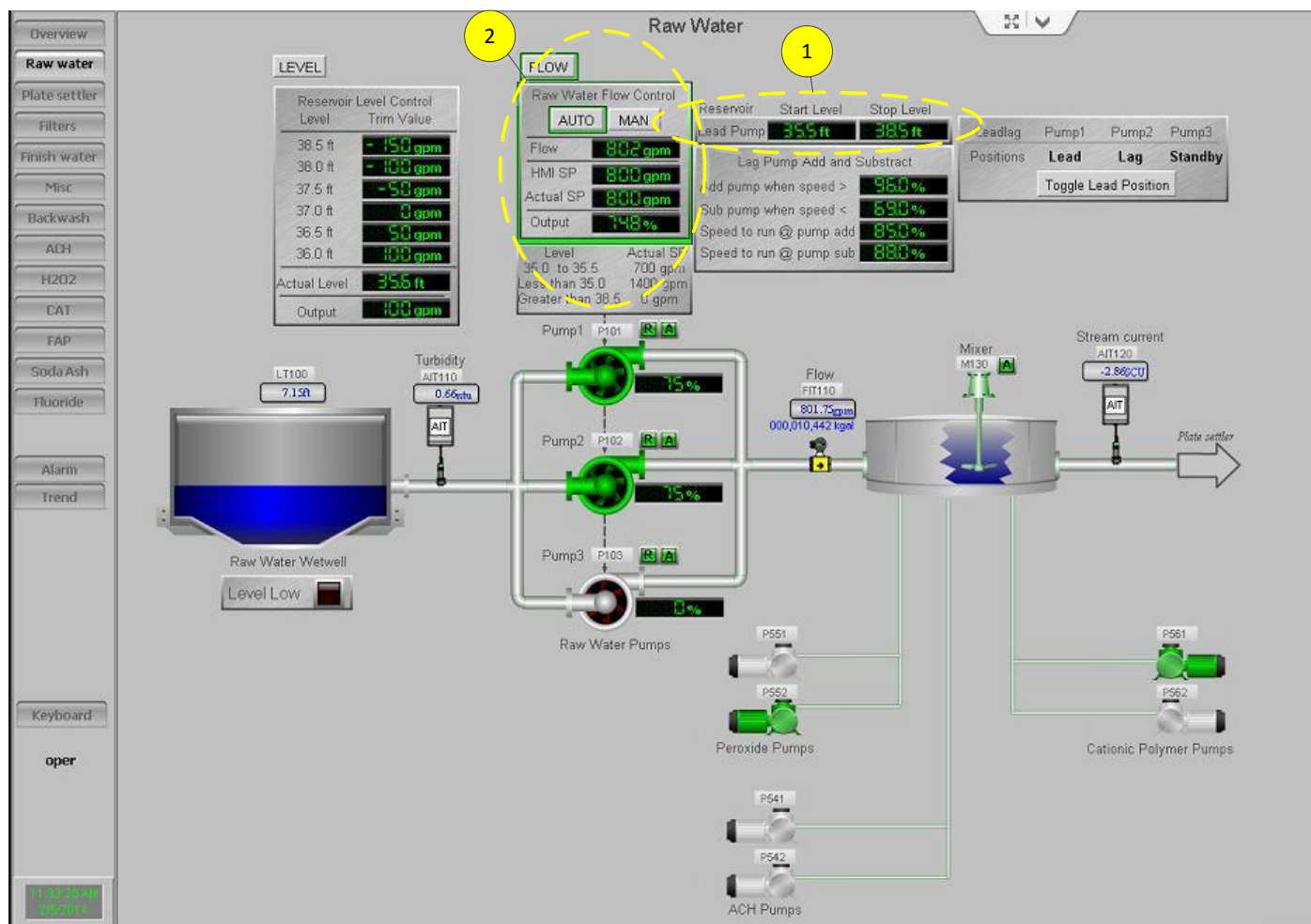


FIGURE 5-3
HMI Flow Control Screen

Level Control

Level control is the normal mode of operation. During Level control, the flow into the facility is adjusted from an operator adjustable base setpoint in order to maintain a constant level in the distribution system storage tank. To control the flow automatically, the plant adjusts the level to maintain the distribution system level of 37.0 ft. If the level in the reservoir is falling and reaches 36.5 feet, the plant

flow will increase by the amount shown in the “Trim Value” column. As the reservoir continues to fall, the flow will increase. Conversely, when the level is above the setpoint, the flow will be adjusted down by operator adjustable increments.

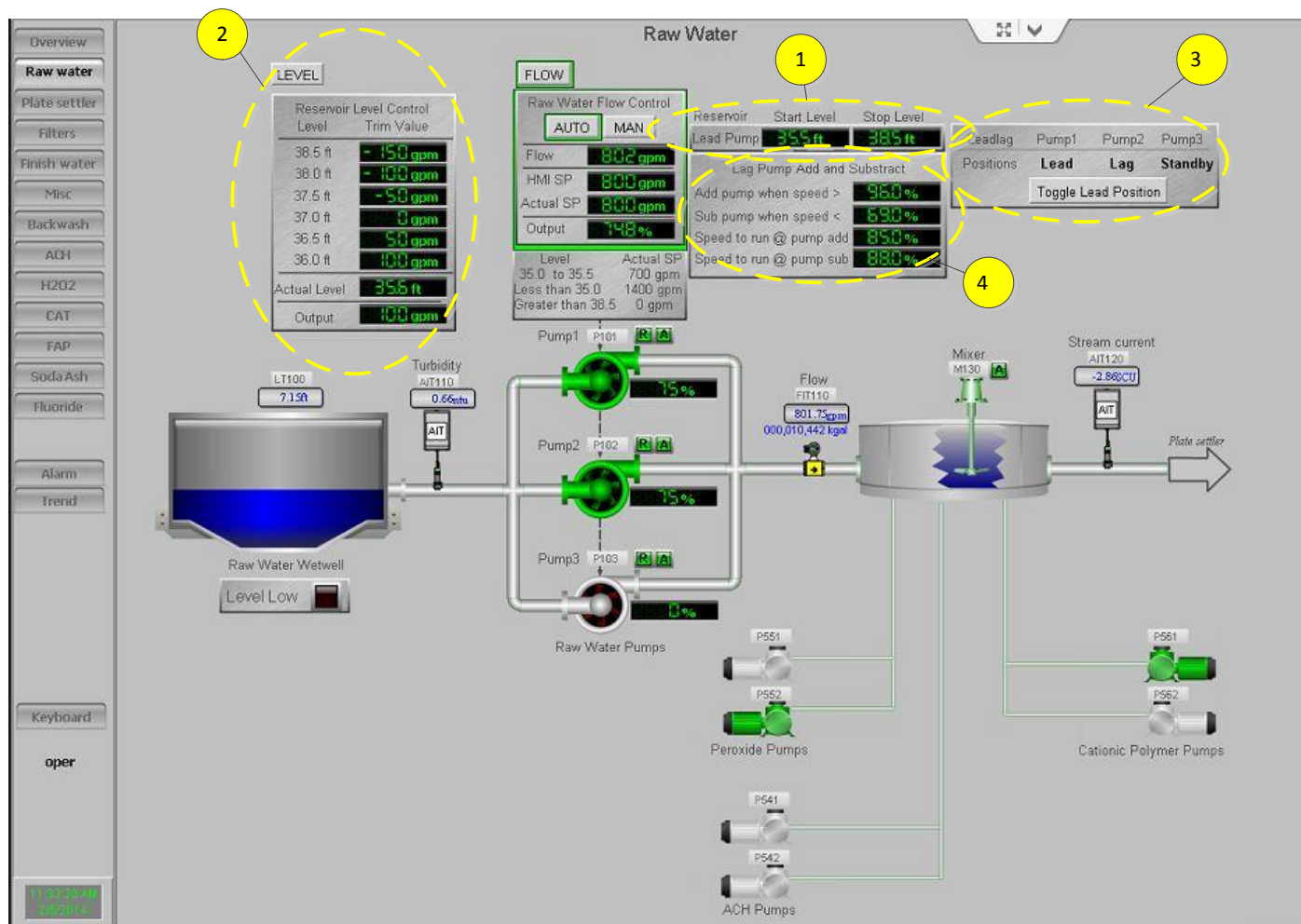


FIGURE 5-4
HMI Flow Control Screen – Level Control.

Flow and Level Control Transition

Transitioning from flow mode to level mode should be done with care to prevent sudden changes in plant flow. To transition from flow control mode to level control mode, set the plant flow at the desired base flow rate. When the reservoir level is between 36.5 and 37.5 feet, push the level control button to transition into level control mode. Making this transition when the level is in this range will ensure that the plant flow will not change by more than 50 gpm at the time of the transition. Transition from level mode to flow mode can be done at any time. The plant will operate with the current flow setpoint at the time of transition.

Raw Water Pump Control

Each raw water pump has an individual faceplate that shows if the pump is being called to run, on, in remote, and ready to run. It also has a manual switch for manual/off/auto selection, and a runtime

calculator, a number of cycles, and indicators for fault and failure. Details of these controls can be found in Section 5.3.18, Standard Functions.

Manual control of the raw water pumps allows the pumps to be controlled by setting a speed at the HMI.

In addition to individual pump control, the pumps automatically start and stop to meet the plant flow requirements and can be cycled through lead/lag/standby positions. The current lead/lag/standby position is shown in area (3) on the Raw Water HMI screen. This area shows which pump is in lead/lag/ and standby. The positions are set until the “Toggle Lead Position” button is pressed, at which point the lead/lag/standby assignment will change. The standard practice is to toggle the lead position monthly.

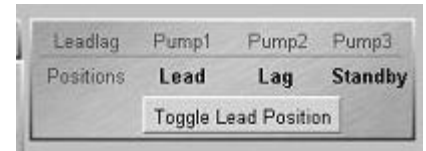


FIGURE 5-5
Lead/Lag/Standby Toggle

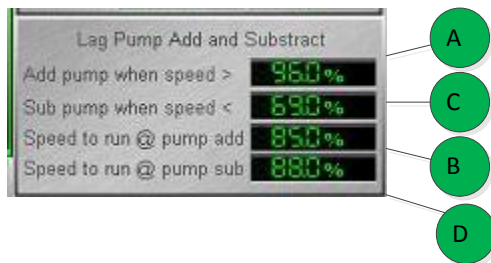


FIGURE 5-6
Lag Pump Speed Control

The control system will automatically start and stop pumps based on the “Lag Pump Add and Subtract” area shown in area (4) on the Raw Water HMI Screen. The control system automatically starts the plant with one raw water pump running. If the pump is not able to meet the flow setpoint when it is running at speed (A), the lag pump is brought online at speed (B) and the lead pump turns down to speed (B). When the speed on both pumps is less than the speed (C), the lag pump will be taken offline and the lead pump will run at speed (D), and then adjust to meet the plant flow requirement.

Mixer Control

Several chemicals are injected into a mechanical mixer between the raw water pumps and the flocculation-sedimentation tanks. The mechanical mixer has a manual speed control which is set by turning a knob on the mixer. The mixer is set to automatically turn on when the plant starts, and off when the plant stops. It has two manually adjustable knobs, one for the direction of rotation, which is set to “L”. The second is the speed of the mixer, which is manually set to “1,000”. Refer to the mixer O&M Manual for additional details on mixer operation.

The mixer is controlled by the SCADA system in the same way the raw water pumps are controlled – with a faceplate. The faceplate for the mixer is nearly identical to the faceplate for the pumps. The options on the selector are shows if the mixer is being called to run (1), on (2), a manual switch for manual/off/auto selection (3), and a runtime calculator (4), a number of cycles (5), and indicators for failure (6).

Operation Failure:

Operation failure occurs when a piece of equipment does not send back a ready signal in response to PLC start command. It indicates that one or more equipment systems are not controlled properly in SCADA auto mode due to equipment failure or that the equipment is not in SCADA Auto mode. Pressing the reset button does not fix the alarm condition; it only clears the alarm from HMI after the problem has been fixed.

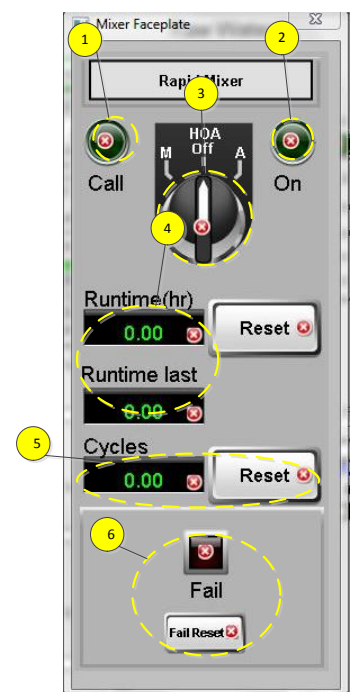


FIGURE 5-7
Mixer Control

5.3.5 Plate Settler Screen

The Flocculation-Sedimentation system (Plate Settlers) is controlled in the plate settler screen and by their local control panels CP-201 and CP-202. The plate settlers flocculate and settle particles and organic matter from the water. Each plate settler has a control faceplate that allows the plate settler to be on or offline and provide some feedback. The Plate Settlers can run in LOCAL or REMOTE. The valves controlling flow into and out of the plate settlers are controlled manually. If these valves are closed, the plate settler unit downstream of the specific closed valve will be unavailable. When plate settlers units are set to LOCAL at the Plate Settler control panels (CP-201 and CP-202), the local panels control the run status of the plate settler. When the Plate Settlers are set to REMOTE, the facility control system controls the plate settlers running status, sludge blowdown, and alarm. Normally, the Plate Settlers units operate in REMOTE. The individual plate settler faceplates are identical to the Raw Water Pumps.

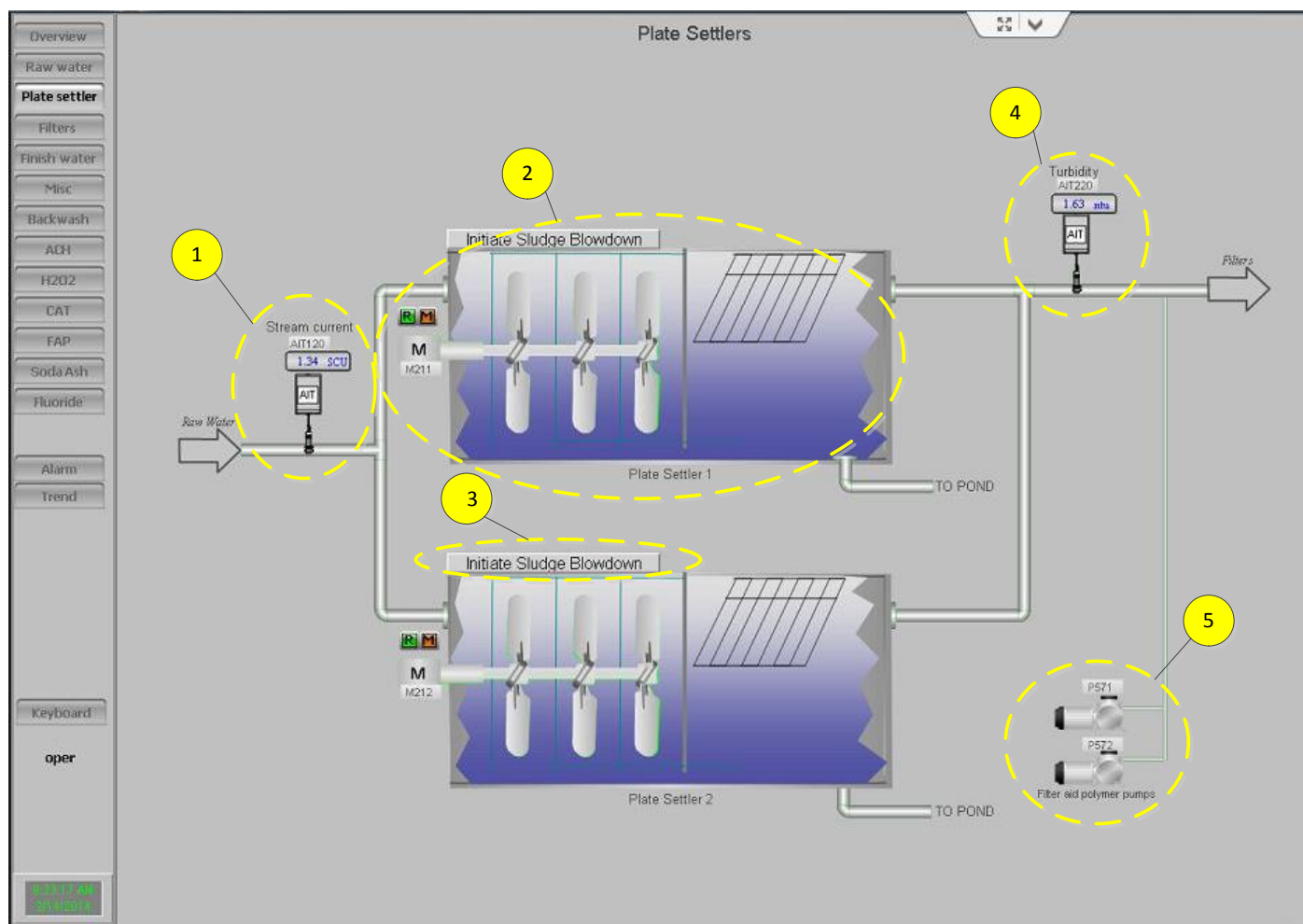


FIGURE 5-8
HMI Plate Settler Screen

The Plate Settler screen shows the streaming current value (1) of the water entering the plate settlers. This value is also shown on the Raw Water screen after mixing. The Plate Settler flocculation paddles are animated and green when a sludge blow-down is in progress (2). A sludge blow-down can be initiated from the HMI using the “Initiate Sludge Blowdown” button. Sludge blowdowns should be performed regularly to remove settled solids to the pond. At a minimum two sludge blowdowns should be done

each week. Sludge blowdowns should not be performed if the plate settler is offline as it will drain the plate settler. See the MRI O&M Manual for additional details about Plate Settler operation. The Settled Water Turbidity (4) is shown on this screen. This turbidity reading is used to evaluate settling performance, and should be less than 1 NTU when the raw water turbidity is less than 10 NTU, and less than 2 NTU at other times to achieve 2.5 log *Giardia* and *Cryptosporidium* removal credit. The status of the Filter Aid Polymer pumps (5) is also shown on the Plate Settler Screen.

Operation Failure:

Operation failure alarms when a plate settler unit does not send back a ready signal in response to PLC start command. It indicates that one or more equipment systems are not controlled properly in SCADA auto mode due to equipment failure or that the equipment is not in SCADA auto mode. Once detected as failed, the plate settler will be inoperable. SCADA will maintain the failed alarm status until the Reset button is selected from the Plate Settler HMI faceplate. Pressing the reset button does not fix the alarm condition; it only clears the alarm from HMI after the problem has been fixed.

5.3.6 Filters Screen

The filter screen shows the status of the filters as well as their corresponding valves. Details of the filter screen are as follows, and a screenshot of the filter screen is below.

1. Filter Level Control: Controls the overall filter effluent pump start and stop points.
2. Clearwell Level Control: Controls the filter effluent and distribution pump start and stop points.
3. Filter Effluent Pump: Pumps filtered water to the clearwell, controls filter level.
4. Filter Level Control Adjustment: Sets desired level in filter and shows filter effluent pump speed control.
5. Backwash Sequence: Shortcut and display of backwash sequence.
6. Air Scour Blower: Blower for air scour during backwash.

The valves

- A. Filter Inlet Valve: Isolates filter from settled water
- B. Filter Effluent Valve: Isolates filtrate from water to clearwell.
- C. Filter to Waste: Opens to allow filtration to backwash pond
- D. Air Scour Valve: Opens to allow air into the filter during backwash
- E. Backwash Supply Valve: Opens to send backwash water to the correct filter.
- F. Backwash Flow Control Valve: Controls flow from the backwash pump.

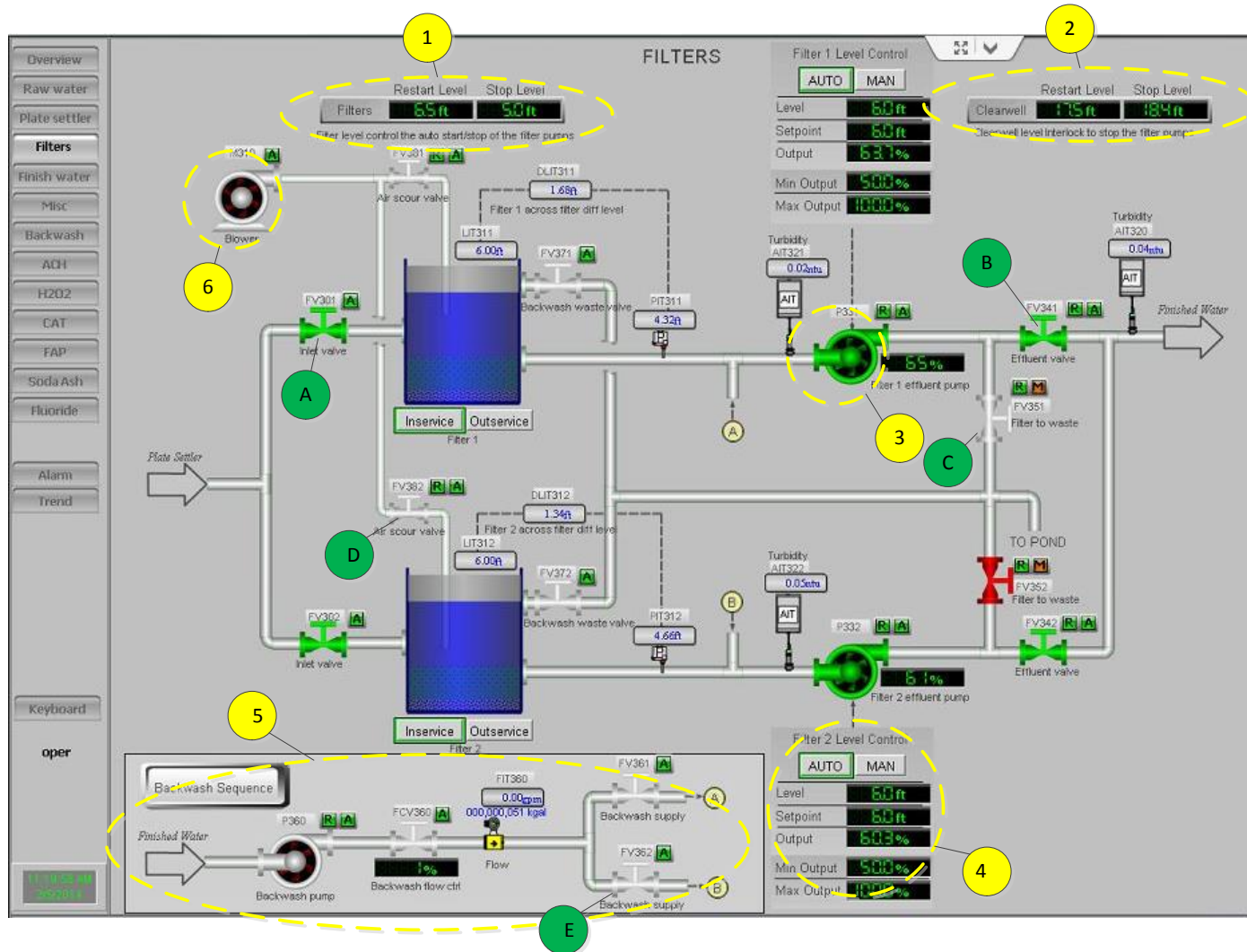


FIGURE 5-9
HMI Filter Screen

Filter Operation

To operate a filter in Auto mode, it must be “Inservice”. This means that the valves controlling forward flow through the filter will be open. Water flows from the Plate Settlers into the filters, and is pumped from the filters to the Clearwell by the Filter Effluent Pumps. The Filter Effluent pumps have adjustable frequency drives, which adjust the speed of the pump to maintain a constant level in the filters. When the plant is shut down or a filter is taken out of service, the Filter Effluent Pumps draw the level of the filter down to the “Filter Stop Level” (1). The Filter effluent pumps are not re-started until the level in the filters reaches the “Restart Level”. In addition to maintaining the level in the filters, the Filter Effluent Pumps can only operate when the Clearwell Level is between the Restart Level and Stop Level (2).

Manual filter operation is accomplished by taking a filter Out of Service using the “Outservice” toggle switch. Once the filter is offline, the valves can be opened and closed as desired, and the Filter Effluent

Pump can be manually controlled by entering a manual pump speed and toggling the Level Control to “manual”.

Backwash

The Backwash Pump is shown on the Filter screen along with the backwash flow control valve. During a backwash, the Backwash Pump is turned on and the flow control valve modulates the flow to the filters. The setup for the backwash sequence is shown on the Backwash Sequence HMI screen.

5.3.7 Finished Water

The Finished Water HMI screen shows the chlorinator status, clearwell, finished water pumps, and distribution system reservoir. It also shows the instruments used to monitor CT for monitoring disinfection.

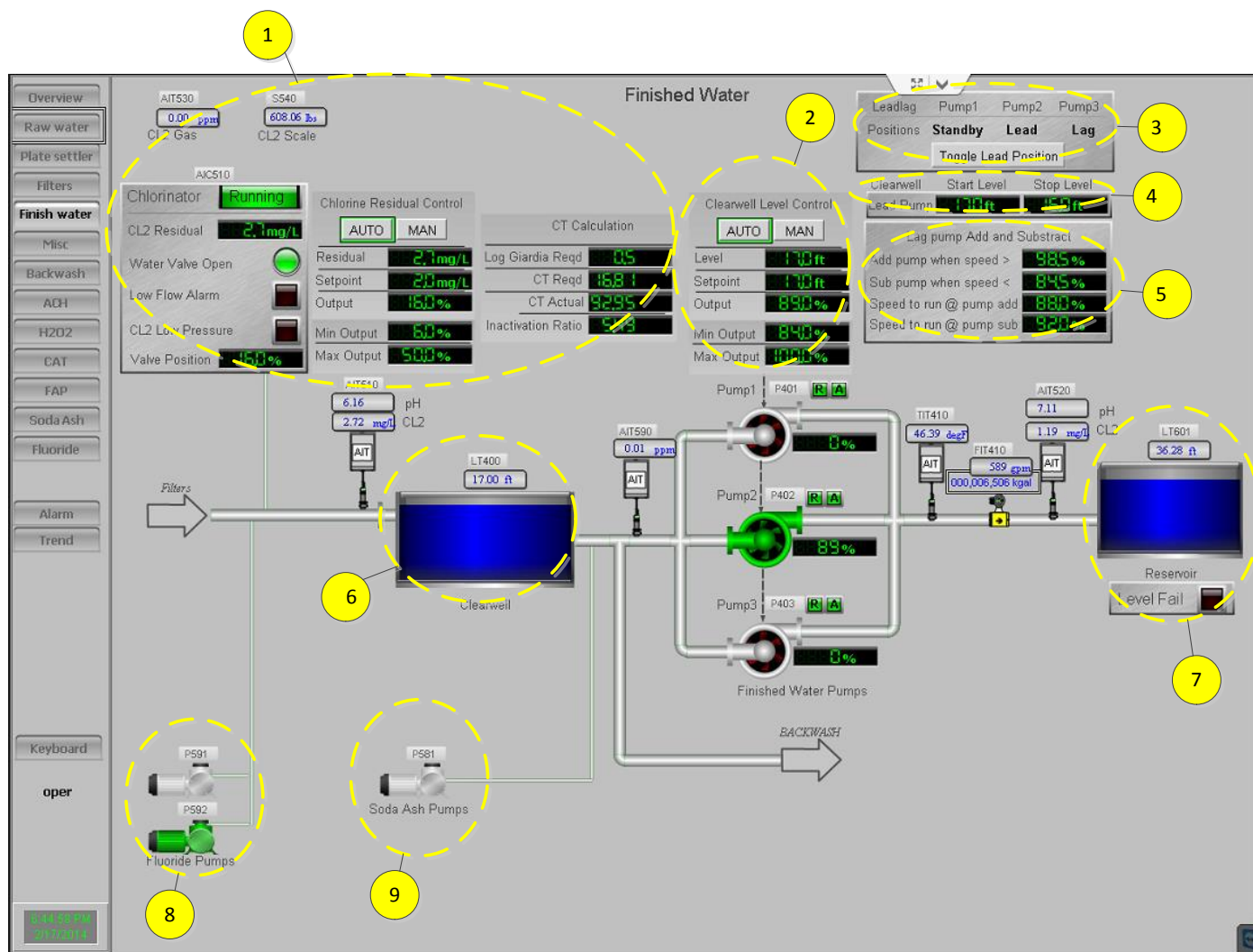


FIGURE 5-10
Finished Water HMI Screen

1. Chlorinator Control and Status: Controls chlorine dose, chlorinator status, and shows alarms for the chlorine system.
2. Clearwell Level Control: Controls the distribution pump speed to maintain clearwell level.
3. Finished Water Pump Lead/Lag Standby: Controls the lead/lag/standby status of the finished water pumps.
4. Clearwell Level: Displays the levels used for starting and stopping the distribution pumps.
5. Lag Pump Add and Subtract: Controls the pump speeds used for starting and stopping the lag pump.
6. Clearwell: Shows the level of the clearwell.
7. Distribution System Reservoir: shows the level of the distribution system reservoir and if the level signal from the reservoir fails.
8. Fluoride Pump: Shows the status of the fluoride pumps
9. Soda Ash Pump: Shows the status of the soda ash pump.

Chlorinator Operation

The chlorinator turns on and off automatically with the raw water pumps. Chlorine gas is fed through an automated valve into a carrier water system. The carrier water system has a solenoid valve that opens when the plant is online. The status of this valve is indicated on the Chlorinator Control box. If there is low flow through this line or low gas pressure, alarms will light up in this box. The chlorinator valve position is indicated as well.

Chlorine can be dosed automatically to maintain a residual going into the clearwell. A chlorine sample is taken just downstream of the chlorine injection point, and the chlorinator valve position is modulated to achieve the desired residual setpoint. There are minimum and maximum valve positions that can be set by the Operator.

The chlorine scale signal is displayed above the chlorinator status as well as the chlorine gas detector from the chlorine room.



FIGURE 5-11
Chlorinator Control Area

Disinfection CT is calculated continuously using the finished water flow, clearwell level, pre-clearwell pH, finished water temperature, and finished water chlorine residual. The SCADA system uses the following equations:

$$CT_{actual} = FWChlorineResidual \left(\frac{mg}{L} \right) * \left[\left(\frac{353}{FWflow(gpm)} \right) + 0.5 * \left[95,171 \left(\frac{ClearwellLevel(ft)/19}{FWflow(gpm)} \right) \right] + \left(\frac{3133}{FWflow(gpm)} \right) \right]$$

Where:

FW Chlorine Residual = AIT 520 (mg/L)

FW Flow = FIT 410 (gpm)

Clearwell Level = LT 400 (feet)

$$CT_{required} = (0.353 * InactivationRequired) * (12.006 + e^{2.46 - 0.073 * temp + 0.125 * FWChlorineResidual + 0.389 * pH}) \text{ for } temp < 12.5C$$

$$CT_{required} = (0.361 * InactivationRequired) * (-2.261 + e^{2.69 - 0.065 * temp + 0.111 * FWChlorineResidual + 0.361 * pH}) \text{ for } temp \geq 12.5C$$

Where:

I = the number of logs inactivation required (Operator input)

Temp= Temperature, TIT 410 (degrees C)

C = Chlorine Residual, AIT 520 (mg/L)

pH = pH, AIT 510A (new, pre clearwell)

e = 2.7183, the base for the natural logarithm

$$InactivationRatio = \frac{CT_{actual}}{CT_{required}}$$

Finished Water Pump Control

Each finished water pump has an individual faceplate that shows if the pump is being called to run, on, in remote, and ready to run. It also has a manual switch for manual/off/auto selection, and a runtime calculator, a number of cycles, and indicators for fault and failure. Details of these controls can be found in Section 5.3.18, Standard Functions.

In addition to individual pump control, the pumps automatically start and stop to meet the plant flow requirements and can be cycled through lead/lag/standby positions. The current lead/lag/standby position is shown in area (3) on the Finished Water HMI screen. This area shows which pump is in lead/lag/ and standby. The positions are set until the “Toggle Lead Position” button is pressed, at which point the lead/lag/standby assignment will change.

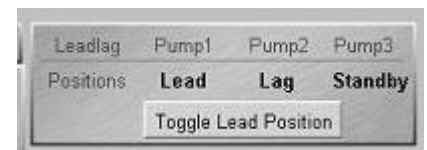


FIGURE 5-12
Lead/Lag/Standby Toggle

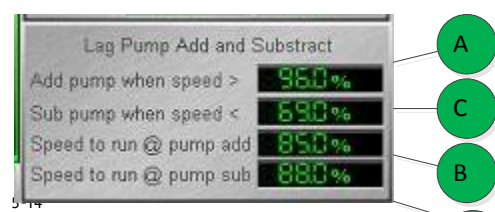


FIGURE 5-13
Lag Pump Speed Control

The control system will automatically start and stop pumps based on the “Lag Pump

Add and Subtract” area shown in area (5) on the Finished Water HMI Screen. The control system automatically starts the finished water pumps with one finished water pump running. If the pump is not able to maintain the clearwell level when it is running at speed (A), the lag pump is brought online at speed (B). When the speed on both pumps is less than the speed (C), the lag pump will be taken offline and the lead pump will run at speed (D), and then adjust to maintain the clearwell level.

Manual control of the raw water pumps allows the pumps to be controlled manually through SCADA by setting a speed. The pump will operate at the given speed regardless of tank levels or other operating parameters.

5.3.8 Miscellaneous

The Miscellaneous screen shows the status of several ancillary systems, as described below.

1. Generator: fault, low fuel, and running. The low fuel sensor is not current installed in the fuel tank.
2. Automatic Transfer Switch: Utility power fail, and indicating Utility or Generator Power
3. UPS: If the uninterruptable power supply fails, this will indicate.
4. Air Compressor: If the pressure in the compressed air manifold is low, this will alarm.
5. Emergency Eyewash: will alarm if the eyewash is in use
6. CP01 PLC: Will alarm if there is a PLC fault and if the battery is low.

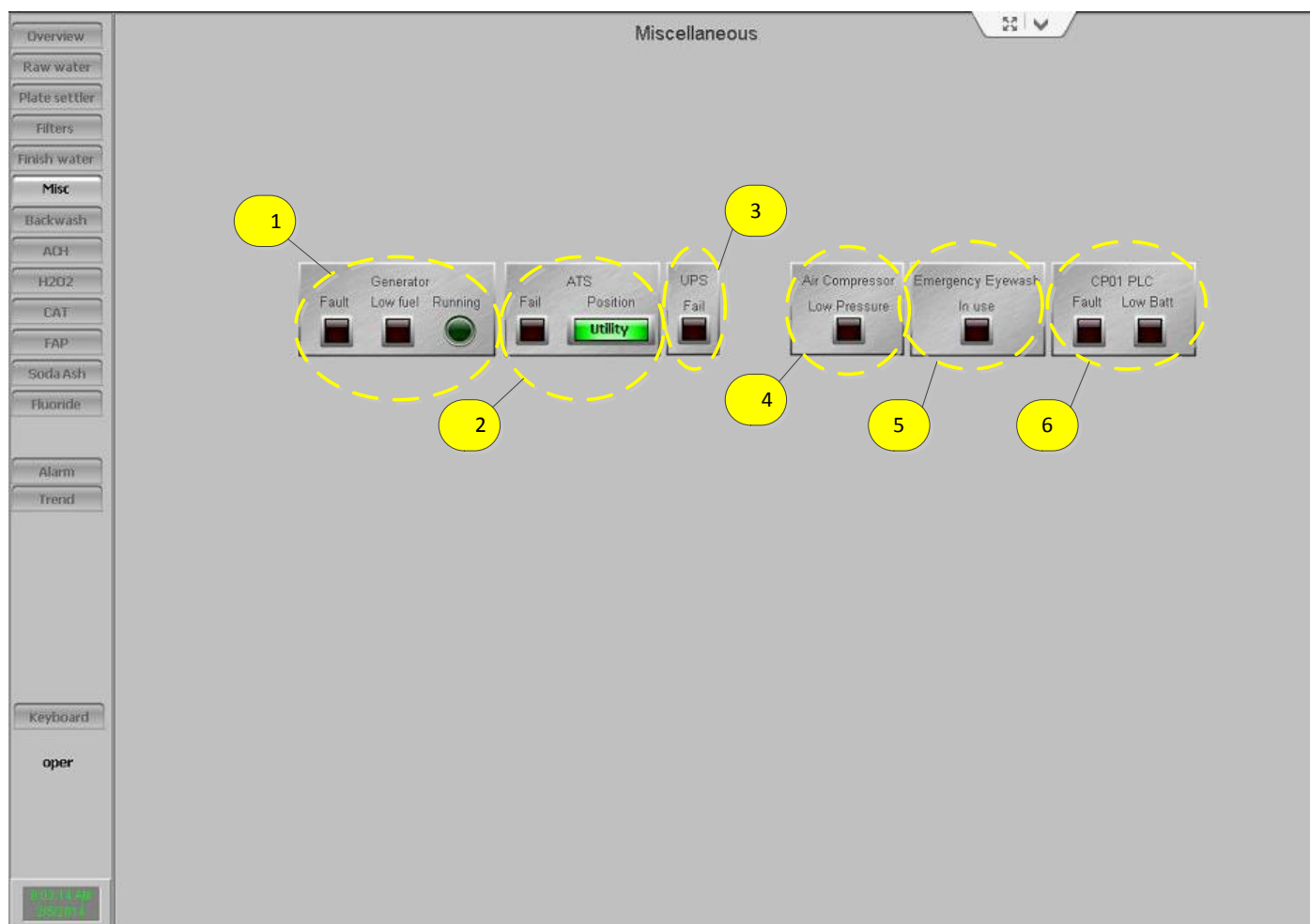


FIGURE 5-14
HMI Miscellaneous Screen

5.3.9 Backwash

The filters require backwashing under several circumstances. The most common is that the headloss through the filters reaches a level that the filter effluent pumps cannot overcome. The less common requirement is that the filtered water turbidity increases above the treatment goals. When a backwash

is required, the plant alarm on either high head loss or high filter effluent turbidity. Backwashes should be performed when operators are on site to observe the backwash and manually hose off the filter effluent troughs.

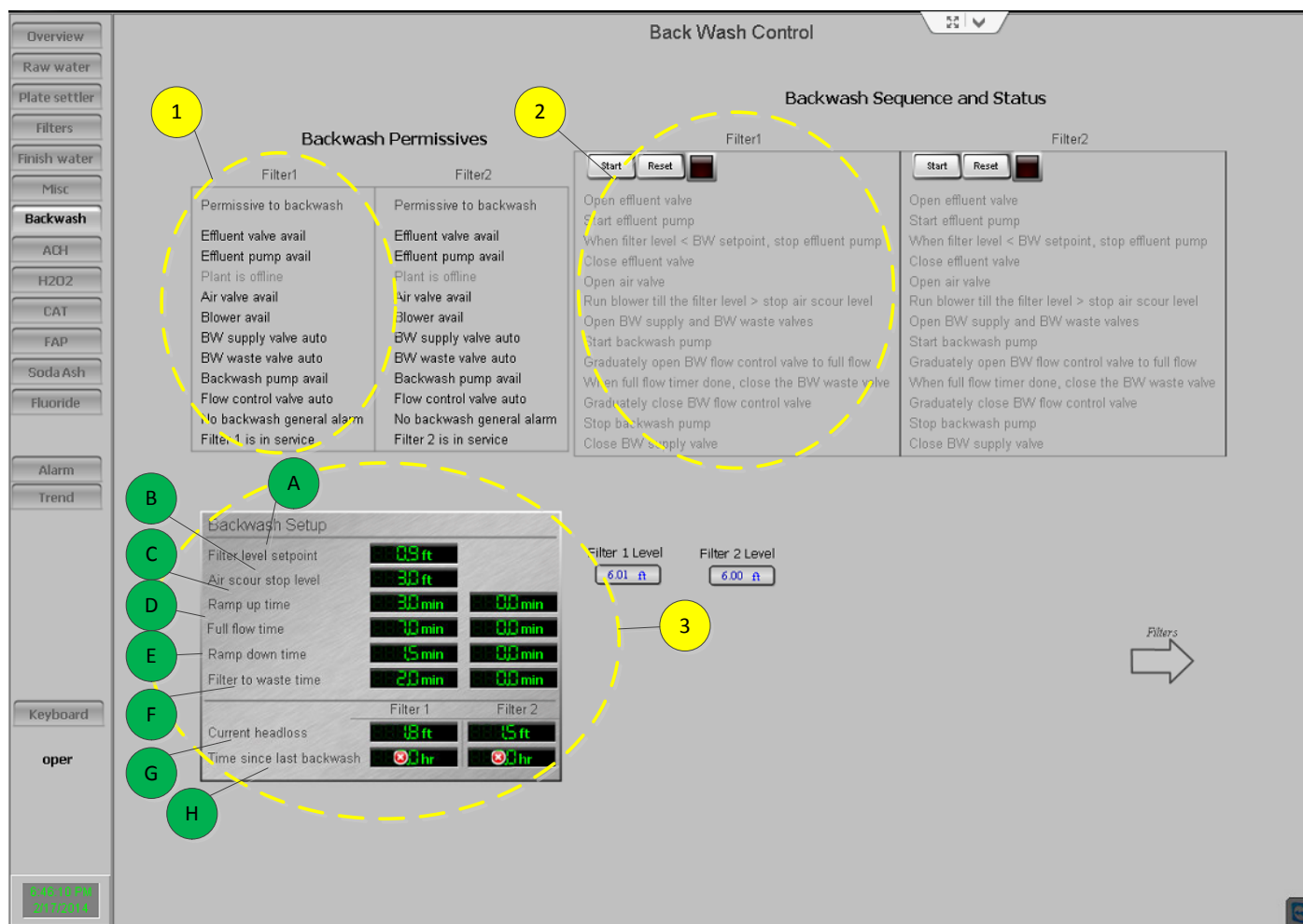


FIGURE 5-15
HMI Backwash Screen

- Area 1 describes the permissive conditions that are required in order to start a backwash. These systems are all required as part of the backwash sequence, and will be bold if they are met and greyed out if they are not.
- Area 2 shows the automatic backwash sequence. Items in this area are bold when the backwash progresses through each step.
- Area 3 shows the setpoints available to the operators to control the backwash as well as a countdown timer on the items that run for a specific time.
 - Pump the remaining water through the filter to an operator adjustable setpoint
 - Run the blower for an air scour until the air/media/water mixture reaches an operator adjustable setpoint

- C. Starting the backwash pump and opening the backwash flow control valve over an operator adjustable time
- D. Running the backwash pump at full flow for an operator adjustable time
- E. Ramping down the backwash flow by closing the backwash control valve over an operator adjustable time.
- F. The filters then filter to waste for an operator adjustable time.
- G. The current filter headloss is shown
- H. The time since the last backwash is shown.

In order to perform a backwash, the clearwell must be full. Operators should stop the plant when the clearwell level is at least 17 feet. Once the plant shuts down (first distribution pumps, then raw water pumps, and lastly the filter effluent pumps) a backwash can be started. The Backwash Control screen covers the details of the backwash sequence and is shown below. To trigger a backwash, confirm the settings for the backwash sequence, and then select the start button for the filter that should be backwashed. There are permissive conditions to allow a backwash which are shown for each filter (1). If the backwash is interrupted, it can be reset with the RESET button, then restarted with the start button. During a backwash the individual steps will change from grey to black in the filter being backwashed as they are completed (2).

5.3.10 ACH

Aluminum Chlorohydrate, ACH, is the primary coagulant and has two control strategies: Constant dose flow pacing, and streaming current control. The two options are shown on the top left side of the pump control screen. The ACH screen is shown in Figure 5-16. The different dose controls are discussed in the sections below. In addition to the pump dosing control, Pump Lead/Lag control is shown (4). The pumps can be operated as a duty/standby with operator control, or alternated by the SCADA system using the Last Off or Runtime options. Clicking on each pump (5) bring up the individual pump control faceplate described in the Standard Function Section below.

5.3.10.1 Streaming Current Control

Streaming Current control adjusts the pump speed to maintain an operator adjustable streaming current setpoint. The streaming current control area (1) allows the operator to set a minimum and maximum dose to ensure that the control system will not over or under dose the chemical. The streaming current control area (1) is only active when the streaming current chemical selection (2) shows which coagulant is controlled by the streaming current meter.

The streaming current chemical selection (2) shows which of the two coagulants (cationic polymer or ACH) is controlled by the streaming current meter. Either ACH, cationic polymer, or neither chemical can be controlled by streaming current. It is not possible to control both chemicals with the streaming current analyzer.

5.3.10.2 Dose Control

Dose control adjusts the pump speed to maintain an operator adjustable dose setpoint. The required pump speed is calculated by the SCADA system based on the operator adjustable dose, the concentration of the chemical, the metering pump calibration data, and the raw water flow. The HMI shows the required pumping speed, and the pump shows the actual pump speed. The calibration of metering pumps is discussed in Section 5.3.18 Standard Control Functions.

The metering pumps can be operated manually by selecting the manual option under “Mode Select” and inputting a manual pump speed. When this mode is active the pump will turn on and off with the plant flow, but will not adjust to changes in plant flow.

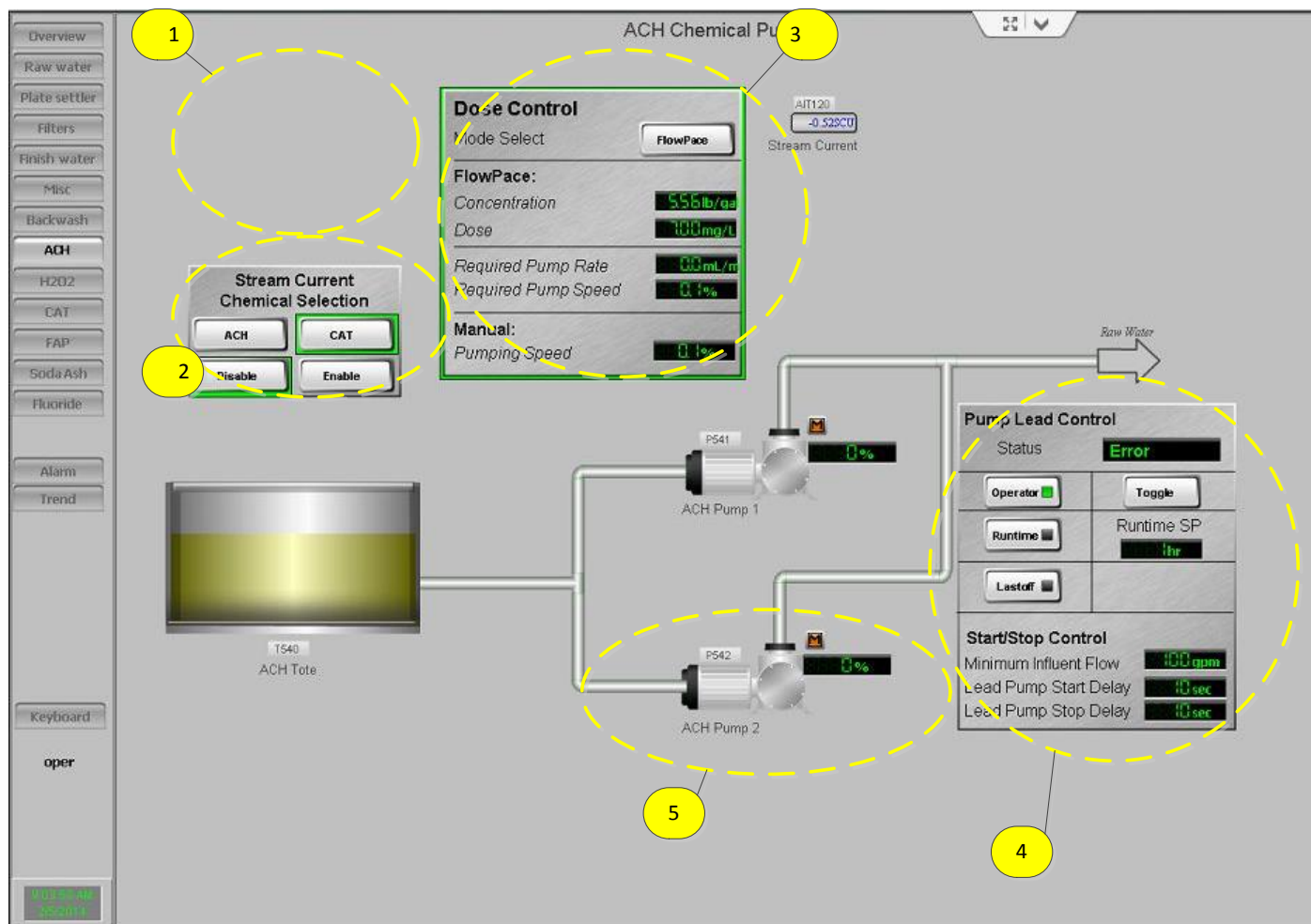


FIGURE 5-16
ACH Control HMI Screen

5.3.11 Peroxide

Hydrogen Peroxide is used to reduce algae and other fouling in the plate settlers and filters prior to chlorine injection. The peroxide HMI screen allows control of the metering pumps. The peroxide delivery is controlled by dose control (1). In addition to the pump dosing control, Pump Lead/Lag control is shown (2). The pumps can be operated as a duty/standby with operator control, or alternated by the SCADA system using the Last Off or Runtime options. Each pump has a control faceplate described in the Standard Function Section below (3).

Dose control adjusts the pump speed to maintain an operator adjustable dose setpoint. The required pump speed is calculated by the SCADA system based on the operator adjustable dose, the concentration of the chemical, the raw water flow and the metering pump calibration data. The HMI shows the required pumping speed, and the pump shows the actual pump speed. The calibration of metering pumps is discussed in Section 5.3.18 Standard Control Functions.

The metering pumps can be operated manually by selecting the manual option under “Mode Select” and inputting a manual pump speed. When this mode is active the pump will turn on and off with the plant flow, but will not adjust to changes in plant flow.

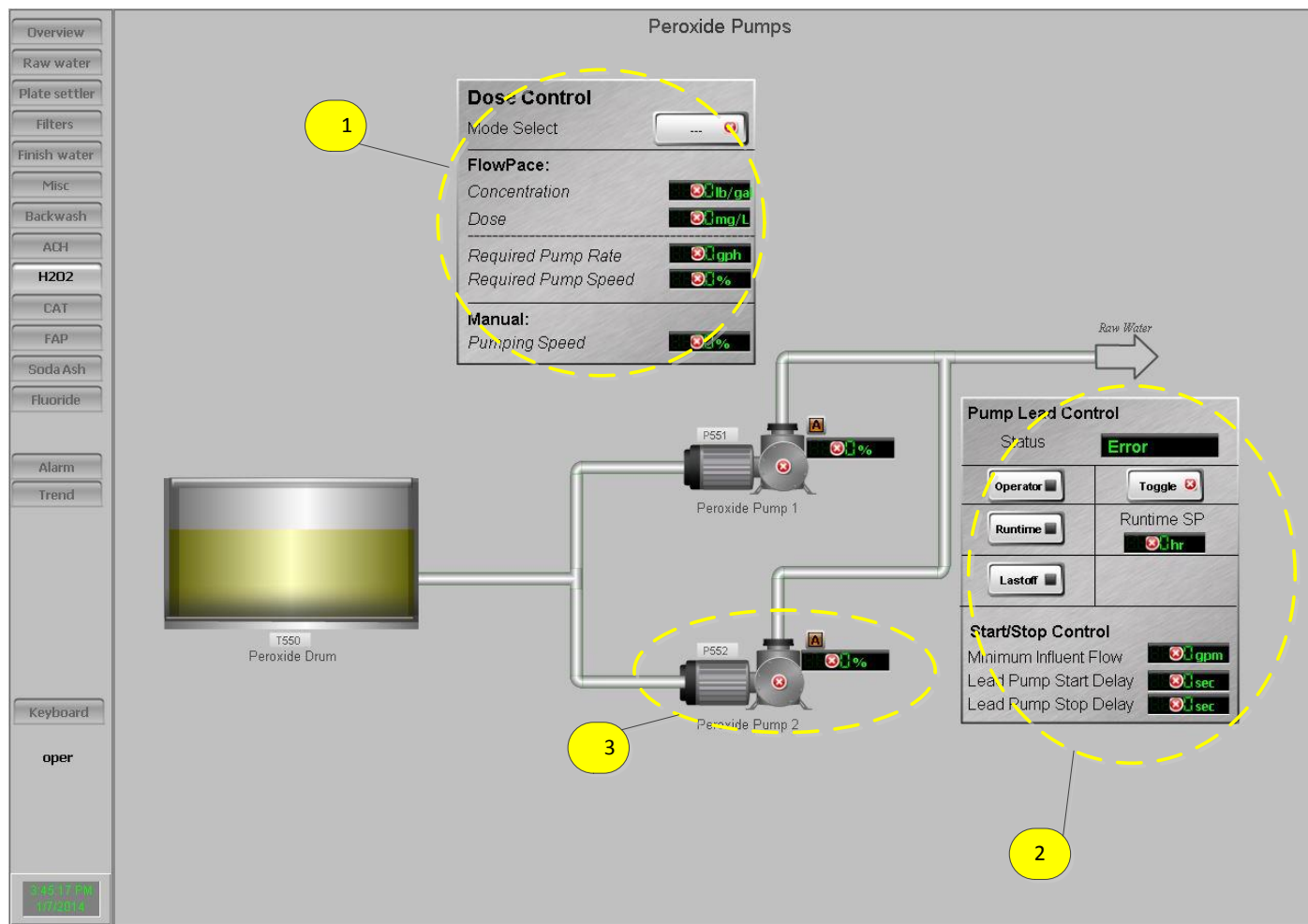


FIGURE 5-17
Peroxide Pump Control HMI Screen

5.3.12 Cationic Polymer

The Cationic Polymer has two control strategies: Constant dose flow pacing, and streaming current control. The two options are shown on the top left side of the pump control screen. The Cationic Polymer screen is shown in Figure 5-18. The different dose controls are discussed in the sections below. In addition to the pump dosing control, Pump Lead/Lag control is shown (4). The pumps can be operated as a duty/standby with operator control, or alternated by the SCADA system using the Last Off or Runtime options. Each pump has a control faceplate described in the Standard Function Section below (5).

5.3.12.1 Streaming Current Control:

Streaming Current control adjusts the pump speed to maintain an operator adjustable streaming current setpoint. The streaming current control area (1) allows the operator to set a minimum and maximum dose to ensure that the control system will not overdose the chemical.

The streaming current chemical selection (2) shows which of the two coagulants (cationic polymer or ACH) is controlled by the streaming current meter.

5.3.12.2 Dose Control:

Dose control adjusts the pump speed to maintain an operator adjustable dose setpoint. The required pump speed is calculated by the SCADA system based on the operator adjustable dose, the concentration of the chemical, raw water flow, and the metering pump calibration data. The HMI shows the required pumping speed, and the pump shows the actual pump speed. The calibration of metering pumps is discussed in Section 5.3.18 Standard Control Functions.

The metering pumps can be operated manually by selecting the manual option under “Mode Select” and inputting a manual pump speed. When this mode is active the pump will turn on and off with the plant flow, but will not adjust to changes in plant flow.

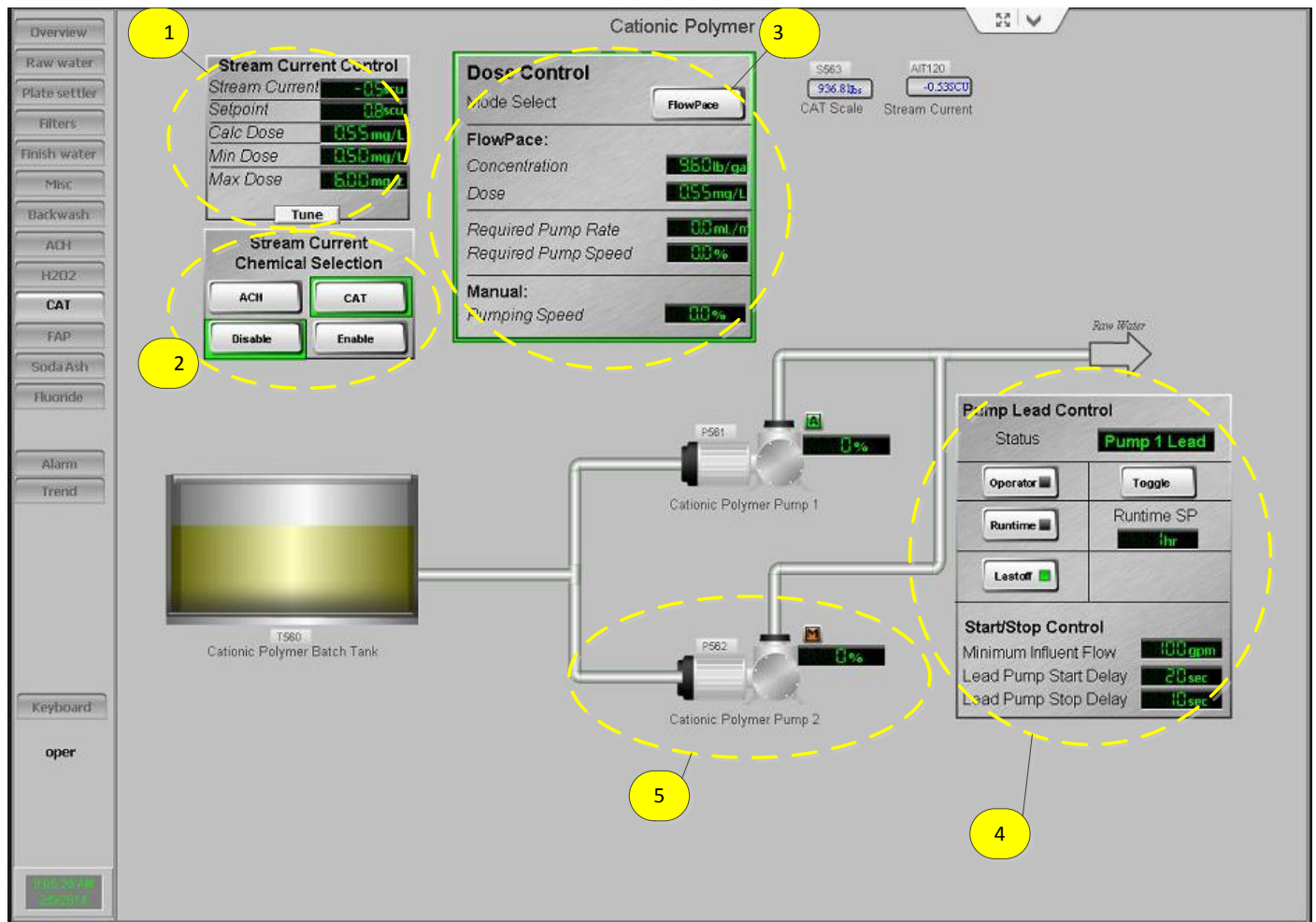


FIGURE 5-18
Cationic Polymer Pump Control HMI Screen

5.3.13 Filter Aid Polymer

Filter Aid Polymer is used during storm events to enhance filtration. The filter aid polymer HMI screen allows control of the metering pumps and the carrier water system. The filter aid polymer delivery is controlled by the dose control (1). The carrier water system (2) comes on automatically when the filter aid polymer pumps are turned on. There is a flow switch to detect low flow in case there are problems with the carrier water. A manual valve and flow meter allow for adjustment of the carrier water flow rate. In addition to the pump dosing control, Pump Lead/Lag control is shown (3). The pumps can be operated as a duty/standby with operator control, or alternated by the SCADA system using the Last Off or Runtime options. Each pump has a control faceplate described in the Standard Function Section below (4).

Dose control adjusts the pump speed to maintain an operator adjustable dose setpoint. The required pump speed is calculated by the SCADA system based on the operator adjustable dose, the concentration of the chemical, the raw water flow, and the metering pump calibration data. The HMI shows the required pumping speed, and the pump shows the actual pump speed. The calibration of metering pumps is discussed in Section 5.3.18 Standard Control Functions.

The metering pumps can be operated manually by selecting the manual option under “Mode Select” and inputting a manual pump speed. When this mode is active the pump will turn on and off with the plant flow, but will not adjust to changes in plant flow.

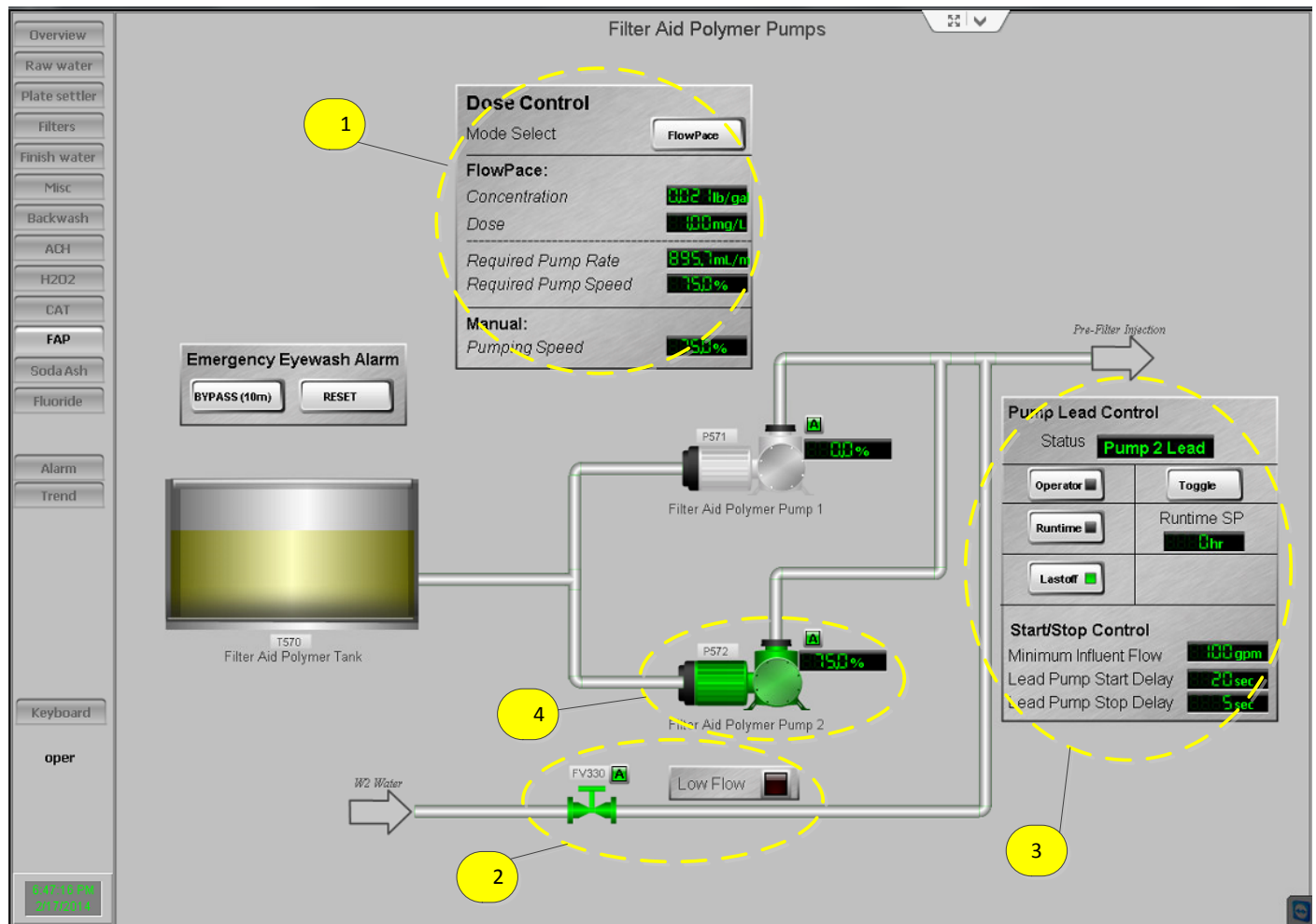


FIGURE 5-19
Filter Aid Polymer Pump Control Screen

5.3.14 Soda Ash

Soda Ash is injected to change the pH of the finished water to reduce corrosion in the distribution system. The Soda ash pump is controlled by a single-loop controller that adjusts the soda ash pump speed to maintain the pH of the finished water. The pump can be turned on and off from the HMI, but it does not send a feedback running signal.

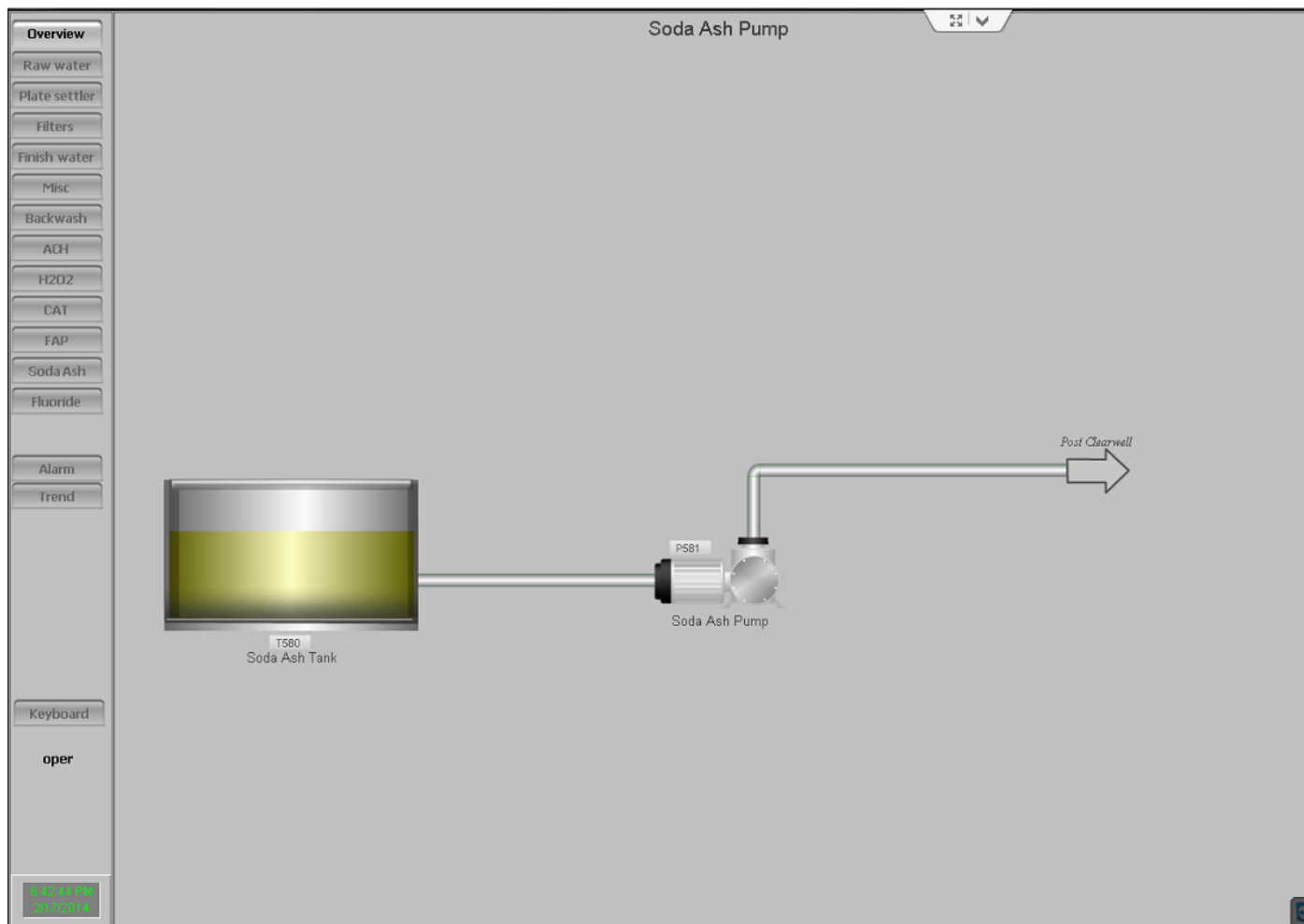


FIGURE 5-20
Soda Ash Control HMI Screen

5.3.15 Fluoride

Sodium Fluoride is used to improve dental health. The peroxide HMI screen allows control of the metering pumps. The fluoride delivery is controlled by the dose control (1). In addition to the pump dosing control, Pump Lead/Lag control is shown (2). The pumps can be operated as a duty/standby with operator control, or alternated by the SCADA system using the Last Off or Runtime options. Each pump has a control faceplate described in the Standard Function Section below (3).

Dose control adjusts the pump speed to maintain an operator adjustable dose setpoint. The required pump speed is calculated by the SCADA system based on the operator adjustable dose, the concentration of the chemical, finished water flow, and the metering pump calibration data. The HMI

shows the required pumping speed, and the pump shows the actual pump speed. The calibration of metering pumps is discussed in Section 5.3.18 Standard Control Functions.

The metering pumps can be operated manually by selecting the manual option under “Mode Select” and inputting a manual pump speed. When this mode is active the pump will turn on and off with the plant flow, but will not adjust to changes in plant flow.

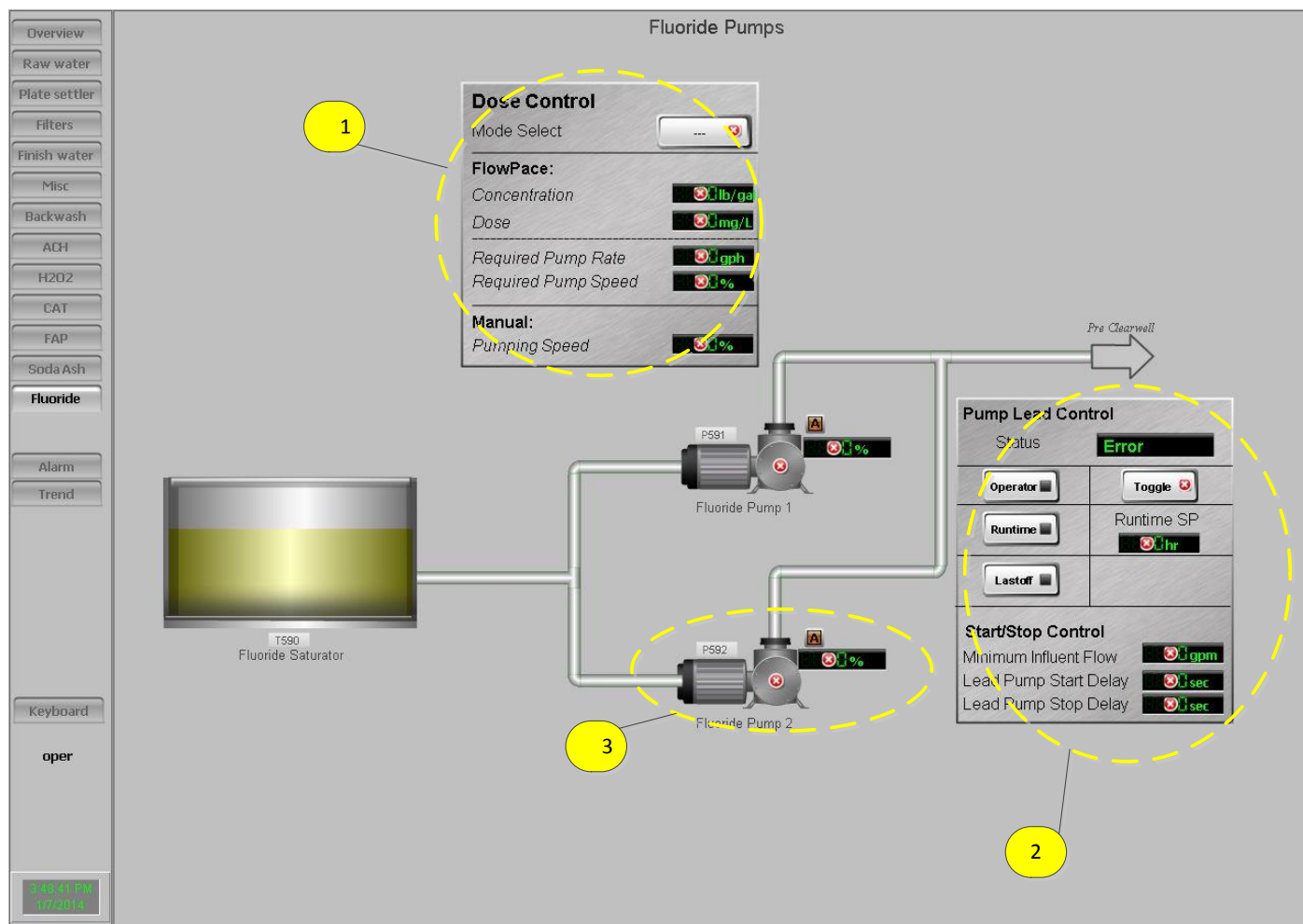


FIGURE 5-21
Fluoride Pump Control HMI Screen

5.3.16 Alarms

There are three ways to get alarm information from the HMI system:

1. Screen animation
2. Alarm summary (footer bar and full page summary)
3. Alarm history

When a device alarm is activated, the device symbol in the HMI screen will be animated with blinking red color to indicate an active alarm in the system. The blinking red color animation will go away when the alarm condition is reset back to normal.

The alarm will be also be listed in the alarm summary (1), which displays alarm details such as tag, description, alarm time, alarm date, and tag value. The color of the text in the alarm summary indicates the current alarm status.

1. Unacknowledged active alarm= red
2. Acknowledged active alarm = purple
3. Unacknowledged Non-active alarm= light blue
4. A non-active alarm will be removed from the alarm summary when it has been acknowledged.

To acknowledge an alarm, highlight the alarm with a mouse click and click on the Acknowledge Selected (2) button.

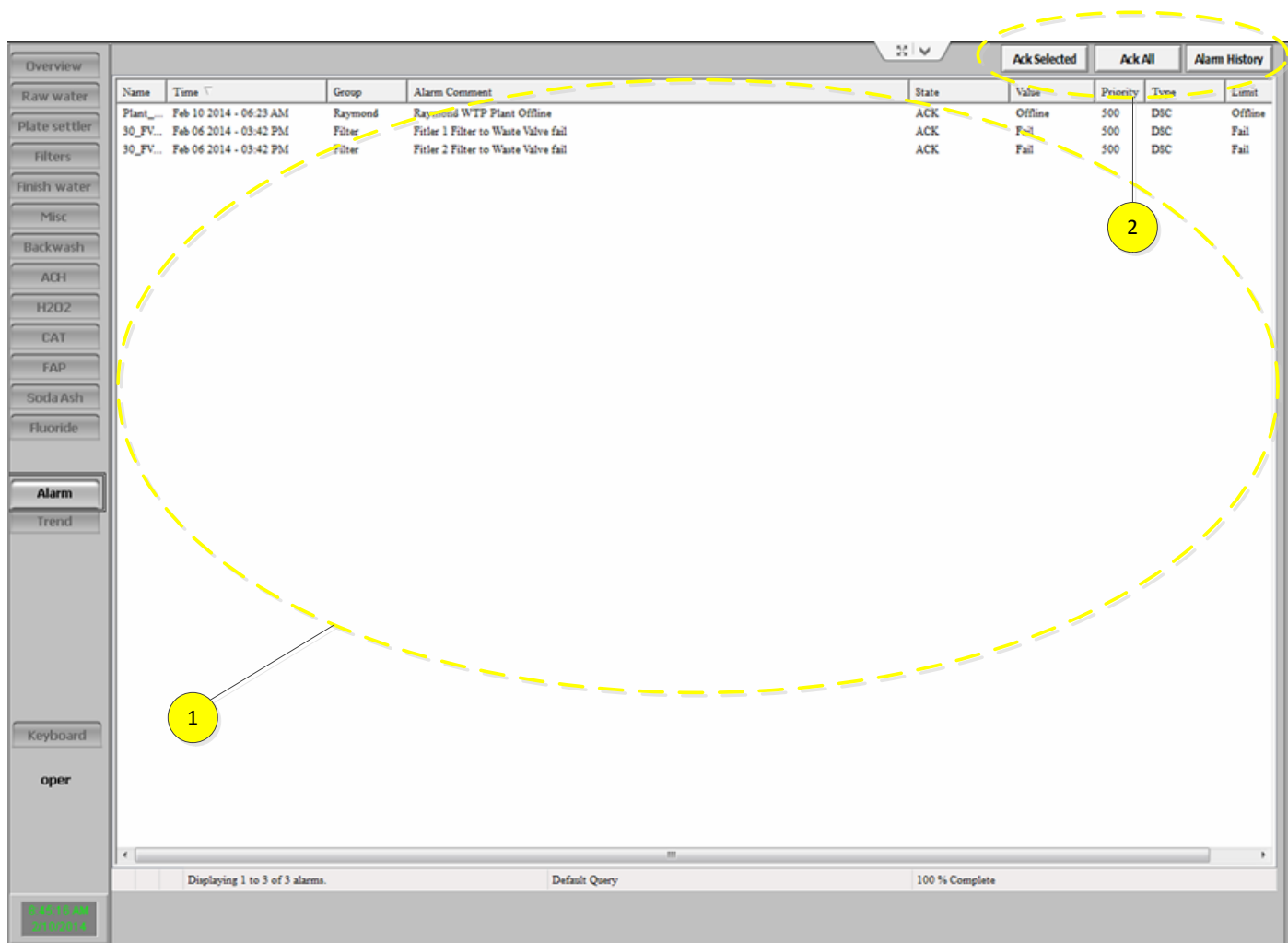


FIGURE 5-22
Alarm Full Page Summary

The HMI system maintains the alarm history records for the last 12 months. The alarm log service in archives the alarm information into the DBF file database format. The DBF file is automatically created

daily under the ALMDLG subfolder. The DBF file database keeps track of the all alarms that go in and out of the system.

AlarmSummary										
Time /	State	Class	Type	Priority	Name	Group	Provider	Value	Limit	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P560_Shift'Min...	Chemical	RaymondHMI In...	100	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P560_Shift Start...	Chemical	RaymondHMI In...	20	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P560_Shift Stop...	Chemical	RaymondHMI In...	10	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_561'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_562'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P550_Shift'Min...	Chemical	RaymondHMI In...	100	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P550_Shift Start...	Chemical	RaymondHMI In...	20	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P550_Shift Stop...	Chemical	RaymondHMI In...	10	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_551'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_552'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P560_Shift ET...	Chemical	RaymondHMI In...	1	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P570_Shift'Min...	Chemical	RaymondHMI In...	100	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P570_Shift Start...	Chemical	RaymondHMI In...	20	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P570_Shift Stop...	Chemical	RaymondHMI In...	5	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_571'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_572'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P580_Shift'Min...	Chemical	RaymondHMI In...	100	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P580_Shift Start...	Chemical	RaymondHMI In...	20	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P580_Shift Stop...	Chemical	RaymondHMI In...	10	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_581'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P590_Shift'Min...	Chemical	RaymondHMI In...	100	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P590_Shift Start...	Chemical	RaymondHMI In...	10	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	P590_Shift Stop...	Chemical	RaymondHMI In...	10	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_591'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	50_P_592'iMode	Chemical	RaymondHMI In...	Auto	Manua	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT311'DisableAL	Filter	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT311'Disable...	Filter	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT311'HiHiLimit	Filter	RaymondHMI In...	7	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT311'HiLiLimit	Filter	RaymondHMI In...	6.5	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'DisableAL	Filter	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'Disable...	Filter	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'HiHiLimit	Filter	RaymondHMI In...	7	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'HiLiLimit	Filter	RaymondHMI In...	6.5	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'LoLiLimit	Filter	RaymondHMI In...	2	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	PIT312'LoLoLi...	Filter	RaymondHMI In...	1	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'Disable...	Distribution	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'Disable...	Distribution	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'Disable...	Distribution	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'Disable...	Distribution	RaymondHMI In...	Dis	En	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'HiHiLi...	Distribution	RaymondHMI In...	3000	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT540'HiLiLimit	Distribution	RaymondHMI In...	2500	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT563'HiHiLi...	Distribution	RaymondHMI In...	1000	0	
Feb 18 2014 - 09:13 AM		EVENT	DDE	999	WIT563'HiLiLimit	Distribution	RaymondHMI In...	900	0	

FIGURE 5-23
Alarm History Screen

5.3.17 Trending Screen

Historical data of the critical and important process variables are stored on the local facility PLC. Trending provides monitoring for the current and historical value of process variables. It should also be used to fill in monthly operator reports. The historical data serves as the official plant record. Several trend screens are created to facilitate fast and easy access to groups of variables that might be of user interest: CT Values, Flows, Water Quality, and Water Quality 2. Each of these trend screens are accessible on the “Open Trend” Window. The Local Historian Trends are stored only locally.

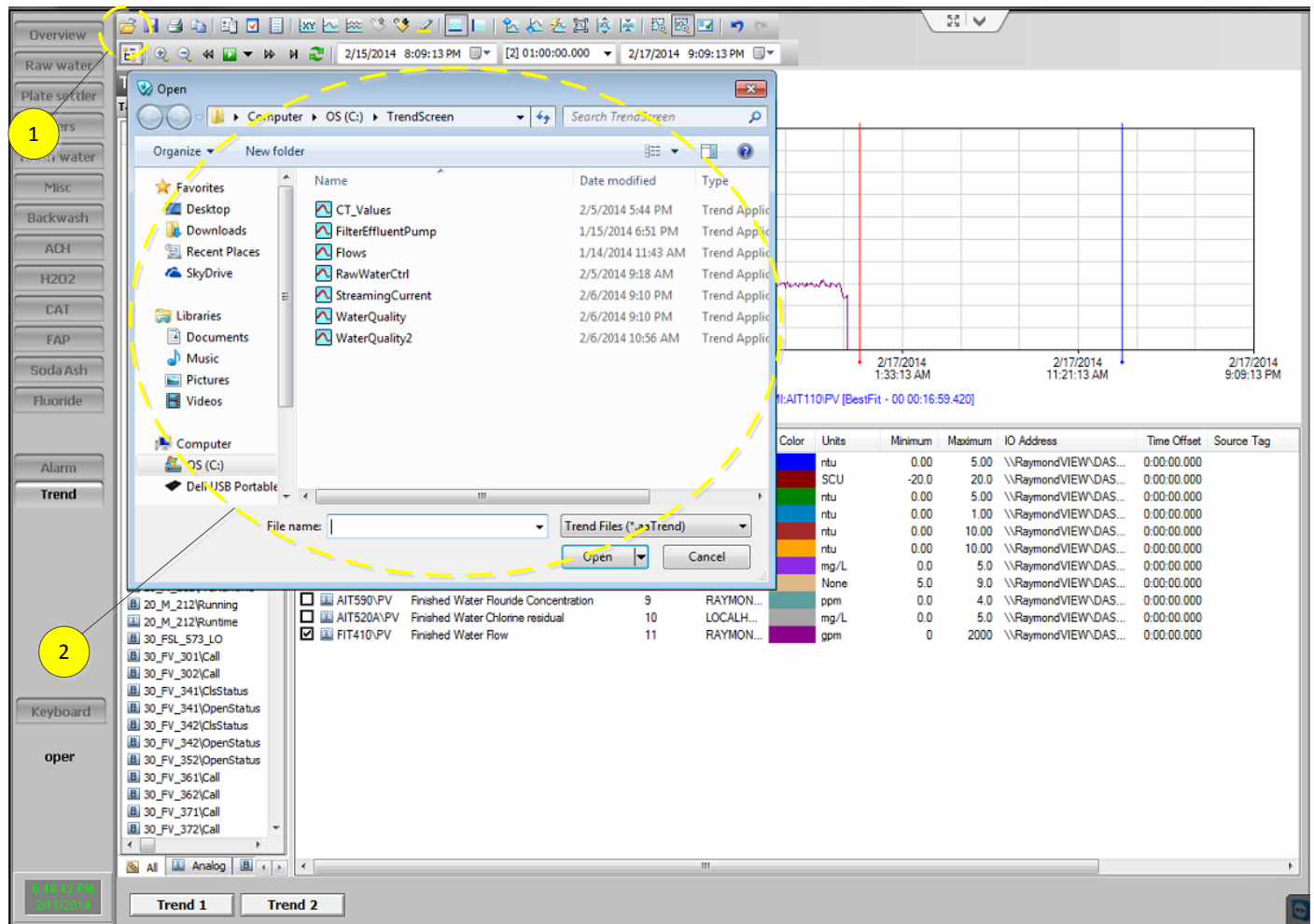


FIGURE 5-24
HMI Trend Selection

The Open Trend icon (1) will open a window (2) listing the trends that have been created. Double clicking a trend group will open the trend data in the main trending window.

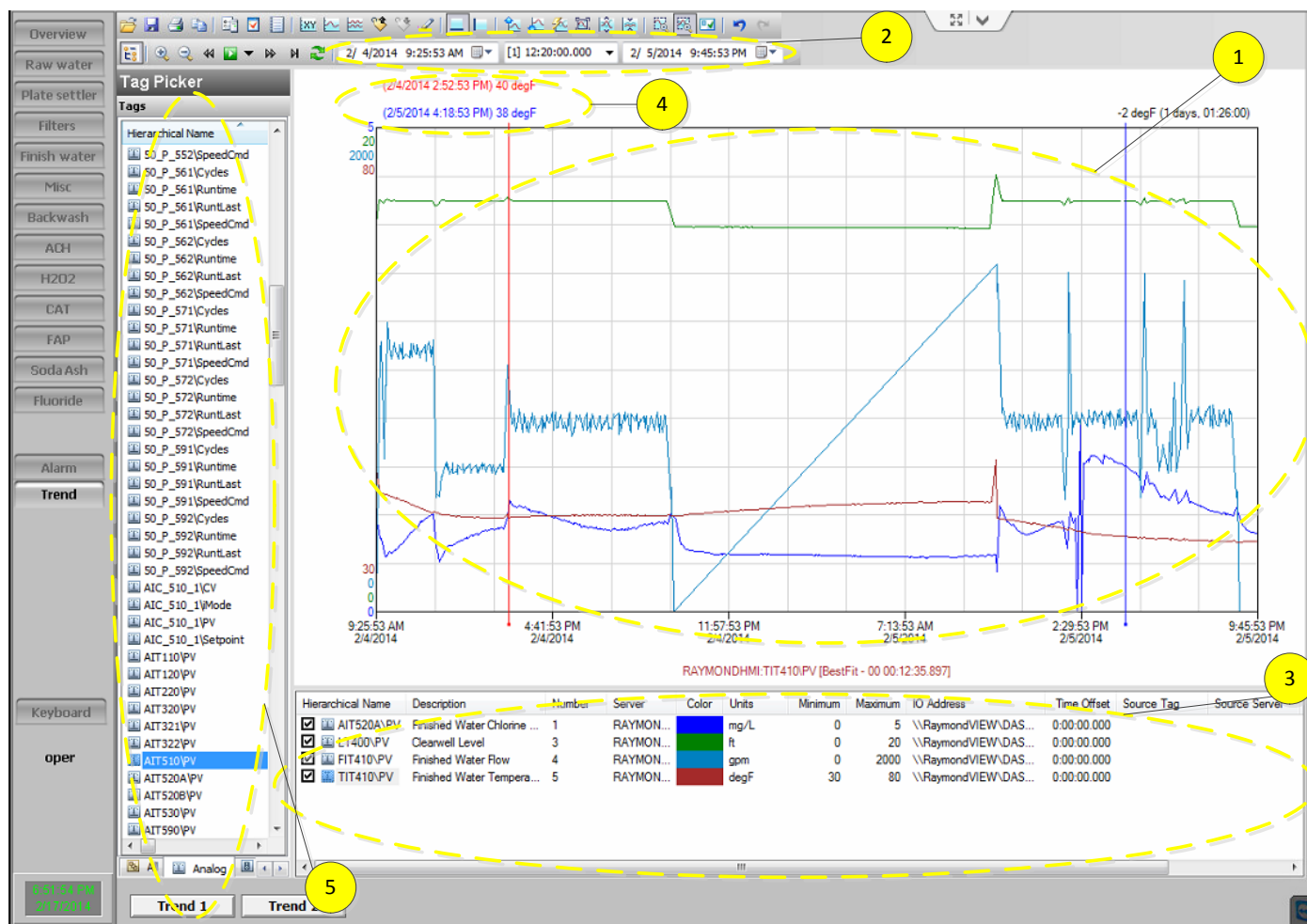


FIGURE 5-25
HMI Trend Example

The figure above shows a snapshot of the CT Values Trend Screen. The trends are shown in the main window (1). The time can be selected for a specific date/time range, or a pre specified range (such as 1 hour, 2 hours, 24 hours, etc) (2). The specific tags being shown in the trend are listed with their color and scale in the bottom of the window (3). The exact values of one of the trends can be determined by highlighting the trend (such as TIT410 in the example above) in the trend list. Once a trend is selected the red and blue vertical bars indicate the times shown with the value at that time in the top left part of the trend area (4). Additional trends can be added to the window using the Tag Picker (5).

The following table displays the list of variables and their scale associated with each of the trend screens.

TABLE 5-1
Raymond WTP Trend Screen Details

	Variable	Hierarchal Name	Scale
CT_Values			
1	Finished Water Chlorine Residual	AIT520A\PV	0 – 5
2	Clearwell Level	LT400\PV	0-20
3	Finished Water Flow	FIT400\PV	0 – 2,000
4	Finished Water Temperature	TIT410\PV	30-80
5	Pre-Clearwell pH	AIT510A\PV	5-9
6	Inactivation Ratio	Inact_Ratio	0 - 5
Flows			
1	Raw Water Flow	FIT110\PV	0 – 2,000
2	Finished Water Flow	FIT410\PV	0 – 2,000
3	Reservoir Level	LT601\PV	0 – 50
4	Clearwell Level	LT400\PV	0 – 20
Water Quality			
1	Raw Water Turbidity	AIT110\PV	0 – 5
2	Raw Water Streaming Current	AIT120\PV	-20-20
3	Settled Water Turbidity	AIT220\PV	0-5
4	Combined Filter Effluent Turbidity	AIT320\PV	0-1
5	Filter 1 Turbidity	AIT321\PV	0-1
6	Filter 2 Turbidity	AIT322\PV	0-1
7	Pre-Clearwell Chlorine Residual	AIT510\PV	0-5
8	Finished Water pH	AIT520B\PV	5-9
9	Finished Water Fluoride Concentration	AIT590\PV	0-4
10	Finished Water Chlorine Residual	AIT520A\PV	0-5
11	Finished Water Flow	FIT410\PV	0-2,000
Water Quality 2			
1	Finished Water Flow		0 – 5
2	Finished Water pH		50 - 100

5.3.18 Standard Functions

The control system uses a set of standard monitoring and control functions. For Example, it is a “standard function” that a reading from a transmitter is displayed as the transmitted value on the HMI.

5.3.18.1 Metering Pumps

The Metering Pump controls control pump on/off status, calibration, and maintenance intervals on three tabs.

Oper. Tab

Shows details of the operation of each pump

1. Speed (can be entered manually with Manual operation, otherwise shows current speed)
2. Call is bright green when the pump is called to run
3. On is bright green when the pumps is on
4. Auto/Manual selection buttons for pump control
5. Interlock is red when there is a control interlock stopping the pump from running
6. Fault is red when the pump is in fault
7. Fail is red when the pump has failed
8. Fail reset will reset the pump

Details Tab

Sets the calibration curves for each pump

9. Calibration curve for the metering pump. Enter data based on pump drawdown.

Maint. Tab

Documents maintenance records from the pump

10. Runtime (hours) can be manually reset
11. Runtime Last shows the runtime at the previous reset
12. Cycles shows start/stop since last reset

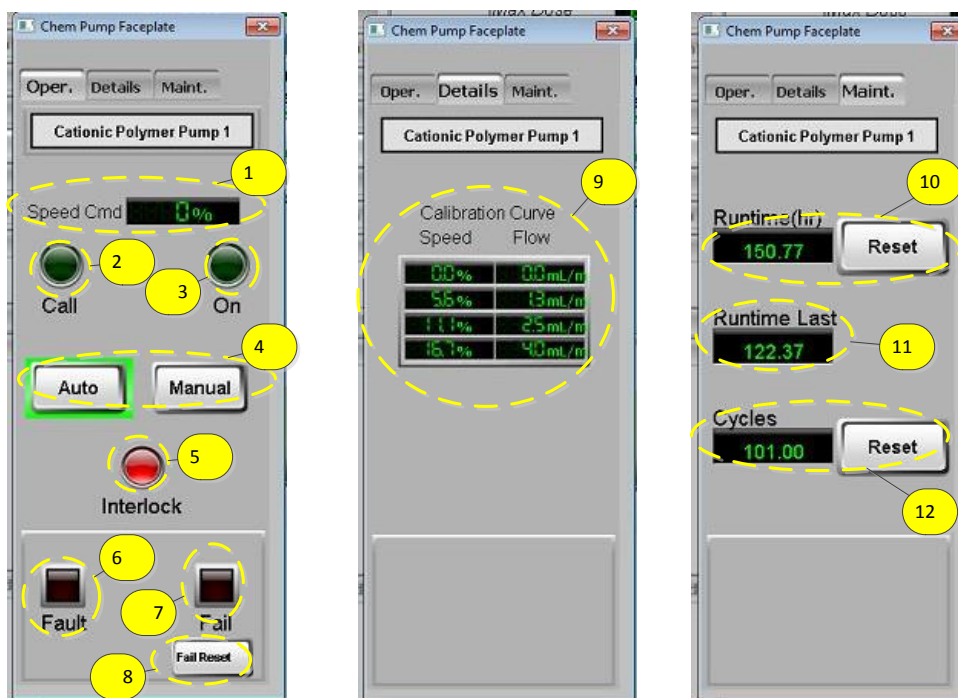


FIGURE 5-26
Metering Pump Standard Functions

Metering Pump Calibration

The chemical metering pumps should be calibrated periodically. To perform a calibration, put the pump in Manual Mode. Perform a drawdown of the calibration cylinder, recording the pump speed and chemical flow at 4 speed setpoints. Enter this information under the “Details” tab of the metering pump control.

5.3.18.2 Analog Inputs

Display real-time values at the HMI. Each analog item has a faceplate that shows data and ranges for the meter.

Value: Shows the current value.

Max EU/Min EU: Describes the maximum and minimum Engineering Unit on the scale.

Signal Status: Displays “OK” when the PLC-meter connection is good.

Alarms: The HMI allows alarm limits to be set for Analog input points. The bell icon will appear crossed out when the alarm is turned off. Care should be taken in turning alarms off.

LL: Low Low – setpoint for low-low alarm

L: Low – setpoint for low alarm

H: High – setpoint for high alarm

HH: High High – setpoint for high-high alarm

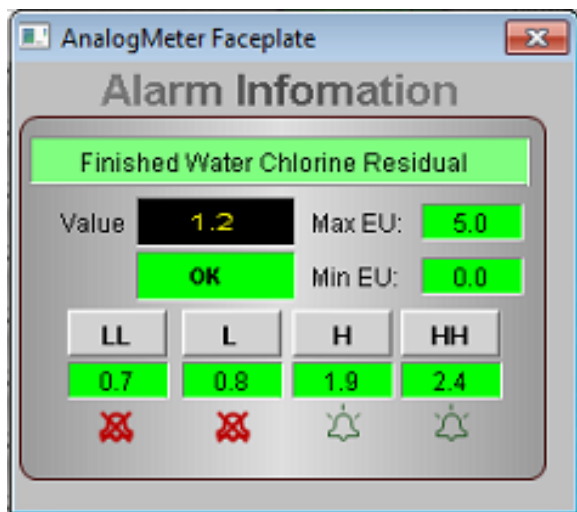


FIGURE 5-27
Analog Meter Faceplate HMI Control

5.3.18.3 Calculated Analog Values

Calculated analog values are values that are not received by controllers as analog inputs but are computed by the controllers or HMI. They are displayed next to the meter used to calculate the present value.

HMI display: Value and Engineering Unit display



FIGURE 5-28
Calculated Analog Values HMI Control

5.3.18.4 Discrete Inputs

Display real-time digital value at HMI.

Engineering Units: On/Off state description

Alarms: The HMI handles alarm annunciation. The alarm points are identified in the process narratives.

Alarm time delay: To prevent nuisance alarms, when an alarm condition has been detected, the alarm will be triggered after a certain time delay.

HMI display: On/Off state description with optional alarm animation



FIGURE 5-29
Discrete Inputs HMI control

5.3.18.5 Open-Close Valves with Operator Control

Provides control function for each valve controlled by a PLC for which the PLC receives OPEN, CLOSE and AUTO or REMOTE status signals. The control function allows automatic valve control by the PLC system or manually by the operator from HMI when it is in remote status.

OCA Selector: To place the valve into SCADA auto mode, the selector should be pointed to the A (for Auto). To control the valve in SCADA manual, point the selector to O (Open) or C (Closed).

Call to Open/Call to Close: If the SCADA system is calling the valve to open or close, the respective circle will be illuminated.

Alarm: If the valve is called to change position and does not the fail light will illuminate and an alarm will be displayed. The FAIL RESET button must be pressed to reset the valve.

5.3.18.6 Open-Close Valves with Solenoid Control:

Provides control function for each solenoid operated valve for which the PLC sends OPEN and CLOSE signals only. The control function receives the valve's open/close status and displays it on the HMI screen.

OCA Selector: To place the valve into SCADA auto mode, the selector should be pointed to the A (for Auto). To control the valve in SCADA manual, point the selector to O (Open) or C (Closed).



FIGURE 5-30
Open-Close Valve Faceplates

5.3.18.7 Modulating Valve Control

Provide control function for valves used to modulate flow. The control function allows automatic PLC system valve control or manual operator valve control through the HMI system. The control function uses discrete open and close commands to adjust the valve position. Valve position transmitters provide position feedback.

SCADA Manual: To place the valve into SCADA manual control mode in remote, click on the Manual button at the popup window. When in SCADA manual mode, the operator is able to control the valve's position to desired value by giving a manual position setpoint from HMI. The manual mode button will have a green highlight behind it when the valve is in manual mode.

SCADA Auto: To place the valve into SCADA auto control mode in remote, click on the Auto button at the popup window. When in SCADA auto mode, the PLC shall control the valve's position to match the process narrative defined setpoint.

HMI display: Valve symbol and a popup window. Click on the valve symbol to open the popup window. Valve symbol will indicate the valve's position value together with the SCADA auto/manual mode status and the local/remote control mode status if these signals are available. Valve popup window provides operator interface to switch the valve SCADA auto/manual mode and to set the manual valve position setpoint in SCADA manual mode.

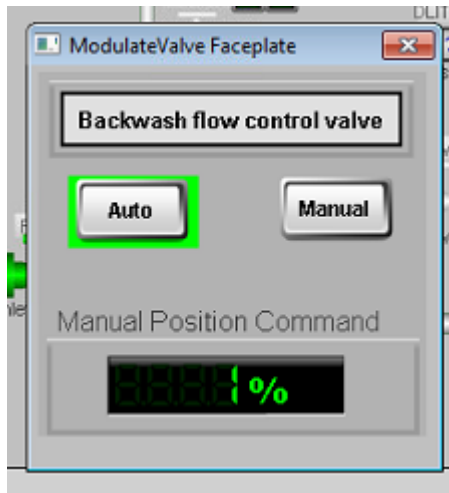


FIGURE 5-31
Modulating Valve Control

5.3.18.8 Set Point Control

Set point control allows user to adjust the set point value by entering a value with keyboard and clicking the Enter key.

Limit Check: If an entered value exceeds the limit set in the PLC, the entered value will be rejected.

HMI display: Operator entry text box with a solid line as shown in the Stop Level setpoint example



FIGURE 5-32
Set Point Control

5.4 Tuning Parameters

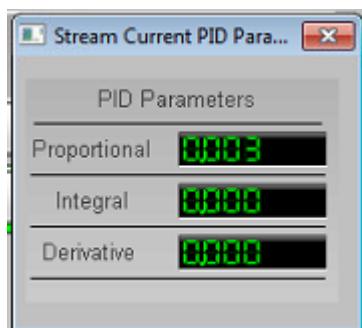
Tuning parameters are provided for the streaming current dose control for the ACH and Cationic Polymer systems. These may need to be adjusted when switching between using the streaming current control for each chemical system. The following sections provide the values programmed at the facility start-up. A PID (proportional-integral-derivative) controller is a generic control loop feedback controller. A PID controller attempts to correct the error between a measured process variable and a desired set point by calculating the difference and then outputting a corrective action that can adjust the process accordingly, to keep the error minimal. The HMI provides faceplate displays and access to PID parameters.

Variables definition:

Proportional- Defines how the output of the controller is scaled in relation to the process variable, which is the process value under control. The value is usually monitored by a transmitter.

Integral- Controls how quickly the SCADA system makes changes to the output in response to the process.

Derivative- Attempts to predict future changes in the system and respond accordingly. This is rarely used.



5.4.1 Cationic Polymer

The streaming current tuning parameters are accessible on the HMI system. These parameters are password-protected for limited access.

Cationic Polymer Streaming Current Controller Parameter

Proportional: 0.003

Integral: 0.00005

Derivative: 0

5.4.2 ACH

The streaming current tuning parameters are accessible on the HMI system. These parameters are password-protected for limited access.

ACH Streaming Current Controller Parameter

Proportional: _____

Integral: _____

Derivative: _____

SECTION 6

Routine Maintenance & Monitoring

The City of Raymond Water Treatment Plant will be maintained in accordance with manufacturer recommendations. Typical maintenance will include standard pump and valve maintenance, washdown of the filter effluent troughs during backwash, periodic washdown of the plate settler units, and calibration of instruments. Manufacturer recommended maintenance activities are outlined in each equipment Operation and Maintenance Manual.

Monitoring of the treatment plant is required to comply with EPA's surface water treatment rules. Reporting forms that must be submitted to WDOH are included in Appendix B.

Forms that must be submitted to the State (Appendix B) include:

WTP Monthly Report – This form includes information on the quantity and quality of water produced, chemicals used, and filter effluent turbidity.

Disinfection Report—This form summarizes the data used to calculate the daily inactivation ratio.

CT Monthly Summary – Summarizes the data collected to monitor plant performance.

Fluoride Report – Documents the amount of fluoride used each day.

Backwash – Documents any sampling done during backwashes.

Appendix A

Selected Record Drawings

Appendix B
Monthly Monitoring and Reporting Forms

Appendix C

Manual CT Calculations

Raymond WTP Manual CT Calculations

CT Required

This equation can be used to calculate the required CT for the treatment plant, regardless of where chlorine is added in the process.

$$CT_{required} = (0.353 * InactivationRequired) * (12.006 + e^{2.46 - 0.073 * temp + 0.125 * FWChlorineResidual + 0.389 * pH}) \text{ for } temp < 12.5C$$

$$CT_{required} = (0.361 * InactivationRequired) * (-2.261 + e^{2.69 - 0.065 * temp + 0.111 * FWChlorineResidual + 0.361 * pH}) \text{ for } temp \geq 12.5C$$

Where:

I = the number of logs inactivation required (Operator input)

Temp = Temperature, TIT 410 (degrees C)

C = Chlorine Residual, AIT 520 (mg/L)

pH = pH, AIT 510A (new, pre clearwell)

e = 2.7183, the base for the natural logarithm

$$InactivationRatio = \frac{CT_{actual}}{CT_{required}}$$

Post Chlorination (Normal Operation)

This calculation applies when chlorine is dosed at the post chlorination location only, upstream of the clearwell. Actual disinfection CT provided is calculated using the finished water flow, clearwell level, pre-clearwell pH, finished water temperature, and finished water chlorine residual. The CT is calculated for three segments: pipe + clearwell + pipe. The SCADA system uses the following equations:

$$CT_{actual} = FWChlorineResidual \left(\frac{mg}{L} \right) * \left[\left(\frac{353}{FWflow(gpm)} \right) + 0.5 * \left[95,171 \left(\frac{ClearwellLevel(ft)}{19} \right) \right] + \left(\frac{3133}{FWflow(gpm)} \right) \right]$$

Where:

FW Chlorine Residual = AIT 520 (mg/L)

FW Flow = FIT 410 (gpm)

Clearwell Level = LT 400 (feet)

Pre Chlorination (No Post Chlorination Addition)

In rare circumstances, disinfection may be accomplished via chlorine addition at the upstream location at the head of the plant. In this case, CT is calculated for the pipeline from the injection point, flocculation & settling tanks, filters, and clearwell and interconnecting piping. The following equation is used:

$$CT_{actual_{prechlor\ only}} = FWChlorineResidual \left(\frac{mg}{L} \right) * \left[\left(\frac{734}{FWflow(gpm)} \right) + 0.5 * \left(\frac{2*29,774}{FWflow(gpm)} \right) + \left(\frac{2*5,385}{FWflow(gpm)} \right) + \left(\frac{353}{FWflow(gpm)} \right) + 0.5 * \left[95,171 \left(\frac{ClearwellLevel(ft)/19}{FWflow(gpm)} \right) \right] + \left(\frac{3133}{FWflow(gpm)} \right) \right]$$

Where:

FW Chlorine Residual = AIT 520 (mg/L)

FW Flow = FIT 410 (gpm)

Clearwell Level = LT 400 (feet)

Floc-Sed Tank Baffling Factor = 0.5

Pre and Post Chlorination

CT can also be calculated when chlorine is added at both the pre- and post-chlorination locations. If the additional CT from the upstream portion is not needed or there is little chlorine residual after the filters, then use the post chlorination CT method. In order to manually calculate CT for the pre and post-chlorination scenario, a chlorine residual grab sample must be collected upstream of the primary chlorine injection point. When CT is calculated, it is done in two parts and summed:

1. CT from pre-chlorination injection point to the sample point. This segment includes pipeline from the injection point, flocculation & settling tanks, and both filters:

$$CT_{actual_{prechlorination}} = GrabSampleChlorineResidual \left(\frac{mg}{L} \right) * \left[\left(\frac{734}{FWflow(gpm)} \right) + 0.5 * \left(\frac{2*29,774}{FWflow(gpm)} \right) + \left(\frac{2*5,385}{FWflow(gpm)} \right) \right]$$

2. CT from primary chlorine injection point to distribution system entry point. This segment includes pipeline between the injection point and the clearwell, clearwell, and pipeline from the clearwell to the finished water sample. This is the same calculation performed by SCADA:

$$CT_{actual_{postchlor}} = FWChlorineResidual \left(\frac{mg}{L} \right) * \left[\left(\frac{353}{FWflow(gpm)} \right) + 0.5 * \left[95,171 \left(\frac{ClearwellLevel(ft)/19}{FWflow(gpm)} \right) \right] + \left(\frac{3133}{FWflow(gpm)} \right) \right]$$

3. The total CT is the sum of CT from the prechlorination segment and the normal chlorination segment.

$$CT = CT_{actual_{prechlorination}} + CT_{actual_{postchlor}}$$

Where:

FW Chlorine Residual = AIT 520 (mg/L)

FW Flow = FIT 410 (gpm)

Clearwell Level = LT 400 (feet)

Floc-Sed Tank Baffling Factor = 0.5