FINAL

WATER SUPPLY INSTRUMENT AND CONTROL SCADA SYSTEM STANDARDS

SCADA Standards and Conventions

B&V PROJECT NO. 183053

PREPARED FOR

Tulsa Metropolitan Utility Authority
SCADA Master Plan

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1.1	September 2019	Michael Graeber	End of Project
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1.4	May 2020	Michael Graeber	Final

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1.0 Introduction

The SCADA System Standards and Conventions Manual is developed and documented as part of the configuration process to ensure consistent application of the tools and functions of the system. This standards and conventions document provides the basis of the work done by Black & Veatch and it also serves as an important guide to the Tulsa Municipal Utility Authority (TMUA), allowing subsequent programming and configuration modifications and additions to be consistent with the initial installation. This document is to be maintained such that it continues to describe the current detailed design of the TMUA SCADA System throughout its life cycle.

1.1 SYSTEM OVERVIEW

TMUA has undertaken upgrading the SCADA System to the A.B. Jewel Water Treatment Plant. One component upgrade is the migration of the existing Wonderware InTouch Human Machine Interface Software to Wonderware System Platform. The other main component is the migration of the existing Programmable Logic Controllers (PLC) from Square D SY/MAX PLC to Allen-Bradley ControlLogix hardware.

1.2 ASSUMPTIONS

This document includes the following assumptions about the reader:

- The reader is familiar with control systems and control system components such as PLCs, HMI and SCADA.
- The reader is familiar with Wonderware System Platform
- The reader is familiar with programming Allen-Bradley ControlLogix PLCs
- The reader is familiar with the systems and processes of TMUA.

2.0 SCADA Hardware and Software

The following sections describe the components of hardware and software packages that are used in the control system. Manufacturer, model numbers, and software versions with the required patches are listed for each component.

2.1 PLC AND RIO HARDWARE

The PLCs are the Allen-Bradley Logix family of controllers. The specific model for each PLC module is listed in Table 1 and Table 2.

Table 2-1 ControlLogix PLC Module Details

CONTROLLOGIX MODULE	CATALOG	SERIES	FIRMWARE REV
CPU	1756-L73	B	24.53
Analog Input	1756-IF16	A	1.001
Analog Output	1756-OF8	A	1.005
Digital Input 16	1756-IA16	A	3.004
Digital Output	1756-OA16	A	3.003
Ethernet (Device Level Ring)	1756-EN2TR	A	10.010
Ethernet	1756-EN2T	A	10.010
Power Supply	1756-PA75	B	N/A

2.2 PLC PROGRAMMING SOFTWARE

The PLCs are programmed using Rockwell Automation's Studio 5000 Version 24.

2.3 HMI SOFTWARE

The installed HMI Software is Wonderware System Platform 2014R2 - Service Pack 1 - Patch 2. System Platform is comprised:

- Wonderware InTouch HMI 2014 (v11.1) R2 SP1
- Wonderware Application Server 2014 (v4.1) R2 SP1
- Wonderware Historian Server 2014 R2 (v11.6) SP1
- Wonderware Historian Client 2014 R2 (v10.6) SP1
- Wonderware Information Server 2014 R2 (v5.6)
- Wonderware InTouch Access Anywhere 2014 R2 (v11.1) SP1

2.4 MICROSOFT SQL SERVER

Wonderware Application Server and Historian Server requires the installation of SQL Server Standard. The installed SQL Server version is 2014 SP1 Standard .

2.5 HMI TO PLC CONNECTIVITY SOFTWARE

The installed I/O Server Software is DASABCIP OI Server 6.1 (G-1 Series)

3.0 Network Configuration

The SCADA System is comprised of various network communication devices. The network shall be configured to isolate traffic of certain SCADA function.

3.1 PLC DEVICE LEVEL RING

Allen-Bradley recommends the use of a Device Level Ring (DLR) to create a stand-alone PLC communications network for Input and Output Cards located in PLC racks external to the main rack where the PLC processor is located. Network switches are integrated into their Ethernet communication modules. It is recommended that no other hardware switches or routers be used as part of the DLR.

3.2 HMI NETWORK

The HMI network is comprised of the necessary computers running different components of Wonderware System Platform as well as network switches and media converters. The HMI Network is also connected to a separate, dedicated Ethernet communication module for each PLC. The HMI network should not connect to the PLC DLR.

3.3 NETWORK IP ADDRESSES

Each device that is connected to the Control System Network has a unique static IP address. The PLC DLR and HMI network will be configured on separate subnets. The last octet of the IP addresses for control system devices are listed below:

Table 3-1 SCADA Network

ADDRESS	DEVICE	DEVICE TYPE
51	High Service Pump Station PLC	ControlLogix PLC
52	Ammonia PLC	ControlLogix PLC
53	Ammonia - Cl2 RIO	ControlLogix Remote I/O Rack
65	HPS 1 Temperature	Modbus Device
66	HPS 2 Temperature	Modbus Device
67	HPS 5 Temperature	Modbus Device
68	HPS 7 Temperature	Modbus Device
69	HPS 3 Temperature	Modbus Device
70	BW_A Temperature	Modbus Device
71	BW_B Temperature	Modbus Device
75	HSP No. 1 OIT	AB Panelview Operator Interface Terminal
76	HSP No. 1 VFD Self-Test	AB Powerflex 7000 VFD
77	HSP No. 1 VFD	AB Powerflex 7000 VFD

ADDRESS	DEVICE	DEVICE TYPE
78	HSP No. 1 L32E	CompactLogix PLC
79	HSP No. 2 OIT	AB Panelview Operator Interface Terminal
80	HSP No. 2 VFD Self-Test	AB Powerflex 7000 VFD
81	HSP No. 2 VFD	AB Powerflex 7000 VFD
82	HSP No. 2 L32E	CompactLogix PLC
86	HSP No. 3 VFD	AB Powerflex 7000 VFD
87	HSP No. 4 VFD	AB Powerflex 7000 VFD
88	HSP No. 4 L32E	CompactLogix PLC
89	HSP No. 5 OIT	AB Panelview Operator Interface Terminal
90	HSP No. 5 VFD Self-Test	AB Powerflex 7000 VFD
91	HSP No. 5 VFD	AB Powerflex 7000 VFD
92	HSP No. 5 L32E	CompactLogix PLC
93	HSP No. 6 VFD	AB Powerflex 7000 VFD
94	HSP No. 6 L32E	CompactLogix PLC
95	HSP No. 7 OIT	AB Panelview Operator Interface Terminal
96	HSP No. 7 VFD	AB Powerflex 7000 VFD
97	HSP No. 7 VFD Self-Test	AB Powerflex 7000 VFD
98	HSP No. 7 L32E	CompactLogix PLC
102	Clarifier 1 Solid Coll PLC	ControlLogix PLC
104	Clar 01 SC-1	Micrologix PLC
106	Clar 01 SC-2	Micrologix PLC
108	Clar 01 SC-3	Micrologix PLC
110	Clar 01 SC-4	Micrologix PLC
112	Clar 01 SC-5	Micrologix PLC
114	Clar 01 SC-6	Micrologix PLC
118	Clar01_Floc	ControlLogix PLC
118	Clarifier 1 PLC	ControlLogix PLC
119	Sludge Pump Station 1	ControlLogix PLC

ADDRESS	DEVICE	DEVICE TYPE
120	Chlorine Dioxide 1	Micrologix PLC
122	Chlorine Dioxide 2	Micrologix PLC
151	Hypervisor Host A	Host Windows Server 2014R2 Hypervisor
152	Hypervisor Host B	Host Windows Server 2014R2 Hypervisor
153	Hypervisor Host C	Host Windows Server 2014R2 Hypervisor
155	ABJ_DEV	Virtual Windows Server 2014R2 – Development
156	ABJ-AOS01	Virtual Windows Server 2014R2 – Application Object Server 1
157	ABJ-HIST	Virtual Windows Server 2014R2 – Historian
158	ABJ-AOS02	Virtual Windows Server 2014R2 – Application Object Server 2
161	ABJ_InTouch_DEV	Windows 10 Operator Workstation
162	ABJ_InTouch01_OPS_North	Windows 10 Operator Workstation
163	ABJ_InTouch02_Super	Windows 10 Operator Workstation
164	ABJ_InTouch03_OpsSup	Windows 10 Operator Workstation
165	ABJ_InTouch04_Maintenace	Windows 10 Operator Workstation
166	ABJ_InTouch05_LAB	Windows 10 Operator Workstation
167	ABJ_InTouch06_OPS_EAST	Windows 10 Operator Workstation
168	ABJ_InTouch07_Chem	Windows 10 Operator Workstation
169	ABJ_InTouch08_Sludge	Windows 10 Operator Workstation
170	Raw Water Pump Station	ControlLogix PLC
171	Filter PLC A	ControlLogix PLC
172	Filter PLC B	ControlLogix PLC
173	Blower RIO	ControlLogix Remote I/O Rack
174	HSPS RIO	ControlLogix Remote I/O Rack
175	Chem PLC	ControlLogix PLC
176	Clarifier 1 PLC	ControlLogix PLC
177	Clarifier 2 PLC	ControlLogix PLC
178	Clarifier 3 PLC	ControlLogix PLC
179	Clarifier 4 PLC	ControlLogix PLC

ADDRESS	DEVICE	DEVICE TYPE
180	Sludge Pump Station 2	ControlLogix PLC
180	Sludge Pump Station 2	ControlLogix PLC
181	OIT Filter 1	Red Lion PLC/Operator Interface Terminal
182	OIT Filter 2	Red Lion PLC/Operator Interface Terminal
183	OIT Filter 3	Red Lion PLC/Operator Interface Terminal
184	OIT Filter 4	Red Lion PLC/Operator Interface Terminal
185	OIT Filter 5	Red Lion PLC/Operator Interface Terminal
186	OIT Filter 6	Red Lion PLC/Operator Interface Terminal
187	OIT Filter 7	Red Lion PLC/Operator Interface Terminal
188	OIT Filter 8	Red Lion PLC/Operator Interface Terminal
189	OIT Filter 9	Red Lion PLC/Operator Interface Terminal
190	OIT Filter 10	Red Lion PLC/Operator Interface Terminal
191	OIT Filter 11	Red Lion PLC/Operator Interface Terminal
192	OIT Filter 12	Red Lion PLC/Operator Interface Terminal
198	Sludge Building	ControlLogix PLC
199	Recovered Water	ControlLogix PLC
200	North Combined Filter Building	CompactLogix PLC

Table 3-2 Filter DLR

FILTER	RIO ADDRESS
Main RIO	11
Filter 1	101
Filter 2	102
Filter 3	103
Filter 4	104
Filter 5	105
Filter 6	106
Filter 7	107
Filter 8	108
Filter 9	109

FILTER	RIO ADDRESS
Filter 10	110
Filter 11	111
Filter 12	112
PLC A	201
PLC B	202

4.0 Object Definition

The intent of this section is to demonstrate a single naming convention to be used at the HMI and PLC. Wonderware System Platform and Rockwell Automation's Studio 5000 PLC programming software may be modeled using Object Oriented Design to define a control system. Object Oriented Design is a paradigm based on modeling a system as a collection of co-operating objects. An object contains encapsulated data and procedures grouped together to represent an entity. Object data is in the form of fields, often known as *attributes;* and code, in the form of procedures, often known as methods*.* A feature of an object is that an object's methods can access and modify its own attributes and attributes of other objects with which they are associated. Objects can protect specific attributes from external entities. Object-oriented design allows the programmer to maintain consistency within one environment, and the programming language will use the same model of representation.

4.1 OBJECT DEFINITIONS IN WONDERWARE SYSTEM PLATFORM

Wonderware System Platform is an object-oriented platform that allows users to add capability as the need arises. Wonderware System Platform represents objects as Derived Templates. Derived Templates are a representation of a group of common devices, computers, or processes. Templates only exist in the development environment. Templates share a parent/child relation such that sub-templates inherit attributes from the template from which it is derived. For instance, a sub-template of an analog device may be a flow meter with additional attributes for a flow totalizer.

4.2 OBJECT DEFINITIONS IN STUDIO 5000

Studio 5000 software uses User Defined Data Types (UDT) and Add-On Instructions (AOI) to integrate an object-oriented programming approach. UDTs concentrate real world and virtual data points into an array type structure. Add-On Instructions are custom program templates. AOIs are used to promote consistency between programs by reusing commonly used algorithms and tags, provide an easier to understand interface, and simplify code maintenance. UDTs are automatically created for all Add-On Instructions. AOIs have been developed and approved by TMUA staff and shall be utilized as standards for all future programming. If a system integrator needs to modify or create a new AOI, it must be approved by the TMUA.

To standardize Studio 5000 with Wonderware System Platform, all tags shall be part of an AOI or UDT such that there is a one to one correlation to Wonderware System Platform's Derived Templates and Studio 5000's AOIs and UDTs.

4.3 DEFINED OBJECTS

This section lists the objects developed for the TMUA SCADA System that exist as both Wonderware System Platform Derived Templates and Rockwell Automation's Studio 5000 AOIs.

- Analog
- DiscreteAlarmEvent
- Filter
- ConstantSpeedMotors
- ComplexMotors
- OpenCloseValves
- ControlValves

4.3.1 Analog

The Analog Object consists of signal scaling, 4 state alarm, Rate of Change Alarms, and simulation logic programmed within an AOI. The attributes for the Analog Object are listed below.

Table 4-1 Analog Object Attributes

ANALOG ATTRIBUTES	DESCRIPTION
Ai_AVG	Average Value
Ai_AVG_Samples	Number of Samples Used for Average
AI_ChannelFault	PLC Card Channel Fault
Ai_Control	Value used for control
Ai_mA	Milliamp Signal from Field
Ai_RawMax	Raw Max Value
Ai_RawMin	Raw Min Value
Ai_Scaled	Scaled Value
Ai_ScaledHigh	Engineering Units Range High
Ai_ScaledLow	Engineering Units Scaled Low
AiSimulate_Enable	Simulate Enable
AiSimulate_Value	Simulated Value
Alarm_Deadband	Dead band Set Point
Alarm_High	High Alarm
Alarm_HighHigh	High High Alarm
Alarm_Low	Low Alarm
Alarm_LowLow	Low Low Alarm
Alarm_Range	Out-Of-Range Alarm
Alarm_Rate	Rate-Of-Change Alarm
Alarm_Rate_Value	Rate-Of-Change Current Value
Alarm_RateNeg	Rate Change Positive
Alarm_RateNegSp	Rate-Of-Change Units-Per-Second Falling Set Point (0 to disable)
Alarm_RatePeriod_Sp	Rate-Of-Change Period Seconds Set Point (0 to disable)
Alarm_RatePos	Rate Change Negative
Alarm_RatePosSp	Rate-Of-Change Units-Per-Second Rising Set Point (0 to disable)
Alarm_SUM	Alarm Active

ANALOG ATTRIBUTES	DESCRIPTION
AlarmDelay_High	Hi Alarm Delay Seconds Set Point
AlarmDelay_HighHigh	Hi Hi Alarm Delay Seconds Set Point
AlarmDelay_Low	Low Alarm Delay Seconds Set Point
AlarmDelay_LowLow	Low Low Alarm Delay Seconds Set Point
AlarmEnable_ALL	Enable All Alarm Command
AlarmEnable_High	High Alarm Enable
AlarmEnable_HighHigh	High High Alarm Enable
AlarmEnable_Low	Low Alarm Enable
AlarmEnable_LowLow	Low Low Alarm Enable
AlarmEnable_PrgHI	Program bit to enable both Hi Alarms
AlarmEnable_PrgLow	Program bit to enable both Low Alarms
AlarmSetPoint_High	High Alarm Set Point
AlarmSetPoint_HighHigh	High High Alarm Set Point
AlarmSetPoint_Low	Low Alarm Set Point
AlarmSetPoint_LowLow	Low Low Alarm Set Point
AoMa	Analog Output in mA to other device
BarGraph_Hi	Used by HMI to set bar graph upper limit
BarGraph_Low	Used by HMI to set bar graph lower limit
OOS	Device is Out of Service
OOS_CMD	Out of Service Command

4.3.2 DiscreteAlarmEvent

The DiscreteAlarmEvent object consists of a delay timer to indicate an alarm condition. The event portion of the object is used as self-acknowledging alarm to display a message at the HMI. The attributes for the DiscreteAlarmEvent Object are listed below.

Table 4-2 Discrete Alarm Event Object Attributes

DISCRETE ATTRIBUTES	DESCRIPTION
AcOff	Signal Low Time Accumulator
AcOn	Signal High Time Accumulator
Alarm	Alarm Active
CntrAlarm	Alarm Active Counter
DelayOff	Delay Off Set Point
DelayOn	Delay Set Point in Seconds
Di	Discrete Input
Ena	Enable Alarm/Event
EventTimer	Operator Message
Evt	Event Flag

4.3.3 Filter

The Filter object is specific to the AB Jewell plant. It contains extensive algorithms to control the flow rate, record turbidity events, automated back wash control, etc. The attributes for the Filter Object are listed below.

Table 4-3 Filter Object Attributes

FILTER ATTRIBUTES	DESCRIPTION
ActiveFilterLevelAVG	Average Level of active filters
AllValvestoAutoRequest	All valves to auto request
AllValvestoManualRequest	All valves to manual request
AllValvesInAuto	All valves in auto indication
AllValvesInManual	All valves in manual indication
AutoCMD	Auto command from HMI
AutoMODE	Filter in auto mode
AvFilterLevel80	80% of Average Filter Level
AvFilterLevel85	85% of Active filters
BW_Abort_CMD	Backwash Abort Command

FILTER ATTRIBUTES	DESCRIPTION
BW_Aborted	Backwash Aborted Indication
BW_Active	Backwash Active Status
BW_Complete	Backwash Complete
BW_CurrentFlow_Total	Backwash Current Flow Totalizer
BW_DrainDownRate_SP	Backwash Drain Down Rate Set Point
BW_EffluentModValveCloseCMD	Backwash effluent mod Valve Close Command
BW_EffluentValveCloseCMD	Backwash effluent Valve Close Command
BW_Enable_CMD	Backwash Enable Alarm Bit
BW_FinishinglLevel_SP	Backwash Finishing Level Set Point
BW_FlowRateFinishing_SP	Backwash Finishing Flow Rate Set Point
BW_FlowRateFinishing_TMR_ACC	Backwash Finishing Timer Time Accumulated
BW_FlowRateFinishing_TMR_SP	Backwash Finishing Timer Set Point
BW_FlowRateHigh_SP	Backwash High Flow Rate Level Set Point
BW_FlowRateHigh_TMR_ACC	Backwash High Flow Rate Timer Time Accumulated
BW_FlowRateHigh_TMR_SP	Backwash High Flow Rate Timer Set Point
BW_FlowRateLow_SP	Backwash Low Flow Rate Level Set Point
BW_FlowRateLow_TMR_ACC	Backwash Low Flow Rate Timer Time Accumulated
BW_FlowRateLow_TMR_SP	Backwash Low Flow Rate Timer Set Point
BW_FlowRateMid_SP	Backwash Mid Flow Rate Level Set Point
BW_FlowRateMid_TMR_ACC	Backwash Mid Flow Rate Timer Time Accumulated

FILTER ATTRIBUTES	DESCRIPTION
BW_FlowRateMid_TMR_SP	Backwash Mid Flow Rate Timer Set Point
BW_FlowRateRefill_SP	Backwash Refill Flow Rate Level Set Point
BW_FlowRateRefill_TMR_ACC	Backwash Refill Flow Rate Timer Time Accumulated
BW_FlowRateRefill_TMR_SP	Backwash Refill Flow Rate Timer Set Point
BW_InfluentClose_TMR_ACC	Backwash Influent Valve Close Time Accumulated
BW_InfluentClose_TMR_SP	Backwash Influent Valve Close Timer Set Point
BW_InfluentValveCloseCMD	Backwash Influent Valve Close Command
BW_Number	Filter in Backwash
BW_OOS_CMD	Backwash Out of Service Command
BW_PreviousFlow_Total	Previous Backwash Flow Total
BW_Ripening_TMR_ACC	Backwash Ripening Timer Time Accumulated
BW_Ripening_TMR_SP	Backwash Ripening Timer Set Point
BW_StartLevel_SP	Backwash Tower Level OK to Start Set Point
BW_Step	Backwash Step
BW_Step_Output	Backwash Step output to Filter Control
BW_WashWaterReady	Backwash Wash Water Ready Indication
CurrentBackwashDuration	Current Backwash Duration
EffluentValveControl	Effluent Mod Valve Control MODE 0 = Close 1= Limited Step 2 = PID Level 3 = PID Drain
EffluentValveLimitAlarm	Effluent Modular Valve Limit Alarm

FILTER ATTRIBUTES	DESCRIPTION
EffluentValveLimitStep	Effluent Modular Valve Limited Step Open Mode
EffluentValveLimitStepCMD	Effluent Modular Valve Limited Step Mode Request from HMI
EffluentValvee	Effluent Modular Valve Mode
EffluentValvePosCMD	Effluent Modular Valve Position Command
EffluentValvePosCmdMAN	Effluent Modular Valve Position Command Remote Manual Mode
EffluentValvePosEU	Effluent Modular Valve Position in %
EffluentValvePosMaxSP	Effluent Modular Valve Max Position Set Point
EffluentValvePosMinSP	Effluent Modular Valve Min Position Set Point
EffluentValveStepSP	Effluent Modular Valve
EffluentValveMode	Effluent Modular Valve
FilterActive	Filter Active Status
FilterActive_TMR_ACC	Time Filter is Active since last start
FilterActivePermissive	Filter Active Permissive
FilterEffluentCl2	Filter Effluent Chlorine
FilterEffluentTurbidity	Filter Effluent Turbidity
FilterEffluentTurbidity_HH10Min	Filter Effluent Turbidity High Alarm Active for 10 Minutes
FilterEffluentTurbidity_HH15Min	Filter Effluent Turbidity High Alarm Active for 15 Minutes
FilterEffluentTurbidity_HH5Min	Filter Effluent Turbidity High Alarm Active for 5 Minutes
FilterEnable_CMD	Filter Enable Alarm Bit
FilterFlow	Filter Effluent Flow

FILTER ATTRIBUTES	DESCRIPTION
FilterFlow_OOS	Filter Effluent Flow Meter Out of Service
FilterFlow_OutofRangeAlm	Filter Effluent Flow Meter Out of Range Alarm
FilterInfluentCl2	Filter Influent Chlorine Residual
FilterLevel	Filter Level
FilterLevel_OOS	Filter Level Transmitter Out of Service
FilterLevel_OutofRangeAlm	Filter Level Transmitter Out of Range Alarm
FilterNumber	Filter Number
Flow_PID	Filter Effluent Flow PID
Flow_PID_CV	Filter Effluent Flow PID Control Variable
Flow_PID_DB	Filter Effluent Flow PID Dead Band
Flow_PID_EWD	Filter Effluent Flow PID Error Within Dead Band
Flow_PID_KD	Filter Effluent Flow PID Derivative
Flow_PID_KI	Filter Effluent Flow PID Integral
Flow_PID_KP	Filter Effluent Flow PID Proportional
Flow_PID_MaxCV	Filter Effluent Flow PID CV Max
Flow_PID_MaxI	Filter Effluent Flow PID PV Max Input
Flow_PID_MaxO	Filter Effluent Flow PID Max Output
Flow_PID_MINCV	Filter Effluent Flow PID CV Min
Flow_PID_MINI	Filter Effluent Flow PID PV Min Input

FILTER ATTRIBUTES	DESCRIPTION
Flow_PID_MINO	Filter Effluent Flow PID Min Output
Flow_PID_Mode	Filter Effluent Flow PID Mode
Flow_PID_Output	Filter Effluent Flow PID Output Signal
Flow_PID_PV_SP	Filter Effluent Flow PID
Flow_PID_SP	Filter Effluent Flow PID Set Point
Flow_PID_SWM	Filter Effluent Flow PID Software Manual Mode
Flow_PID_TMR_Update	Filter Effluent Flow PID Timer Update Set Point
FlowOkForAutoSP	Flow is High Enough for Effluent Mod Valve Auto Control
HoursSinceLastBackwash	Hours Since Last Backwash
HoursSinceLastBackwashRST	Hours Since Last Backwash Reset
HoursSincePreviousBackwash	Hours Since Previous Backwash
InfluentValveClosed	Influent Valve Closed
InfluentValveMode	Influent Valve Mode
InfluentValveOpenCMD	Influent Valve Open Command
InfluentValveOpened	Influent Valve Opened
LastBackwashDuration	Last Backwash Duration in Minutes
Level_LessThan80	Level less than 80% of active filters online
Level_PID_CV	Level Control PID Control Variable – MGD command to Filter Effluent Mod Valve PID
LevelOKforAverage	Level is OK to Include in Filter Average Levels
ManCMD	Manual Mode Command

FILTER ATTRIBUTES	DESCRIPTION
ManMODE	Filter in Manual Mode
MasterLevelSP	Master Level Set Point passed to all filters
MaxFlowSP	Max Flow Set Point for filters
Mode	0 = OOS 1 = Manual 2 = Auto 3 = Backwash
OOS	Out of Service
OOS_CMD	HMI Out of Service Command
WashWaterFlow	Wash Water Flow Signal used to Totalize Backwash Flow
WashWaterModValvePID_EWD	Wash Water Flow Control PID – Error within dead band
WashWaterModValvePos	Wash Water Modular Valve Position
WashWaterModValvePos_SP	Wash Water Modular Valve Position Set Point
WashWaterModValveRateLimit	Wash Water Modular Valve Rate Limit Set Point
WashWaterModValveRemt	Wash Water Modular Valve in Remote Auto
WashWaterValveClosed	Wash Water Valve Closed
WashWaterValveMode	Wash Water Valve Mode
WashWaterValveOpenCMD	Wash Water Valve Open Command
WashWaterValveOpened	Wash Water Valve Opened
WasteWaterValveClosed	Wastewater Valve Closed
WasteWaterValveMode	Wastewater Valve Mode
WasteWaterValveOpenCMD	Waste Water Valve Open Command
WasteWaterValveOpened	Wastewater Valve Opened

4.3.4 ConstantSpeedMotor

The ConstantSpeedMotor template contains the logic for start/stop control, fail to start/stop alarms, hours, start counts, and other common alarms. The attributes for the ConstandSpeedMotor Object are listed below.

Table 4-4 Constant Speed Motor Object Attributes

CONSTANTSPEED MOTOR ATTRIBUTES	DESCRIPTION
AlarmReset	Alarm Reset Command from HMI
AlarmSum	Summation of all alarms
AutoCmd	Command for Remote Auto Mode from HMI
AutoCmdOns	PLC Command One Shot
AutoMode	Remote Auto/ Remote Manual Software Switch 1= Remote Auto 0 = Remote Manual
AutoModeDefault	Default to Remote Auto Mode when HOR is moved to Remote Position.
Available	Available to Operate in Remote Auto Mode
CommLoss	Loss of Communications with other PLC or data source
FailACOff	Fail Alarm Accumulator Off
FailACOn	Fail Alarm Accumulator On
FailAlarm	General Motor Fault
FailDi	General Motor Fault Input
FailEna	General Motor Fault Enable Alarm Bit
FailOff	Fault Alarm Off Delay in Seconds
FailOn	Fault Alarm Set Point in Seconds
FaultReset	Hardwired Fault Reset from PLC to MCC
FaultResetTMR	Timer to reset Fault Reset
HasAutoControl	Flag for if valve has Remote Auto or only Remote Manual Control
ManCmd	Command for Remote Manual Mode from HMI
ManCmdOns	Manual Command One Shot

CONSTANTSPEED MOTOR ATTRIBUTES	DESCRIPTION
Mode	Control Mode 3 – Remote Auto 2 – Remote Manual 1-Local Control 0 – Software Lockout
NotAvailACOff	Not Available Alarm Accumulator Off
NotAvailACOn	Not Available Alarm Accumulator On
NotAvailAlarm	Not Available Alarm
NotAvailDi	Not Available Input
NotAvailEna	Not Available Alarm Enabled
NotAvailOff	Not Available - Off Delay
NotAvailOn	Not Available - On Delay
OOS	Motor in Out of Service Mode
OOS_Cmd	HMI command to set motor Out of Service
RemtDi	HOR Switch in Remote
ResetCommand	Run Time Reset
RotatePos	Rotation Position 0 = Off Rotation, 1 = Lead, 2 = Lag1, 3 = Lag2
RunCmdCALL	Run command call bit used for fail to start/stop alarms
RunCmdDo	Output to Start Motor
RunDi	Motor Running Input
RunningInAuto	Motor is running in Remote Auto Mode
RunningStatus	Device Running
RunPermMan	Run Permissive for Remote Manual Mode
RunPermRemt	Run Permissive for Remote Auto Mode
Hours_TotalHours	Device Run Time Hours
Hours_LastDay	Run Time for Last Day
Hours_LastWeek	Run Time for Last Week
Hours_LastMonth	Run Time for Last Month

CONSTANTSPEED MOTOR ATTRIBUTES	DESCRIPTION
Hours_LastYear	Run Time for Last Year
Hours_NewDay	New Day input for resetting run time
Hours_NewMonth	New Month input for resetting run time
Hours_NewWeek	New Week input for resetting run time
Hours_NewYear	New Year for resetting run time
Hours_ThisDay	Run Time for Current Day
Hours_ThisWeek	Run Time for This Week
Hours_ThisMonth	Run Time for This Month
Hours_ThisYear	Run Time for This Year
HoursReset	Run Timer Reset Command
SelfClearAlarm	Motor will automatically clear alarms and attempt to restart when applicable
Simulate	Simulate Mode for testing
StartCmdAuto	Command to start in Remote Auto Mode
StartCmdMan	Command to start in Remote Manual Mode
StartCounts	Counter for the number of starts
StartFailACOff	Start Fail Alarm Accumulator Off
StartFailACOn	Start Fail Alarm Accumulator On
StartFailAlarm	Motor failed to start when commanded
StartFailDi	Motor fail to start when commanded Input
StartFailEna	Motor failed to start when commanded Enable Alarm Bit
StartFailOff	Start Failure Off Delay in Seconds
StartFailOn	Start Failure On Delay in Seconds
StopCmdAuto	Command to Stop in Remote PLC Mode
StopCmdMan	Command to Stop in Remote Manual Mode
StopFailACOff	Stop Alarm Fail Accumulator Off

CONSTANTSPEED MOTOR ATTRIBUTES	DESCRIPTION
StopFailACOn	Stop Alarm Fail Accumulator On
StopFailAlarm	Motor failed to stop when commanded
StopFailDi	Motor fail to stop when commanded Input
StopFailEna	Motor failed to stop when commanded Enable Alarm Bit
StopFailOff	Stop Failure Off Delay in Seconds
StopFailOn	Stop Failure Alarm Set Point in Seconds

4.3.5 ComplexMotor

The ComplexMotor template contains the same logic as the ConstantSpeedMotor template and in addition has speed control. The attributes for the ComplexMotor Object are listed below.

Table 4-5 Complex Motor Object Attributes

COMPLEXMOTOR ATTRIBUTES	DESCRIPTION
AlarmReset	Alarm Reset Command from HMI
AlarmSum	Summation of all alarms
AutoCmd	Command for Remote Auto Mode from HMI
AutoCmdOns	PLC Command One Shot
AutoMode	Remote Auto/ Remote Manual Software Switch 1= Remote Auto 0 = Remote Manual
AutoModeDefault	Default to Remote Auto Mode when HOR is moved to Remote Position.
Available	Available to Operate in Remote Auto Mode
CommLoss	Loss of Communications with other PLC or data source
FailACOff	Fail Alarm Accumulator Off
FailACOn	Fail Alarm Accumulator On
FailAlarm	General Motor Fault
FailAlarm_AOI	Fault AOI

COMPLEXMOTOR ATTRIBUTES	DESCRIPTION
FailDi	General Motor Fault Input
FailEna	General Motor Fault Enable Alarm Bit
FailOff	Fault Alarm Off Delay in Seconds
FailOn	Fault Alarm Set Point in Seconds
FaultReset	Hardwired Fault Reset from PLC to MCC
FaultResetTMR	Timer to reset Fault Reset
HasAutoControl	Flag for if valve has Remote Auto or only Remote Manual Control
HasSpeedFeedback	Flag for if valve has Remote Auto or only Remote Manual Control
ManCmd	Command for Remote AUTO Mode from HMI
ManCmdOns	Manual Command One Shot
Mode	Control Mode 3 – Remote Auto 2 – Remote Manual 1- Local Control 0 – Software Lockout
NotAvailACOff	Not Available Alarm Accumulator Off
NotAvailACOn	Not Available Alarm Accumulator On
NotAvailAlarm	Not Available Alarm
NotAvailDi	Not Available Input
NotAvailEna	Not Available Alarm Enabled
NotAvailOff	Not Available - Off Delay
NotAvailOn	Not Available - On Delay
OOS	Motor in Out of Service Mode
OOS_Cmd	HMI command to set motor Out of Service
RemtDi	HOR Switch in Remote
ResetCommand	Run Time Reset
RotatePos	Rotation Position 0 = Off Rotation, 1 = Lead, 2 = Lag1, 3 = Lag2

COMPLEXMOTOR ATTRIBUTES	DESCRIPTION
RunCmdCALL	Run command call bit used for fail to start/stop alarms
RunCmdDo	Output to Start Motor
RunDi	Motor Running Input
RunningInAuto	Motor is running in Remote Auto Mode
RunningStatus	Device Running
RunPermMan	Run Permissive for Remote Manual Mode
RunPermRemt	Run Permissive for Remote Auto Mode
Hours_Total	Device Run Time Hours
Hours_Today	Run Time for Current Day
Hours_ThisWeek	Run Time for This Week
Hours_ThisMonth	Run Time for This Month
Hours_ThisYear	Run Time for This Year
HoursReset	Run Timer Reset Command
HasSelfClearAlarm	Motor will automatically clear alarms and attempt to restart when applicable
Simulate	Simulate Mode for testing
SpeedAi	Speed Feedback in %
SpeedAiEUMax	Max Speed in Engineering Units
SpeedAiEuMin	Min Speed in Engineering Units
SpeedAiMa	Speed Feedback in Milliamps
SpeedAiMaMAX	Max Speed Feedback in Milliamps
SpeedAiMaMIN	Min Speed Feedback in Milliamps
SpeedCmdAo	Speed Command in 0-100%
SpeedCmdAoEUMax	Max Speed Output Command in Engineering Units
SpeedCmdAoEUMin	Min Speed Output Command in Engineering Units

COMPLEXMOTOR ATTRIBUTES	DESCRIPTION
SpeedCmdAoMa	Analog Output Speed Milliamp Signal
SpeedCmdAORawMax	Max Speed Output Command in Milliamps
SpeedCmdAORawMin	Min Speed Output Command in Milliamps
SpeedCmdAuto	Speed % value used when Motor is in Remote Auto Mode
SpeedCmdMan	Speed % value used when Motor is in Remote Manual Mode
StartCmdAuto	Command to start in Remote Auto Mode
StartCmdMan	Command to start in Remote Manual Mode
StartCounts	Counter for the number of start commands issued
StartFailACOff	Start Fail Alarm Accumulator Off
StartFailACOn	Start Fail Alarm Accumulator On
StartFailAlarm	Motor failed to start when commanded
StartFailDi	Motor fail to start when commanded Input
StartFailEna	Motor failed to start when commanded Enable Alarm Bit
StartFailOff	Start Failure Off Delay in Seconds
StartFailOn	Start Failure On Delay in Seconds
StopCmdAuto	Command to Stop in Remote PLC Mode
StopCmdMan	Command to Stop in Remote Manual Mode
StopFailACOff	Stop Alarm Fail Accumulator Off
StopFailACOn	Stop Alarm Fail Accumulator On
StopFailAlarm	Motor failed to stop when commanded
StopFailDi	Motor fail to stop when commanded Input

COMPLEXMOTOR ATTRIBUTES	DESCRIPTION
StopFailEna	Motor failed to stop when commanded Enable Alarm Bit
StopFailOff	Stop Failure Off Delay in Seconds
StopFailOn	Stop Failure Alarm Set Point in Seconds
StrokeAiMa	Stroke Feedback in Milliamps
StrokeAiMaMAX	Max Stroke Feedback in Milliamps
StrokeAiMaMIN	Min Stroke Feedback in Milliamps
StrokeCmdAo	Stroke Command in 0-100%
StrokeCmdAoEUMax	Max Stroke Output Command in Engineering Units
StrokeCmdAoEUMin	Min Stroke Output Command in Engineering Units
StrokeCmdAoMa	Analog Output Stroke Milliamp Signal
StrokeCmdAORawMax	Max Stroke Output Command in Milliamps
StrokeCmdAORawMin	Min Stroke Output Command in Milliamps
StrokeCmdAuto	Stroke % value used when Motor is in Remote Auto Mode
StrokeCmdMan	Stroke % value used when Motor is in Remote Manual Mode

4.3.6 OpenCloseValve

The OpenCloseValve Template contains logic for open/close control, fail to open/close alarms, and other common alarms. The attributes for the OpenCloseValve Object are listed below.

Table 4-6 OpenCloseValve Object Attributes

VALVE ATTRIBUTES	DESCRIPTION
AlarmsDisabled	All Alarms Disabled
AlarmSum	Alarm Summation
AutoCmd	Command from HMI to Set Mode to Remote Auto
AutoCmdOns	Plc Command One Shot
AutoMode	Auto PLC/ Auto HMI Software Switch 1= REMOTE AUTO 0 = REMOTE MANUAL
AutoModeDefault	Default to Remote Auto Mode when HOR is moved to Remote Position.
Available	Available to Operate in Remote Auto Mode
CloseCmd	Close Command
CloseCmd_Tmr	Delay to release close command
CloseCmdAuto	Close Command – Remote Auto Mode
CloseCmdDo	Close Command Discrete Output
CloseCmdMan	Close Command – Remote Manual Mode (HMI)
ClosedDb	Closed Dead Band
ClosedDi	Closed Limit Input
CloseFailACOff	Close Alarm Alarm Accumulator Off
CloseFailACOn	Close Alarm Alarm Accumulator On
CloseFailAlarm	Close Alarm
CloseFailDi	Indication for closed failure alarm input
CloseFailEna	Closed Alarm Enabled
CloseFailOff	Close Alarm - Off Delay
CloseFailOn	Close Alarm - On Delay
CloseManDisb	Close Manually Disabled
ClosePermAuto	Close Command Permissive for Remote Auto Mode

VALVE ATTRIBUTES	DESCRIPTION
ClosePermMan	Close Command Permissive for Remote Manual Mode
CloseTmr	Time to Close Timer
FailACOff	Fail Alarm Accumulator Off
FailACOn	Fail Alarm Accumulator On
FailAlarm	Fault Alarm
FailDi	Fault Input
FailEna	Fault Alarm Enabled
FailOff	Fault Alarm – Off Delay
FailOn	Fault Set Point
HasAutoControl	Flag for if valve has Remote Auto or only Remote Manual Control
HasClosedLimitSwitch	Has Closed Limit Switch Config Bit
HasOpenedLimitSwitch	Has Opened Limit Switch Config Bit
LimitsACOff	Limits Alarm Accumulator Off
LimitsACOn	Limits Alarm Accumulator On
LimitsAlarm	Valve has both limit switches active Alarm
LimitsDi	Valve has both limit switches active Input
LimitsEna	Valve has both limit switches active Alarm Enable
LimitsOff	Both Limits On - Off Delay
LimitsOn	Both Limits ON - On Delay
MaintainedContacts	Bit to enable maintained outputs for open/close commands
ManCmd	Command from HMI to set Remote Manual Mode
ManCmdOns	Remote Manual Mode Command One Shot

VALVE ATTRIBUTES	DESCRIPTION
Mode	Control Mode 3-Remote Auto 2-Remote Man 1- Local 0-OOS
NotAvailACOff	Not Available Alarm Accumulator Off
NotAvailACOn	Not Available Alarm Accumulator On
NotAvailAlarm	Not Available Alarm
NotAvailDi	Not Available Input
NotAvailEna	Not Available Alarm Enabled
NotAvailOff	Not Available - Off Delay
NotAvailOn	Not Available - On Delay
OneSecPulseOutputs	Bit to enable one second pulse outputs for open/close commands
OOS	Out of Service Status
OOS_Cmd	Out of Service Command from HMI
OpenCmdAuto	Command to Open when Device is in Remote Auto Mode
OpenCmdDo	Open Command Discrete Output
OpenCmdMan	Command to Open when Device is in Remote Manual Mode (HMI)
OpenedDi	Valve Opened
OpenFailACOff	Open Alarm Alarm Accumulator Off
OpenFailACOn	Open Alarm Alarm Accumulator On
OpenFailAlarm	Valve failed to open when commanded
OpenFailDI	Indication for Open Failure
OpenFailEna	Valve failed to open Enabled
OpenFailOff	Open Alarm - Off Delay
OpenFailOn	Open Alarm - On Delay
OpenPermAuto	Open Permissive – Remote Auto Mode
OpenPermMan	Open Permissive – Remote Manual Mode

VALVE ATTRIBUTES	DESCRIPTION
OpenTmr	Time in seconds valve took to fully open last time it opened
RemtDi	HOR Hardwired Input
Simulate	Simulation bit for testing

4.3.7 ControlValve

The ControlValve template contains logic for valves controlled by an analog output signal. It also contains logic for alarms. The attributes for the ControlValve object are listed below.

Table 4-7 ControlValve Object Attributes

CONTROLVALVE ATTRIBUTES	DESCRIPTION
AlarmsDisabled	All Alarms Disabled
AlarmSum	Alarm Summation
AutoCmd	Command from HMI to Set Mode to Remote Auto
AutoCmdOns	Plc Command One Shot
AutoMode	Auto PLC/ Auto HMI Software Switch 1= REMOTE AUTO 0 = REMOTE MANUAL
AutoModeDefault	Default to Remote Auto Mode when HOR is moved to Remote Position.
Available	Available to Operate in Remote Auto Mode
ClosedDb	Closed Dead Band
ClosedDi	Closed Limit Input
FailACOff	Fail Alarm Accumulator Off
FailACOn	Fail Alarm Accumulator On
FailAlarm	Fault Alarm
FailDi	Fault Input
FailEna	Fault Alarm Enabled
FailOff	Fault Alarm – Off Delay
FailOn	Fault Set Point
HasAutoControl	Flag for if valve has Remote Auto or only Remote Manual Control
HasClosedLimitSwitch	Has Closed Limit Switch Config Bit
HasNoPositionFeedback	Has No Position Feedback Config Bit
HasOpenedLimitSwitch	Has Opened Limit Switch Config Bit
LimitsACOff	Limits Alarm Accumulator Off
LimitsACOn	Limits Alarm Accumulator On

CONTROLVALVE ATTRIBUTES	DESCRIPTION
LimitsAlarm	Valve has both limit switches active Alarm
LimitsDi	Valve has both limit switches active Input
LimitsEna	Valve has both limit switches active Alarm Enable
LimitsOff	Both Limits On - Off Delay
LimitsOn	Both Limits ON - On Delay
ManCmd	Command from HMI to set Remote Manual Mode
ManCmdOns	Remote Manual Mode Command One Shot
Mode	Control Mode 3-Remote Auto 2-Remote Man 1- Local 0-OOS
NotAvailACOff	Not Available Alarm Accumulator Off
NotAvailACOn	Not Available Alarm Accumulator On
NotAvailAlarm	Not Available Alarm
NotAvailDi	Not Available Input
NotAvailEna	Not Available Alarm Enabled
NotAvailOff	Not Available - Off Delay
NotAvailOn	Not Available - On Delay
OOS	Out of Service Status
OOS_Cmd	Out of Service Command from HMI
OpenedDi	Valve Opened
PosAi	Position Feedback
PosAiMa	Position Feedback in Milliamps
PosAoMa	Analog Output Position Milliamp Signal
PosCmdAuto	Position Command when in Remote Auto Mode

CONTROLVALVE ATTRIBUTES	DESCRIPTION
PosCmdMan	Position Command when in Remote Manual Mode
RemtDi	HOR Hardwired Input
Simulate	Simulation bit for testing

4.4 INSTANCES OF OBJECTS NAMING CONVENTIONS

Each defined object or parent in the system may have multiple children derived. Wonderware refers to these as Instances while Rockwell Automation's Studio 5000 refers to them as Tags. The common field devices will incorporate the same naming convention for instances and attributes in Wonderware System Platform and Rockwell Automation's Studio 5000. Restrictions for the naming conventions are a collaboration of rules for both software packages and are as follows:

- Object name is limited to 32 characters
- Attribute name is limited to 40 characters
- Names may consist of alpha characters (A-Z or a-z where letter case is not considered significant), numbers and the underscore character ("_")
- Names must begin with an alpha character
- PLC Arrays shall not be used since Wonderware tags may not contain a bracketed pointer such as ArrayTag[3]
- Object names contain words and acronyms describing the plant, area, and device
  - Each word or acronym in a tag shall start with a capital letter
  - Plant, area and device definitions are separated by an underscore character ("_")
  - Multiple consecutive underscores and trailing underscores are not permitted
- The following reserved words may not be use:
  - RetVal
  - Me
  - MyContainer
  - MyArea
  - MyHost
  - MyPlatform
  - MyEngine
  - System

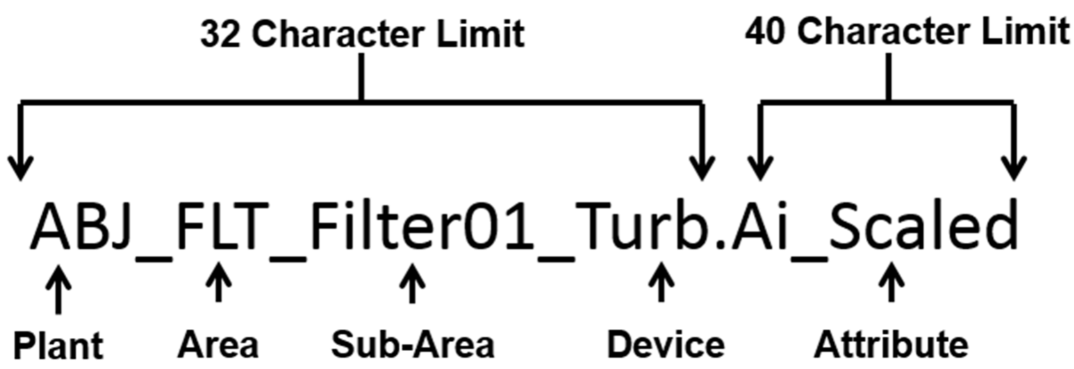


Figure 4-1 Example Object Name

4.4.1 Plant Names

Each plant shall have a unique three-character acronym that will be the first segment of each instance definition.

Table 4-8 Plant Acronyms

PLANT	DESCRIPTION
ABJ	AB Jewell Water Treatment Plant
MHK	Mohawk Water Treatment Plant

4.4.2 Area Names

Process Area Names define which part of the plant process the instance resides.

Table 4-9 Process Area Acronyms

AREA	DESCRIPTION
RAW	Raw Water
BOP	Balance of Plant
CLAR	Clarification
FLT	Filtration
CW	Clear Well
CHM	Chemical Feed
REC	Recovered Water
SLG	Sludge Dewatering
HSPS	High Service Pump Station
DIST	Distribution

Table 4-10 Example Sub Area Names

SUB AREA	DESCRIPTION
ACH	Aluminum Chlorohydrate
NH3	Ammonia
Cl2	Chlorine
Fluor	Fluoride
NaOH	Sodium Hydroxide
PAC	Powder Activated Carbon
PolyC	Cationic Polymer
Clar01	Clarifier 1
CWEast	East Clearwell
Filter01	Filter 1
Thickener01	Thickener 1
Ch01	Channel 1
AirScour	Filter Air Scour System
BW	Filter Backwash

4.4.3 Device Names

The device names typically use abbreviations to describe the instance. Additional descriptors may be added for clarity within the 32-character limit.

DEVICE	DESCRIPTION
Llv	Level
Pmp	Pump
RecircPump	Recirculation Pump
XPmp	Transfer Pump
Mxr	Mixer
Floc	Flocculator
Flw	Flow
Tnk	Tank
Feeder	Chemical Feed Pump
Temp	Temperature
Mtr	Motor
Brng	Bearing
Windg	Winding

pH	pH
Vlv	Valve
Infl	Influent
Effl	Effluent
Psi	Pressure
PID	Proportional Integral Derivative Controller
Gen	Generator
Vac	Vacuum

5.0 PLC Programming Standards

5.1 PLC PROGRAMMING STANDARDS OVERVIEW

The following sections will describe the standardization of PLC programming file naming conventions, programming languages, signal addressing, PLC card configuration, alarming, virtual push buttons, PLC to PLC messaging, valves, and motors. The standards are written to coincide with Allen Bradley ControlLogix and CompactLogix PLCs. These standards shall be implemented in other types of PLCs if approved for use by TMUA.

5.2 PROGRAM FILE NAMING CONVENTIONS

The file name shall use the naming conventions in section 4.4 followed by the date formatted as YYYY_MM_DD. Each time edits are made in PLC code, a new version of the code shall be created to ensure the ability to revert to the preceding code. The Filter PLC program for ABJ would be ABJ_FLT_2017_01_01 if last edited on January 1, 2017.

5.3 PROGRAMMING LANGUAGES

Programs are written using Function Block Diagrams (FBD) and Ladder Diagrams (LD). The TMUA's software license only allows these two programming languages. Other programming languages shall not be used unless approved by the TMUA.

5.4 PROGRAMMING STRUCTURE

The Studio 5000 programming software allows the programs to run continuously or periodically. All programs shall be configured as periodic and not continuous per Rockwell Software's best practices. A separate program shall be created for each major process. Each program shall contain a main task. The main task shall only use Jump to Subroutine (JSR) commands to call all the other routines in the program.

5.5 SIGNAL ADDRESSING

Each remote rack has its own routine with a program for linking the base tag to a PLC object attribute. Each routine has a program for each signal type. The main program calls the signal type programs with JSR functions. This allows that each signal type program may be disabled for testing and troubleshooting. There is a ladder program for each of the four signal types (Analog Input, Analog Output, Digital Input, Digital Output) as seen in Figure 5-1. Analog signals shall use MOV statements to pass the RIO signal to the appropriate template element. Digital signals shall use contacts and relays instructions to pass the signal to the appropriate template element.

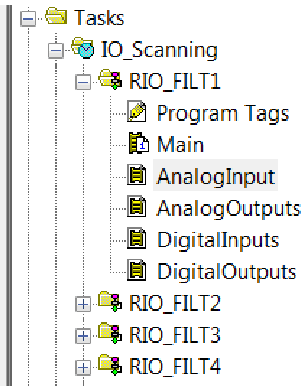


Figure 5-1 Signal Addressing Routine Structure in PLC

5.6 ANALOG INPUT CARD CONFIGURATION

Analog point scaling is done using PLC logic such that the high and low engineering units may be modified at the HMI. The PLC analog input card input scaling is set to a 4-20mA range. All alarming at the card level is disabled. Figure 5-2 and Figure 5-3 show the input card configuration screens.

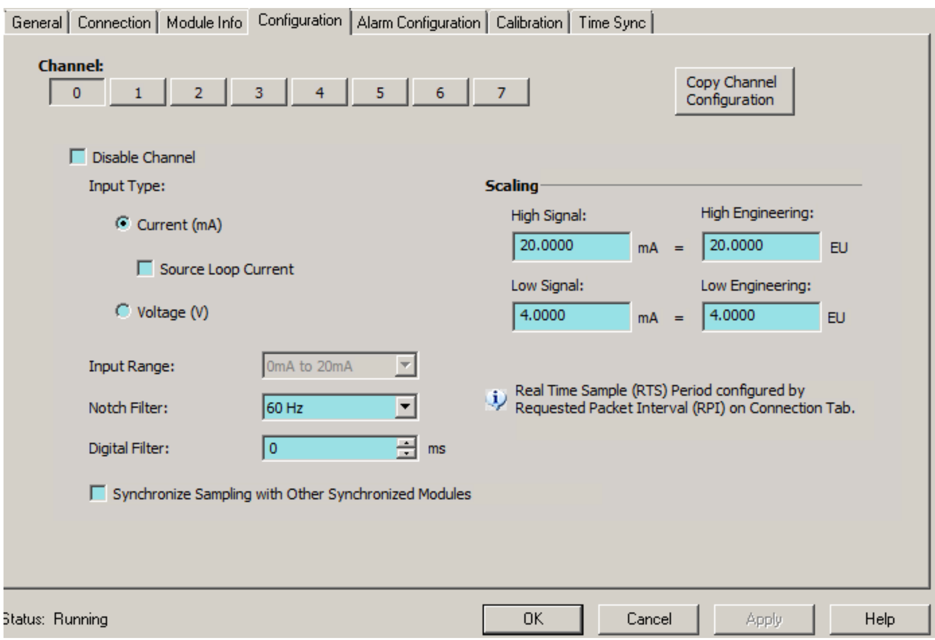


Figure 5-2 PLC Analog Input Card Range Configuration

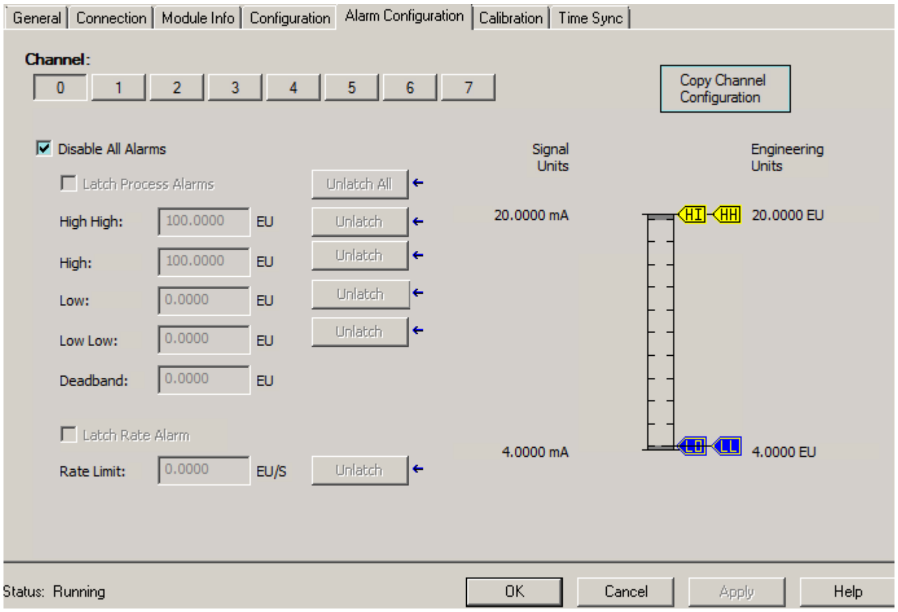


Figure 5-3 PLC Analog Input Card Alarm Configuration

All analog input tags are scaled in an AnalogInput AOI. The routine assigns aliases for the high and low engineering unit so that these range values may be changed at the HMI. Hard coded engineering unit ranges should be avoided.

5.7 ANALOG OUTPUT CARD CONFIGURATION

All analog point scaling is done using PLC logic such that the high and low engineering units may be modified at the HMI. The PLC analog output card Output range of 0 mA to 20 mA shall be selected from the drop-down box. The High Signal and High Engineering shall be set to 20.0 ma and the Low Signal and Low Engineering shall be set to 4.0 ma. The Output State in Programming Mode and Output State in Fault Mode shall be set to Hold Last State. Figures 5-4 and 5-5 show the output card configuration screens.

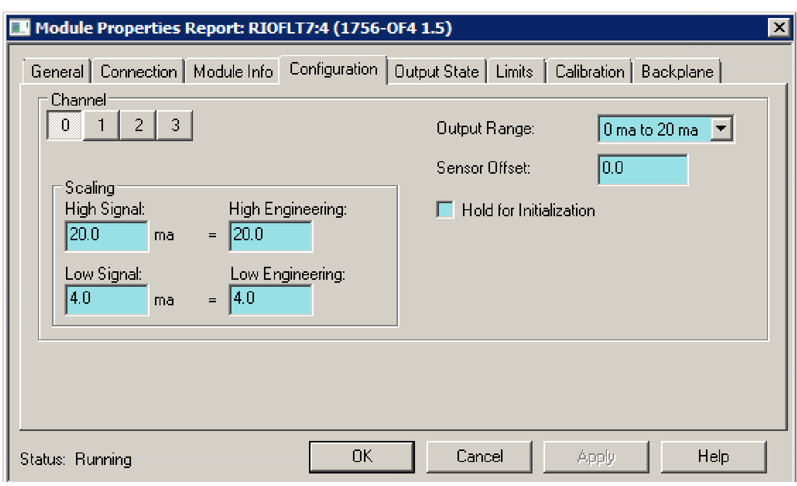


Figure 5-4 PLC Analog Output Card Range Configuration

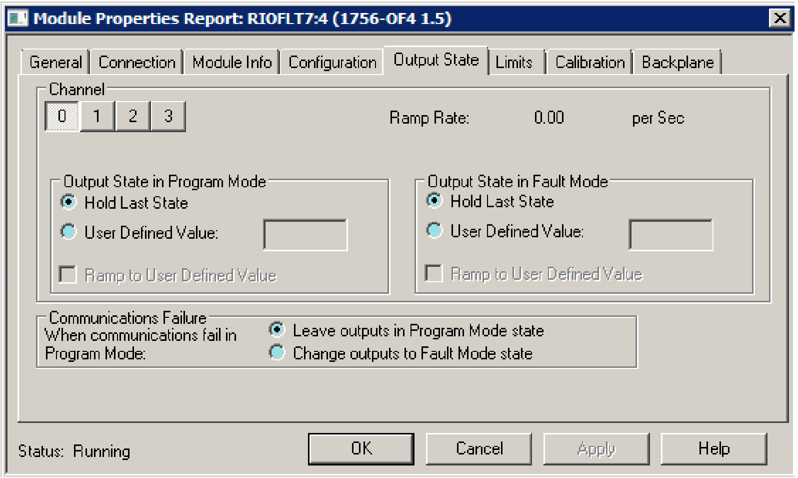


Figure 5-5 PLC Analog Output Card Output State Configuration

5.8 PLC PROGRAMMING GUIDELINES

The following is meant to provide minimum guidelines for the documenting and programming of PLCs. System integrators on future projects shall present a programming guideline to provide additional detail on how the program and logic will be developed. Standards contained herein shall also apply to vendor-provided PLCs.

Programming shall be done in IEC 61131-3 compliant ladder logic or function block diagram formats unless otherwise approved by TMUA.

5.8.1 Alarm Handling

Alarms will provide critical and timely information to operations in case of an abnormal process condition or equipment failure. Alarms typically fall into one of the following categories:

- Discrete alarms
- Process alarms
- Change of state alarms
- Communication alarms

In general, PLC alarms will be handled as follows:

- All discrete input alarms should be preconditioned with a de-bounce timer to validate the alarm condition.
- On a case by case basis, alarms should be preconditioned to prevent nuisance alarms. Typical preconditioning will include pump running status for a low flow alarm or a valid level signal (i.e. not out-of-range) in order for low or high alarms to be generated.
- All analog (process) alarms shall be configurable based on alarm setpoint from Operator Workstations. A dead band will be determined by TMUA (typically 10% above low alarms or 10% below high alarms). Alarms will be latched until analog value returns to normal (above low alarm dead band or below high alarm dead band).

Future project shall utilize the standard AOIs for ControlLogix and CompactLogix PLCs. The tags and functionality of these AOI shall be replicated if other types of PLCs are approved.

5.8.1.1 Discrete Alarms

Discrete alarm inputs will generate an alarm based on field device input. Examples of these include a high-pressure signal from a pressure switch or a low-level signal from a float switch.

5.8.1.2 Process Alarms

Process alarms will generate an alarm based on an analog value exceeding adjustable alarm setpoints. It is suggested that the security level for adjusting alarm setpoints be set at the supervisor or programmer level.

5.8.1.3 Change of State Alarms

All PLC discrete output commands will be compared with their respective process feedback status signal, where available, to verify proper execution. A descriptive alarm message will be displayed on the operator workstations when the feedback status does not match the output command after a predefined time delay. The condition will be logged in the alarm database and requires operator acknowledgment.

Some examples of change of state alarms:

- If Pump Running feedback is not on within 5 seconds after Pump Run command is issued, a Pump Failed to Start Alarm will be generated.
- If Valve Closed feedback is not on within 90 seconds after Valve Closed command is issued, a Valve Failed to Close Alarm will be generated.
- All alarms will be generated within respective PLC controller and indicated at Operator Workstation alarm summary. Set points for each analog alarm will be adjustable from the workstations. It is suggested that the security level for adjusting alarm setpoints be set at the supervisor or administrator level.

5.8.1.4 Communication Alarms

The SCADA System shall continuously monitor the status of all network communication links within the system. For PLC to PLC communications, the PLC shall monitor the error bit on the message function block and send an alarm to the HMI when an error is active. Wonderware also provides a graphic display to show I/O driver statistics such as error, timeouts, etc.

5.8.1.5 Alarm Activations

All alarms will latch in alarm state until acknowledged. The exceptions are alarms that are driven solely by self-curing process changes, such as under voltage (power failure), seal water low pressure, or low suction pressure. Once an alarm has cleared (returned to normal state) the latch will automatically reset, if previously acknowledged.

In Remote/Manual mode, any devices that use alarms as interlocks must be reset and re-started from an Operator Workstation (if latched). In Remote/Auto, any devices that use alarms as interlocks must be reset from an Operator Workstation (if latched) – start/stop will be based on Auto logic state.

Alarms will be suppressed during start-up or shutdown of a device or process where those alarm conditions are irrelevant during these periods. Alarms will be reviewed during the control strategy design stage on a case-by-case basis to confirm appropriate behavior.

5.8.2 Simulating Momentary Contact Push Buttons

Using logic to simulate a momentary contact push button is used on HMI screens most commonly for control buttons. For example, the HMI will set a bit in the PLC to start a motor and then the PLC will reset that bit after sending a start command to the motor. In general, using an HMI to clear the reset bit is not a preferred programming practice since the HMI may clear the bit prior to the desired function being performed in the PLC. For this reason, all momentary contact programming should be accomplished at the PLC level to avoid potential problems that may occur due to the timing constraints of the network. The HMI shall set the bit and the PLC shall reset the bit when the commanded action is executed.

5.8.3 Peer to Peer Messaging

Communication is necessary between PLCs to pass process variables for some control algorithms. Ladder Logic read message blocks are used for PLC to PLC messaging. Write message blocks should be avoided if possible. Write blocks must be used to message from a ControlLogix PLC to a SLC or MicroLogix PLC. Produced/Consumed messaging should not be used.

5.8.4 Analog Signal Scaling

Each analog input shall be scaled into English engineering units. The engineering units shall then be used for any limit comparisons, PID loop setpoint and feedback, and display inside the PLC programming software.

5.8.5 Flow Totalization

Flow Totalization is programmed in the Flow Meter AOI. The AOI shall be configured in the PLC logic for the instantaneous flow signal units (e.g. GPH, GPM, MGD) and the totalized flow value units (Gallons, MG, etc).

5.8.6 Run-Time Tracking

Run-time calculations shall be programmed into each AOI required. The logic shall use one timer and counter to track minutes and another counter to accumulate hours.

5.8.7 Program Documentation

Documentation for all PLC programs shall include comments, tag/register descriptions, or any other programming tags. All PLC programs shall be generously documented with comments minimally provided for each subroutine and/or section. For PLCs provided outside of a vendor provided control system, the PLC program and associated documentation shall be stored in the PLC memory. Use of abbreviations in comments and subroutine/section titles should be avoided. Copies of programs shall be provided at the completion of projects in both printed and electronic (.pdf) format. Additionally, the program file shall be provided on DVD-R media.

5.8.8 Analog Input Failure Checks

All hardwired analog input raw count bounds shall be checked and normal or fault flag bits created. These flags shall be used to detect instrumentation failures and create a SCADA alarm. All analog inputs shall have a live zero to differentiate between a zero value and a failed analog input. All analog devices should use a 4-20mA scaling.

5.8.9 Equipment Control

Equipment control utilizes three control states: Local, Remote/Auto, and Remote/Manual. Equipment is in control when the control switch is not in the Remote position. This is a physical switch that is usually located at the Motor Control Center (MCC), on a control panel close to the equipment, or physically on the equipment. When equipment is in Local, it is manually operated from the MCC or control panel and the PLC control is overridden. When the local control switch is in the Remote position, the equipment is controlled by the SCADA system and can be in either Remote/Auto control or Remote/Manual based on the HMI operator's selection from the process screen. Remote/Auto control uses the control algorithms programmed specifically for each process. When in Remote/Manual control, operators control process equipment by selection of Open/Close, Start/Stop, or other control interfaces on the HMI screens as appropriate for each piece of equipment.

5.8.10 Motor Control

Motor control includes start/stop command, fail to start alarm, field alarms, and run time accumulator. When the motor is in Remote/Auto control, the motor will start/stop when called from the automatic control algorithm. The Operator can override automatic control by switching the motor control to Remote/Manual at the HMI and selecting start or stop software pushbuttons.

When the motor is called to start in either Remote/Auto or Remote/Manual control, a timer will monitor the motor run contact. If the motor does not start within a predefined time, the run command terminates, and a start fail alarm is sent to the HMI. An alarm reset from the HMI must be sent prior to normal operation of the motor resuming. Once the motor run contact is closed, a run timer will accumulate the total run hours of the pump.

Motor alarms are monitored by the PLC. If any motor failure alarm is received by the PLC, the motor run command terminates, and an alarm is sent to the HMI. An alarm reset from the HMI must be sent prior to normal operation of the motor resuming.

Variable speed motor control will pass either the automatic control set-point when in Remote/Auto control or the manual speed set-point when in Remote/Manual to the motor. If the motor is in Remote/Auto, the automatic control algorithm will determine the required motor speed. The automatic speed set-point shall be written to the manual speed set-point to ensure bumpless transfer from Remote/Auto to Remote/Manual mode. When the motor is in Remote/Manual mode, the HMI operator may override the automatic control and manually enter the desired motor speed set-point. All motors use a standardized AOI template to ensure consistency of all motor tags in each PLC.

5.8.11 Valve Control

There are two types of controlled valves used in the system; analog and digital valves. An analog valve position is monitored and controlled by a 4-20 mA signal that corresponds to 0-100% open. A 12mA signal would then equate to a 50% open signal. A digital valve is controlled by open and close relays and monitored by limit switches. A digital valve can only be in the open or closed position and typically may not be modulated.

Analog valve control utilizes the automatic position set-point when in Remote/Auto control or the manual position set-point when in Remote/Manual control. If the valve is in Remote/Auto, the automatic control algorithm will determine the required valve position in percent open. This position set-point is written to the manual position set-point to ensure bumpless transfer from

Remote/Auto to Remote/Manual mode. When the valve is in Remote/Manual mode, the HMI operator manually enters the desired valve position set-point.

Digital valve control consists of open/close control, fail to open alarm, fail to close alarm, and both limit switches active alarm. When the valve is in Remote/Auto control, the valve will open/close when called from the automatic control algorithm. The HMI operator can override automatic control by switching the valve control to Remote/Manual and selecting open or close. When the valve is called to open or close in either Remote/Auto or Remote/Manual control, a timer will monitor the open or closed limit switch respectively. If the valve does not reach the fully open or fully close within a predefined time, a fail to open/close alarm is sent to the HMI. The PLC tracks the most current time the valve takes to fully open or close to aid in setting these alarm delay times. If both the open and closed limit switches are active simultaneously, a both limit switches active alarm will be sent to the HMI.

6.0 HMI Programming Standards

This section provides guidelines that shall be used for Wonderware System Platform (HMI). It is assumed that the reader has extensive knowledge of Wonderware Application Server, Historian, Historian Client and InTouch.

6.1 SECURITY

The follow section details the security for operator workstations, servers, and Wonderware software.

6.1.1 Security Configuration

Wonderware System Platform Security is configured inside the IDE. The Authentication Mode shall be Galaxy. There shall be only one security group unless directed otherwise by TMUA. Security Roles shall be used to restrict access. Access Level is a legacy feature and should be avoided for restricting access. Instead, access shall be controlled by the General Permissions and Operational Permissions.

6.1.2 Operational Permissions

Security levels shall be set inside the object for each attribute. Valid options shall be Operate, Tune, and Configure. All other Operational Permissions shall not be used without consent from TMUA.

Operate – This shall be the default value. Operate allows operators, supervisors and administrators to change these attributes.

Tune – This shall be used for restricted attributes that only a supervisor or administrator may change.

Configure – This shall be used for items only an administrator may change. The object must be undeployed or placed off-scan to change this attribute. It is intended for attributes that are not changed on a regular interval.

In the example below, the $Analog template is shown. The Ai_ScaledHigh attribute is set to Tune such that only a supervisor or administrator may change the value. This is done to prevent an operator from accidently changing the scale of the analog signal.

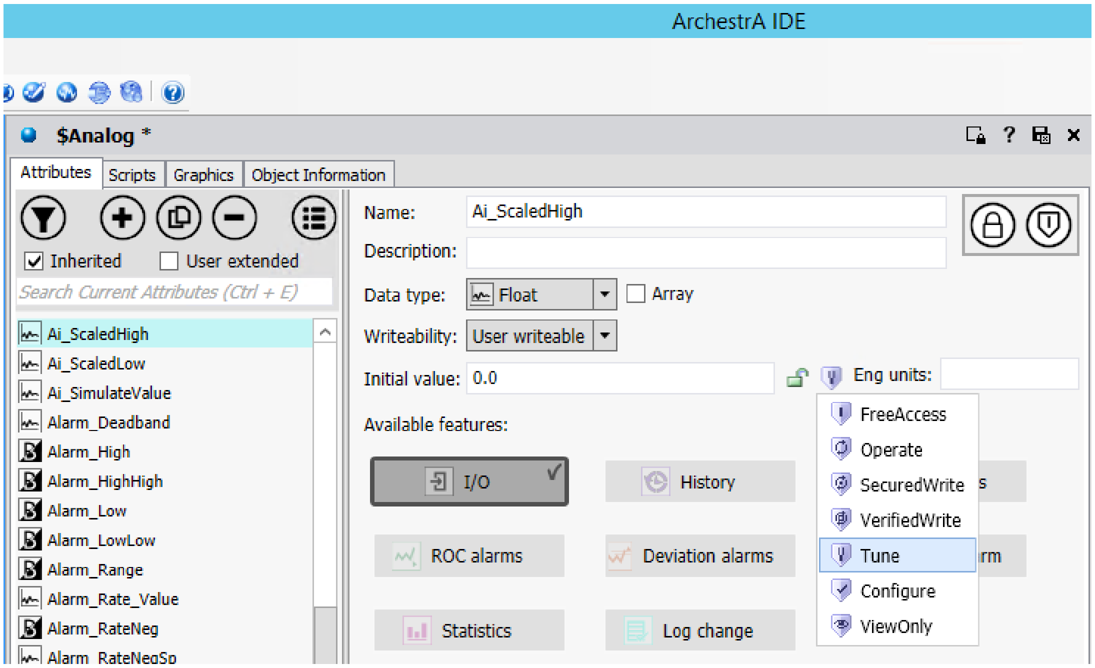


Figure 6-1 Security Configuration

6.1.3 Security Groups

Each user will be assigned to a security group. HMI security provides four levels of user access. The system allows definition of an access level for each user.

Guest – This is the default access level and provides rudimentary functions only and can generally view most parameters and other information. Guests cannot change any information in the system, nor can they execute functions which control device or alter system parameters.

Operator – This level provides access to those functions that are used in normal process of monitoring and controlling the system. Functions available to an operator include acknowledging alarms, change control set-points, change equipment control modes and manually control equipment.

Supervisor – This role has all the access of an operator as well as the ability to change parameters that are configured as "Tune" in security.

Administrator – This is the most powerful and complete level of access and permission to the Wonderware IDE development environment.

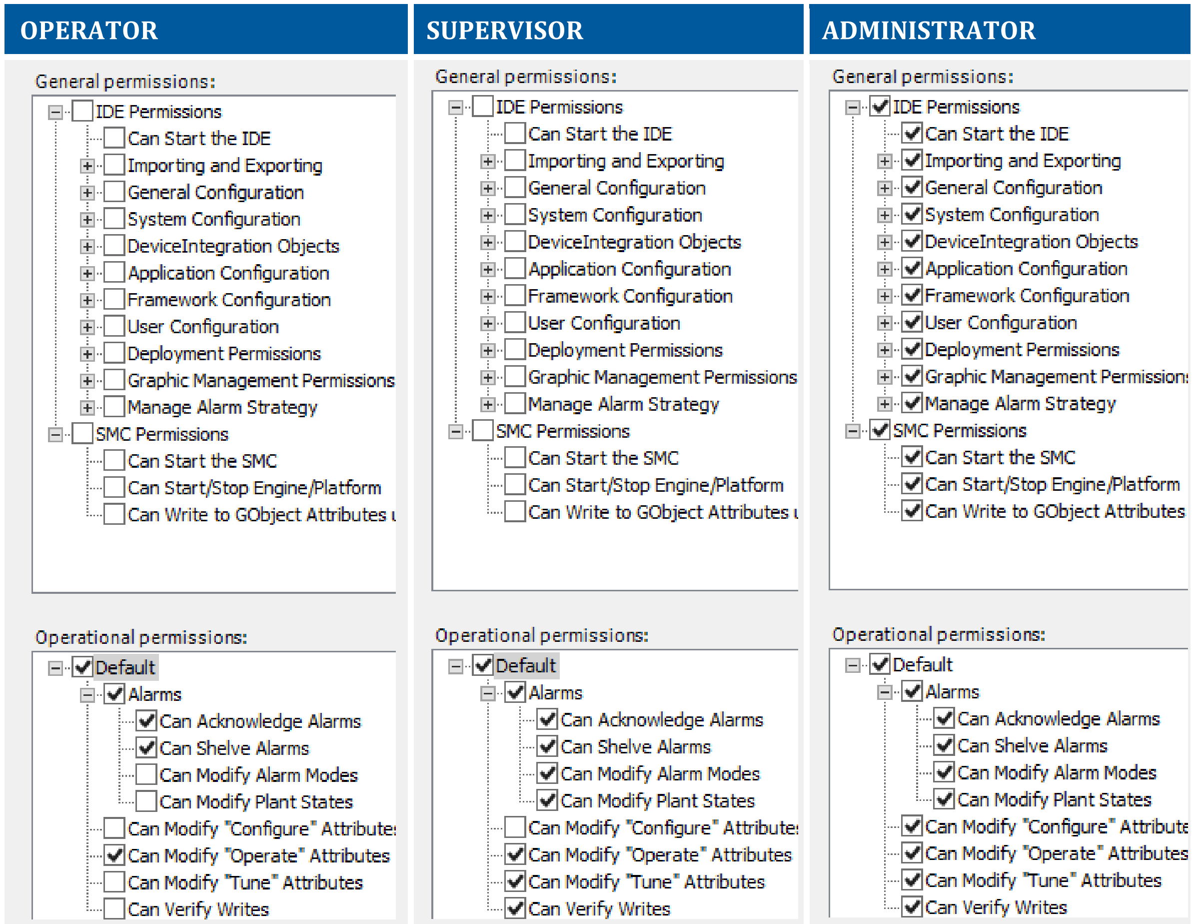


Figure 6-2 Security Groups

6.1.4 User Accounts

All operators will use the same “operator” account. Each supervisor and administrator shall have their own Windows OS and Wonderware account. The user name shall consist of their first initial and last name.

6.1.5 Network Account

Each Windows OS with Wonderware software must have the same user account with administrator privileges. Contact TMUA for the username and password for this account.

6.1.6 Workstation Security

Operator workstations shall be configured in the BIOS to automatically start when connected to power or after a loss of power. Operator workstations in a controlled area shall be configured to automatically log into the Windows OS by editing the registry. The Wonderware InTouch WindowViewer shall be configured to automatically login the generic “operator” account upon an operator initiated start of the program. This shall be scripted in the WindowMaker Application Scripts.

6.2 GALAXY REPOSITORY

The galaxy repository contains a SQL database that stores all the objects and instances in System Platform. Wonderware best practices states that all development should be done in an offline, non-production "sandbox" server and thoroughly tested. Once tested, modified files should be imported into the production environment.

6.3 GALAXY CONFIGURATION

A Galaxy is a collection of computers (platforms), engines, templates, instances, and attributes you define as the parts of your specific application. Persistent information about this collection of objects is stored in a Galaxy database. A Galaxy's namespace is the set of unique object and attribute identifiers. Each plant may be its own galaxy. This section describes the configuration of the major components of the ABJ Galaxy.

6.3.1 Galaxy Name

The galaxy name should be based on the TMUA HMI platform software organization and how TMUA intends to maintain and support the software. A galaxy is a system consisting of a single logical name space (defined by the Galaxy Database) and a collection of Platforms, Engines and Objects. This is referred to as the Galaxy Namespace. The galaxy names typically reflect the name of a facility where the control system components are physically located. A galaxy may communicate with another galaxy.

Table 6-1 Plant Abbreviations

PLANT	DESCRIPTION
ABJ	AB Jewell Water Treatment Plant
MHK	Mohawk Water Treatment Plant

6.3.2 WinPlatforms

A WinPlatform is a physical or virtual computer running a Microsoft operating system. The WinPlatform is configured for a specific role. Below is a listing of the roles for each computer and operating systems.

Table 6-2 WinPlatform Designations

WINPLATFORM	ROLE	DESCRIPTION	OPERATING SYSTEM
ABJ-DEV	Galaxy Repository	Development computer	MS Server 2012 R2
ABJ-AOS1 ABJ-AOS2	Application Object Server	Communicates with PLCs and handles alarming and historical data collector	MS Server 2012 R2
ABJ-HIST	Historian	Stores historical data in an SQL database	MS Server 2012 R2
ABJ-WORKSTATION01 - 08	Workstation	Acts as an operator graphical interface	MS Windows 10

6.3.3 Application Object Servers and Redundancy

An Application Object Server (AOS) is a computer that hosts An AOS pair implement automatic failover redundancy. The two AOS should be configured to split the load of the entire system to ensure faster failover events. It is recommended that the two AOS reside in separate locations to provide a higher level of fault tolerance and reliability.

6.3.4 Application Engines

Application Engines or AppEngines are containers for application objects, device integration objects and areas. It contains the logic to set up and initialize objects when they are deployed and remove objects from the engine when they are undeployed. It also determines the scan time which all objects within that engine run.

The optimal number of AppEngines in a project is a multiple of the number of processors the AOS has. For instance, an AOS with a quad core processor should host at least 4 AppEngines. This enables the work load to be distributed among the several processors. It is not necessary to evenly distribute the objects among the engines. For organizational purposes, each major process shall have its own AppEngine. The default scan time for AppEngines is 1 second.

AppEngines may be configured as a single or redundant object. Network communication objects shall be placed on single AppEngines and all other objects shall be placed on redundant AppEngines.

Table 6-3 Application Engines

APPLICATION ENGINE	PRIMARY HOST	BACKUP HOST
AppEngine_Chemical	WiNPlatform_AOS2	WiNPlatform_AOS1
AppEngine_Clarifiers	WiNPlatform_AOS1	WiNPlatform_AOS2
AppEngine_Filters	WiNPlatform_AOS1	WiNPlatform_AOS2
AppEngine_HSPS	WiNPlatform_AOS2	WiNPlatform_AOS1
AppEngine_RWPS	WiNPlatform_AOS1	WiNPlatform_AOS2
AppEngine_Sludge	WiNPlatform_AOS2	WiNPlatform_AOS1
AppEngine_ABJ_DDE_AOS1	WiNPlatform_AOS1	N/A
AppEngine_ABJ_DDE_AOS2	WiNPlatform_AOS2	N/A

6.3.5 Field Device Configuration

This section describes how to configure Wonderware communications to field devices such as PLCs and other field devices.

6.3.5.1 Redundant Dynamic Data Exchange Architecture

Each PLC shall have a primary and secondary Dynamic Data Exchange objects (DDESuiteLinkClient) and a RedundantDIO (RDIO) object The RDIO provides failover capability for the primary and backup IO Drivers that reside on the primary and backup AOS respectively. As mentioned in the Application Engines section above, the DDESuiteLinkClients are deployed to a non-redundant AppEngine while the RDIO are deployed to a redundant AppEngine.

Table 6-4 Redundant DIO Objects

REDUNDANT DIO	DESCRIPTION	APP ENGINE	I/O SERVER	DEVICE IP ADDRESS
DDE_BFP1	Belt Filter Press #1	AppEngine_Sludge	DAS AB CIP	15
DDE_BFP2	Belt Filter Press #2	AppEngine_Sludge	DAS AB CIP	20
DDE_BFP3	Belt Filter Press #3	AppEngine_Sludge	DAS AB CIP	25
DDE_CHM	Chemical PLC	AppEngine_Chemical	DAS AB CIP	175
DDE_Diox01	Chlorine Dioxide Generator 1 PLC	AppEngine_Chemical	DAS AB CIP	122
DDE_Diox02	Chlorine Dioxide Generator 2 PLC	AppEngine_Chemical	DAS AB CIP	120
DDE_HSPS	High Service PLC	AppEngine_HSPS	DAS AB CIP	51
DDE_NH3	Ammonia/Chlorine PLC	AppEngine_Chemical	DAS AB CIP	52
DDE_Recover	Recovered Water PLC	AppEngine_ Sludge	DAS AB CIP	199
DDE_SLG	Sludge PLC	AppEngine_ Sludge	DAS AB CIP	198
DDE_Sludge01	Sludge Pump Station 1 PLC	AppEngine_ Sludge	DAS AB CIP	119
DDE_Sludge02	Sludge Pump Station 2 PLC	AppEngine_ Sludge	DAS AB CIP	180
DDE_Clar01_Floc	Clarifier 1 Flocculation PLC	AppEngine_Clarifiers	DAS AB CIP	118
DDE_Clar01_SC	Clarifier 1 Sludge Collector PLC	AppEngine_Clarifiers	DAS AB CIP	102
DDE_Clar02	Clarifier 2 PLC	AppEngine_Clarifiers	DAS AB CIP	177
DDE_Clar03	Clarifier 3 PLC	AppEngine_Clarifiers	DAS AB CIP	178
DDE_Filter	Filter PLC	AppEngine_ Filters	DAS AB CIP	171

REDUNDANT DIO	DESCRIPTION	APP ENGINE	I/O SERVER	DEVICE IP ADDRESS
DDE_NCFB	North Combined Filter Building PLC	AppEngine_HSPS	DAS AB CIP	200
DDE_RAW	Raw Water PLC	AppEngine_RWPS	DAS AB CIP	170
DDE_ModbusTCP_HPSP_Temp_01	High Service Pump 1 Temperature Device	AppEngine_HSPS	DAS MB TCP	65
DDE_ModbusTCP_HPSP_Temp_02	High Service Pump 2 Temperature Device	AppEngine_HSPS	DAS MB TCP	66
DDE_ModbusTCP_HPSP_Temp_03	High Service Pump 3 Temperature Device	AppEngine_HSPS	DAS MB TCP	69
DDE_ModbusTCP_HPSP_Temp_05	High Service Pump 5 Temperature Device	AppEngine_HSPS	DAS MB TCP	67
DDE_ModbusTCP_HPSP_Temp_07	High Service Pump 7 Temperature Device	AppEngine_HSPS	DAS MB TCP	68

Each type of field device shall have its own derived template container. The figure below shows the derived template hierarchy for the Redundant DI Objects.

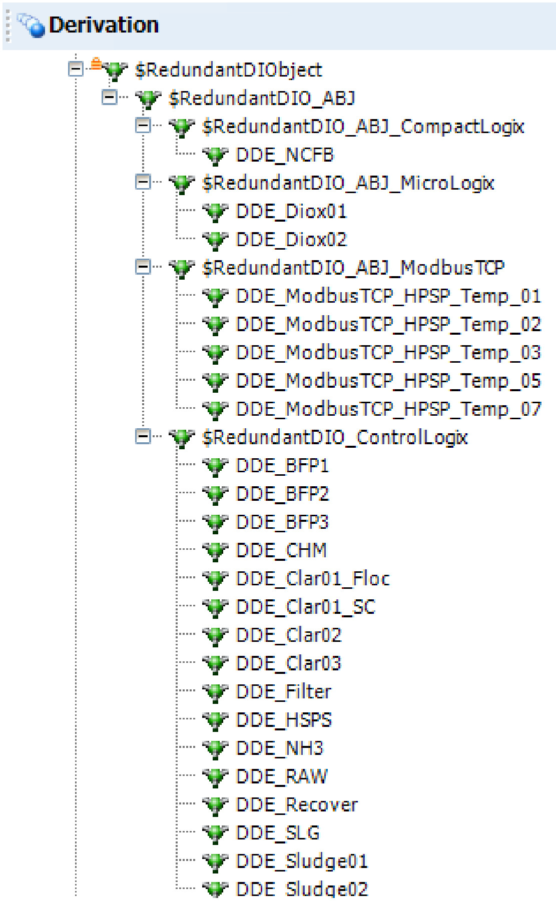


Figure 6-3 Redundant DI Object Hierarchy

For each Redundant DI Object, there will be two DDE_SuiteLinkClient created. The naming convention shall be <RedundantDI Name>_<AppEngine AOS Acronym>. The figure below displays the DDE objects within the IDE in deployment view.

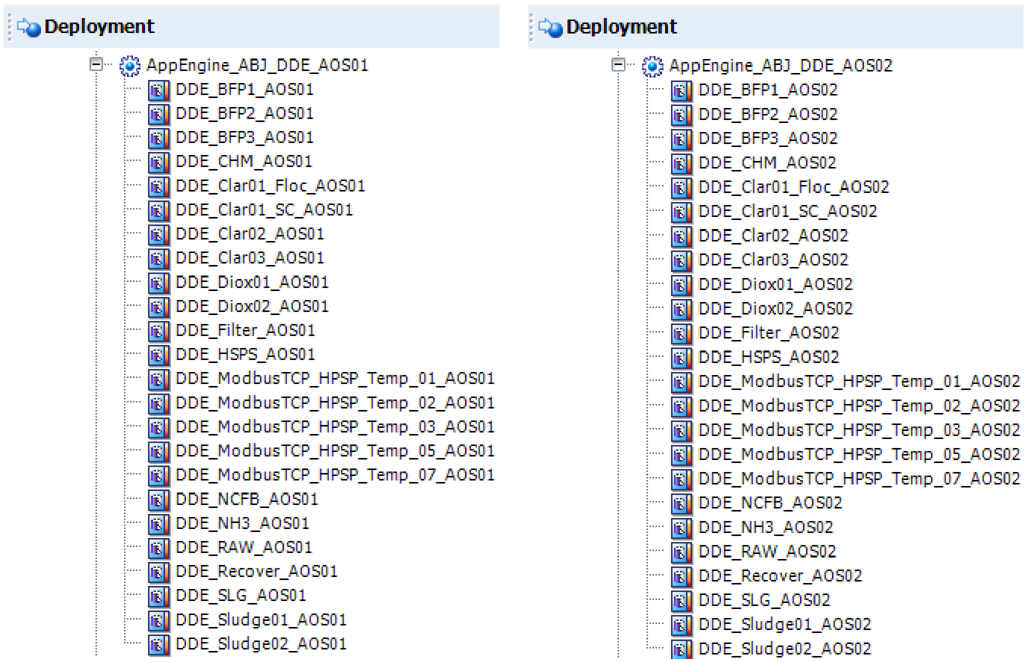


Figure 6-4 DDE Suite Link Clients

6.3.5.2 Allen Bradley PLCs

Network configuration is completed in two software programs; the System Management Console (SMC) and within the IDE. The parameters for these two programs must match.

The parameters for an Allen Bradley ControlLogix or CompactLogix PLC at the SMC are shown below. Note that the Network Address has been masked for security purposes.

The Slot Number is the location of the PLC in the rack. Optimization shall be set to Optimize for Read. All other default values shall be used.

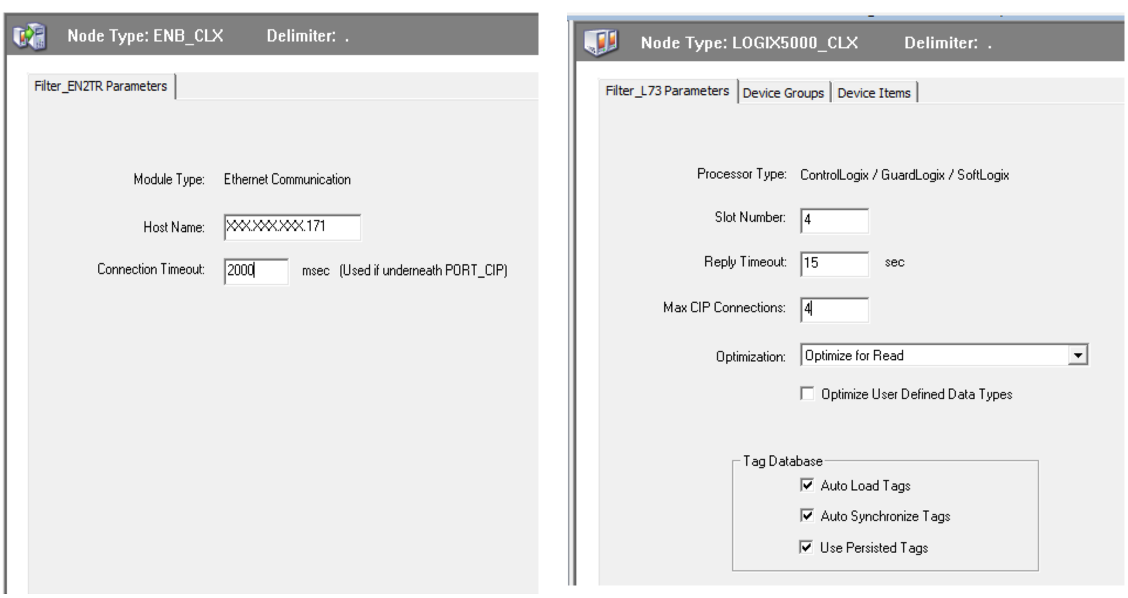


Figure 6-5 SMC ControlLogix PLC Configuration

The Device Group in the SMC must match the Topic in the DDE Object. Below, the right shows the Device Groups setting inside the SMC and the right shows the Topic inside the IDE object. The IDE Scan Mode shall be set to ActiveAll.

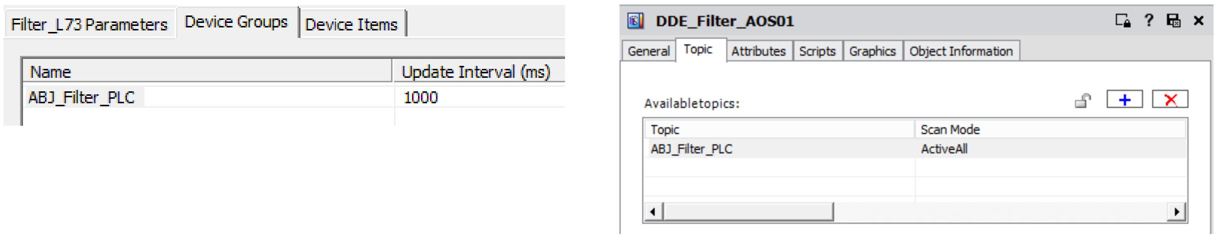


Figure 6-6 Device Group and Topic Matching Configuration

The configuration of a MicroLogix PLC at the SMC is shown below. The Host Name is the IP Address for the device. Note that it is masked in this document for security purposes. Maximum CIP Connections shall be set to 1.

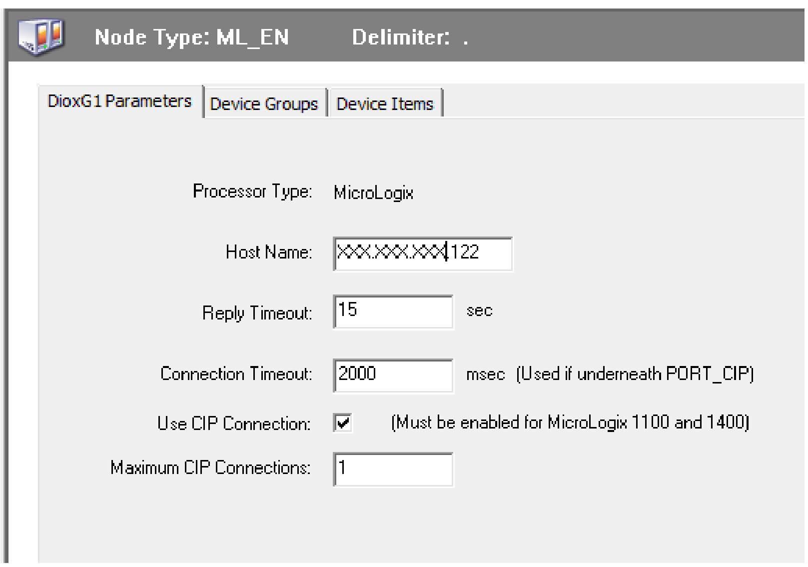


Figure 6-7 SMC Micrologix Configuration

6.3.5.3 Modbus TCP/IP Devices

The High Service Pumps contain devices that read several temperature readings. These devices use the common industrial protocol Modbus TCP/IP. The SMC configuration of these devices is shown below. All Modbus TCP/IP devices shall be configured using a Modbus Bridge. Note that the Network Address has been masked for security purposes.

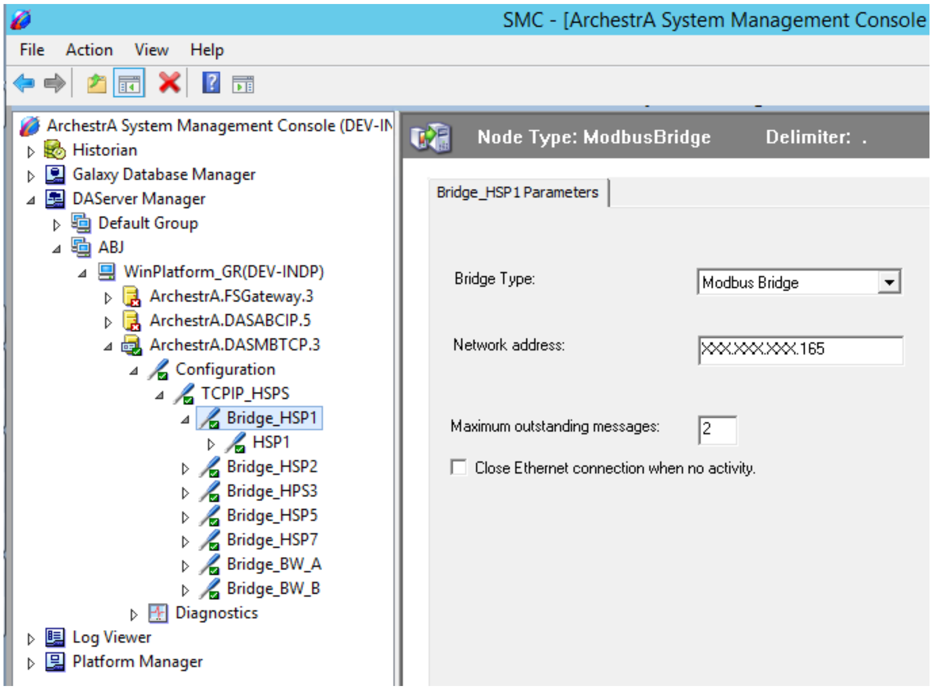


Figure 6-8 SMC Modbus Bridge Configuration

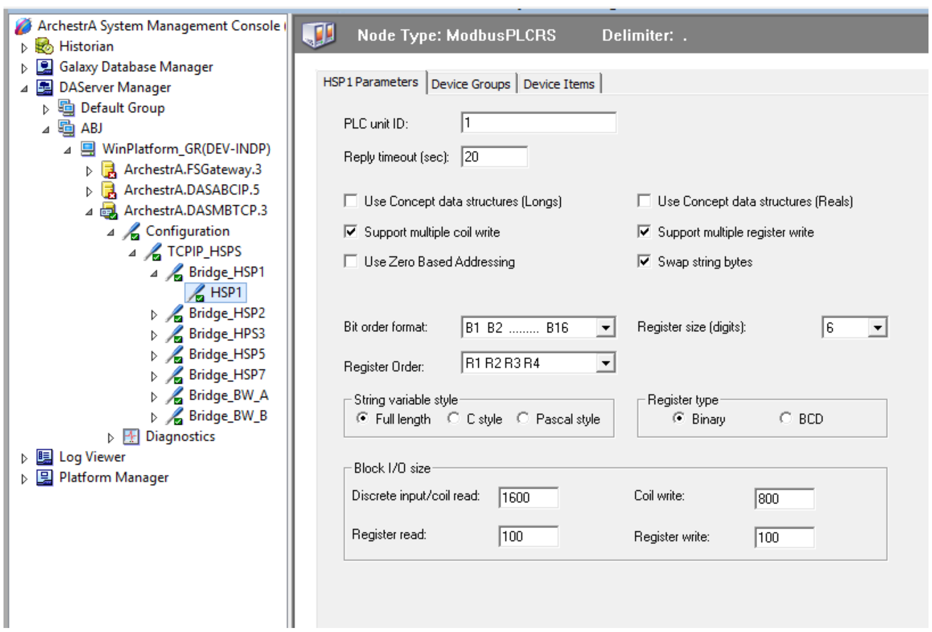


Figure 6-9 SMC Modbus Device Configuration for HSP Temperature Device

6.3.6 Areas

Wonderware System Platform requires all objects to be placed in an Area. Areas are the building blocks of the Wonderware Process Model. These areas can be used for alarm management and security role assignments. Below is the list of Areas and where each are contained.

Table 6-5 Wonderware Area Assignments

AREA	CONTAINER
Area_ABJ	N/A
Area_BalanceOfPlant	Area_ABJ
Area_Chemical	Area_ABJ
Area_Clarification	Area_ABJ
Area_ClearWell	Area_ABJ
Area_Filters	Area_ABJ
Area_PlantEffluent	Area_ABJ
Area_RawWater	Area_ABJ
Area_SludgeHandling	Area_ABJ
Area_SludgePumps	Area_ABJ
Area_System	Area_ABJ
Area_CHM_ACH	Area_Chemical
Area_CHM_Fluor	Area_Chemical
Area_CHM_NaOH	Area_Chemical
Area_CHM_NH3	Area_Chemical
Area_CHM_PolyC	Area_Chemical
Area_CHM_H2SO4	Area_Chemical
Area_CHM_Cl2	Area_Chemical
Area_CHM_PAC	Area_Chemical
Area_CHM_Caustic	Area_Chemical
Area_ClearWell_East	Area_ClearWell
Area_ClearWell_West	Area_ClearWell
Area_Filter01	Area_Filters
Area_Filter02	Area_Filters
Area_Filter03	Area_Filters
Area_Filter04	Area_Filters
Area_Filter05	Area_Filters
Area_Filter06	Area_Filters
Area_Filter07	Area_Filters

AREA	CONTAINER
Area_Filter08	Area_Filters
Area_Filter09	Area_Filters
Area_Filter10	Area_Filters
Area_Filter11	Area_Filters
Area_Filter12	Area_Filters
Area_FilterBackwash	Area_Filters
Area_HighService	Area_PlantEffluent
Area_HSPS_Pmp01	Area_HighService
Area_HSPS_Pmp02	Area_HighService
Area_HSPS_Pmp03	Area_HighService
Area_HSPS_Pmp04	Area_HighService
Area_HSPS_Pmp05	Area_HighService
Area_HSPS_Pmp06	Area_HighService
Area_HSPS_Pmp07	Area_HighService

6.3.7 User Defined Object

User Defined Object contains each field device and virtual device. The objects must match the templates created in the PLC AOIs as described in Section 4. Wonderware Best Practices suggest that the object templates start three hierarchical levels from the main $UserDefined base template which may not be edited. The $UserDefined hierarchical architecture is shown below for the A.B. Jewell Water Treatment Plant.

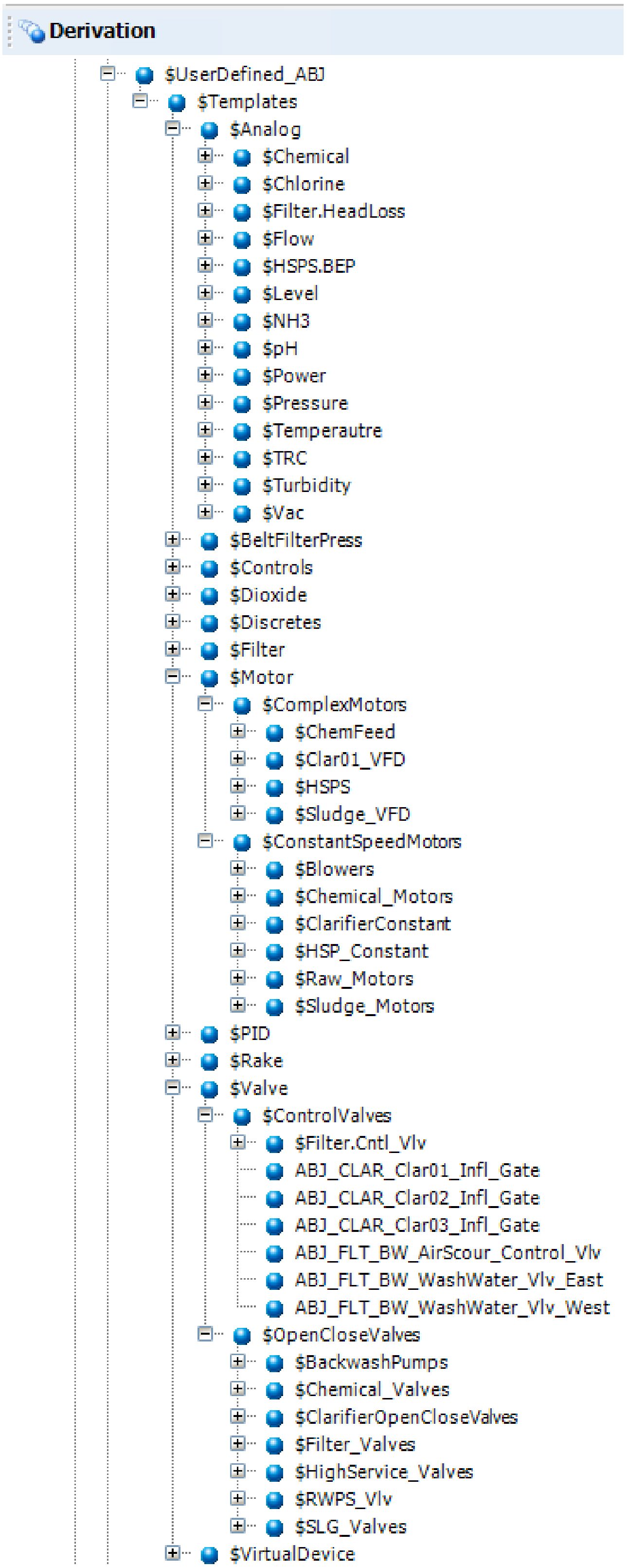


Figure 6-10 User Defined Hierarchical Architecture

6.3.7.1 $UserDefined_ABJ

$UserDefined_ABJ contains attributes, graphics and scripts for the operator note system. Each child template and instance will inherit the note capabilities even if not used. The note tags are virtual (i.e. Note tags are saved in Wonderware only and not in the PLC).

6.3.7.2 $Templates

$Templates inherits all properties of $UserDefined_ABJ. This is the first level of PLC field objects. Each child template and instance will inherit the following attributes:

- EnableAddressScripting – This attribute allows the use of the Addressing Script which automatically addresses each attribute.
- NotCheckedOut – This tag must be defined in each PLC AOI. It is used to indicate that the device has not been field tested.
- PLCPathName – This is a virtual attribute that is set to the PLC Path used in the Addressing Script. It must be configured correctly otherwise communications will not be valid.
- ScriptStagger – This is a virtual tag used to stagger the scripts for each device type. Wonderware Best Practices suggest each template type have a unique integer value set to ensure all the Addressing Scripts do not execute at the same time during deployment.

6.3.7.3 $Analog

$Analog mimics the Analog AOI in the PLC. The $Analog template has 14 derived or child templates as shown above in Figure 6-10. The child templates are used for organizational containers and have no additional attributes with exception to the $Flow template. The 14 derived instances may have the engineering units locked for consistency when applicable. No derived instance shall be created from the $Analog Template. Each derived instance shall be derived by one of the 14 child templates or a new derived template. It contains all the graphic elements used on the graphical displays. All future graphics shall be contained in the $Analog.

6.3.7.4 $Flow

$Flow contains all the properties of the $Analog template with the addition of flow meter totalization attributes. The $Flow template mimics the FlowMeter AOI at the PLC.

6.3.7.5 $BeltFilterPress

$BeltFilterPress is a custom template used to connect data from each of the three Belt Filter Press PLCs. The Belt Filter Press PLC was provided by Andritz and therefore does not use the standard PLC AOIs. This template contains a single graphic to display the process. Modifications were necessary to mask the I/O address for the NotCheckedOut attribute inherited from $Template. $BeltFilterPress is a good example of how to integrate vendor supplied PLCs.

6.3.7.6 $Controls

$Controls contains custom attributes for each of its instances. There are not any attributes created in $Controls since each instance differs from the other. $Controls references a PLC User-Defined Template (UDT) rather than an AOI since the code for control in done in a routine rather than an AOI. This is an example of how to contain attributes in an object when repeatable PLC code is nonexistent and contain those objects in a blank template.

6.3.7.7 $ChemicalControl

$ChemicalControl is a derived template from $Control and mimics the Chem_Control AOI. An AOI was created for controlling chemicals since repeatable code could be used for each chemical system.

6.3.7.8 $Dioxide

$Dioxide is a custom template used to connect data from the two Chlorine Dioxide Micrologix PLCs. EnableAddressScript is set and locked to false in this template since the PLC uses registers versus mnemonic tags. Each attributes I/O address must be manually entered. $Dioxide is a good example of how to integrate register-based PLCs such as an Allen Bradley Micrologix.

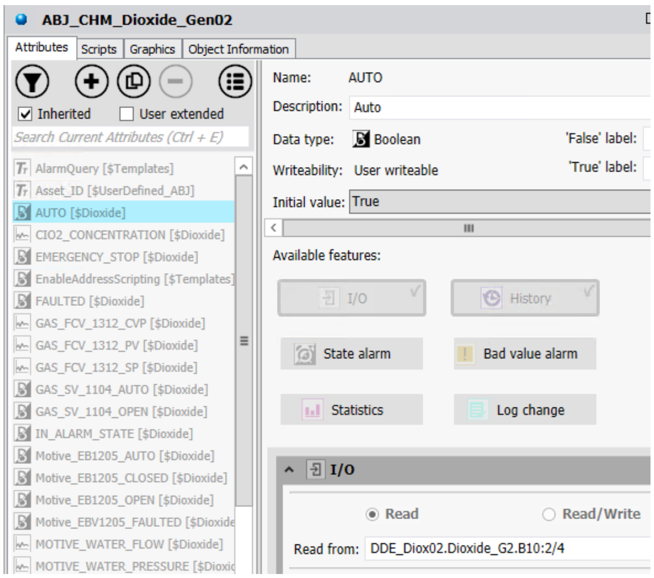


Figure 6-11 Register-Based PLC I/O Addressing Example

6.3.7.9 $Discretes

$Discretes mimics the DiscreteAlarmEvent AOI in the PLC. It is used for discrete alarms such as Level Sensors High (LSH) and power loss alarms.

6.3.7.10 $Filters

$Filters mimics the Filter AOI in the PLC. It contains all attributes, scripts and graphics associated with an individual filter. $Filters uses the containment feature of System Platform. $Filters contains all the associated analogs and valves for easy of creating graphics. Refence Creating Contained Template in Archestra IDE Help for information. The figure below displays the IDE in Model View to show the filter contained instances.

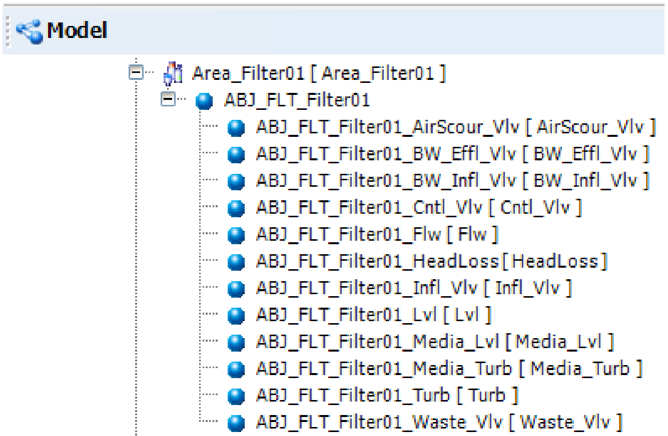


Figure 6-12 Filter Containment

6.3.7.11 $Motor

$Motors is the base template for all motor devices. It contains the common attributes, graphics and scripts for both $ComplexMotors and $ConstantSpeedMotors. No derived instance shall be created from the $Motor Template.

6.3.7.11.1 $ComplexMotors

$ComplexMotors is the base template for all variable speed motors. It contains the common attributes, graphics and scripts for all its derived templates. No derived instance shall be created from the $ComplexMotors Template. Each derived template of $ComplexMotors may have additional properties that are unique to that specific type of device. The following sections define the additional properties.

6.3.7.11.1.1 $ChemFeed

$ChemFeed mimics the Motor_Chemical AOI in the PLC. It contains additional attributes for a calculated flow measurement, high pressure alarms, and stroke length.

6.3.7.11.1.2 $Clar01_VFD

$Clar01_VFD mimics the Motor_VFD AOI in the PLC. There are not any additional properties.

6.3.7.11.1.3 $HSPS

$HSPS mimics the Motor_HSP AOI in the PLC. It contains additional attributes for high and low discharge pressure, e-stop, frequency, power fail, RDT temperature alarm, low suction pressure, and valve statuses.

6.3.7.11.1.4 Sludge_VFD

$Sludge_VFD mimics the Motor_VFD AOI in the PLC. There are not any additional properties.

6.3.7.11.2 $ConstantSpeedMotors

$ConstantSpeedMotors is the base template for all constant speed motors. It contains the common attributes, graphics and scripts for all its derived templates. There are not any additional properties. It is used as an organizational container. No derived instance shall be created from the $ConstantSpeedMotors Template. Each derived template of $ConstantSpeedMotors may have additional properties that are unique to that specific type of device. The following sections define the additional properties.

6.3.7.11.2.1 $Blowers

$Blowers mimics the Blower AOI in the PLC. It contains additional attributes for a high temperature alarm.

6.3.7.11.2.2 $ChemicalMotors

$ChemicalMotors mimics the Motor_VFD AOI in the PLC. There are not any additional properties.

6.3.7.11.2.3 $ClariferConstant

$ClarifierConstant mimics the Motor_ConstantSpeed AOI in the PLC. There are not any additional properties.

6.3.7.11.2.4 $HSP_Constant

$HSP_Constant mimics the Motor_ConstantSpeed_HSP AOI in the PLC. It contains additional attributes for statuses for associated valves.

6.3.7.11.2.5 $Raw_Motors

$Raw_Motors mimics the Motor_ConstantSpeed AOI in the PLC. There are not any additional properties.

6.3.7.11.2.6 $SludgeMotors

$SludgeMotors mimics the Motor_ConstantSpeed AOI in the PLC. There are not any additional properties.

6.3.7.12 $PID

$PID mimics the PID AOI in the PLC. It contains all parameters necessary for a Proportional, Integral, Derivative control algorithm.

6.3.7.13 $Rake

$Rake mimics the Rake UDT in the PLC. $Rake is unique in that each rake at Clarifier 1 has its own MicroLogix PLC that communicates with a Master ControlLogix PLC. The ControlLogix is set for monitoring status only. All manual control is performed at a local OIT for each rake.

6.3.7.14 $Valve

$Valve is the base template for all valve devices. It contains the common attributes, graphics and scripts for both $ControlValves and $OpenCloseValves. No derived instance shall be created from the $Valve Template.

6.3.7.14.1 $ControlValves

$ControlValves mimics the Valves_Modular AOI in the PLC. They contain additional attributes for valve position control and feedback.

6.3.7.14.1.1 $Filter.Cntl_Vlv

$Filter.Ctrl_Vlv mimic the Valves_Modular AOI in the PLC. There are not any additional properties. It is a contained valve template for the $Filter template

6.3.7.14.2 $OpenCloseValves

$OpenCloseValves mimics the Valves_OpenClose AOI in the PLC. It contains additional attributes for fail to open and fail to close alarms. There are several derived templates created as children for

$OpenCloseValves however there are not any additional properties for these templates. Rather they are used as organizational containers. The hierarchical architecture for the $OpenCloseValves templates is shown below. Note that there are 5 contained $Filter valves and a contained valve for the back wash pumps.

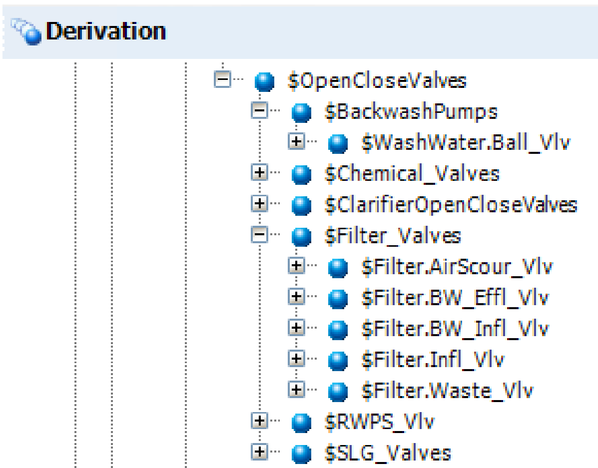


Figure 6-13 OpenCloseValves Template

6.4 DISPLAY HIERARCHY

The graphic display screens should be organized in a hierarchical structure. Navigation is accomplished by using a pointing device to "click" on the object where more information is available.

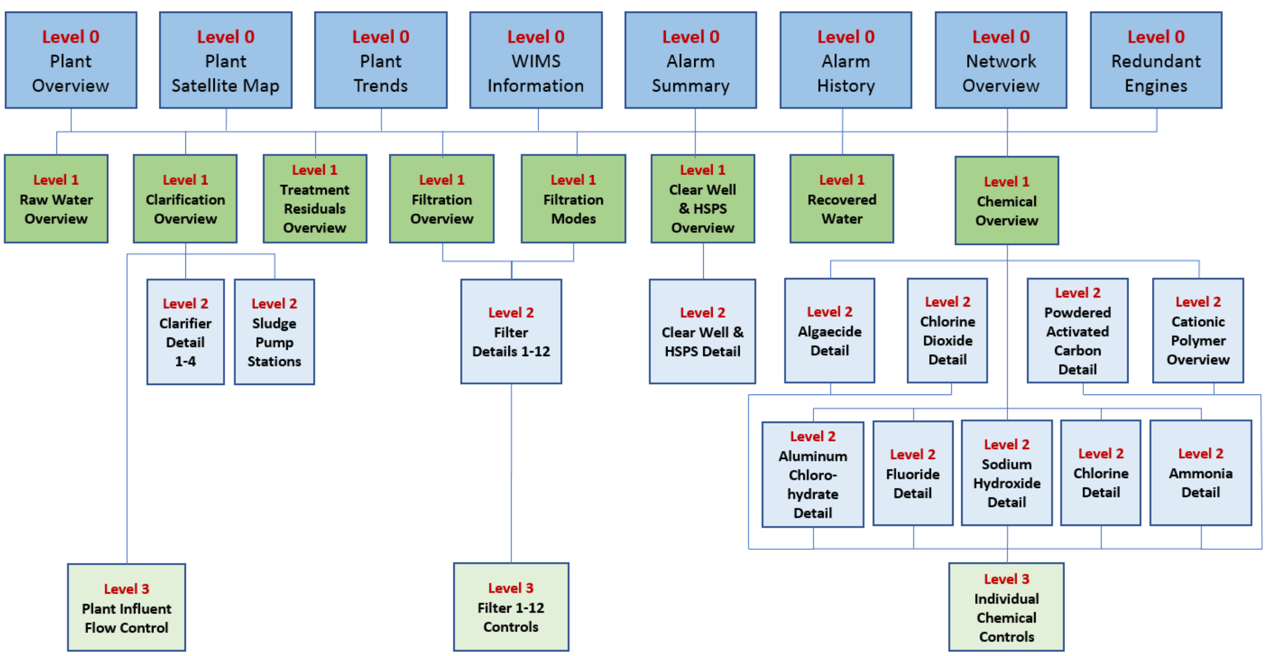


Figure 6-14 Display Hierarchy

As an example, the Level 0 plant overview screen has graphics depicting the process layout of the plant; an operator would click on the desired process area to navigate to that process area's overview screen (Level 1). The process overview screen should show more process information and equipment within that area. For specific process information, an operator would click on the desired sub process area to navigate to the Level 3 Process Detail screen. The screen shows more detail for the process, which indicates the current field status of equipment and data. From the Process Detail screen an operator can select a specific piece of equipment or unit to navigate to the Process Detail control popup display (Level 4). A button on the navigation bar shall be linked to the overview screen and each major process area, thereby allowing the operator to quickly return to the top of the hierarchy or process overviews from any process screen in the system.

6.4.1 Level 0 Displays

The Level 0 Displays is the top of the display hierarchy. The Level 0 displays data for the entire plant rather that an individual process. It includes a plant overview, a satellite image overview, trends, and alarms.

6.4.2 Level 1 Displays

The Level 1 Displays are the process overview displays that provide an overview of a process or group of processes. The Level 1 Displays provide key performance indicators (KPIs), equipment status, major process variables, trends and critical alarms. Control Setpoints for the overall process shall either be visible on the display or there shall be a link to them. These screens graphically display the specific process using a process and instrumentation diagram (P&ID) format with flow from the left to right. Displays are developed based on functionality and flow rather than physical layout. Typically, the main screen area will follow process flow from left to right and not follow cardinal coordinates. Clicking on a specific piece of equipment navigates to the Level 4 Displays.

6.4.3 Level 2 Displays

The Level 2 Displays are process area dashboards and provide more detailed data for a sub-process. Navigation links on plant overview (Level 0) or process area overviews (Level 1) shall be linked to the subsequent Level 2 Displays.

6.4.4 Level 3 Displays

The Level 3 Displays are the process area control pop-ups. Level 3 Displays will contain setpoints and tools used to monitor and control a specific process area.

6.4.5 Level 4 Displays

The Level 4 Displays provide individual process unit control and detail popup windows. The popup windows include equipment controls, quick trends, alarm summaries, operator notes, and alarm set points.

6.5 HMI WINDOW NAMING

Wonderware InTouch WindowMaker windows must be given a unique name. The windows names shall be composed of the area, sub-areas and unit number. This naming method will allow the programmer to organize the windows in an orderly manner. Pop-up screens shall start with *XPopUp_* followed by a descriptive verbiage for the function of the screen. The table below contains the screen names at the AB Jewell WTP.

Table 6-6 Graphic Screen Names

SCREEN NAMES			
Alarm History	Clarifier 1	Filtration Detail 05	Plant Overview 2
Alarm Summary	Clarifier 1 Sludge Collectors	Filtration Detail 06	Plant Trends
Chemical ACH	Clarifier 2	Filtration Detail 07	Raw Water Overview
Chemical Algaecide	Clarifier 3	Filtration Detail 08	Redundant Engines
Chemical Ammonia	Clarifier 4	Filtration Detail 09	Settled Water Overview
Chemical Cationic Polymer	Clarifier Overview	Filtration Detail 10	Sludge Handling Overview
Chemical Chlorine	Clear Well HSPS Detail	Filtration Detail 11	Sludge Pump Stations
Chemical Dioxide	Clear Well HSPS Overview	Filtration Detail 12	WIMS Info
Chemical Fluoride	Filtration Detail 01	Filtration Modes	XPopUp_ChlorineScrubber
Chemical Overview	Filtration Detail 02	Filtration Overview	XPopUp_CriticalAlarm
Chemical Powder Activated Carbon	Filtration Detail 03	Network Overview	
Chemical Sodium Hydroxide	Filtration Detail 04	Plant Overview	

6.6 HMI SCREEN DEVELOPMENT

The HMI screens will utilize object-oriented programming and a modified Situational Awareness (or High Performance) graphics philosophy. This approach minimizes colors to draw an operator's attention to abnormal equipment status and alarm conditions. Wonderware provides a toolbox of objects that have adopted the Situational Awareness Guidelines. These objects should be utilized where possible.

6.6.1 Best Practices

The most up to date Wonderware System Platform Best Practices should be followed. There is not a single "best practices" document in existence. Developers should reference the System Platform User's Guide and the tech articles and tech notes found on the Wonderware Developers Network website.

6.6.2 Screen Configuration

InTouch WindowViewer screens should be built in the Integrated Development Environment (IDE). All objects that constitute a complete WindowViewer screen shall be contained in a IDE graphical object. This Archestra Graphic shall then embedded into the InTouch WindowMaker software. All screen graphics shall be created in the SystemGraphics object.

6.6.3 Screen Resolution

All Wonderware System Platform workstations will use a screen resolution of 1920x1080.

6.6.4 Font and Color Conventions

Color and font selections should be consistent throughout all screens and pop-ups. Fonts shall be Arial only. The default font size is 16 pt. while the minimum allowed size is 10 pt.

Colors used shall be part of Wonderware's Standard Palette or the custom palette using TMUA colors. Equipment status colors will be based on a modified Situational Awareness (or high performance) The color selection options are depicted below.

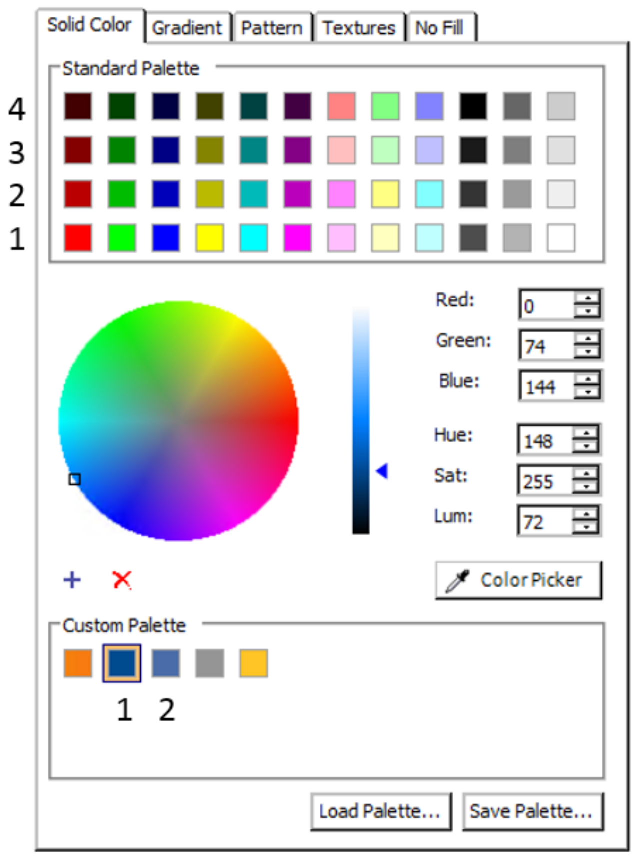


Figure 6-15 Wonderware Color Selections

Table 6-7 Graphics Color Definitions

COLOR	FUNCTION	RGB
Red 1	Severity 1 Alarm	255,0,0
Yellow 1	Severity 2 Alarm	255,255,0
Green 2	On/Opened	0,186,0
Custom Palette Gray	Off/Closed	149.149.149
Cyan 1	Valve Traveling	191,255,255
Yellow 2	Out of Service	186,186,0
Green 3	Any Operator Selectable Target including: Navigation Links, Set Points, Radio Buttons, Control Buttons	0,132,0

COLOR	FUNCTION	RGB
Pink 2	Wonderware Error	255,131,255
Custom Palette Blue 1	Live Value	0,74,144
Black 1	Static Text, Engineering Units	77,77,77
White 2	Screen Background	239,239,239
Gray 3	Piping	126,126,126

6.6.5 Equipment Alarm Colors

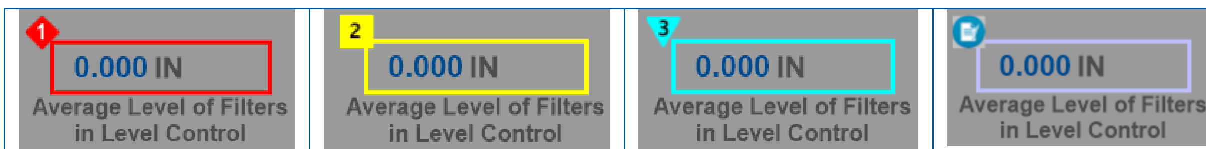
Equipment alarms are symbols that appear to the upper left of the equipment symbol when an alarm condition is present. Alarms have a different color, shape, and priority number inside the shape for quick recognition of the alarm's priority. Alarm border shall blink until acknowledged.

Red Diamond = Priority 1 alarm condition. Critical equipment failed to start - Critical Open/Close valve failed to open or failed to close

Yellow Square = Priority 2 alarm condition - Equipment failed to start. Open/Close valve failed to open or failed to close

Light Blue Triangle pointing down = Priority 3 alarm - Equipment has not been checked out

Blue Notebook Icon = Priority 4 alarm – Operator Notes



Priority 1 Alarm Critical	Priority 2 Alarm Non-Critical	Priority 3 Alarm Not Checked Out	Priority 4 Alarm Operator Note

Figure 6-16 Priority Alarm Display Object

6.6.6 Screen Layout

The following section will describe the design parameters used for HMI screen development.

6.6.6.1 Navigation Bar

A navigation bar will be located at the top of the screen. The navigation bar will display the time and date. The navigation bar will also be used to log into the Wonderware System Platform system and display the current logged in user. A left mouse click or pressing the associated keyboard function key e.g. F1 will navigate to the Level 1 display. A right mouse click or pressing the associated function key and *Shift* will navigate to the Level 2 display when applicable. The navigation bar shall include alarm counts and note counts for each process. SCADA Alarms will totalize alarms for the entire system.

The navigation bar will be its own screen and not part of the main screen. No screen shall hide or overlap the navigation bar.

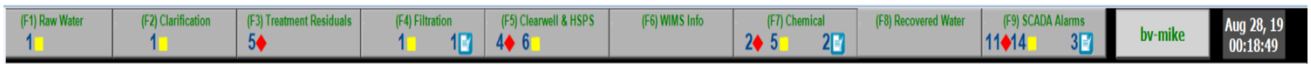


Figure 6-17 Navigation Bar

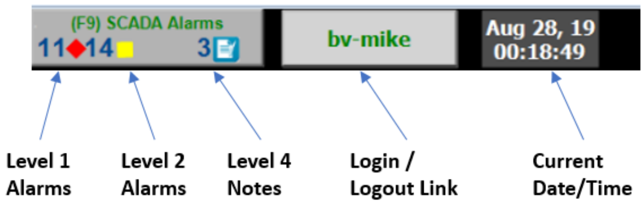


Figure 6-18 Navigation Bar Close-up

6.6.6.2 Secondary Navigation

Along with the navigation bar, navigation may be accomplished via the navigation breadcrumbs and process links.

Breadcrumbs shall always fill the upper left of the main screen area, directly below the navigation bar. It will use underlined text to mimic a typical internet browser hyperlink. It shall be "Green 3" since the links are operator selectable targets. All breadcrumbs shall use the graphics symbol "NavLinkHyperlink" found in the Graphics Toolbox.

Figure 6-19 Navigation Breadcrumbs

Process links will provide the navigation from screen to screen where process is linked by piping. Process links shall use underlined text enclosed in an arrow to mimic a typical internet browser hyperlink. All process links shall use the graphics symbol "NavLinkArrow" found in the Graphics Toolbox. NavLinkArrow text and line uses "Green 3" since the links are operator selectable targets and the text is underlined to indicate a navigation link.

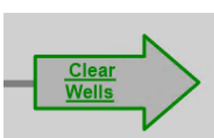


Figure 6-20 Process Arrow with Navigation

Process links do not provide navigation to another screen shall use graphic symbol ProcessArrow. Process arrow uses the Gray 3 text and a Custom Pallet Blue 1 line color.

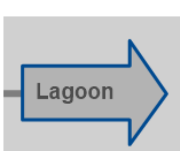


Figure 6-21 Process Arrow without Navigation

6.6.6.3 Main Screen Area

Located below the navigation bar is an area used for the main process screens. This area contains the graphical depiction for control and data acquisition of the plant. The graphic screens in this area can be a Level 0 or Level 1 screen. The Window Properties within InTouch WindowMaker are shown below.

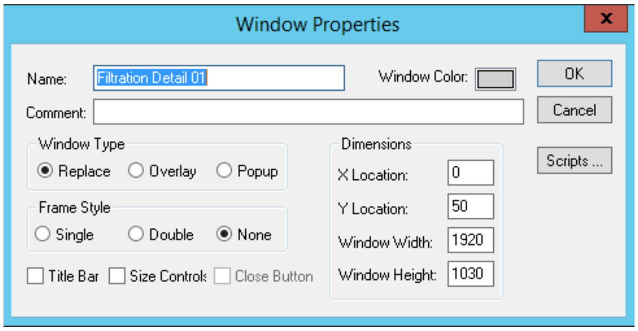


Figure 6-22 Windowmaker Windows Properties

This main screen area will display data read from the plant control system including analog values, motor statuses, valve statuses, etc. The standards used for the presentation of this data are described in the following sections of this document.

6.6.6.4 Pop-up Control Window

Pop-up screens are smaller "sub" screens that are called from the main graphic. Pop-ups can contain Level 3 or Level 4 screens. Popup screens are always smaller and called from the main graphic. Popup screens will have a title bar and can be moved just like any Microsoft window. Pop-up screens can be opened by selecting a graphic icon with a pop-up associated to it or by selecting a "button" on the main graphic area. All pop-ups shall be configured within the IDE and use the Show Symbol Animation as shown below. The position setting shall be set to Center/Client area to ensure proper positioning on multi-monitor workstations.

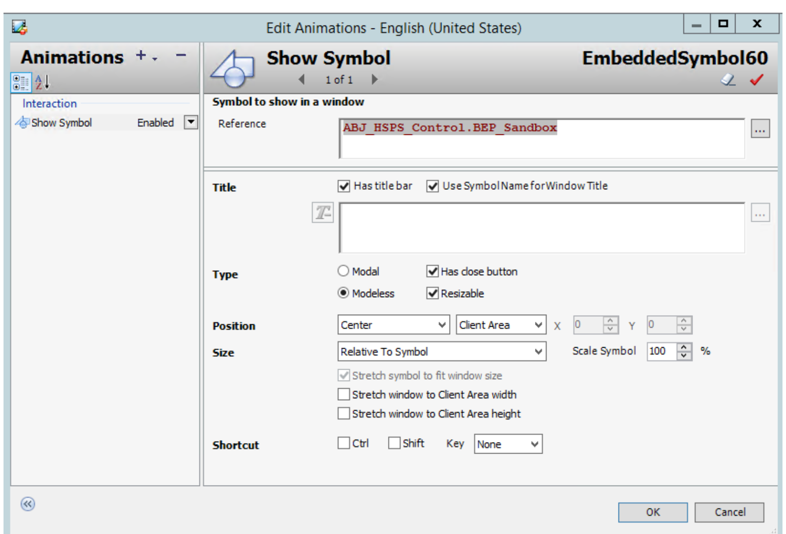


Figure 6-23 Popup Window Properties

6.6.6.5

6.6.6.5 Animated Graphics

Animated, or moving, graphics will not be used. The only exception will be trend indicators associated with select analog values such as tank level. Animated graphics generally do not provide meaningful information to an operator and increase data acquisition rates. Do not use spinning pumps, spinning mixers, moving bubbles, etc. All graphics will use color for status indication.

6.6.6.6 Piping

Process pipes will be represented by horizontal and vertical lines with a weight of 3. 3D pipes are not to be used. All line color will shall be Gray 3. Solid, dashed or dotted lines may be used to differentiate processes piping.

6.7 GRAPHICAL TEMPLATE

The following section covers the basic components of all graphics and individualized properties of all the User Defined Objects in Section 6.3.7.

6.7.1 Graphic Toolbox

The Graphic Toolbox within the IDE is a container to keep all base templates that may be used in several other derived graphics. Examples of this would be various text styles, control panel borders and tabs, alarm queries, trends and navigation links. All base template graphics shall be contained under the Tulsa folder. If using existing graphics native to System Platform, a copy shall be made and placed in the Tulsa folder. The Graphic Toolbox is shown below with the Alarm folder expanded as a reference.

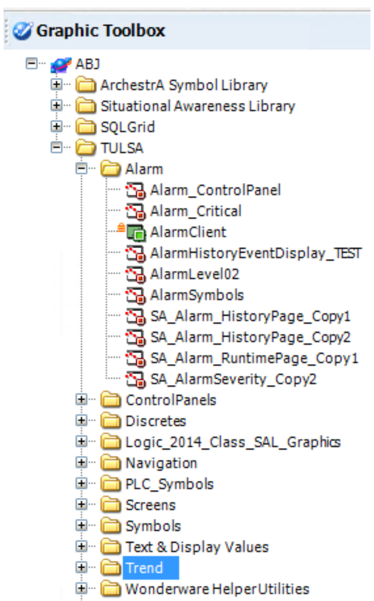


Figure 6-24 Graphic Toolbox Tree

6.7.1.1 RemoteAuto Graphic

The RemoteAuto graphic shall be used on all equipment that contains a Local/Remote switch in the field. The graphic contains color animations and scripts to display the standards for each of the possible states. The table below displays each of these states.

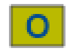
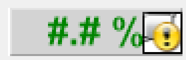
				
Remote Auto	Remote Manual	Local	Out of Service	Wonderware Error

Figure 6-25 Equipment RemoteAuto Graphic

6.7.1.2 Setpoints

Three setpoint templates shall be used on all displays are shown below.

Table 6-8 Operator Setpoint Graphics

NAME	DESCRIPTION	GRAPHIC
ControlPanelSetpoint_EU	Set point graphic for float with engineering units	
ControlPanelSetpoint_EU_INT	Set point graphic for integer with engineering units	
ControlPanelSetpoint_short	Set point graphic for float with one optional character for engineering units	

The custom properties of these objects may be linked to tags or hard coded.

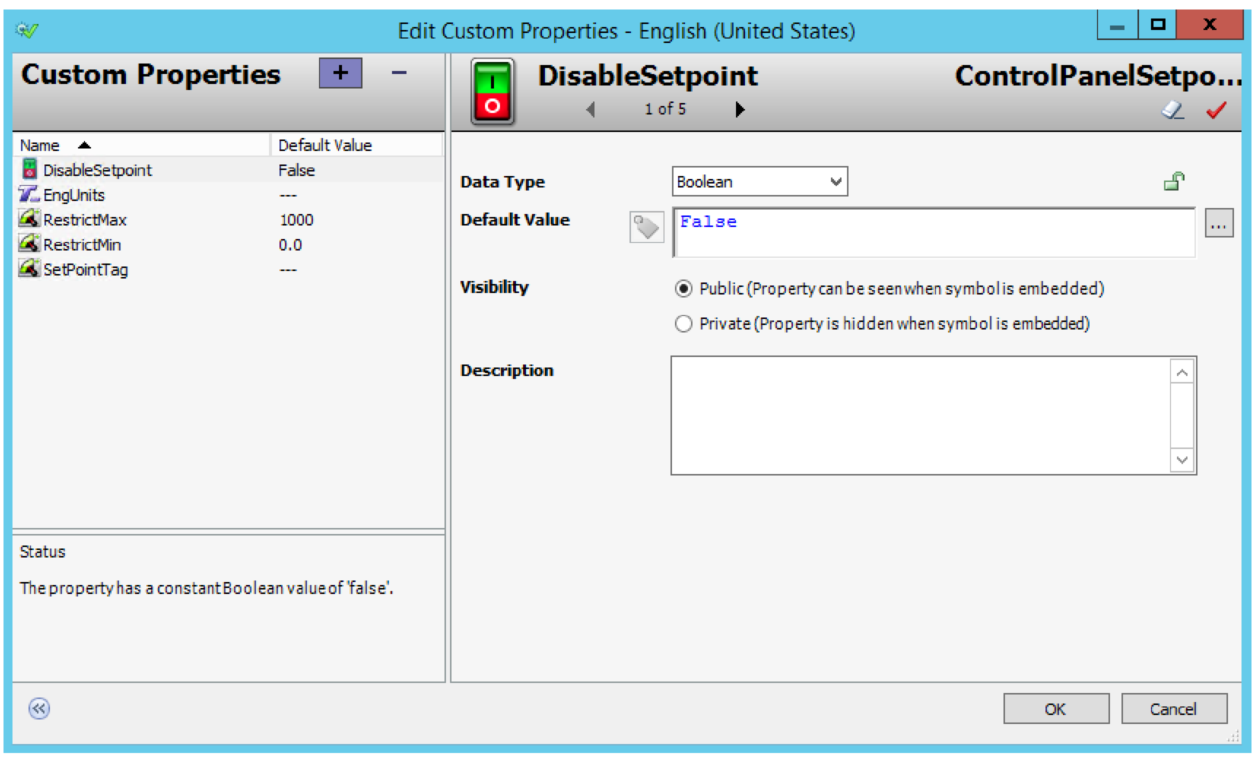


Figure 6-26 Graphic Custom Properties

6.7.1.3 Simulating

The simulating graphic shall be used on all objects that contain the ability to be place in a simulation mode for testing. The graphic may be linked to the PLC simulation tag in the custom properties.

Figure 6-27 Simulating Icon

6.7.2 Template Embedded Graphics

The follow sections describe that unique graphics that are created in each of the templates. Graphics shall use the Embed Graphic feature and select the actual instance for each object to be displayed.

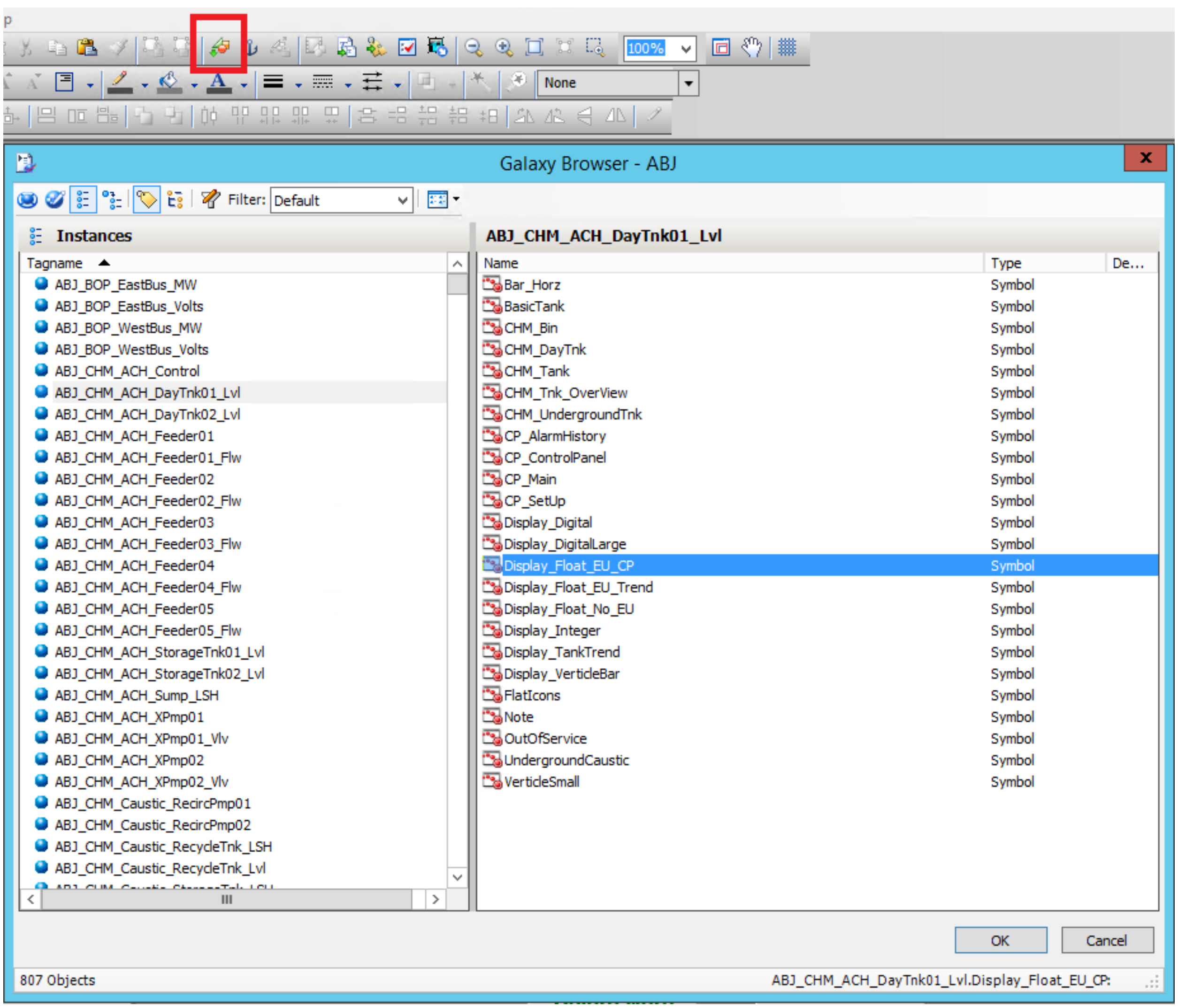


Figure 6-28 Template Embedded Graphic Picker

6.7.2.1 $UserDefined

The $UserDefined template contains the graphics for operator notes. It shall be embedded to all control panels developed. The operator note graphic contains scripting to capture the notes into the system. The note tab shall be the third tab from the left on all control panels.

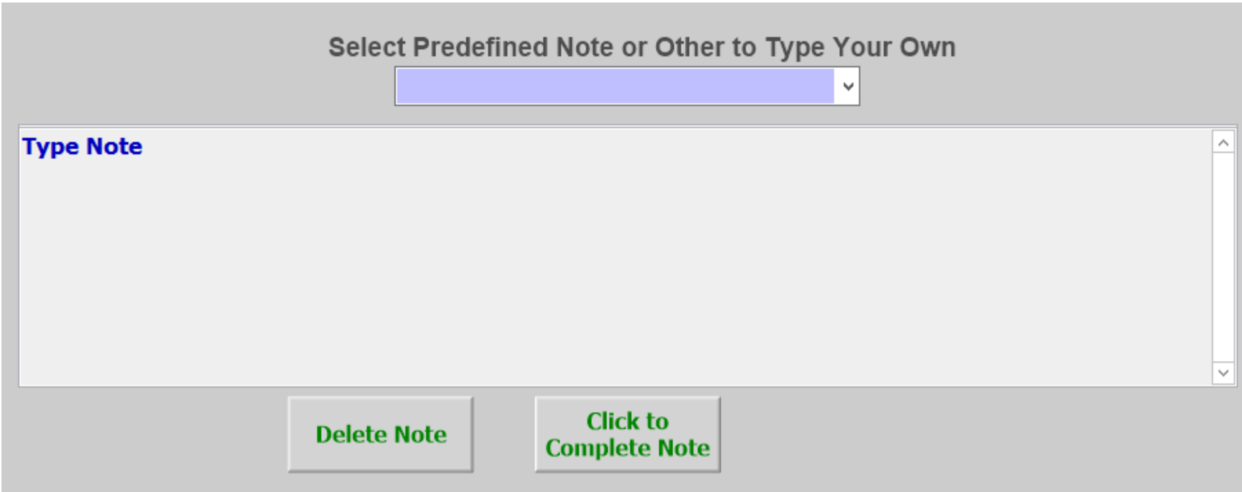
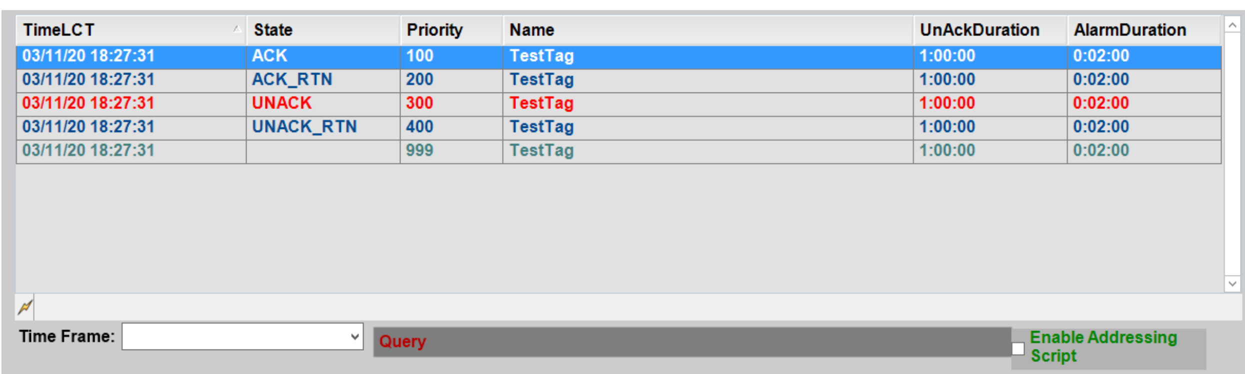


Figure 6-29 Operator Notes Entry

6.7.2.2 $Templates

$Templates contains the graphic for historical alarms. The historical alarm graphic has scripting to automatically populate the alarm query to just the individual object. The historical alarm graphic shall be the second tab on all developed control panels.



TimeLCT	State	Priority	Name	UnAckDuration	AlarmDuration
03/11/20 18:27:31	ACK	100	TestTag	1:00:00	0:02:00
03/11/20 18:27:31	ACK_RTN	200	TestTag	1:00:00	0:02:00
03/11/20 18:27:31	UNACK	300	TestTag	1:00:00	0:02:00
03/11/20 18:27:31	UNACK_RTN	400	TestTag	1:00:00	0:02:00
03/11/20 18:27:31		999	TestTag	1:00:00	0:02:00

Figure 6-30 Historical Alarm Display

6.7.2.3 $Analog

$Analog contains all the graphics for displays and control panels. All display units shall use a font of Arial 16 Bold and follow the color conventions in Table 6-5. Analog displays typically will use the graphic Display_Float_EU_CP or Display_VerticleBar.

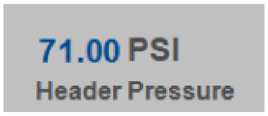
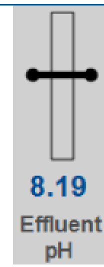
	
Display_Float_EU_CP	Display_VerticleBar

Figure 6-31 Analog Value Display

The control panels contain 4 tabs; Detail, Alarm, Note and Config. An example of a live control panel pop up screen is shown below.

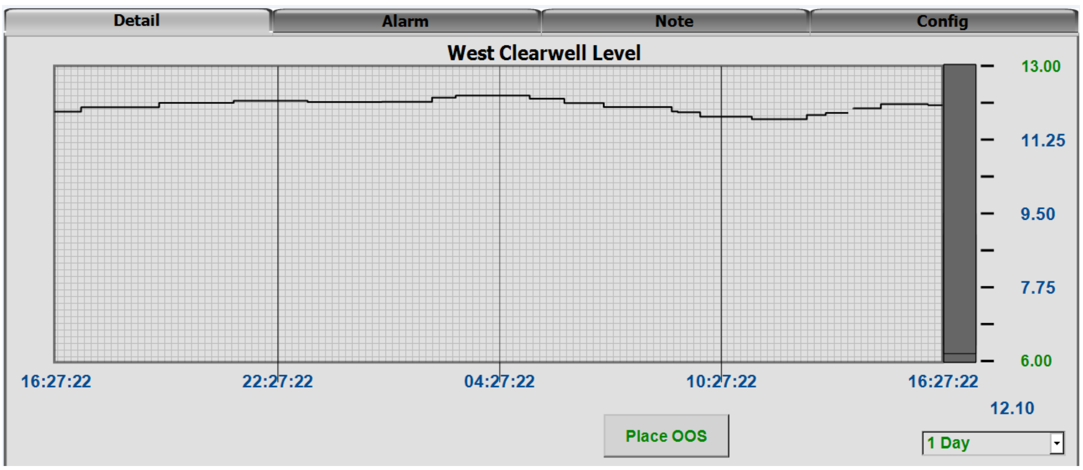


Figure 6-32 Analog Value Popup Detail Tab

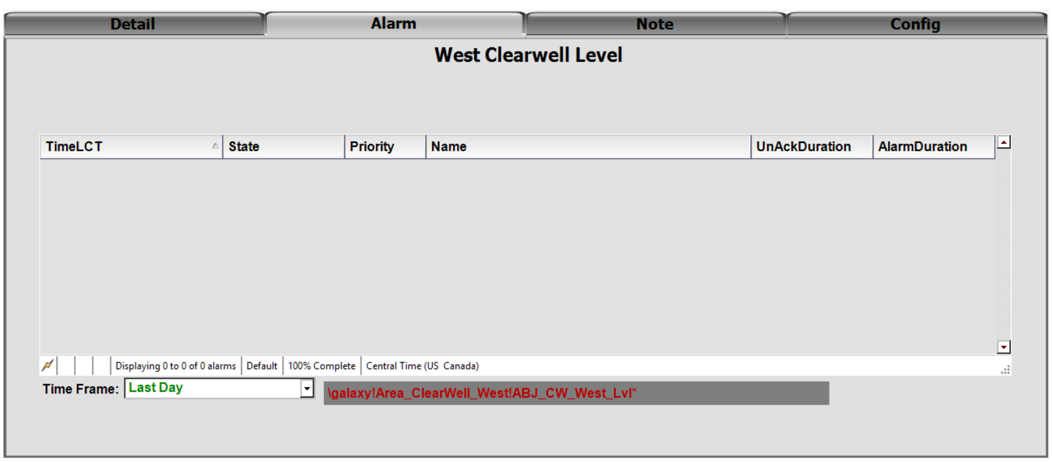


Figure 6-33 Analog Value Popup Alarm Tab

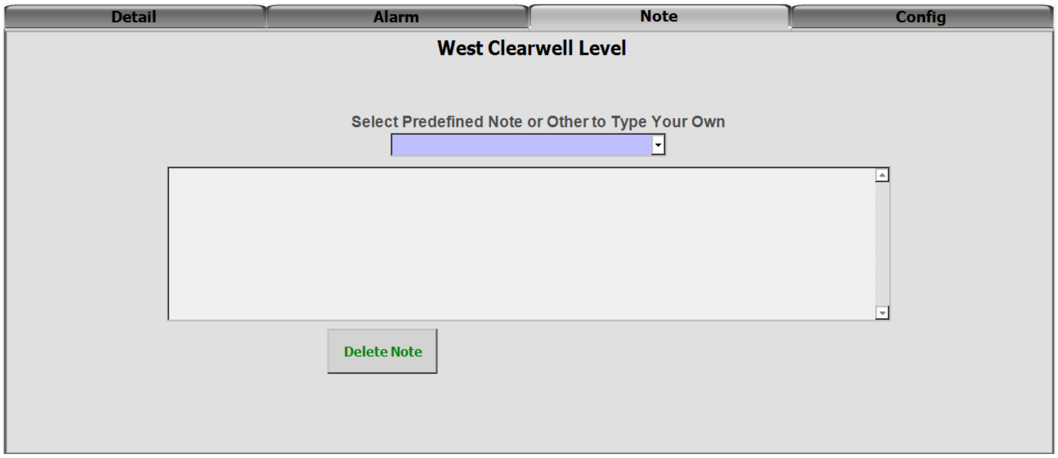


Figure 6-34 Analog Value Popup Note Tab

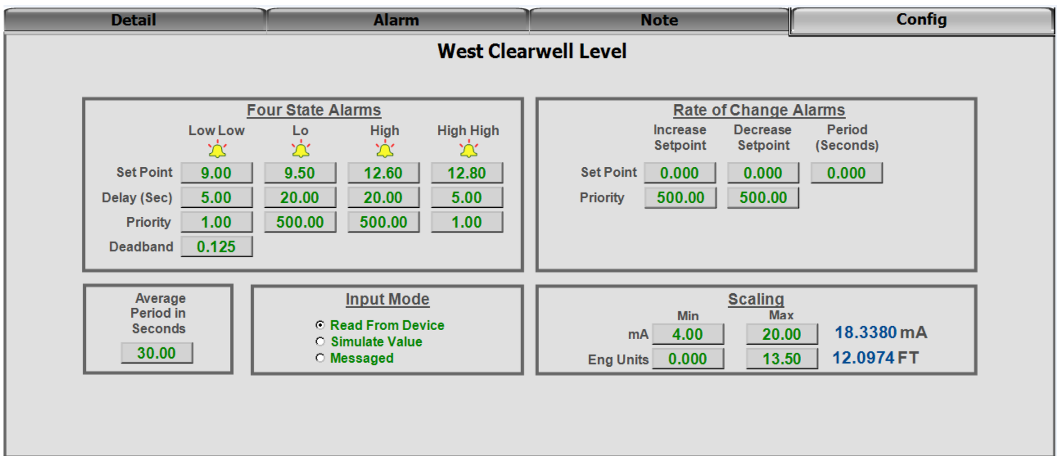


Figure 6-35 Analog Value Popup Config Tab

6.7.2.3.1 $Flow

$Flow has additional information shown on the control panel graphic detail tab for totalizers.

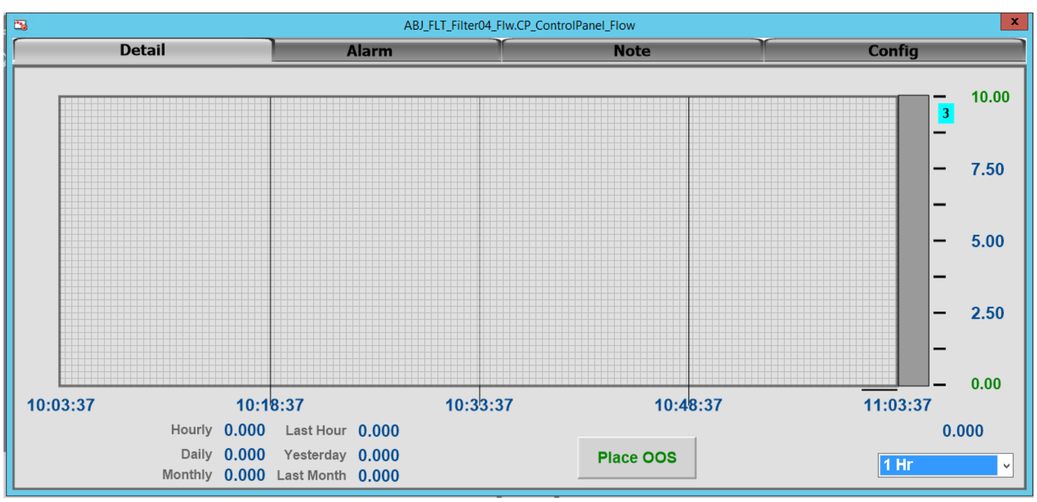


Figure 6-36 Analog Flow Value Popup Detail Tab

6.7.2.4 $BeltFilterPress

$BeltFilterPress contains a single graphic that visualizes the vendor PLC devices.

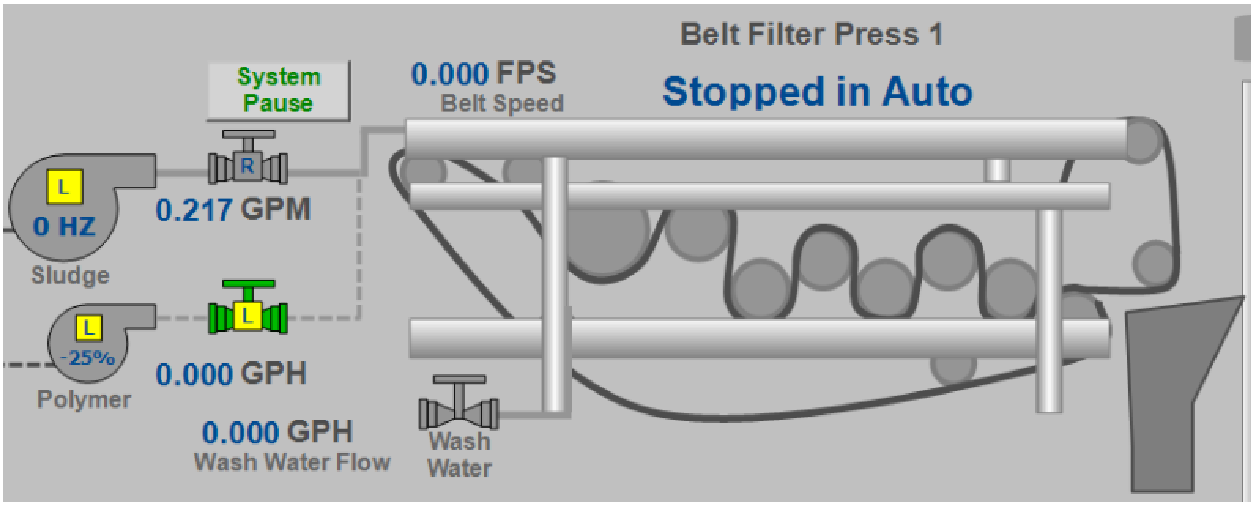


Figure 6-37 Belt Filter Press Graphic

6.7.2.5 $Control

The following section demonstrates the custom graphics for each control object.

6.7.2.5.1 ABJ_CLAR_Control

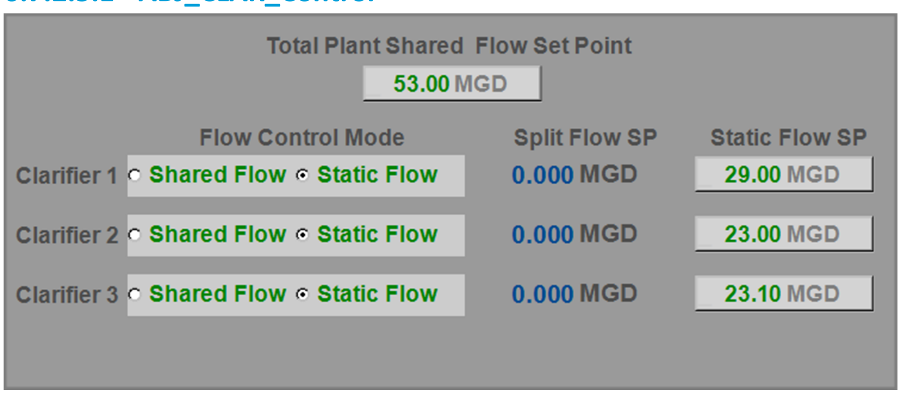


Figure 6-38 Plant Flow Setpoint Graphic

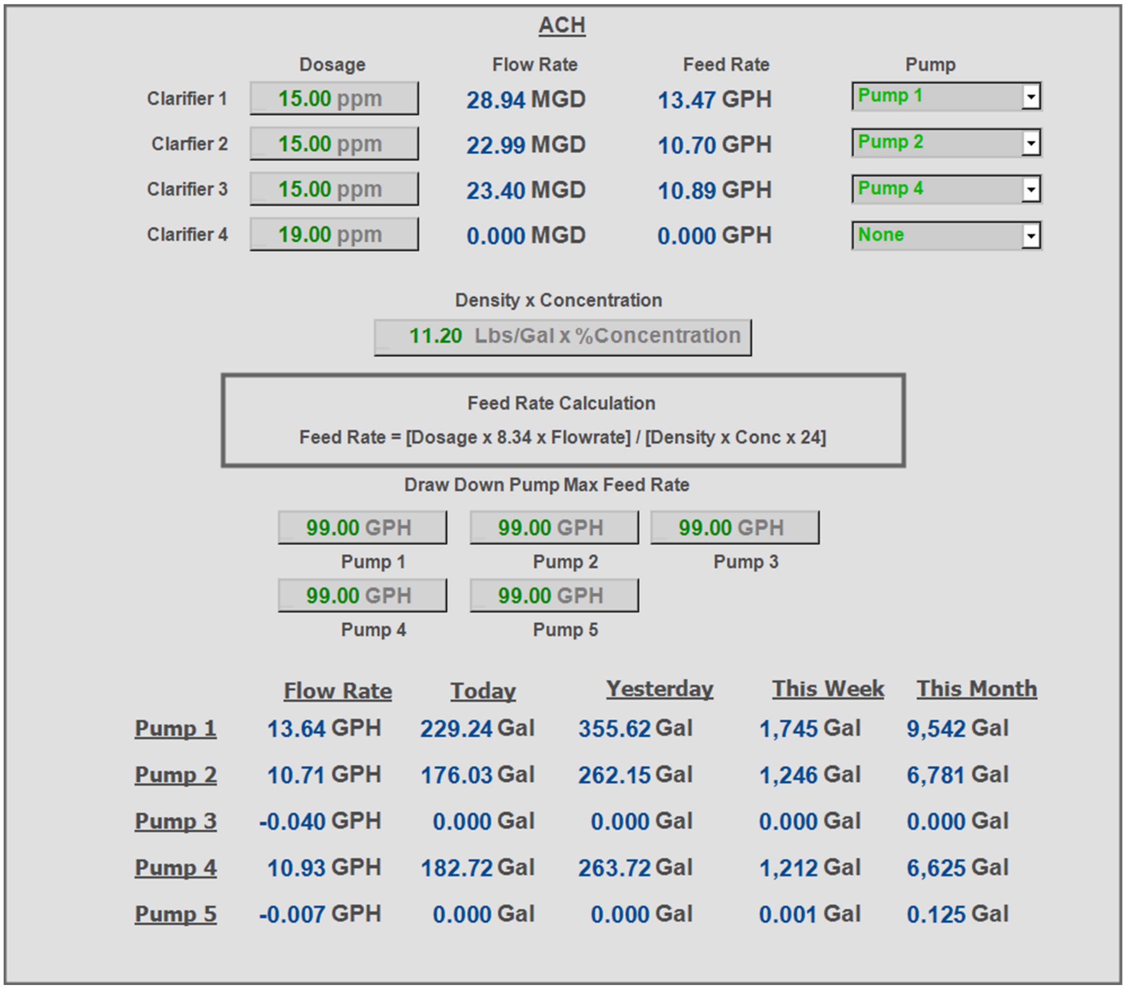


Figure 6-39 ACH Chemical Control Popup

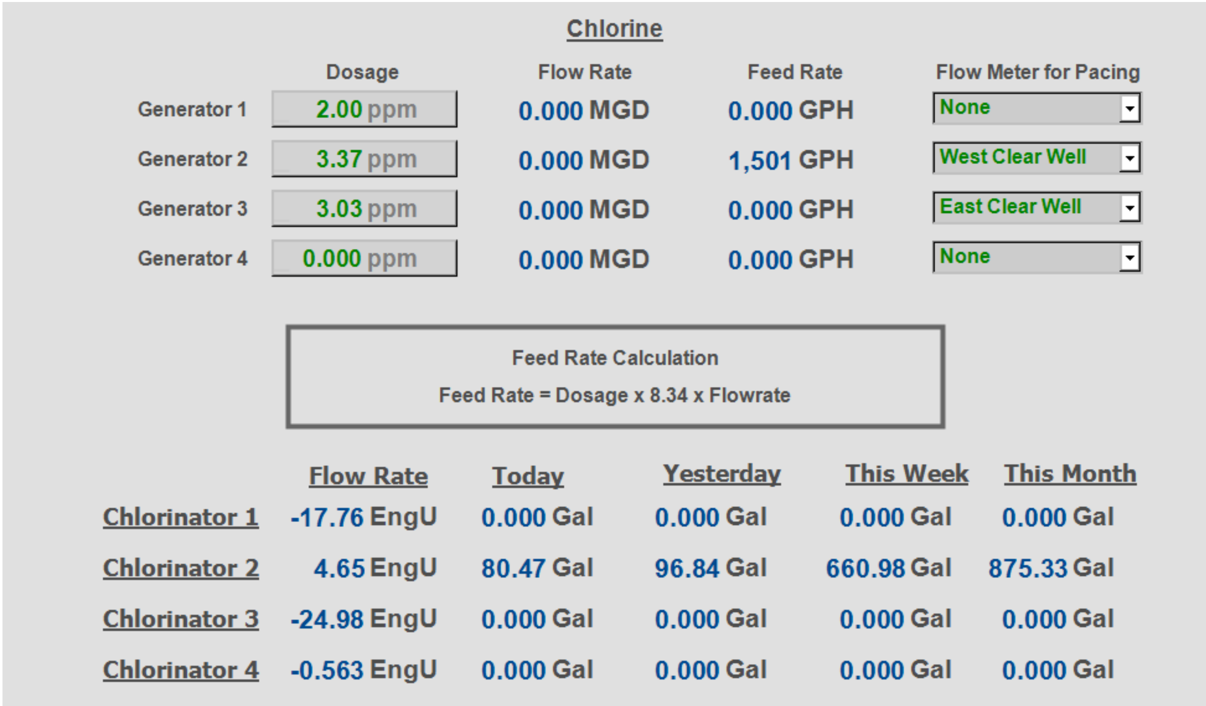


Figure 6-40 Cl2 Chemical Control Popup

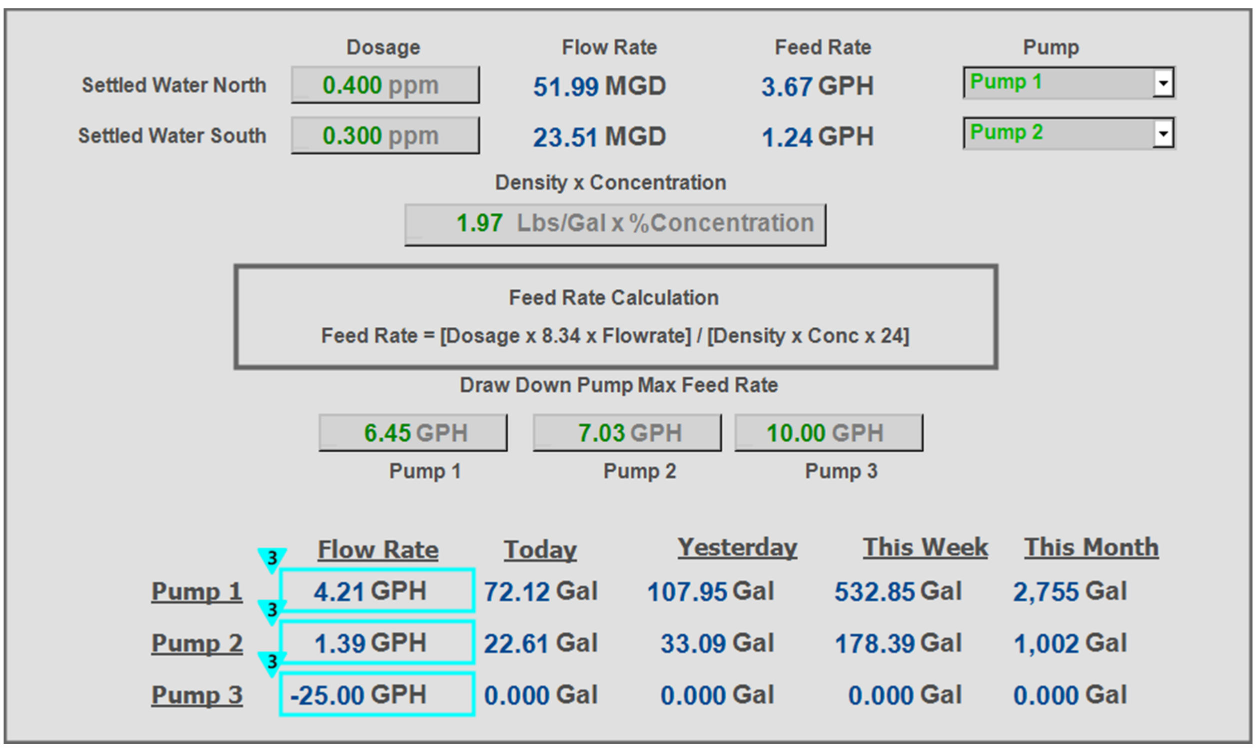


Figure 6-41 Fluoride Chemical Control Popup

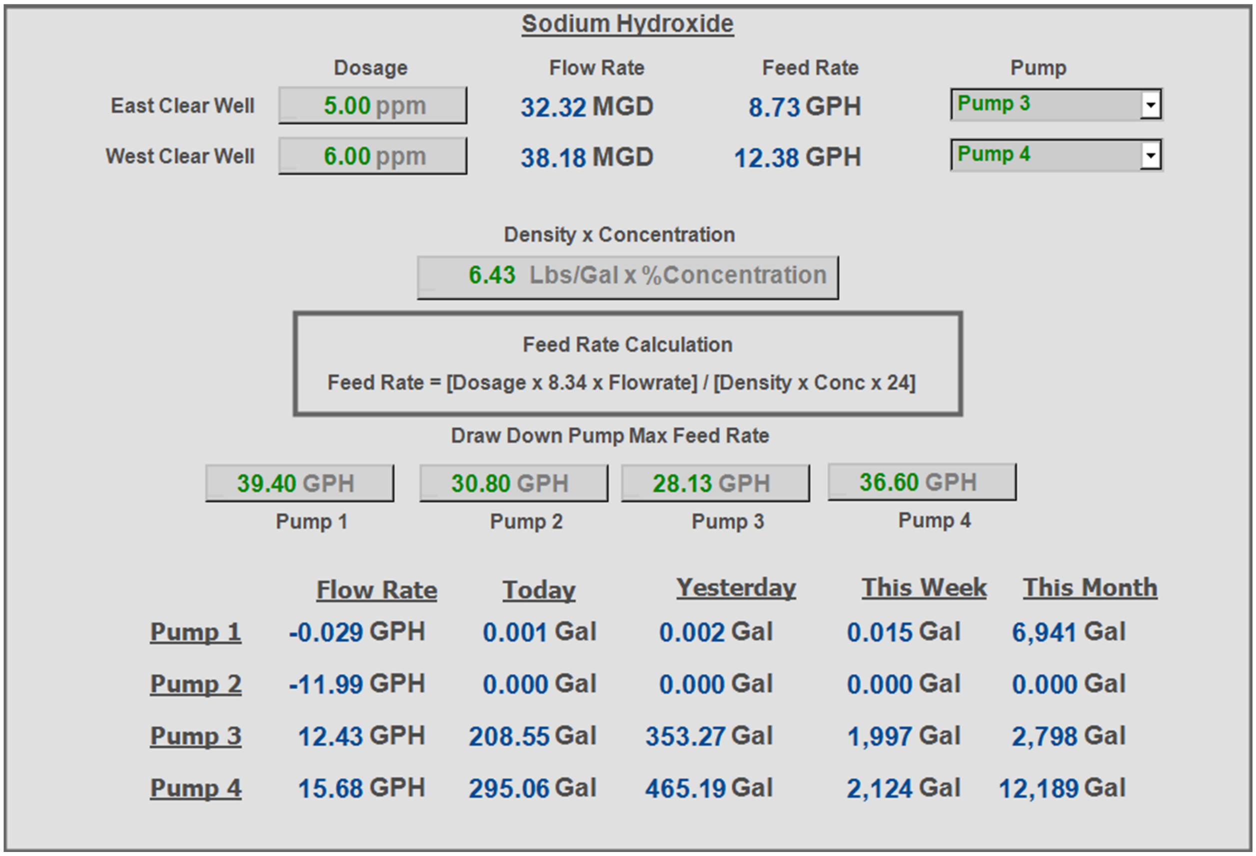


Figure 6-42 **NaOH Chemical Control Popup**

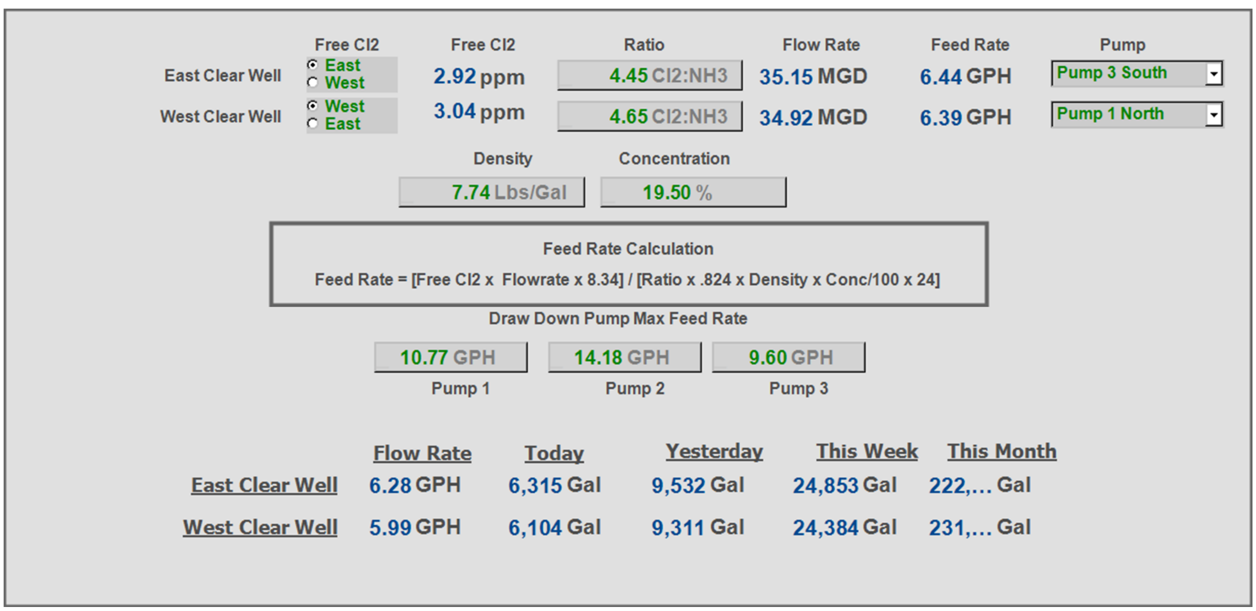


Figure 6-43 Ammonia Chemical Control Popup

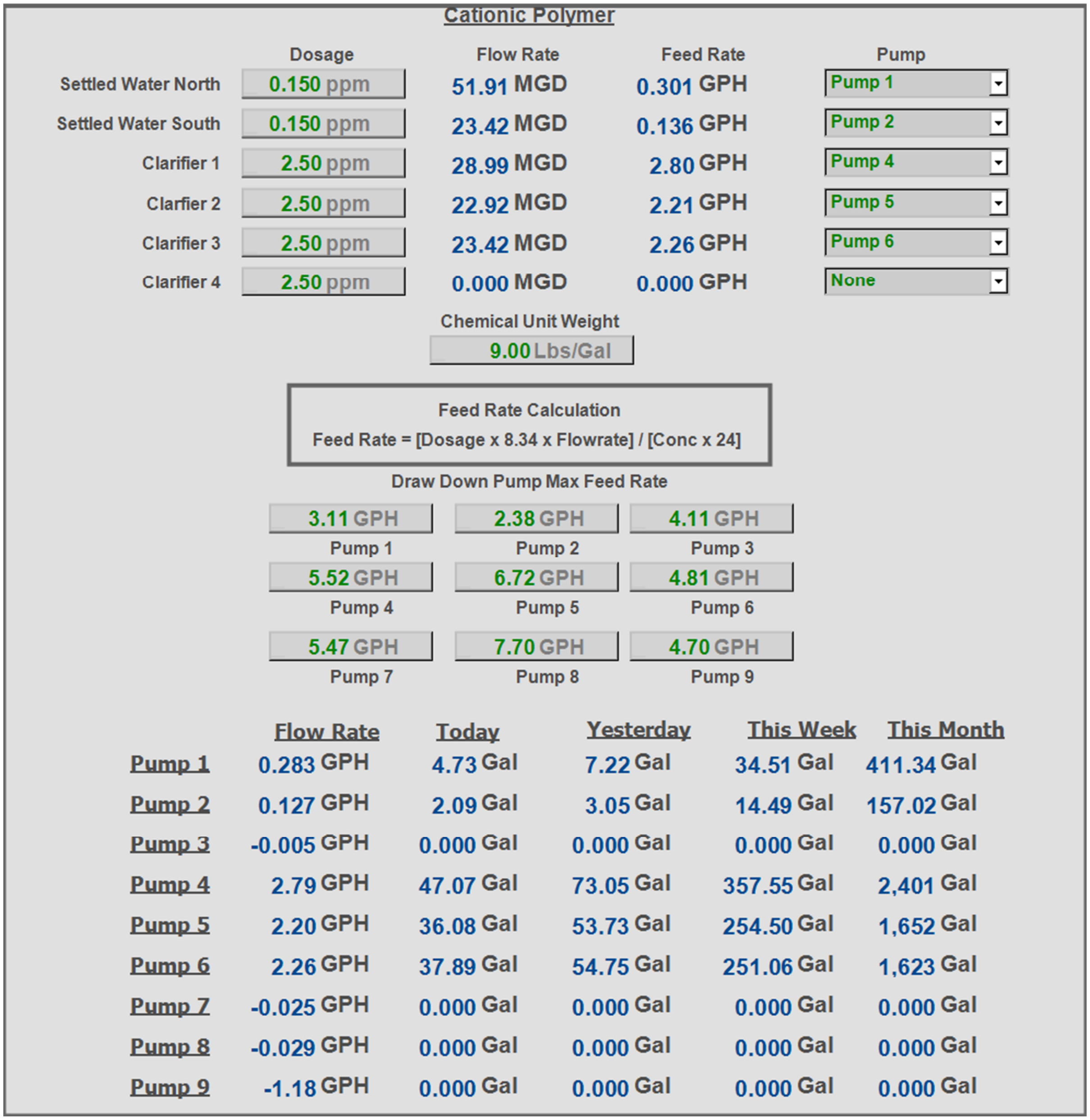


Figure 6-44 Polymer Chemical Control Popup

6.7.2.6 $Discretes

$Discretes contain graphics for displays and control panels.

Figure 6-45 Discrete Alarm Display

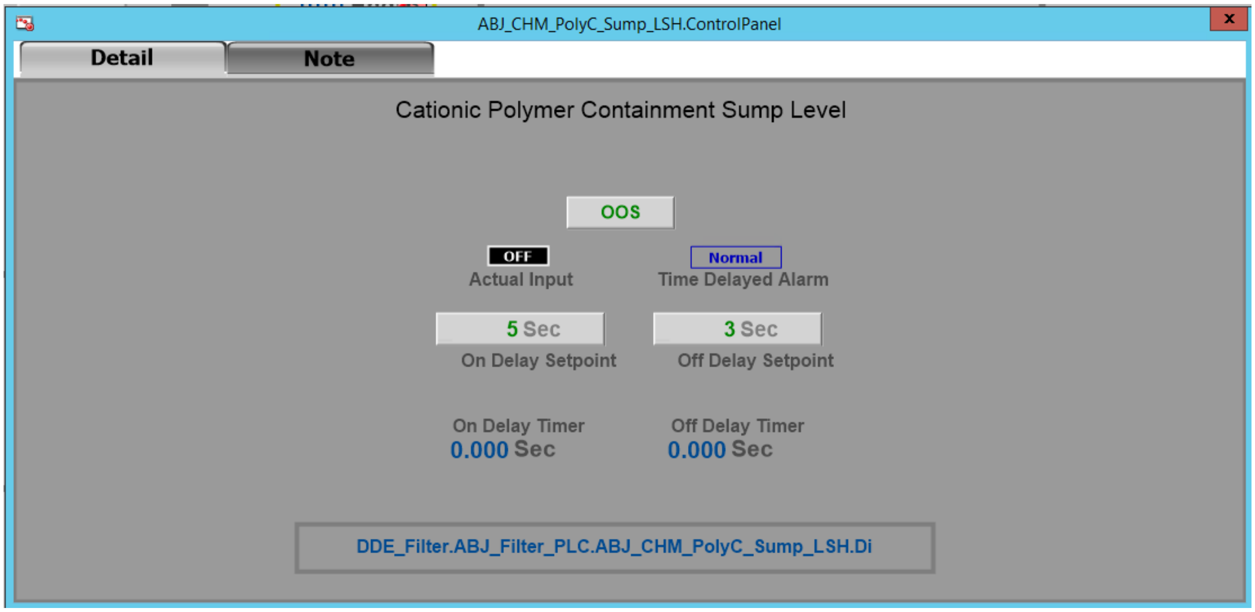


Figure 6-46 Discrete Alarm Popup Detail Tab

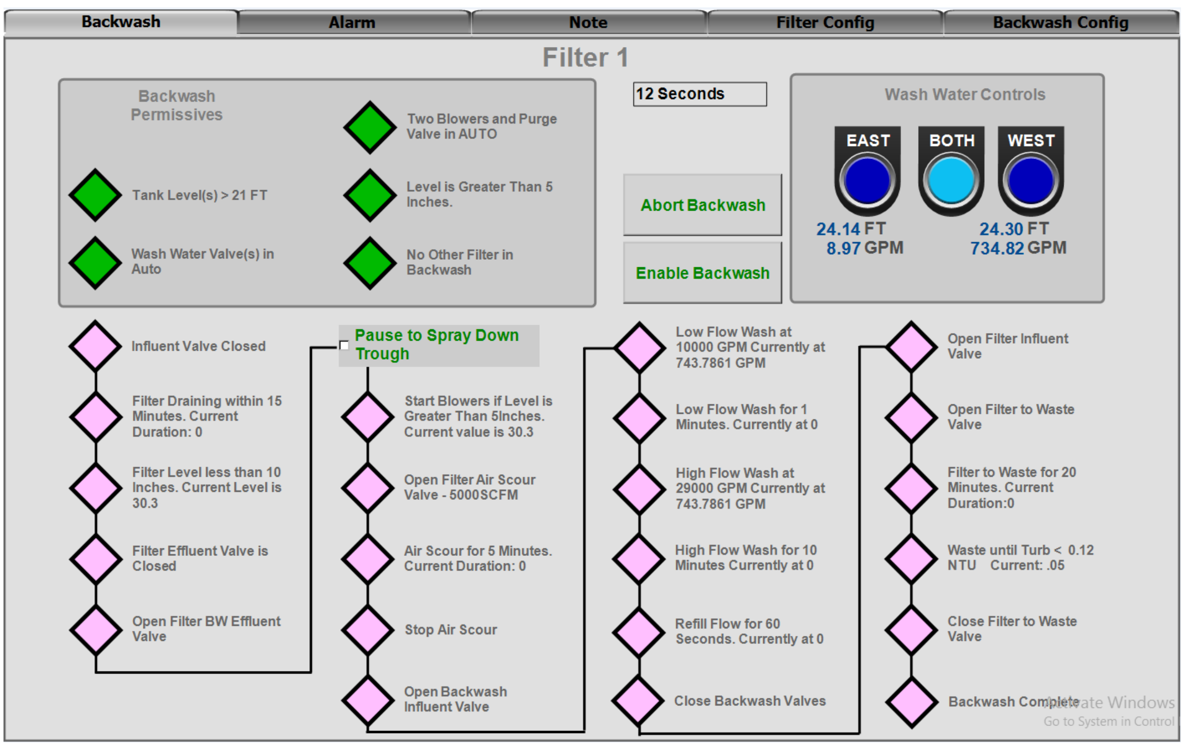


Figure 6-47 Filter Control Popup Backwash Tab

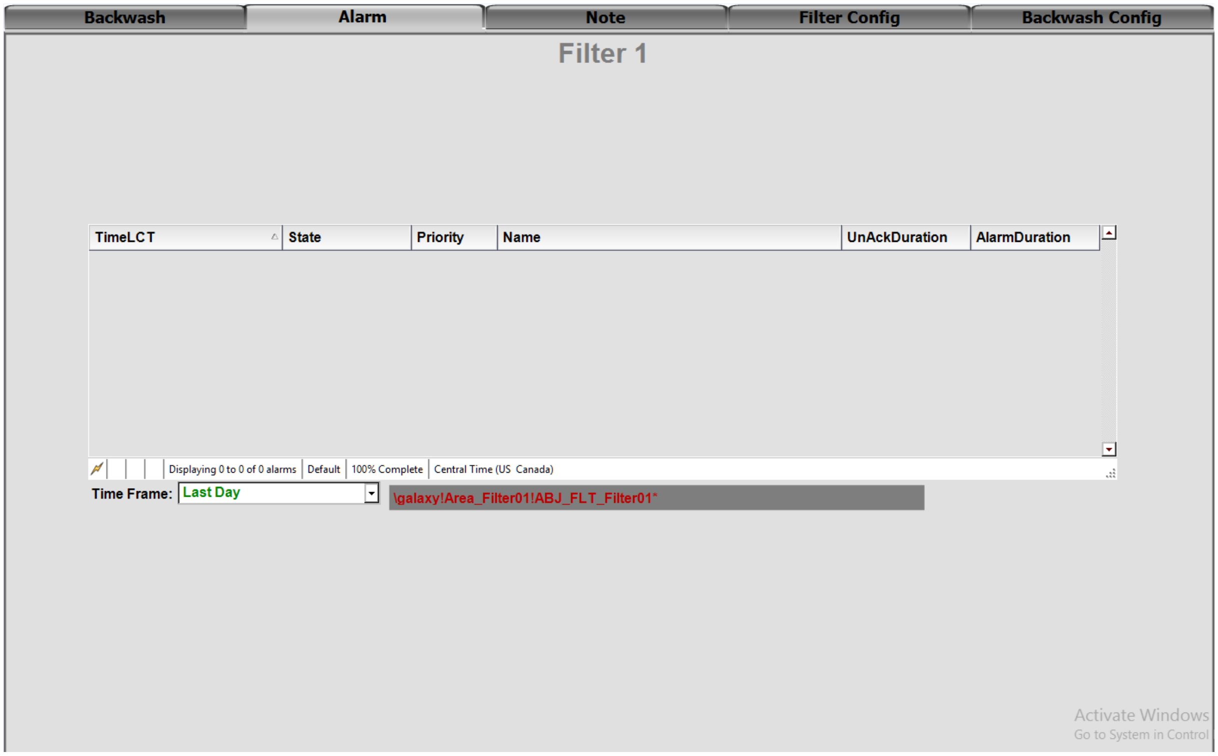


Figure 6-48 Filter Control Popup Alarm Tab

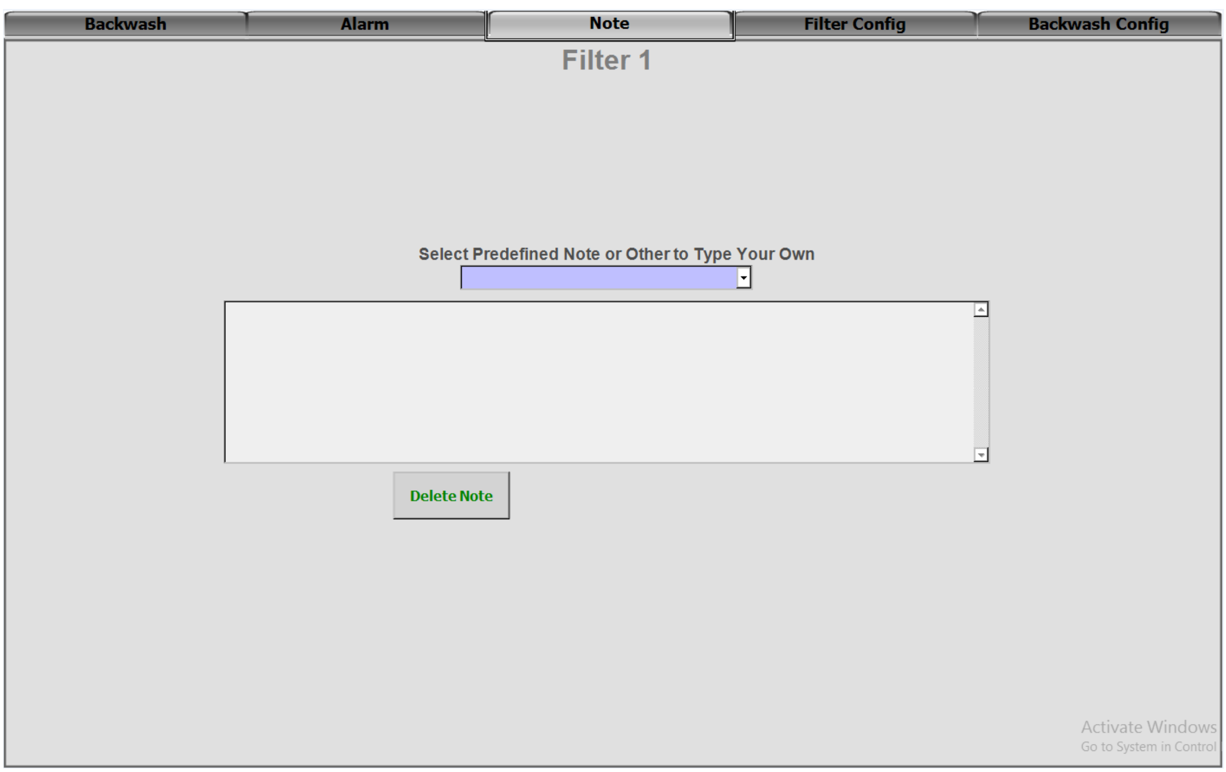


Figure 6-49 Filter Control Popup Note Tab

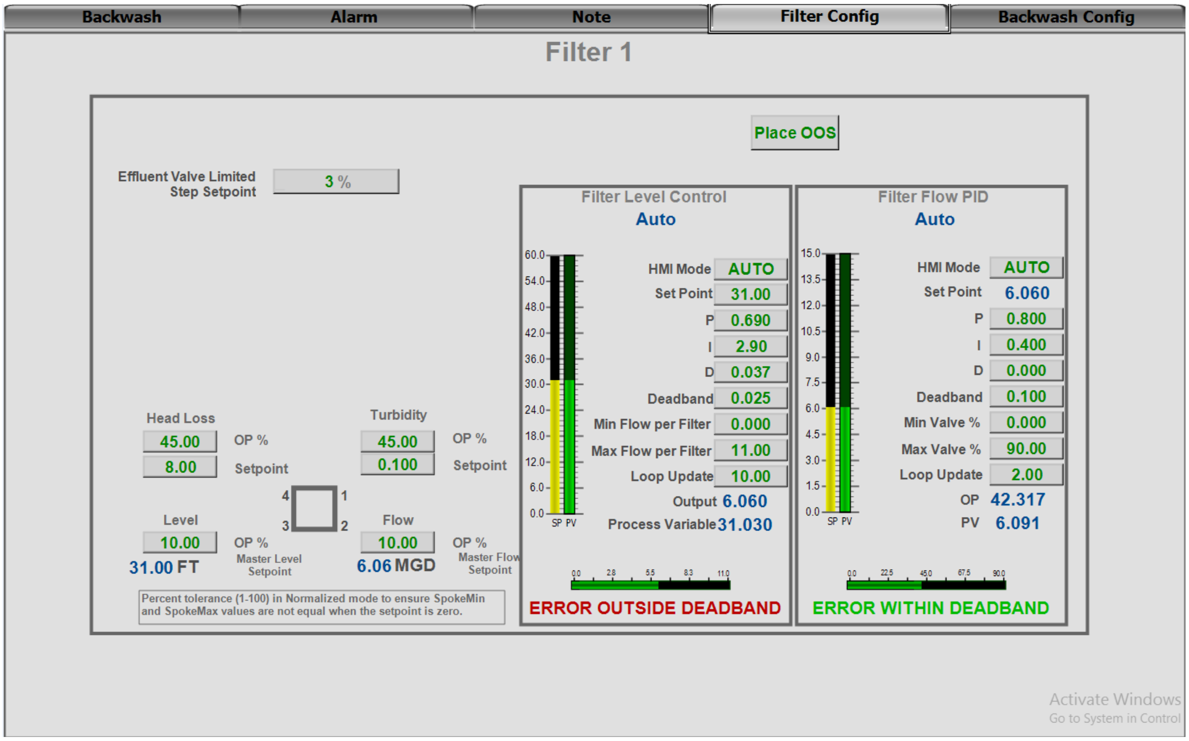


Figure 6-50 Filter Control Popup Filter Config Tab

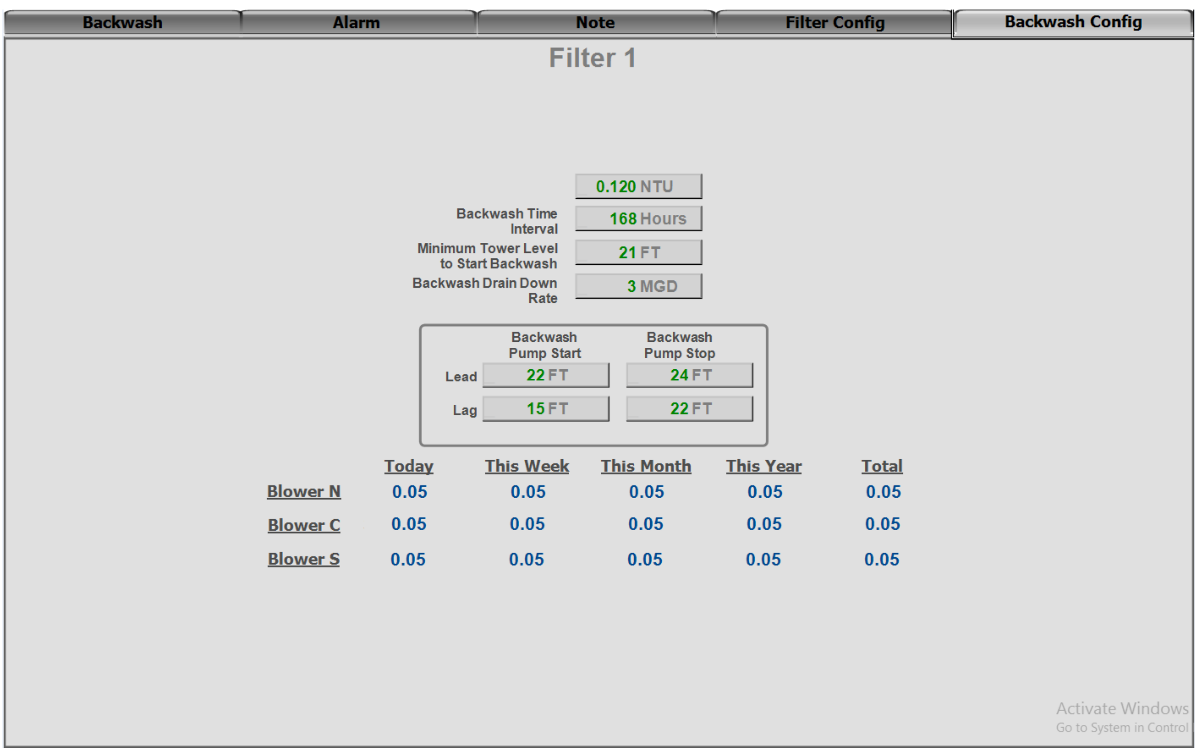


Figure 6-51 Filter Control Popup Backwash Config Tab

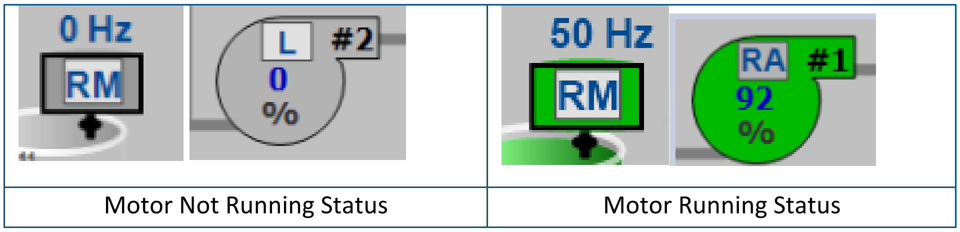


Figure 6-52 $ComplexMotors Template Graphic

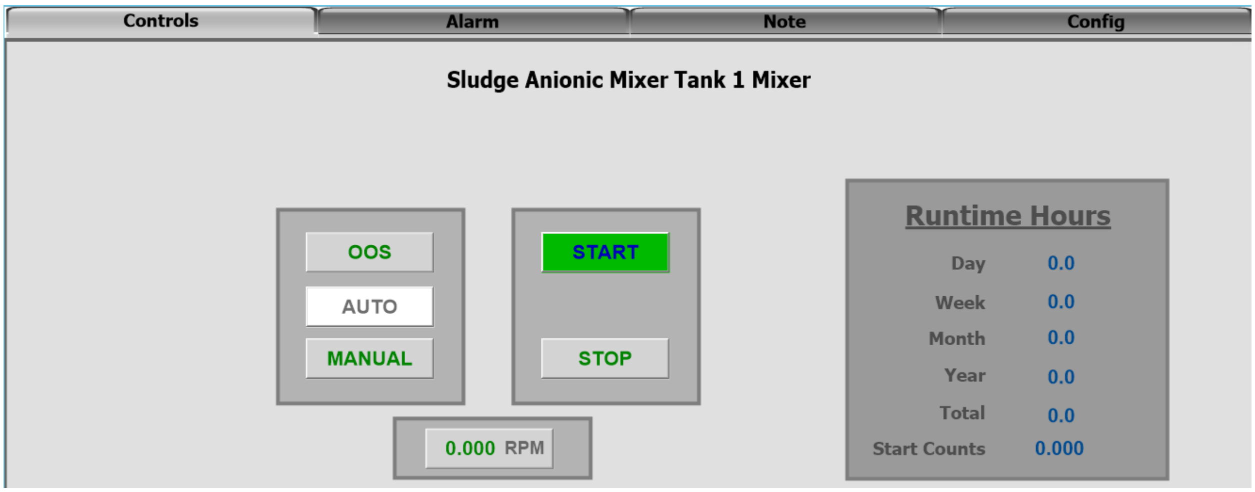


Figure 6-53 $ComplexMotors Template Popup Controls Tab

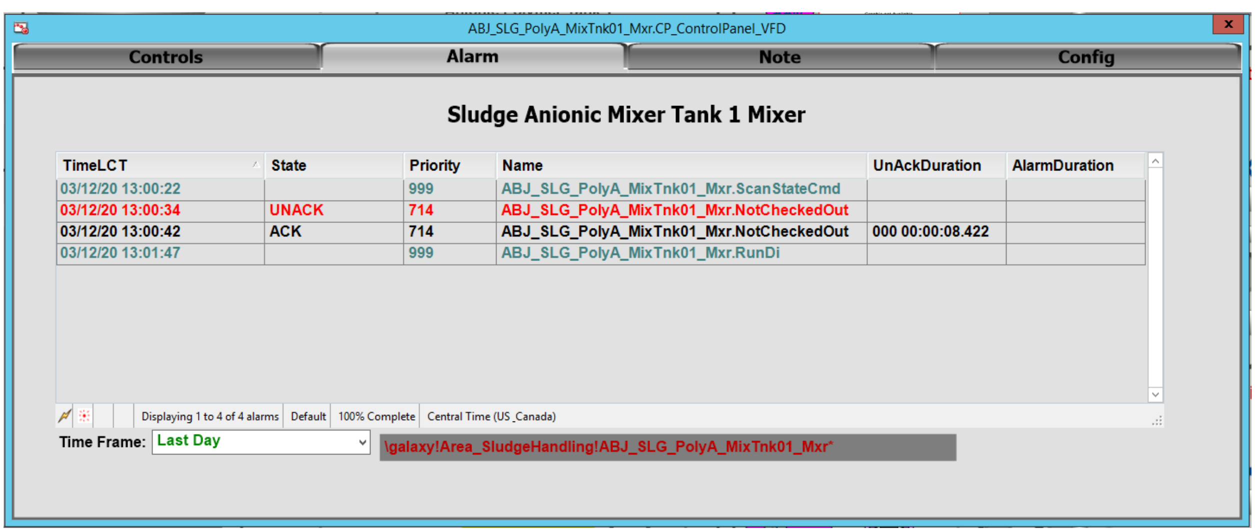


Figure 6-54 $ComplexMotors Template Popup Alarm Tab

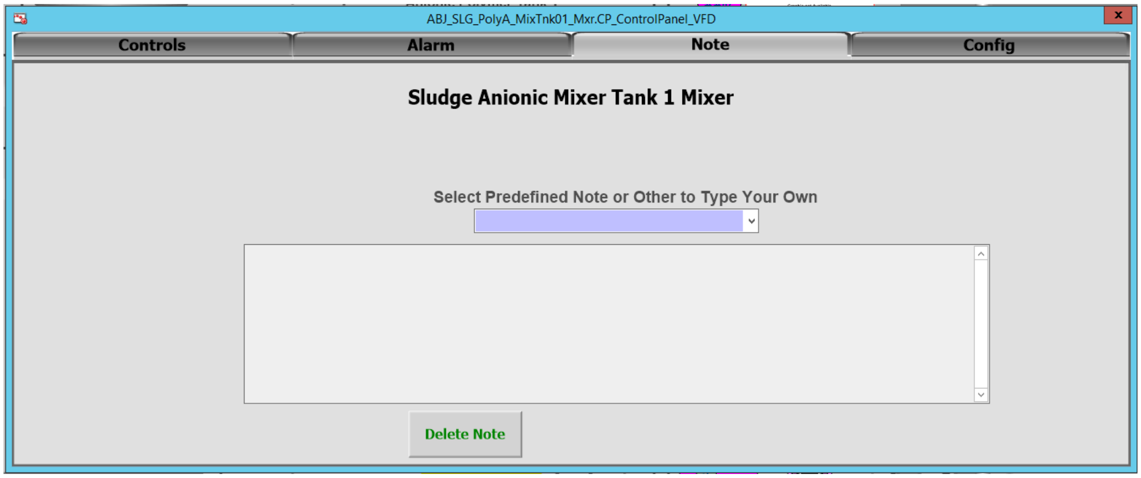


Figure 6-55 $ComplexMotors Template Popup Note Tab

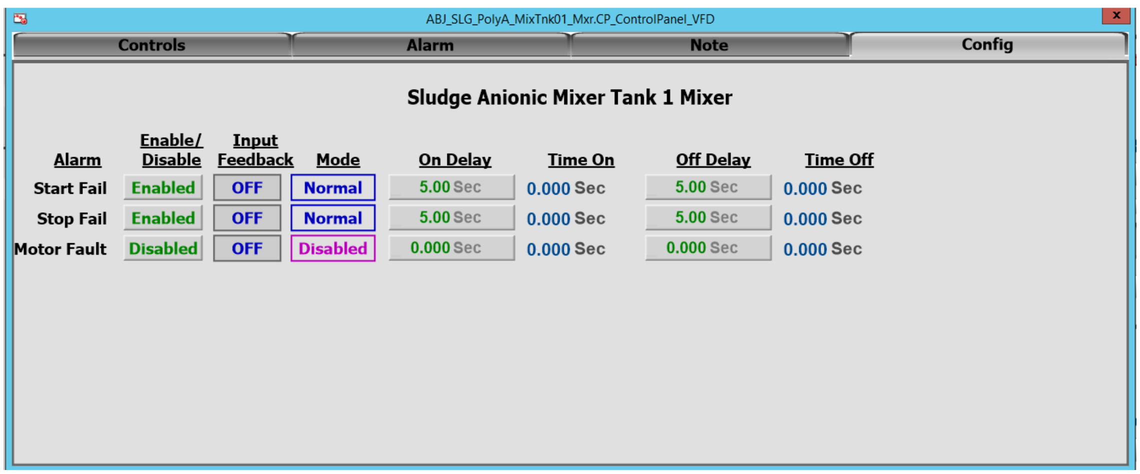


Figure 6-56 $ComplexMotors Template Popup Config Tab

6.7.2.6.1 $ChemFeed

$ChemFeed has an enhanced control panel config tab for draw down and stroke setpoints.

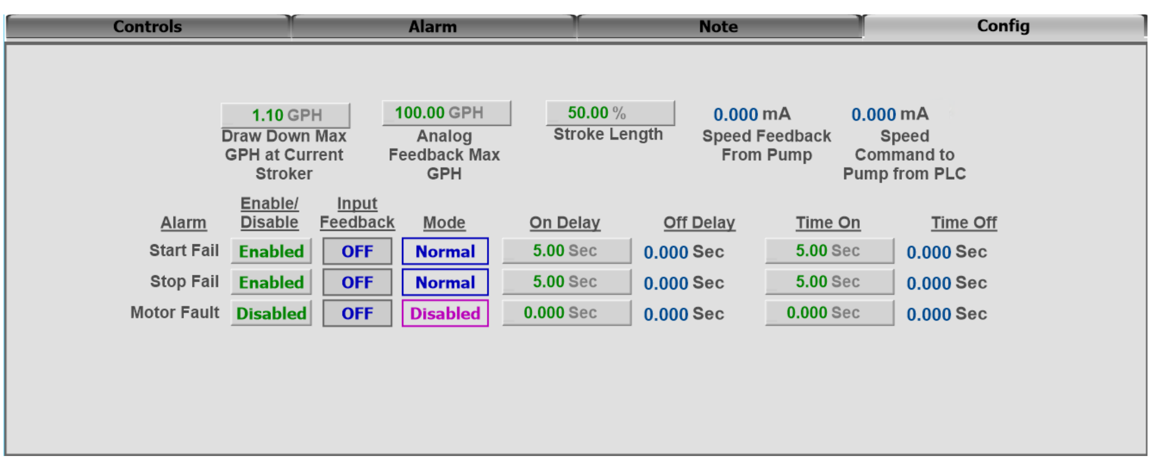


Figure 6-57 $ChemFeed Template Popup Config Tab

6.7.2.6.2 $HSPS

$HSPS contains an enhanced control panel for additional equipment.

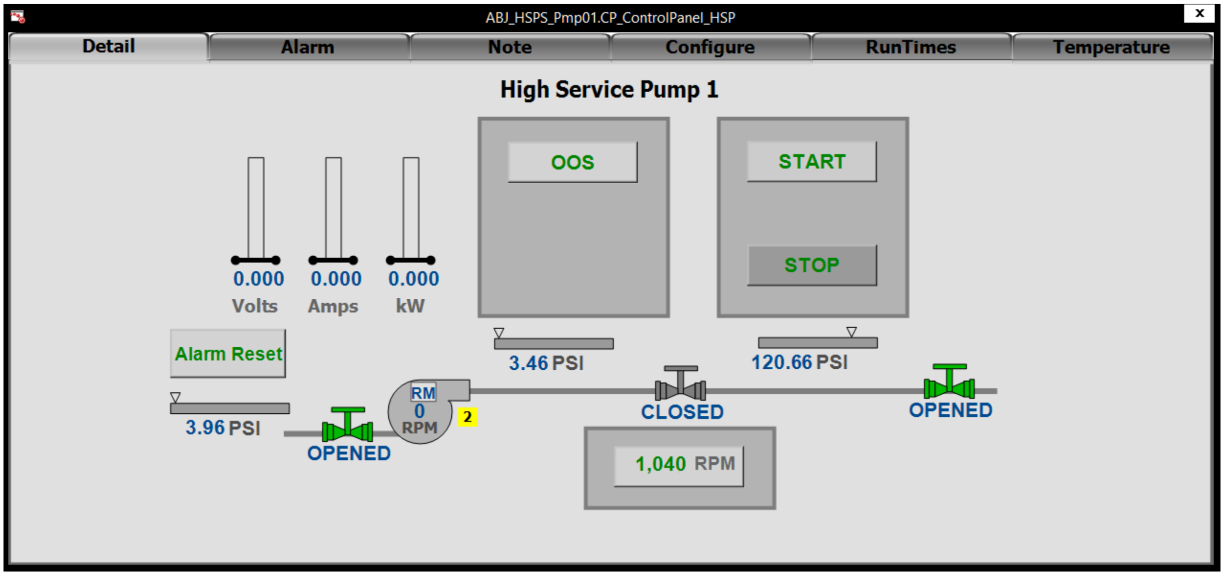


Figure 6-58 $HSPS Template Popup Detail Tab

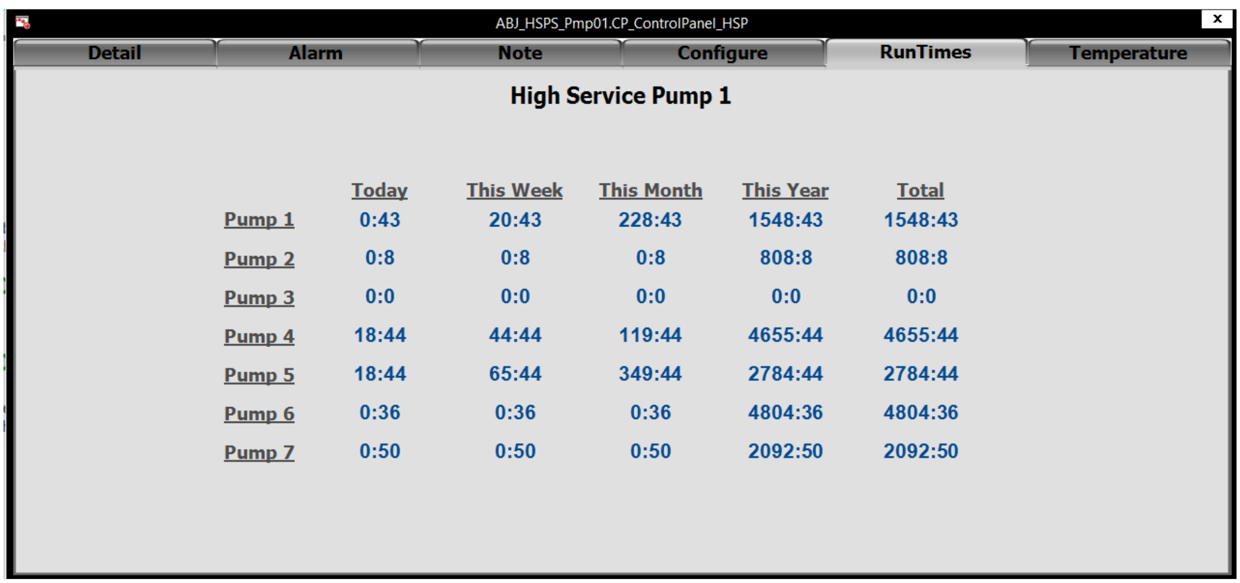


Figure 6-59 $HSPS Template Popup Runtimes Tab

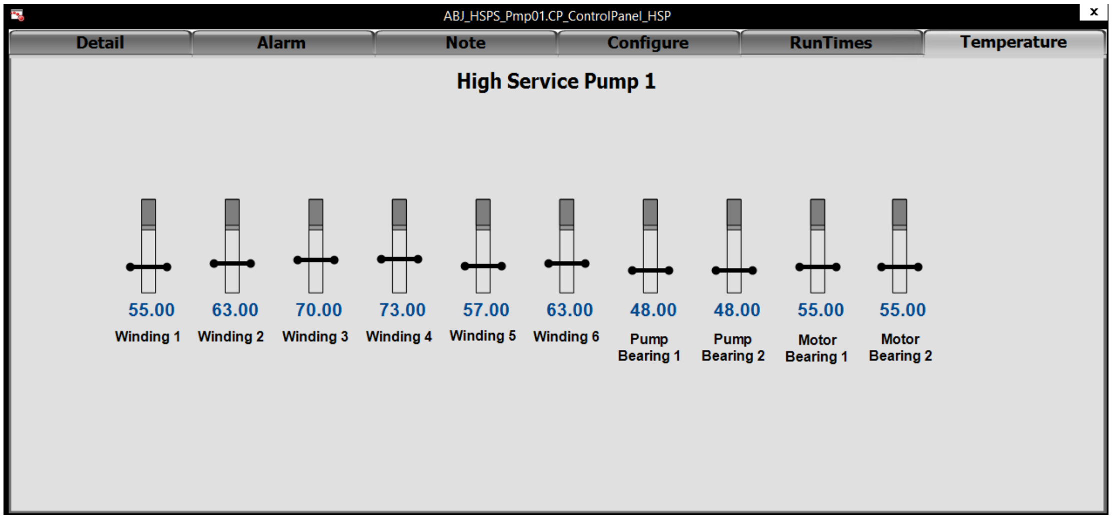


Figure 6-60 $HSPS Template Popup Temperature Tab

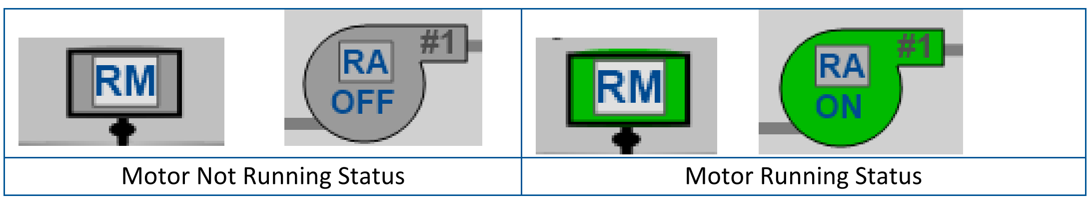


Figure 6-61 $ConstantSpeedMotors Template Graphic

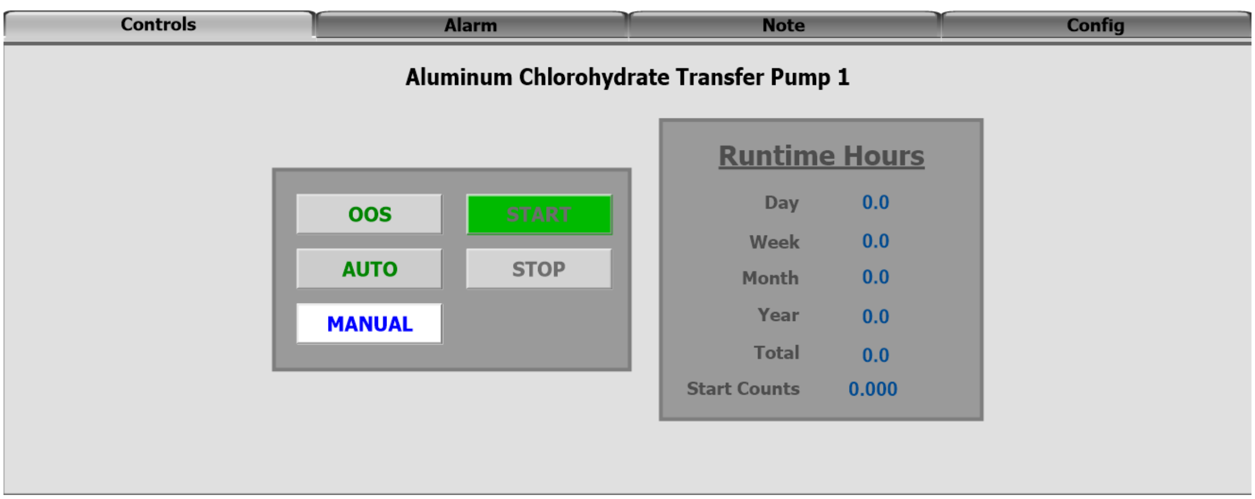


Figure 6-62 $ConstantSpeedMotors Template Popup Controls Tab

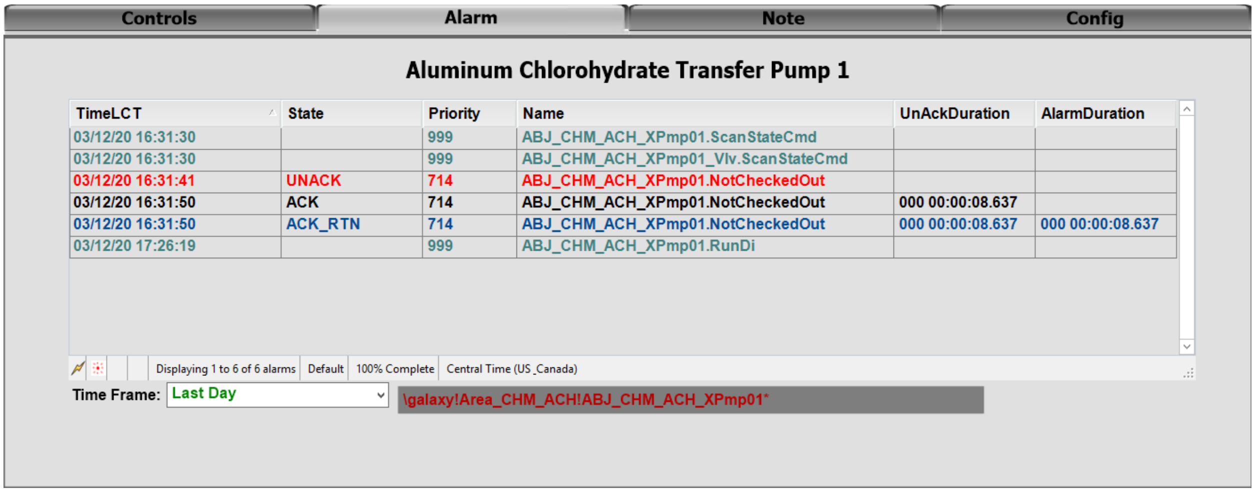


Figure 6-63 $ConstantSpeedMotors Template Popup Alarm Tab

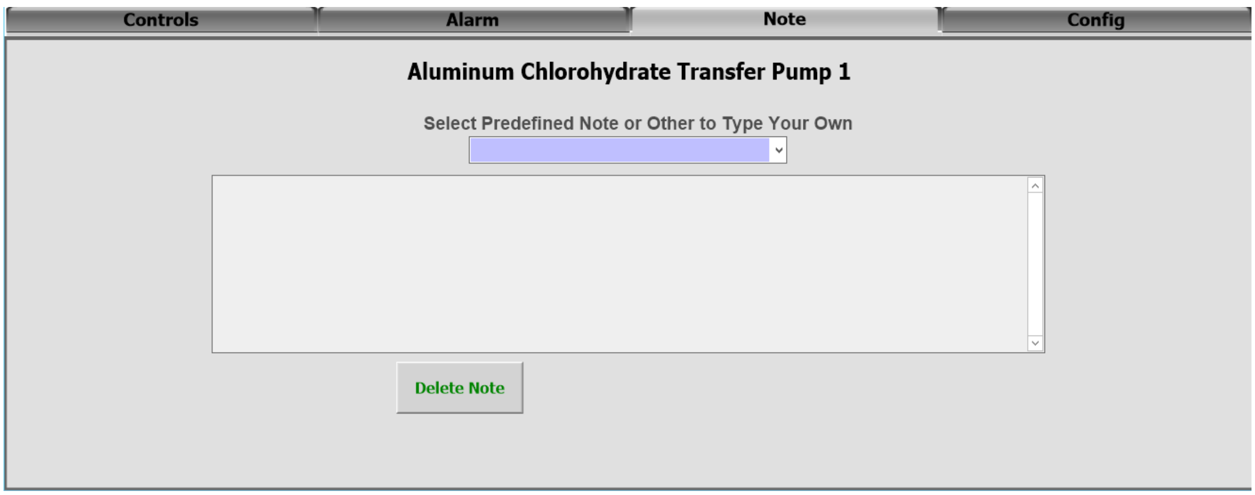


Figure 6-64 $ConstantSpeedMotors Template Popup Note Tab

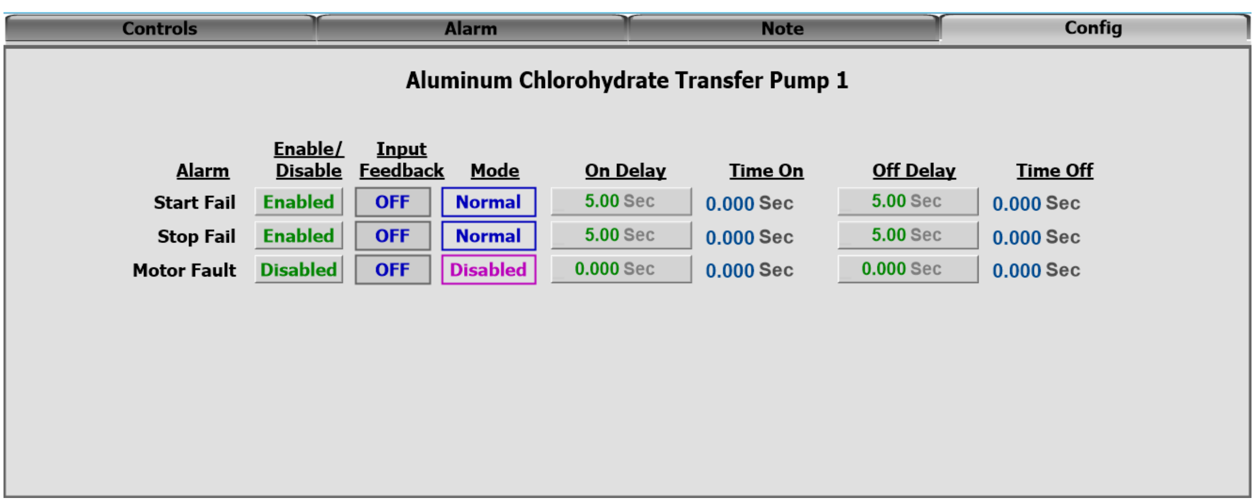


Figure 6-65 $ConstantSpeedMotors Template Popup Config Tab

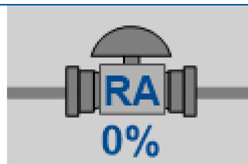
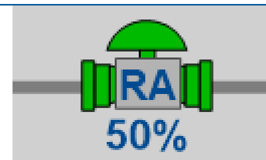
	
Valve Closed	Valve Opened more than threshold

Figure 6-66 $Valves Template Graphic

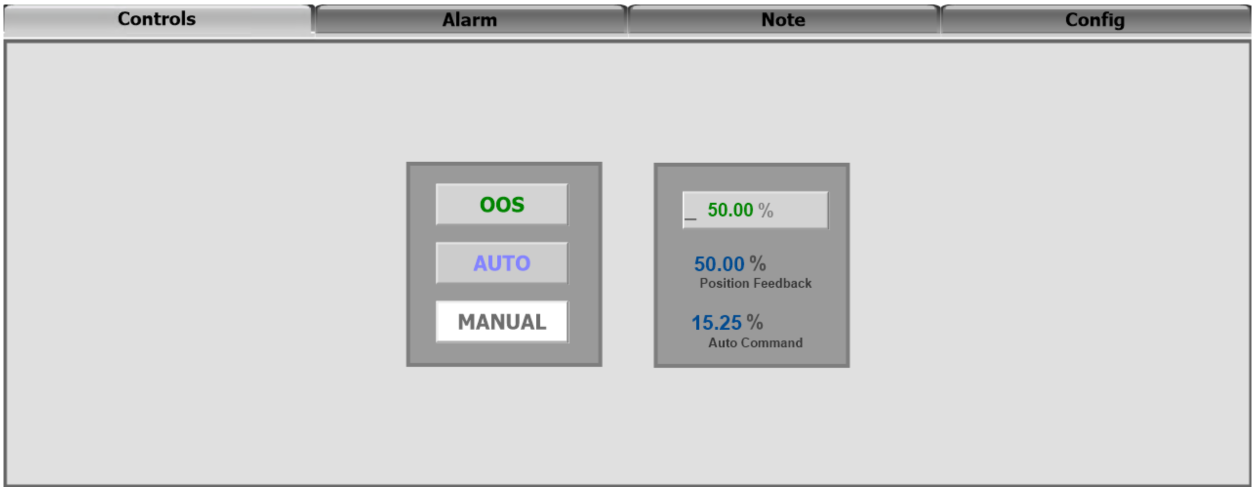


Figure 6-67 $Valves Template Popup Controls Tab

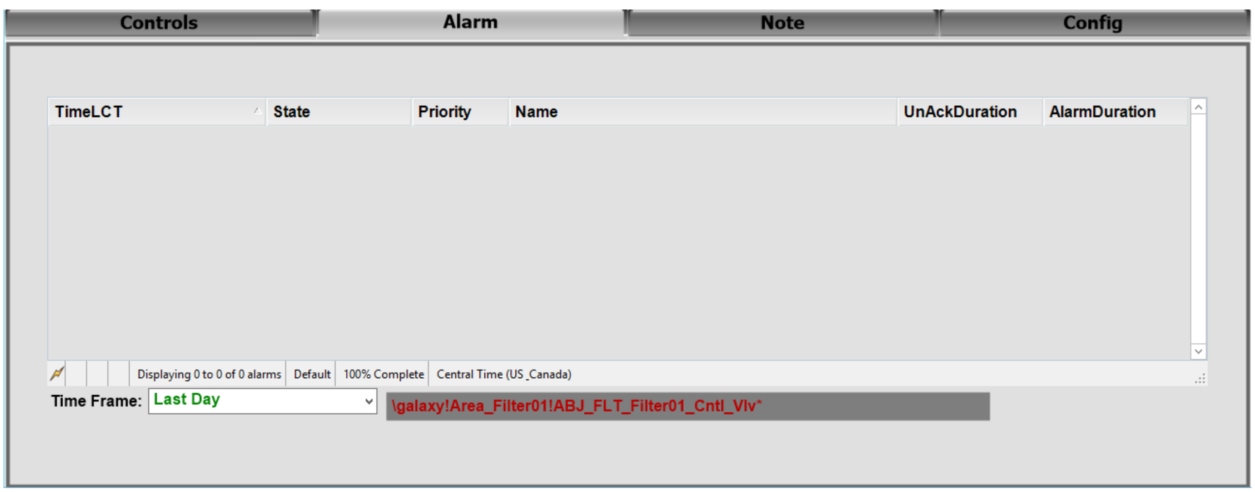


Figure 6-68 $Valves Template Popup Alarm Tab

Figure 6-69 $Valves Template Popup Note Tab

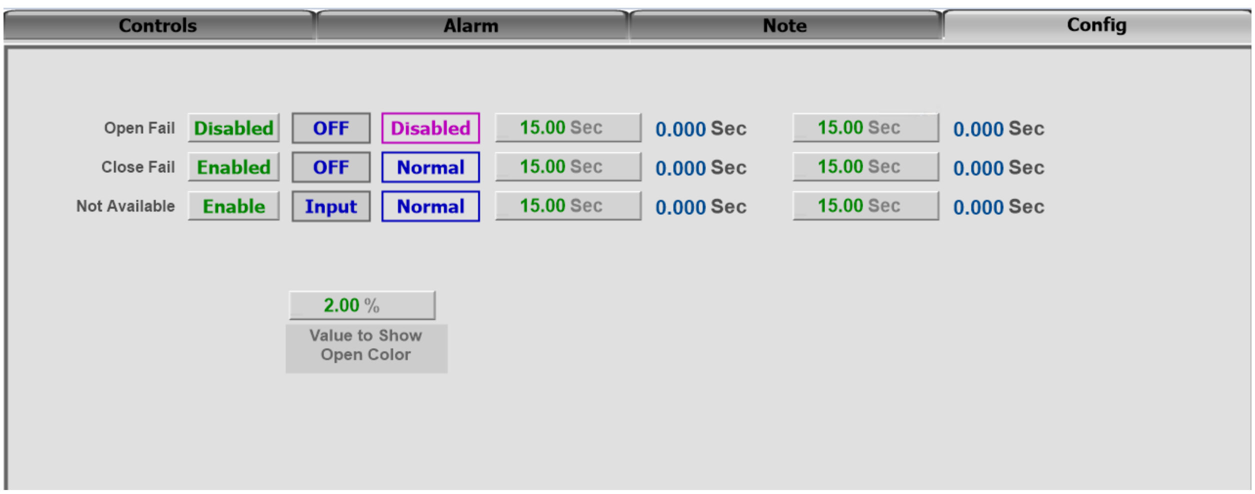


Figure 6-70 $Valves Template Popup Config Tab

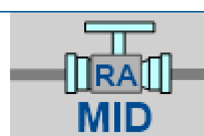
		
Valve Closed Status	Valve Traveling Status	Valve Opened Status

Figure 6-71 $OpenClose Valves Template Graphic

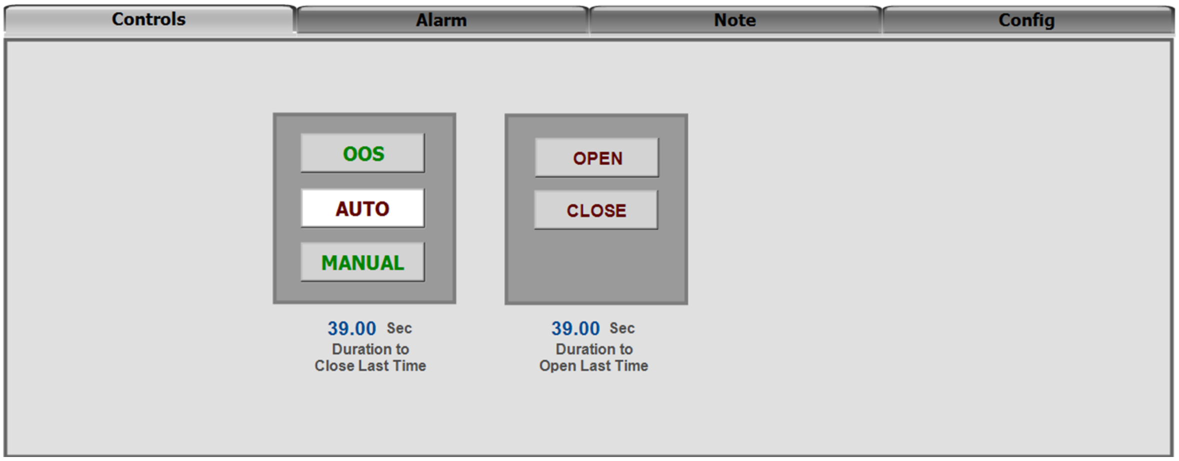


Figure 6-72 $OpenCloseValves Template Popup Controls Tab

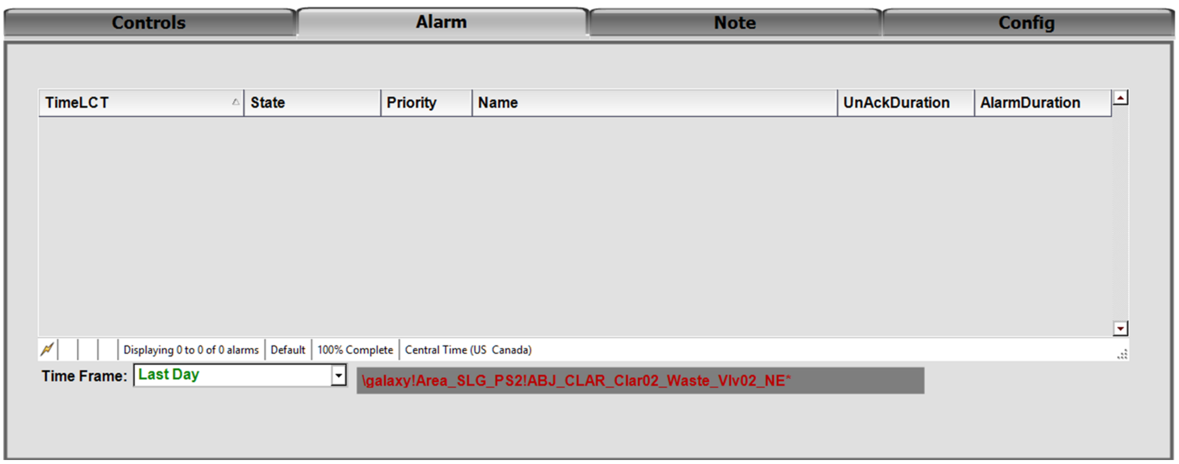


Figure 6-73 $OpenCloseValves Template Popup Alarm Tab

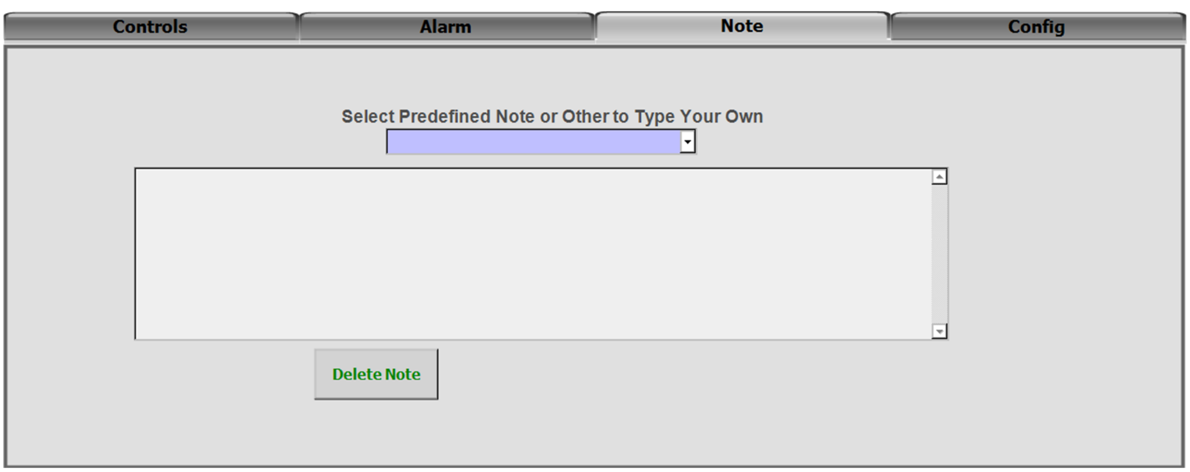


Figure 6-74 $OpenCloseValves Template Popup Note Tab

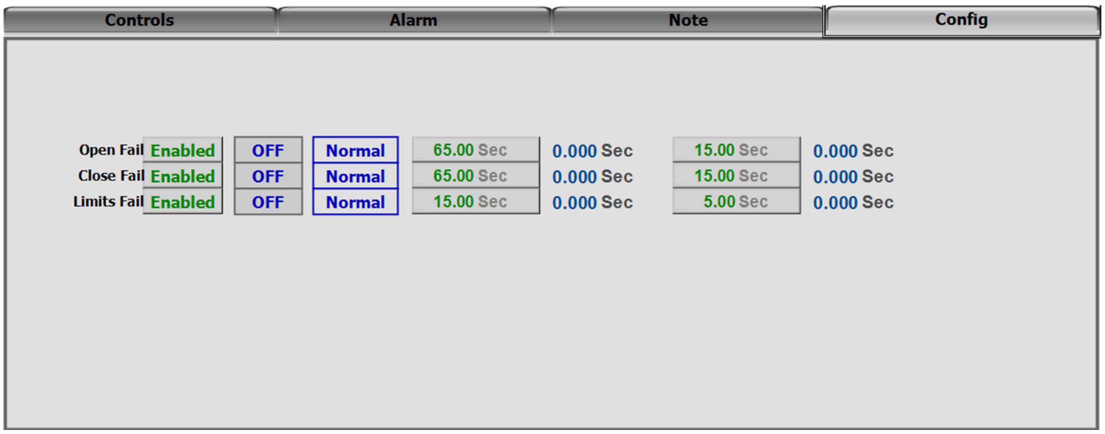


Figure 6-75 $OpenCloseValves Template Popup Config Tab

6.7.3 Trending

Trending shall be provided for both real-time data and historical data. Trends are either bar graph dashboards or x-y line graphs. The line graphs should typically trend four parameters, but never more than six parameters. Bar graphs and x-y line graphs should include TMUA predefined and custom trends. Parameters to be stored for historical trending shall include run statuses, flow, level, pressure, temperature, analytical values and others as directed by TMUA.

The two main templates that are used for trends are GraphicToolbox\Tulsa\Trends\ SA_Trend_MultiPen_4Pen_PURGE and SystemGraphics\ Plant_Trends.

6.7.3.1 SA_Trend_MultiPen_4Pen_PURGE

SA_Trend_MultiPen_4Pen_PURGE is found in the IDE GraphicToolbox tab in the folder Tulsa then Trends. This template is used on overview screens and may display up to four trend pens. The trend only allows changing the trend duration when linked to the TrendDuration graphic.

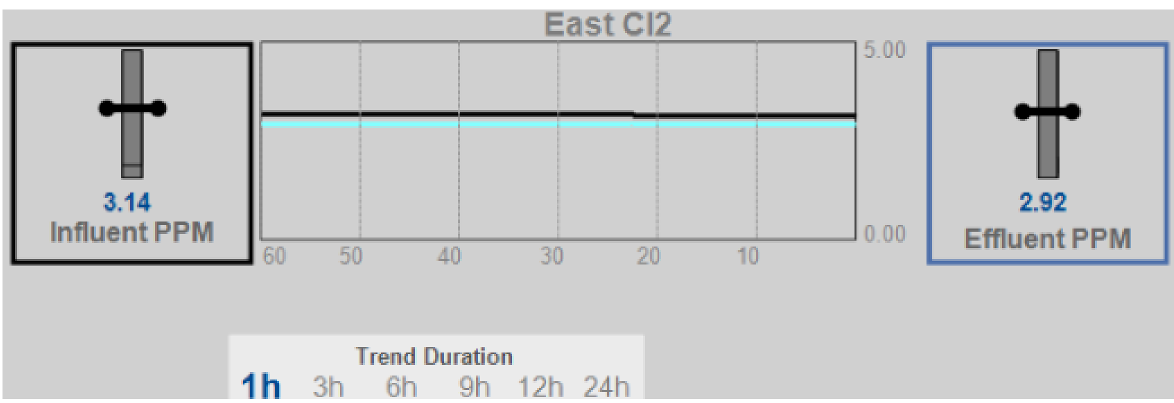


Figure 6-76 Situational Awareness 4 Pen Trend Graphic

6.7.3.2 Plant_Trends

Plant_Trends is a graphic within the SystemGraphics IDE object. Plant_Trends contains a single .NET aaTrendControl and uses scripting to change the pens. Up to six pens may be displayed on a single trend. New trends need to be created and placed in the default directory; that is \\abj-hist\trends\. Use an existing trend file for reference of pen colors and line types.

The Plant_Trend screen has 7 drop down combo-boxes used to store links to the trends. The value used in the drop-down must match the file name exactly (Case Sensitive).

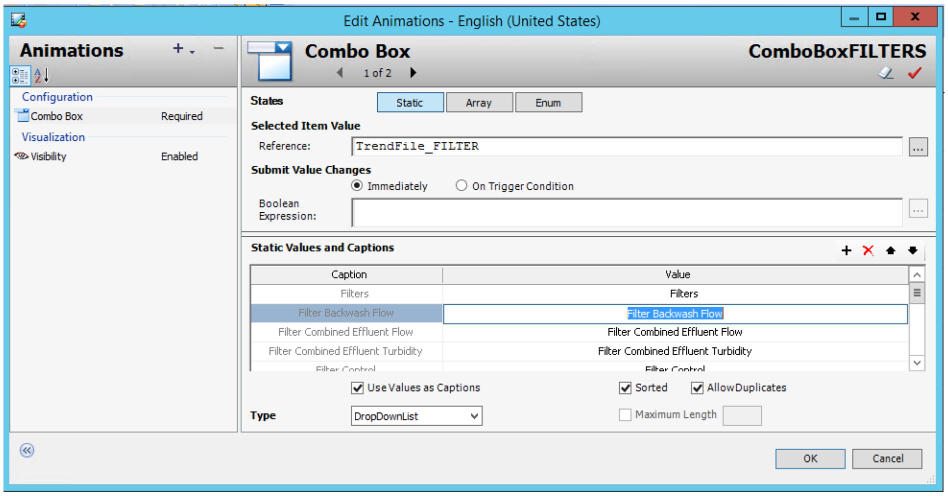


Figure 6-77 Plant_Trend Graphic Combo Box Animation Editor

Each trend shall need to create a script to load the trend based on the selected drop-down value. The script shall be set each pen to a tag and then indicate how many trend pens are used.

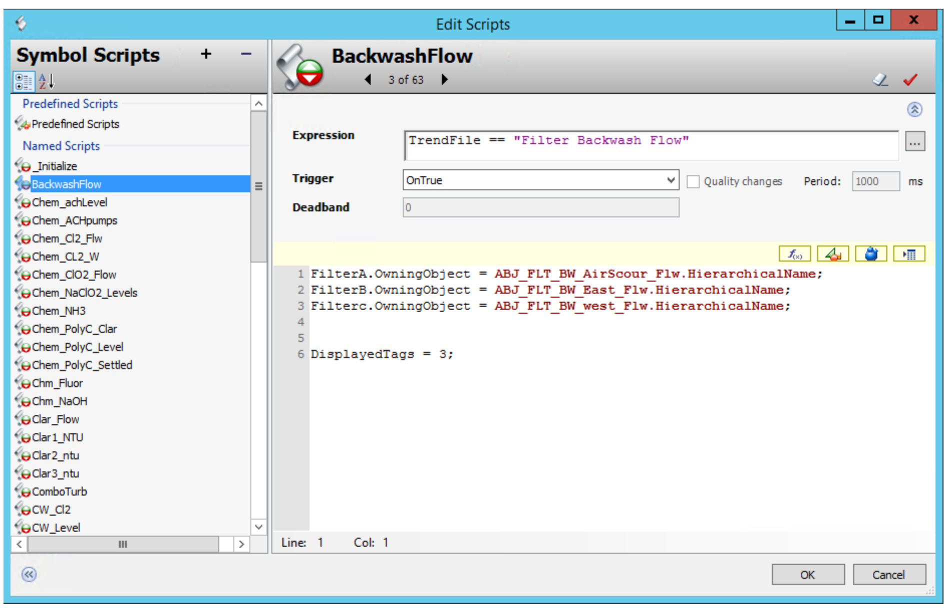
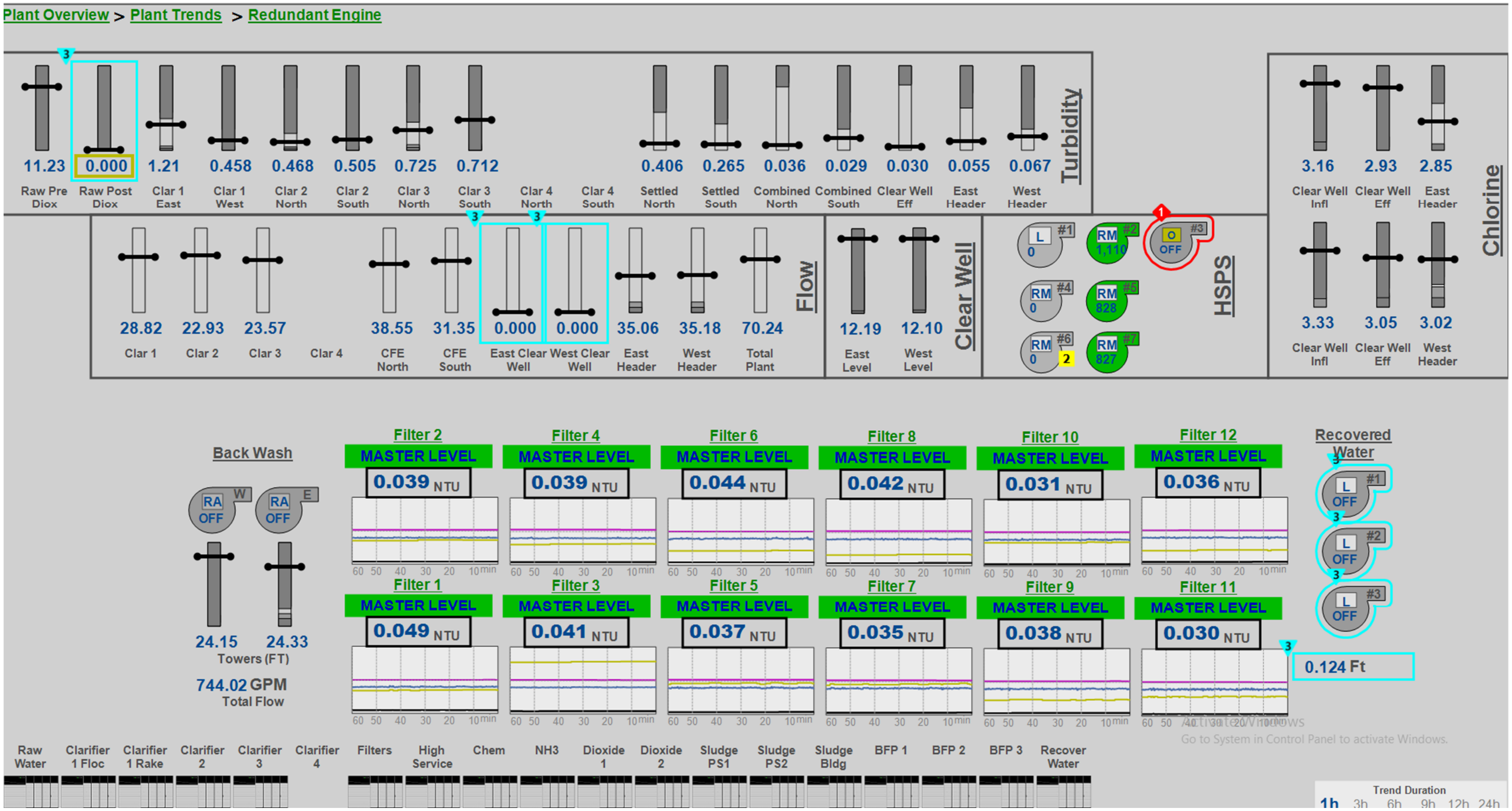


Figure 6-78 Plant_Trend Graphic Script Editor

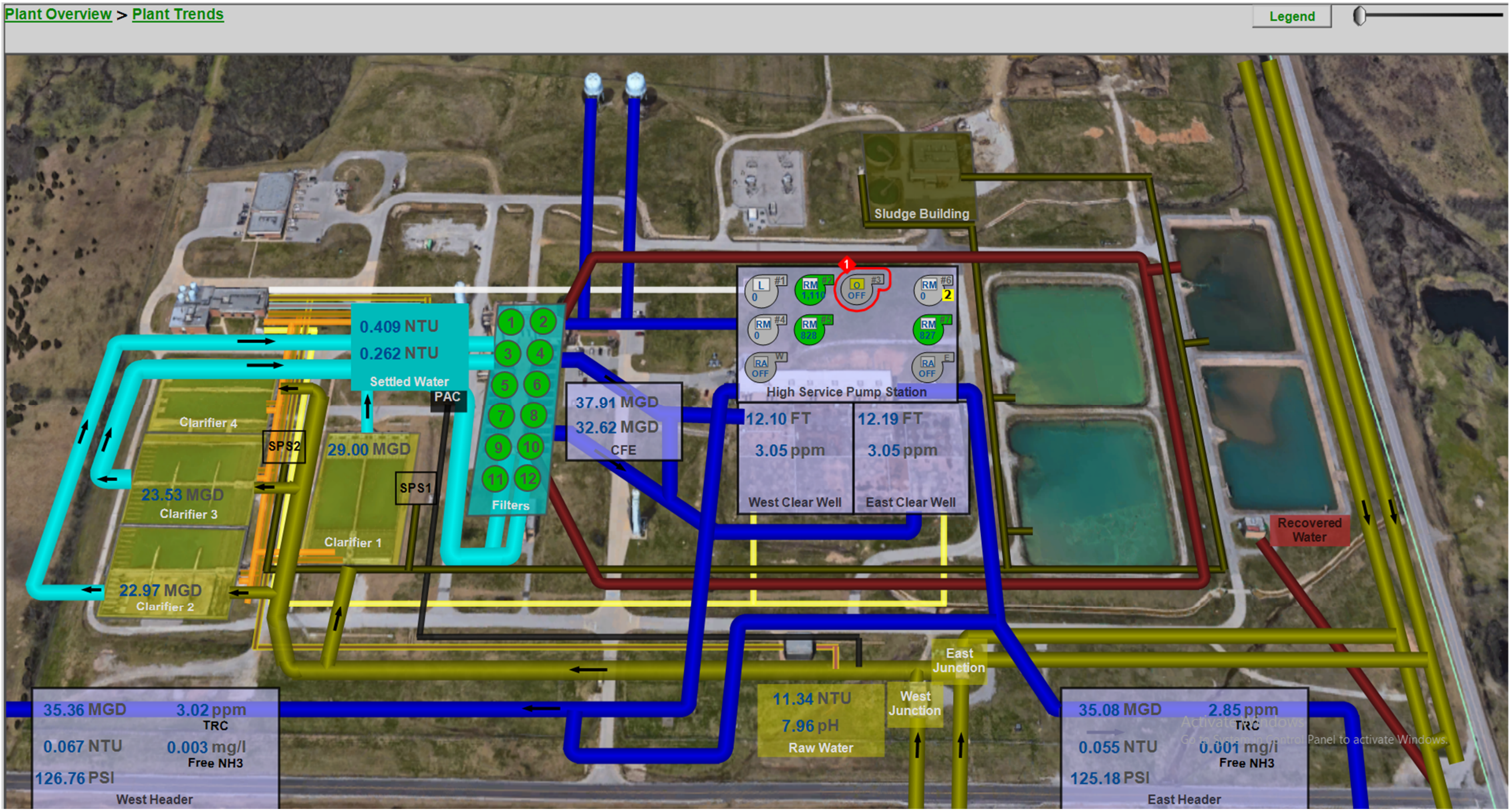
Last, the new trend shall be added appropriately to the ZZ_TrendLoad and ZZ_TrendScroll scripts. These two scripts index the trends for the trend Auto-Scroll function.

Appendix A. Operator Graphic Screenshots

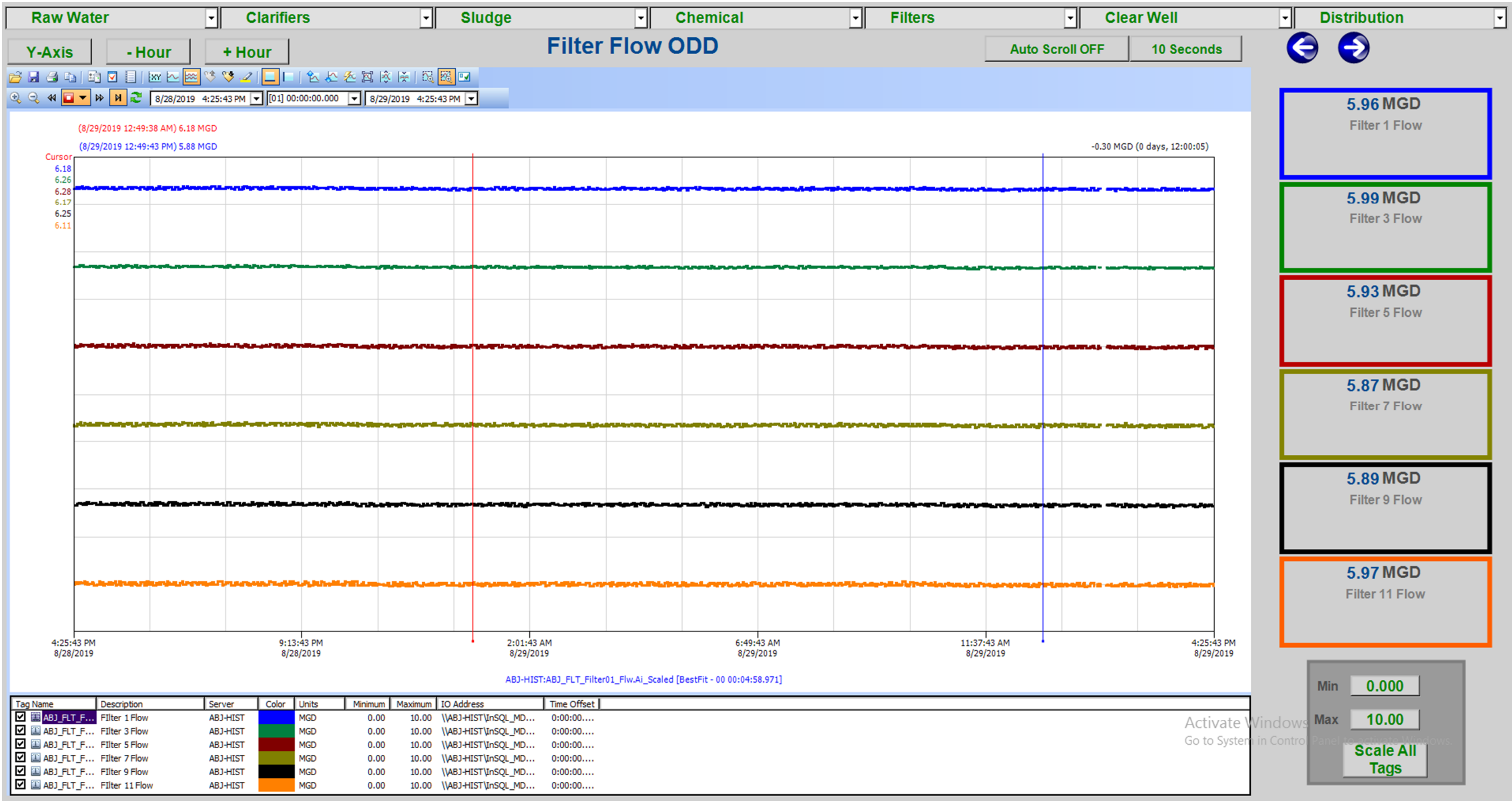
Plant Overview



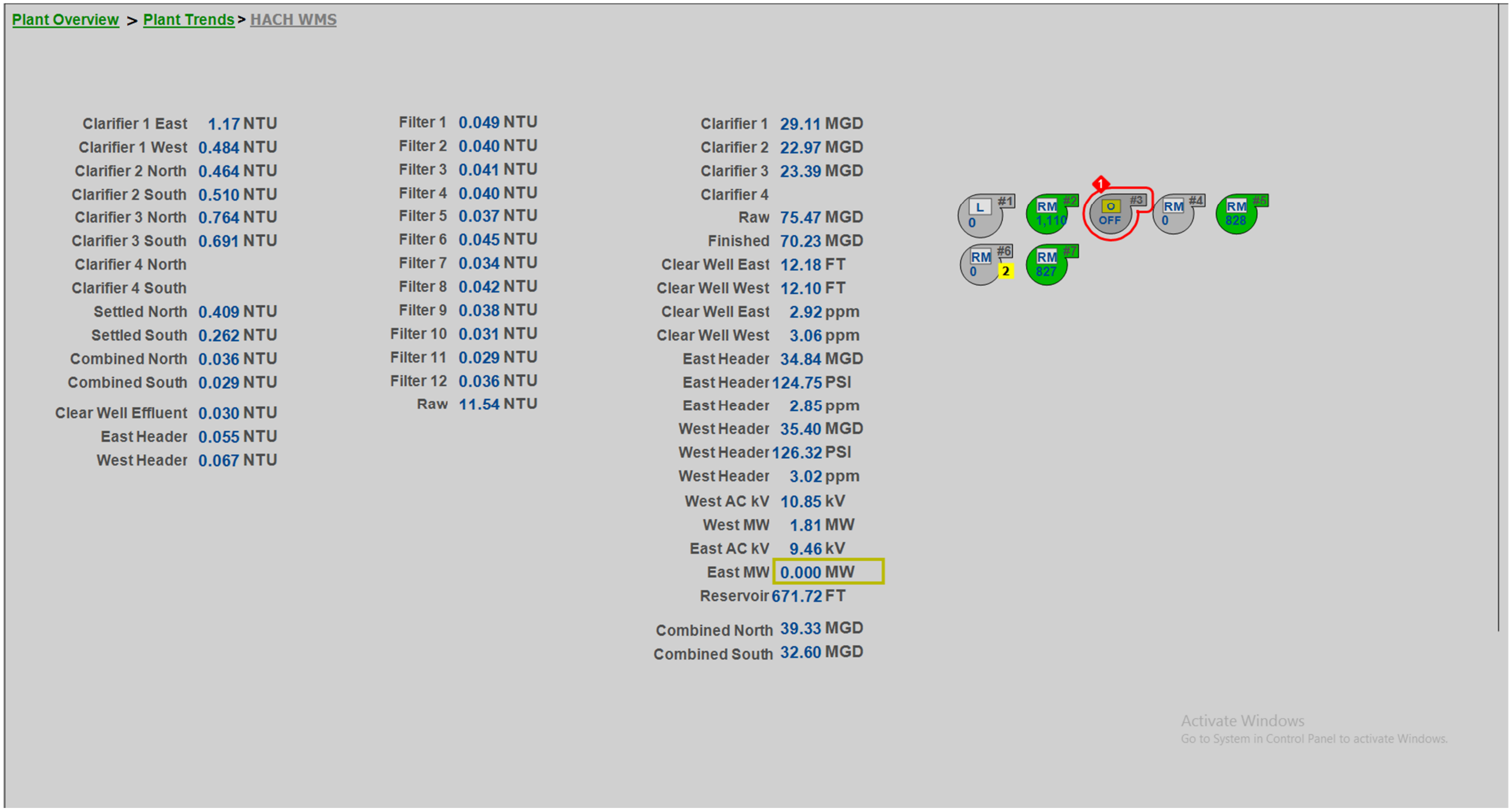
Plant Satellite Map



Plant Trend


Raw Water
Clarifiers
Sludge
Chemical
Filters
Clear Well
Distribution
Y-Axis
- Hour
+ Hour
Filter Flow ODD
Auto Scroll OFF
10 Seconds
5.96 MGD
Filter 1 Flow
5.99 MGD
Filter 3 Flow
5.93 MGD
Filter 5 Flow
5.87 MGD
Filter 7 Flow
5.89 MGD
Filter 9 Flow
5.97 MGD
Filter 11 Flow
Min 0.000
Max 10.00
Scale All Tags

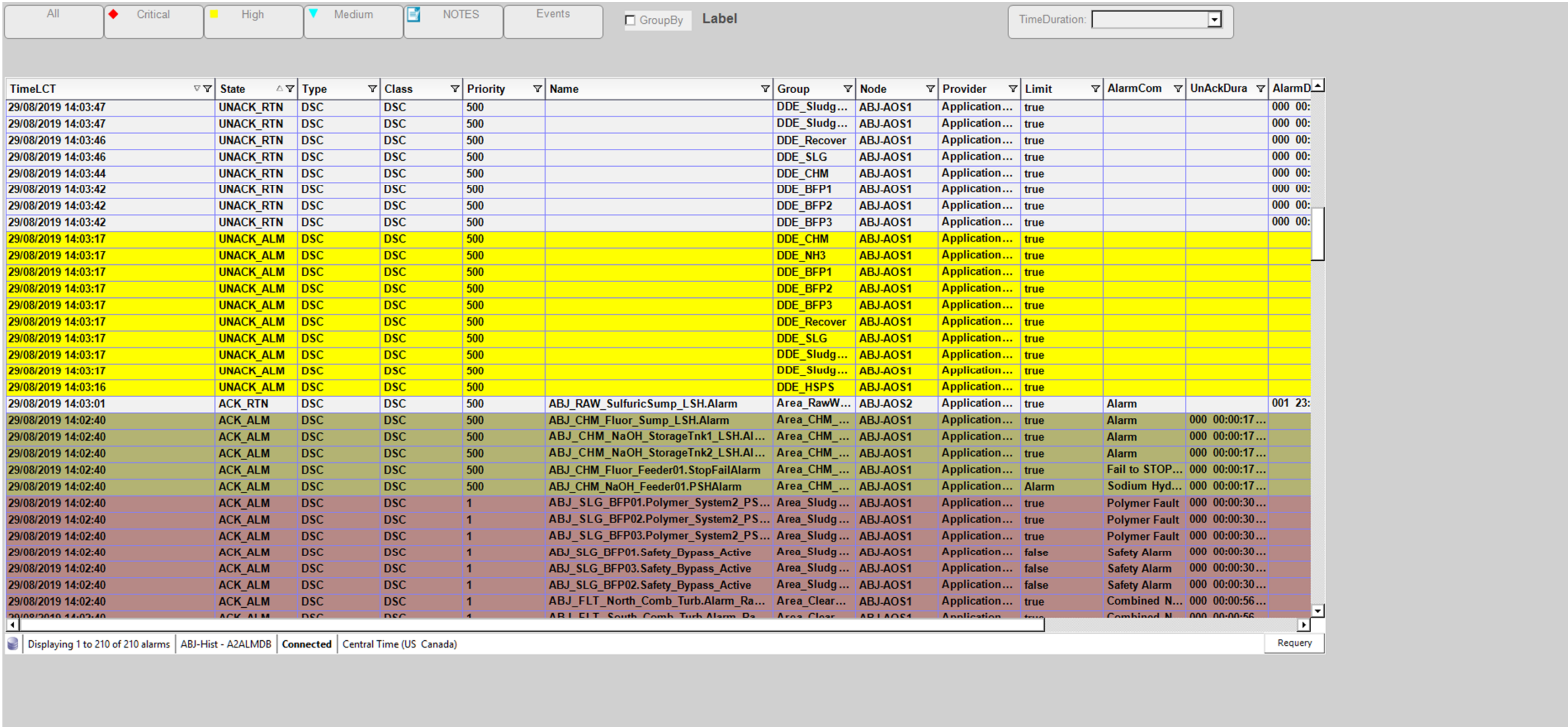
WIMS Information



Alarm Summary

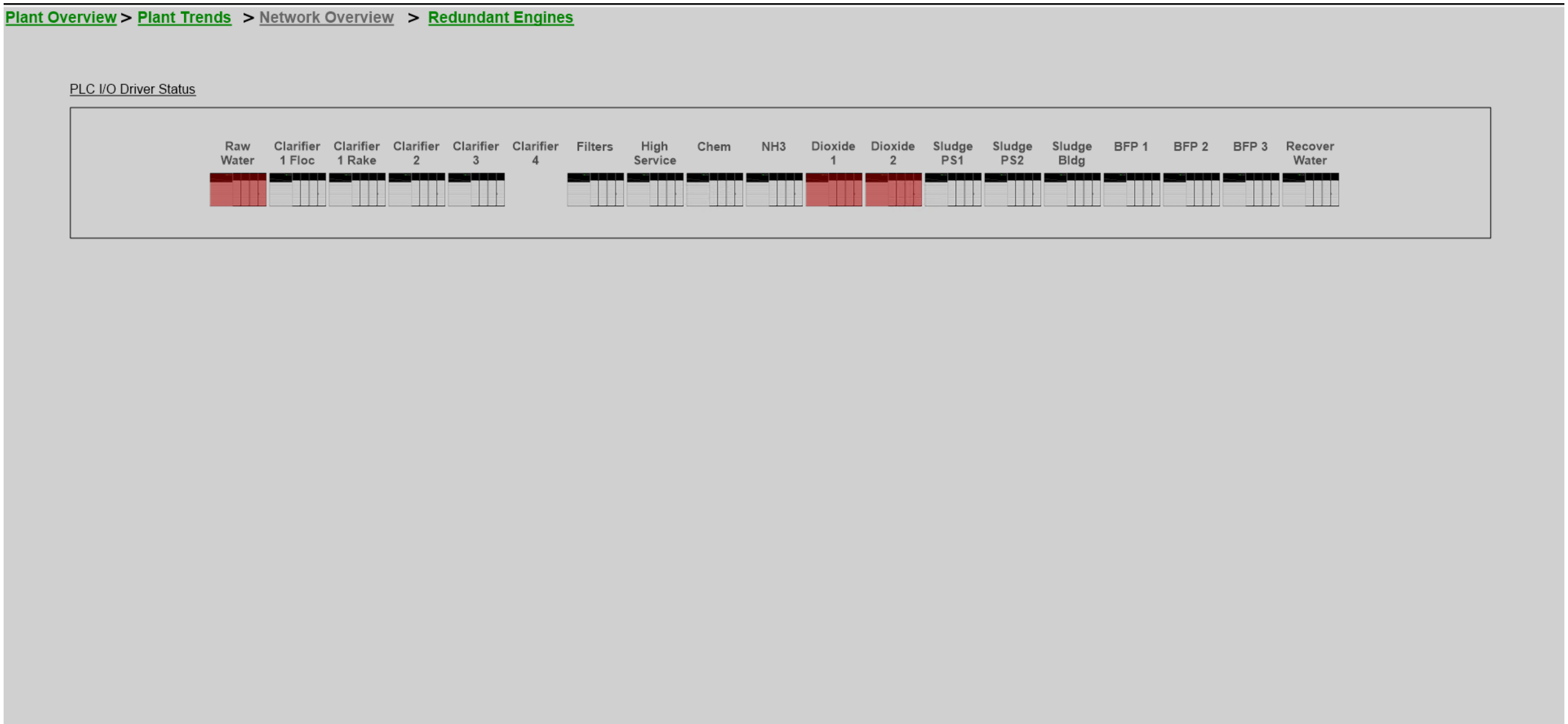
Severity	State	Tagname	Type	Time	AlarmDuration	UnAckDuration	Description	Operator	OperatorNod
2	ACK	ABJ_RAW_SulfuricSump_LSH.Alarm	DSC	8/29/2019 14:09:38		000 00:00:12.998	Alarm	bv-mike	WORKSTATI...
2	ACK	ABJ_CHM_Fluor_Feeder01.StopFailAlarm	DSC	8/29/2019 14:02:40		000 00:00:17.533	Fail to STOP Alarm	bv-mike	WORKSTATI...
2	ACK	ABJ_CHM_Fluor_Sump_LSH.Alarm	DSC	8/29/2019 14:02:40		000 00:00:17.533	Alarm	bv-mike	WORKSTATI...
2	ACK	ABJ_CHM_NaOH_Feeder01.PSHAlarm	DSC	8/29/2019 14:02:40		000 00:00:17.470	Sodium Hydroxide Feed Pump 1	bv-mike	WORKSTATI...
2	ACK	ABJ_CHM_NaOH_StorageTnk1_LSH.Alarm	DSC	8/29/2019 14:02:40		000 00:00:17.533	Alarm	bv-mike	WORKSTATI...
2	ACK	ABJ_CHM_NaOH_StorageTnk2_LSH.Alarm	DSC	8/29/2019 14:02:40		000 00:00:17.533	Alarm	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP01.Polymer_System2_PSH_input	DSC	8/29/2019 14:02:40		000 00:00:30.674	Polymer Fault	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP01.Safety_Bypass_Active	DSC	8/29/2019 14:02:40		000 00:00:30.674	Safety Alarm	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP02.Polymer_System2_PSH_input	DSC	8/29/2019 14:02:40		000 00:00:30.658	Polymer Fault	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP02.Safety_Bypass_Active	DSC	8/29/2019 14:02:40		000 00:00:30.658	Safety Alarm	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP03.Polymer_System2_PSH_input	DSC	8/29/2019 14:02:40		000 00:00:30.674	Polymer Fault	bv-mike	WORKSTATI...
1	ACK	ABJ_SLG_BFP03.Safety_Bypass_Active	DSC	8/29/2019 14:02:40		000 00:00:30.674	Safety Alarm	bv-mike	WORKSTATI...
1	ACK	ABJ_FLT_North_Comb_Turb.Alarm_Range	DSC	8/29/2019 14:02:40		000 00:00:56.945	Combined North Turbidity	bv-mike	WORKSTATI...
1	ACK	ABJ_FLT_South_Comb_Turb.Alarm_Range	DSC	8/29/2019 14:02:40		000 00:00:56.945	Combined North Turbidity	bv-mike	WORKSTATI...
2	ACK	ABJ_HSPS_Pmp03_Pmp_Brng02_Temp.Alarm_High	Hi	8/29/2019 14:02:40		000 00:00:13.673	me.Alarm_High.Description	bv-mike	WORKSTATI...
1	ACK	ABJ_HSPS_Pmp03_Pmp_Brng02_Temp.Alarm_Hig...	HiHi	8/29/2019 14:02:40		000 00:00:13.673		bv-mike	WORKSTATI...
2	ACK	ABJ_HSPS_Pmp06.VFDWarning	DSC	8/29/2019 14:02:40		000 00:00:13.657	Low Discharge Alarm	bv-mike	WORKSTATI...
1	UNACK_RTN	ABJ_ViewEngine_05_LAB from WinPlatform_GR	Comm	8/29/2019 12:28:42	000 00:01:38.039		Lost alarm communication to ABJ_View...		ABJ-DEV

Alarm History

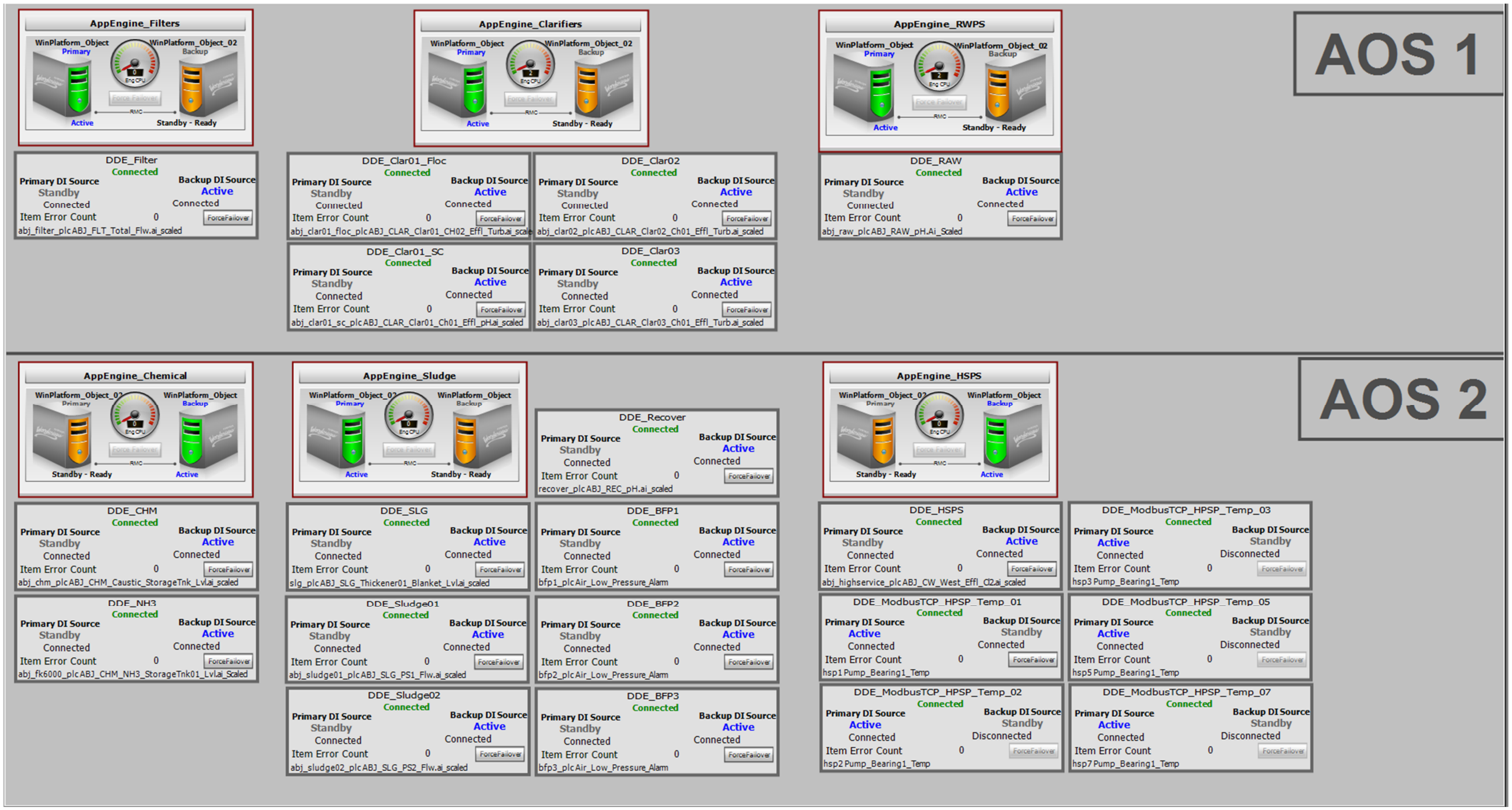


TimeLCT	State	Type	Class	Priority	Name	Group	Node	Provider	Limit	AlarmCom	UnAckDura	AlarmD
29/08/2019 14:03:47	UNACK_RTN	DSC	DSC	500		DDE_Sludg...	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:47	UNACK_RTN	DSC	DSC	500		DDE_Sludg...	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:46	UNACK_RTN	DSC	DSC	500		DDE_Recover	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:46	UNACK_RTN	DSC	DSC	500		DDE_SLG	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:44	UNACK_RTN	DSC	DSC	500		DDE_CHM	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:42	UNACK_RTN	DSC	DSC	500		DDE_BFP1	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:42	UNACK_RTN	DSC	DSC	500		DDE_BFP2	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:42	UNACK_RTN	DSC	DSC	500		DDE_BFP3	ABJ-AOS1	Application...	true			000 00:
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_CHM	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_NH3	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_BFP1	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_BFP2	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_BFP3	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_Recover	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_SLG	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_Sludg...	ABJ-AOS1	Application...	true			
29/08/2019 14:03:17	UNACK_ALM	DSC	DSC	500		DDE_Sludg...	ABJ-AOS1	Application...	true			
29/08/2019 14:03:16	UNACK_ALM	DSC	DSC	500		DDE_HSPS	ABJ-AOS1	Application...	true			
29/08/2019 14:03:01	ACK_RTN	DSC	DSC	500	ABJ_RAW_SulfuricSump_LSH.Alarm	Area_RawW...	ABJ-AOS2	Application...	true	Alarm		001 23:
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	500	ABJ_CHM_Fluor_Sump_LSH.Alarm	Area_CHM_...	ABJ-AOS1	Application...	true	Alarm	000 00:00:17...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	500	ABJ_CHM_NaOH_StorageTnk1_LSH.Al...	Area_CHM_...	ABJ-AOS1	Application...	true	Alarm	000 00:00:17...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	500	ABJ_CHM_NaOH_StorageTnk2_LSH.Al...	Area_CHM_...	ABJ-AOS1	Application...	true	Alarm	000 00:00:17...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	500	ABJ_CHM_Fluor_Feeder01.StopFailAlarm	Area_CHM_...	ABJ-AOS1	Application...	true	Fail to STOP...	000 00:00:17...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	500	ABJ_CHM_NaOH_Feeder01.PSHAlarm	Area_CHM_...	ABJ-AOS1	Application...	Alarm	Sodium Hyd...	000 00:00:17...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP01.Polymer_System2_PS...	Area_Sludg...	ABJ-AOS1	Application...	true	Polymer Fault	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP02.Polymer_System2_PS...	Area_Sludg...	ABJ-AOS1	Application...	true	Polymer Fault	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP03.Polymer_System2_PS...	Area_Sludg...	ABJ-AOS1	Application...	true	Polymer Fault	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP01.Safety_Bypass_Active	Area_Sludg...	ABJ-AOS1	Application...	false	Safety Alarm	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP03.Safety_Bypass_Active	Area_Sludg...	ABJ-AOS1	Application...	false	Safety Alarm	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_SLG_BFP02.Safety_Bypass_Active	Area_Sludg...	ABJ-AOS1	Application...	false	Safety Alarm	000 00:00:30...	
29/08/2019 14:02:40	ACK_ALM	DSC	DSC	1	ABJ_FLT_North_Comb_Turb.Alarm_Ra...	Area_Clear...	ABJ-AOS1	Application...	true	Combined N...	000 00:00:56...	

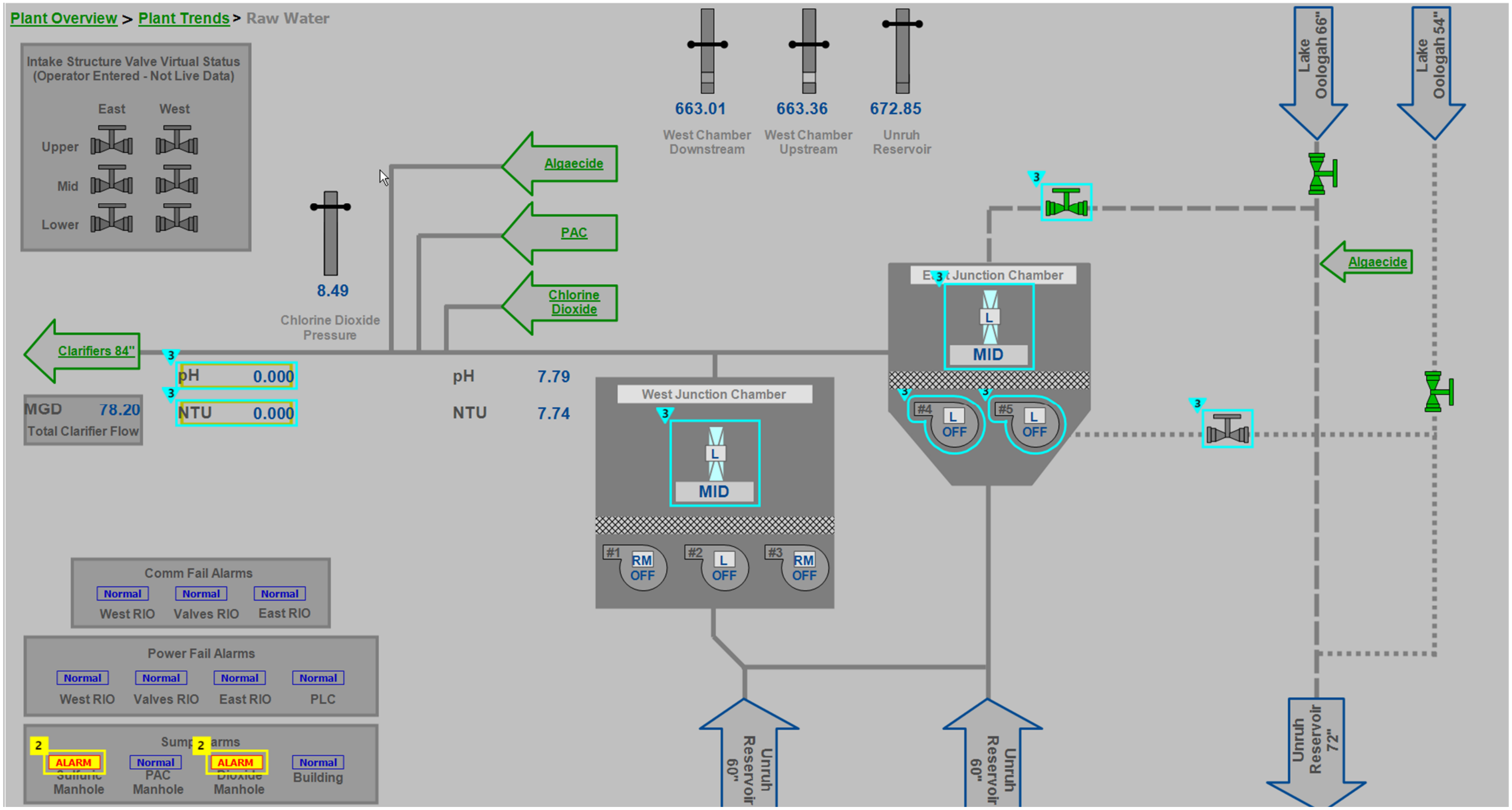
Network Overview



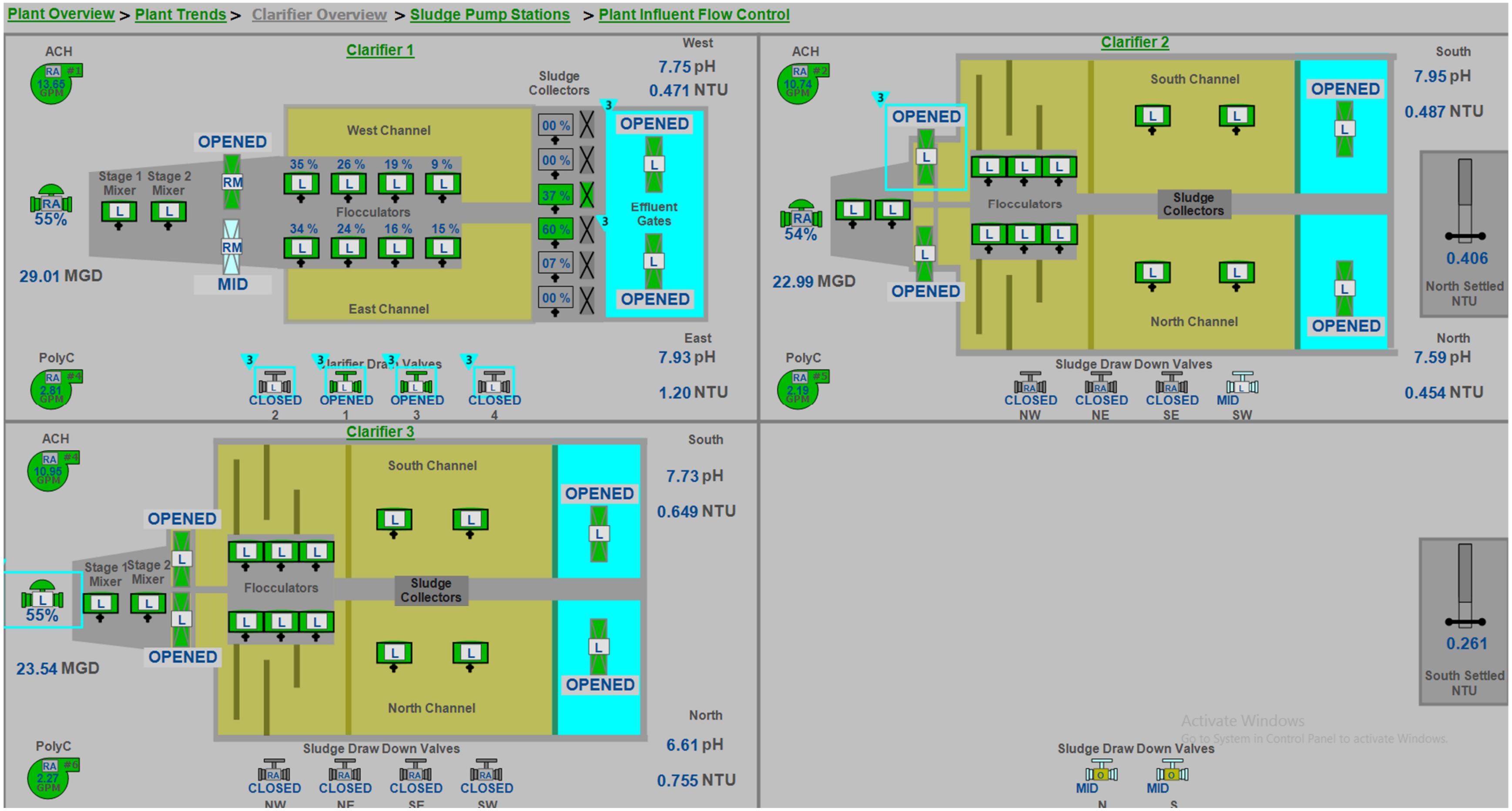
Redundant Engines



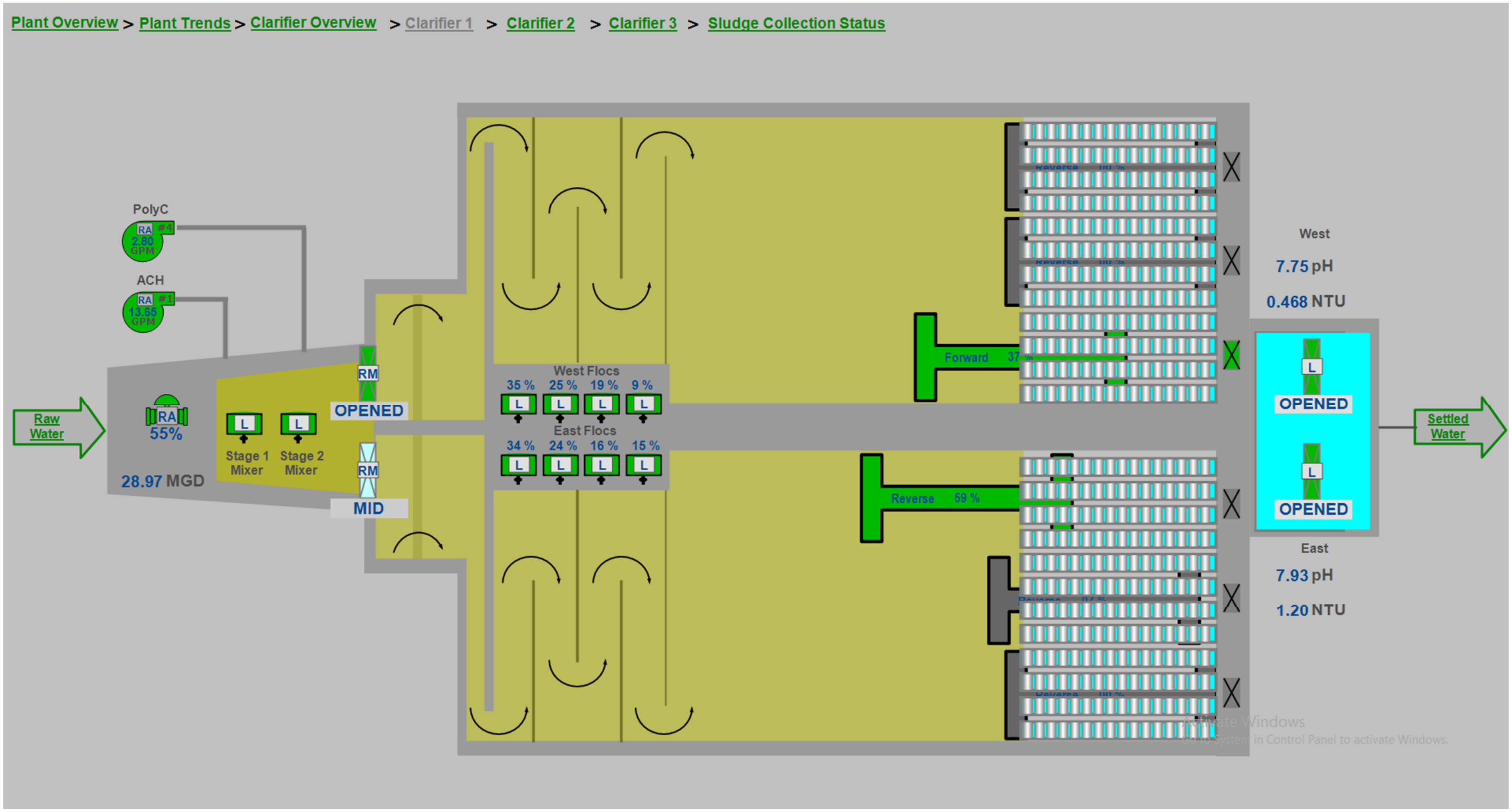
Raw Water Overview



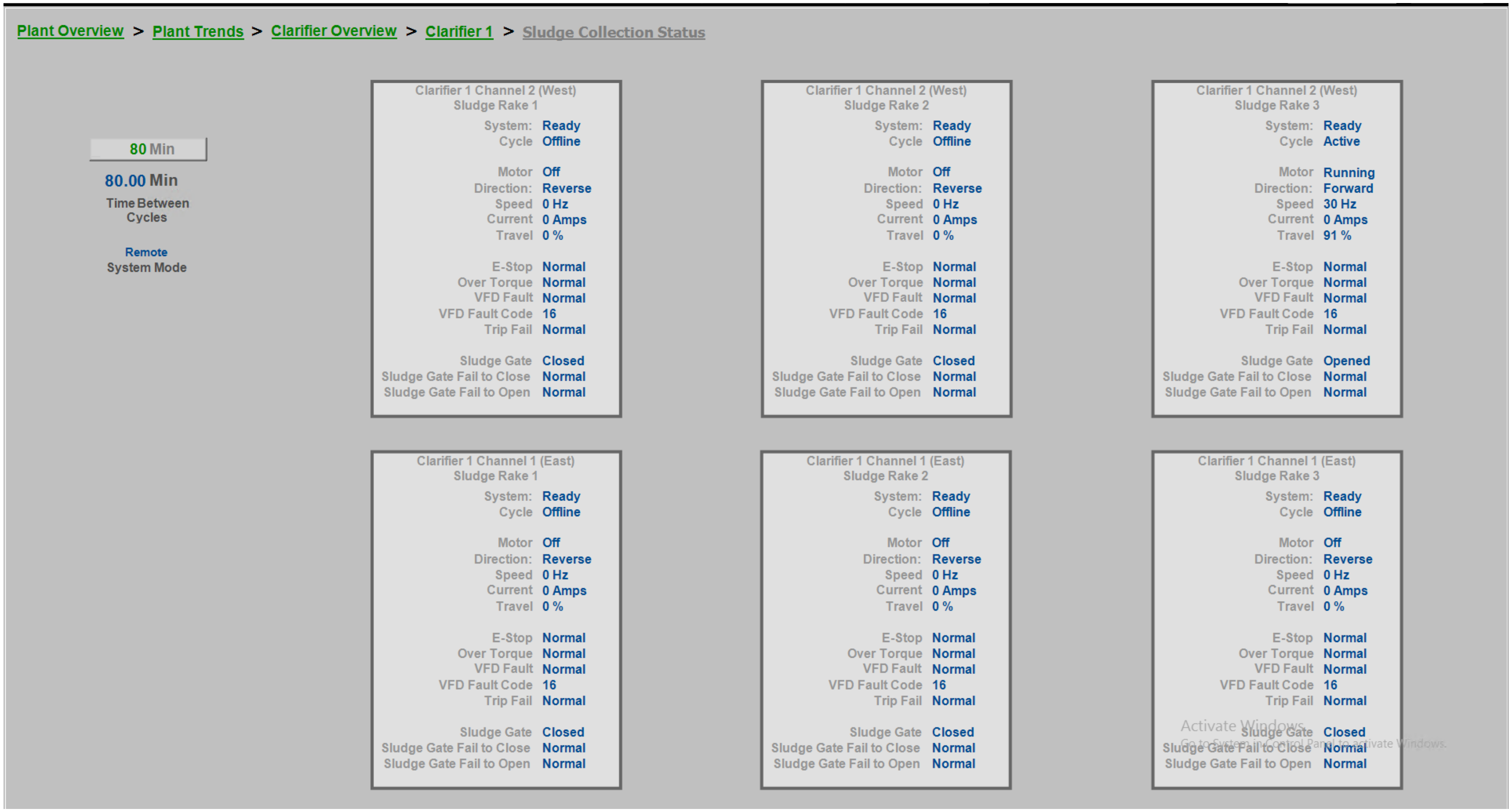
Clarifier Overview



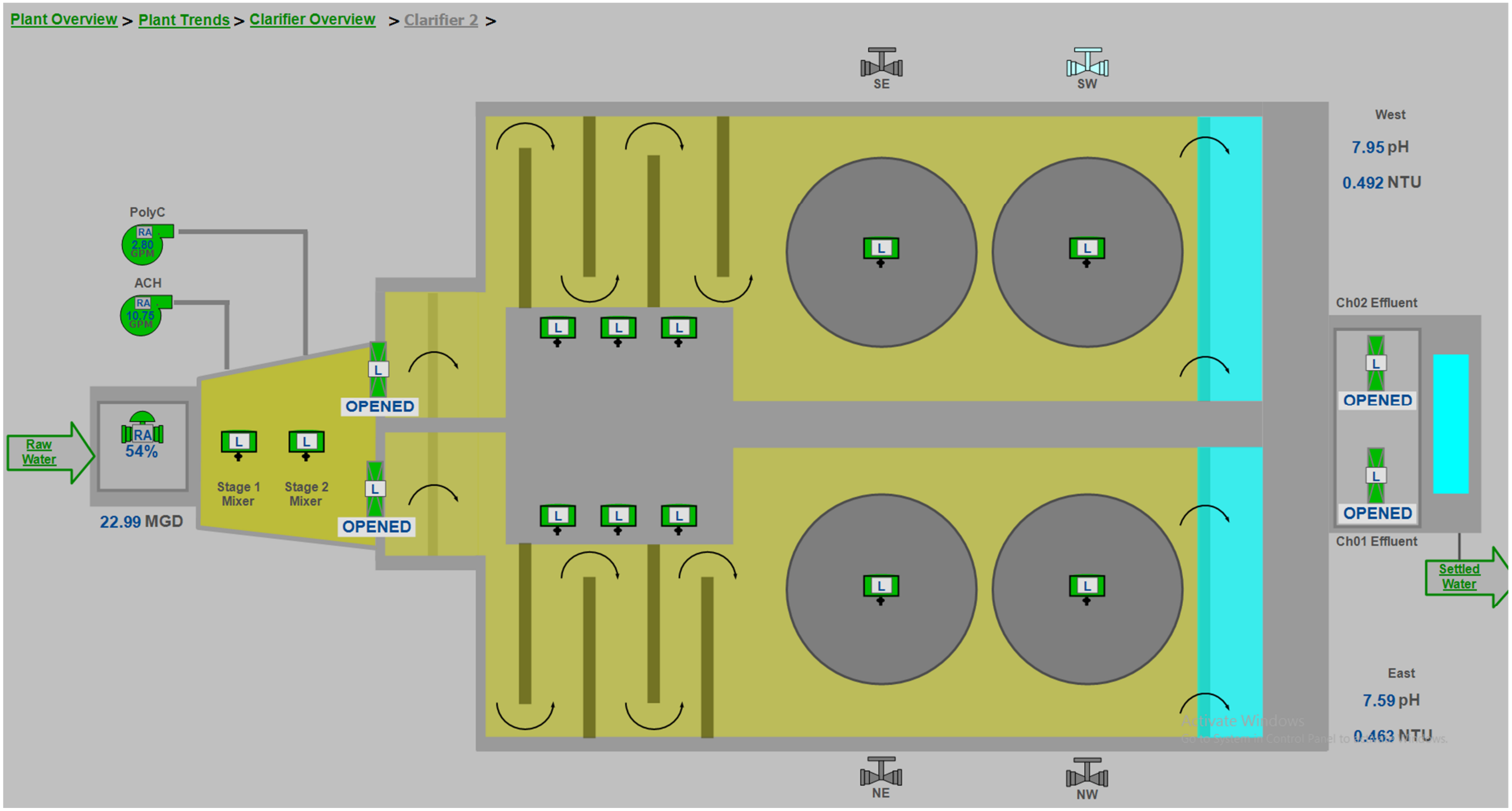
Clarifier 1 Detail



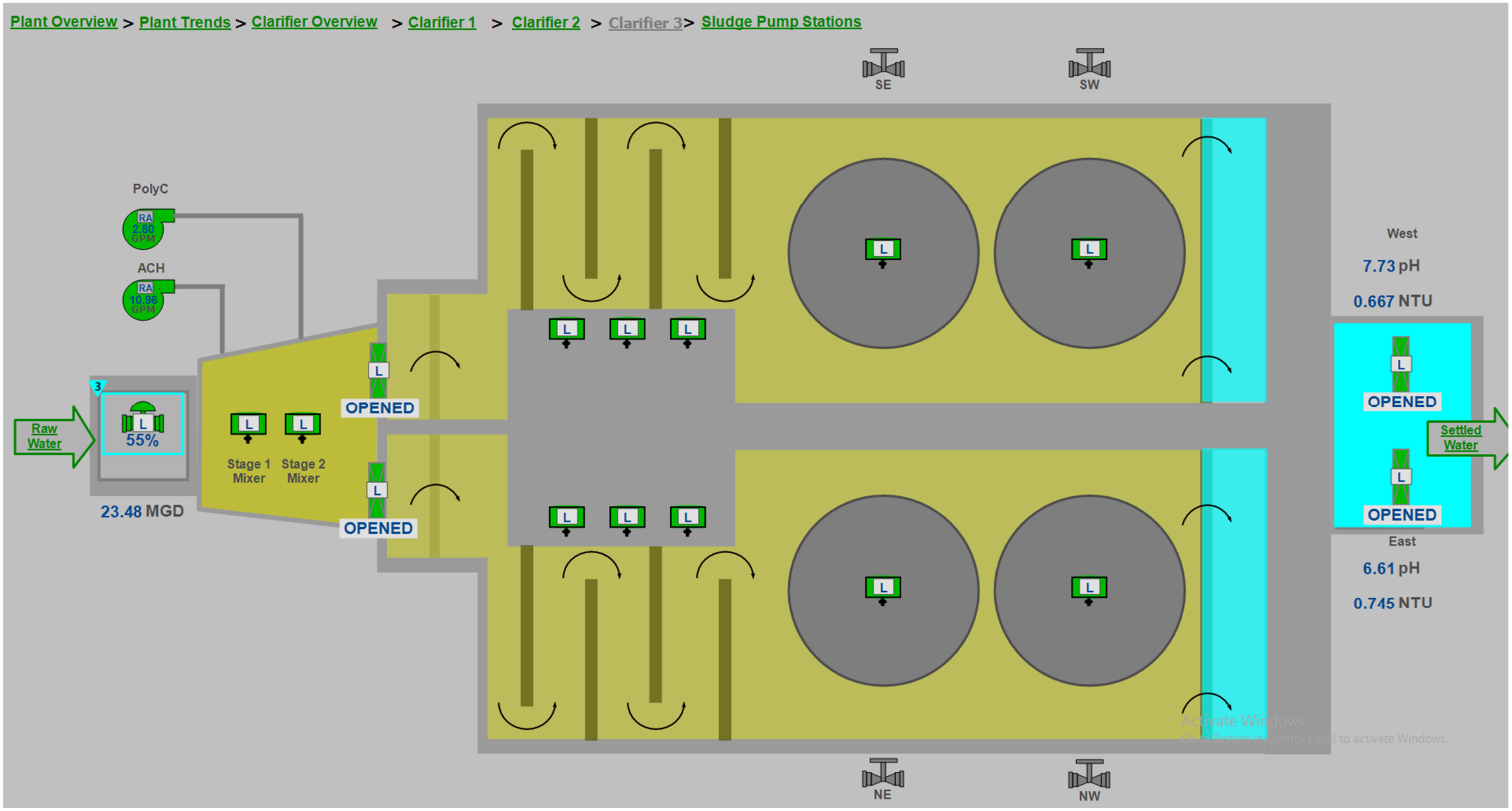
Sludge Collector Status



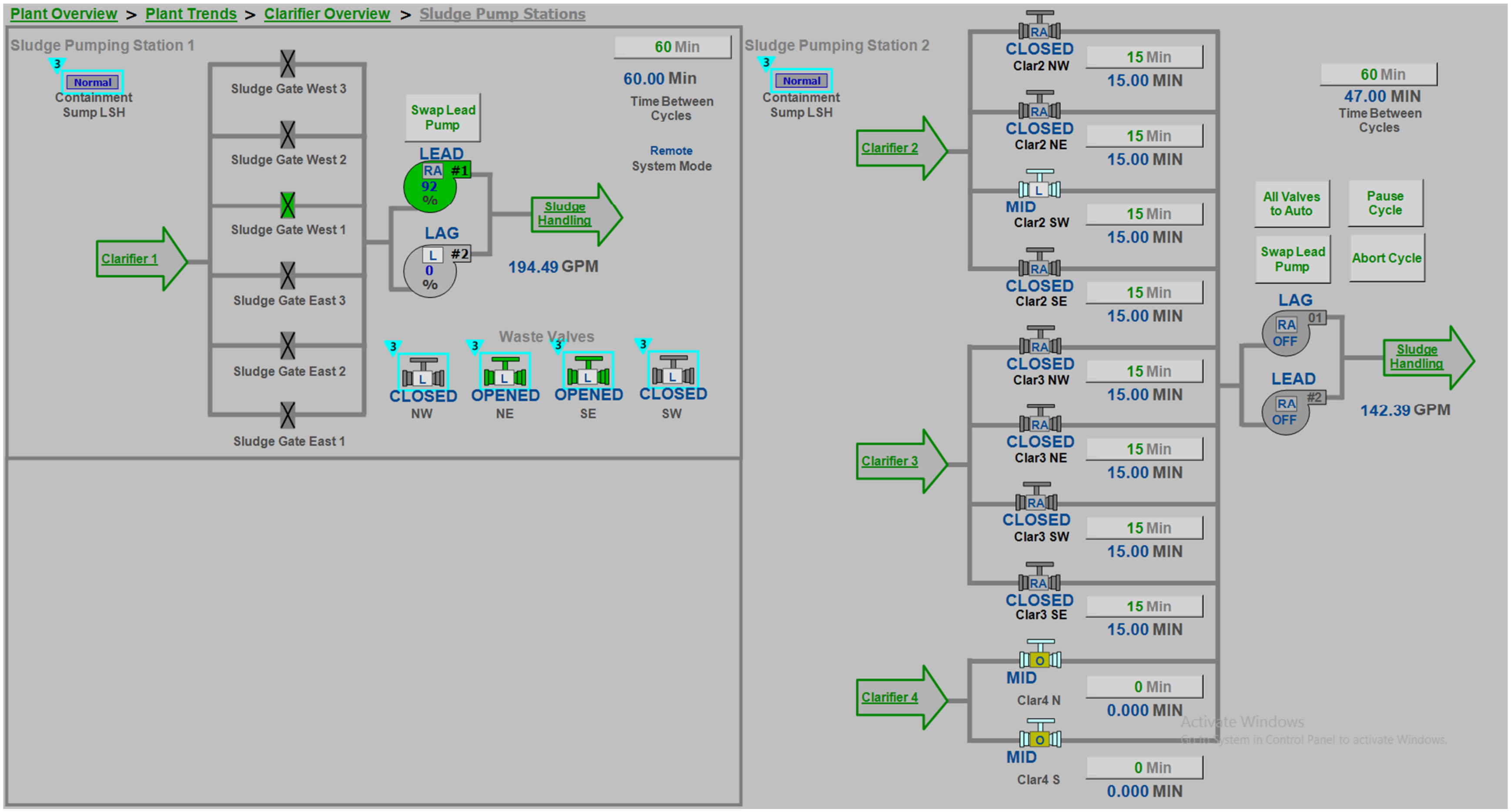
Clarifier 2 Detail



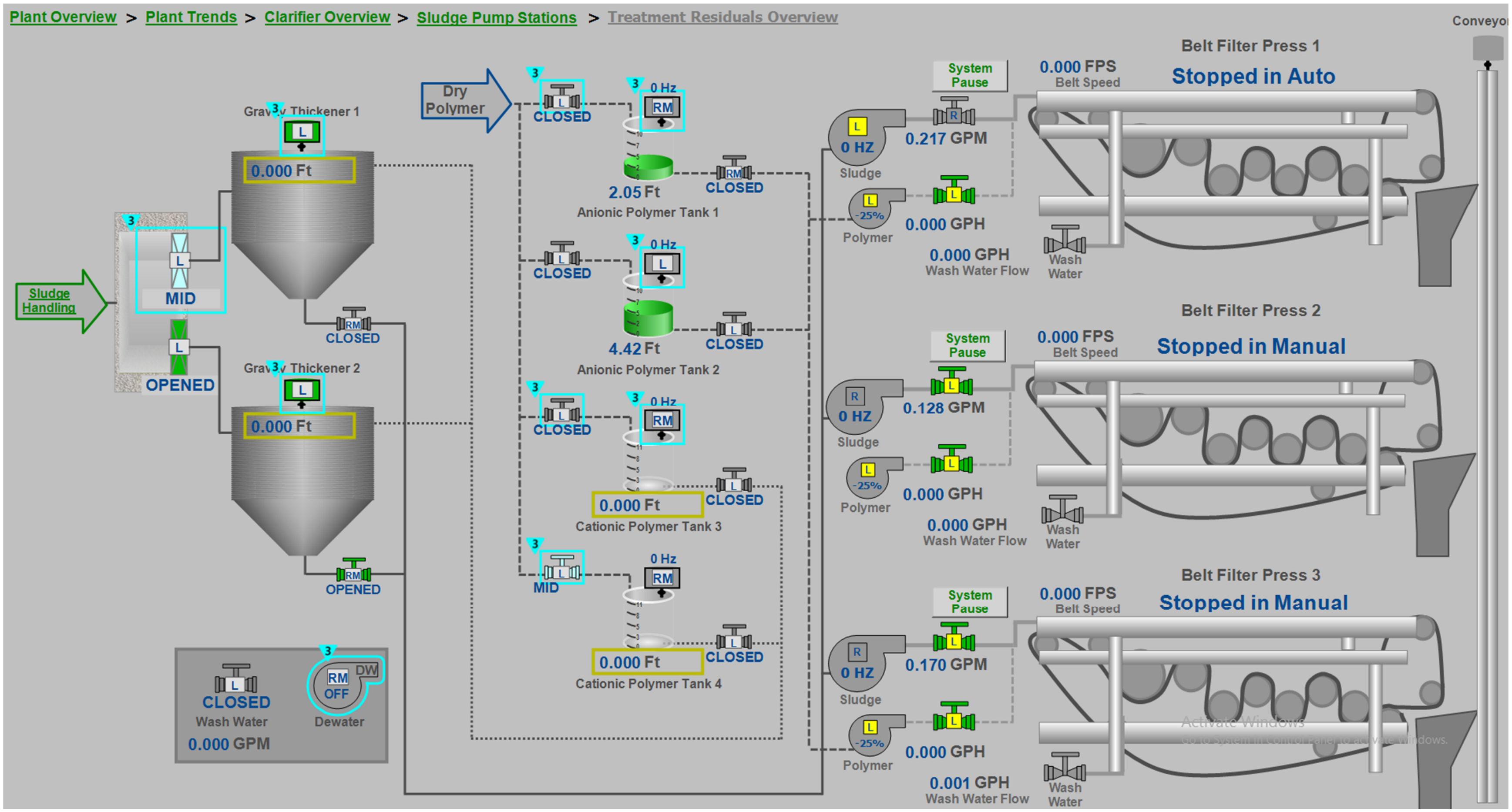
Clarifier 3 Detail



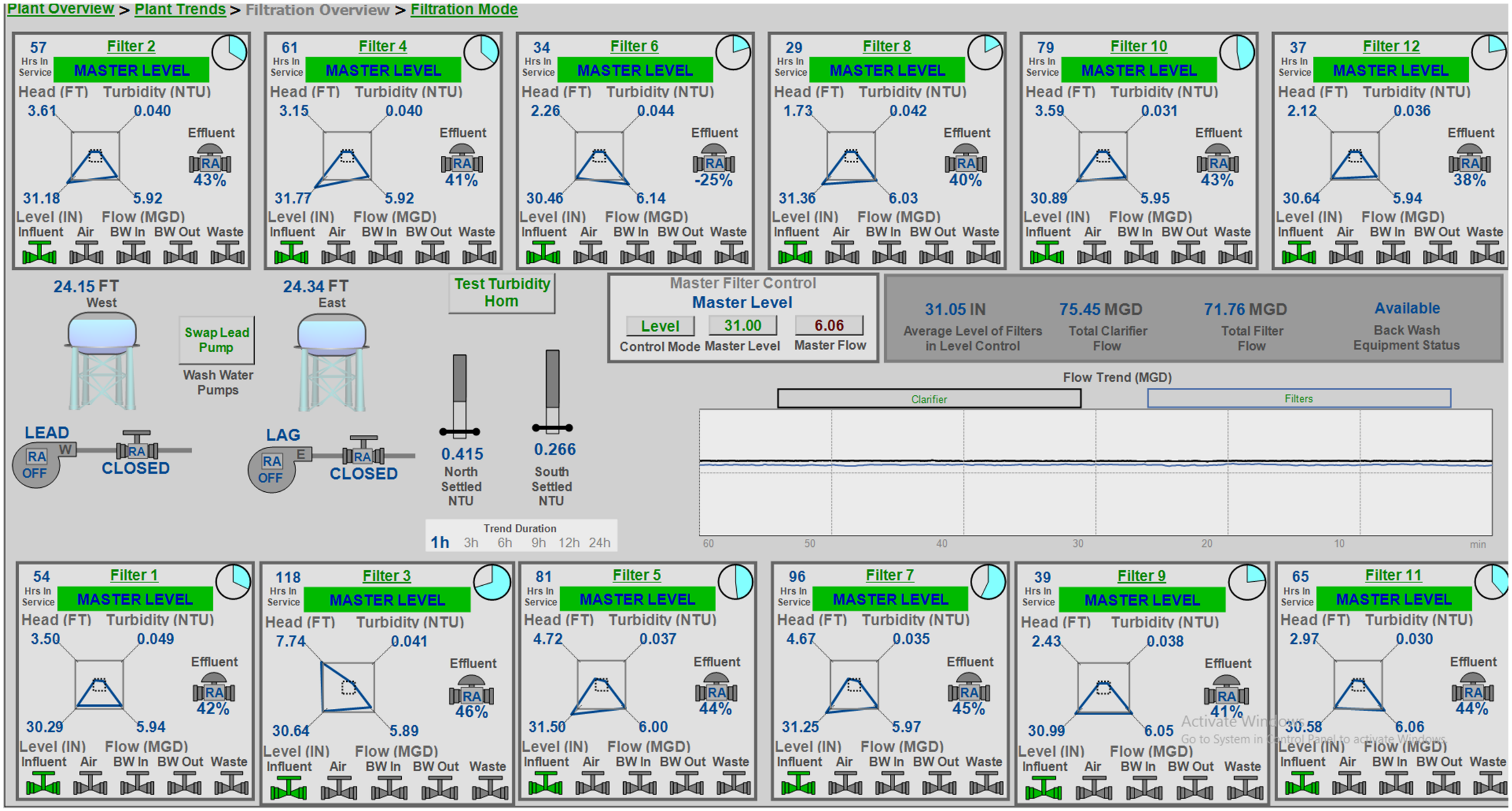
Sludge Pump Stations Overview



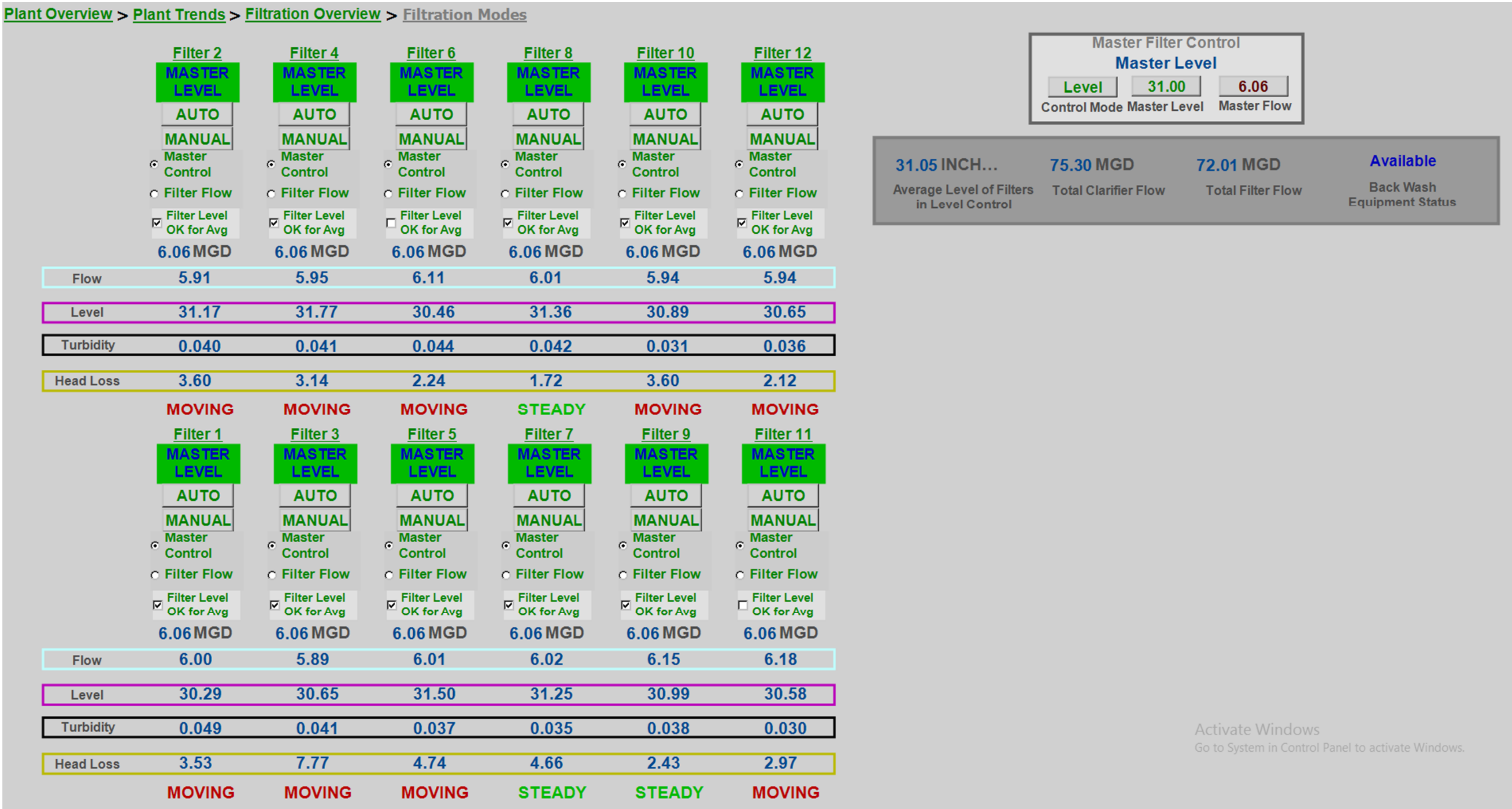
Treatment Residuals Overview



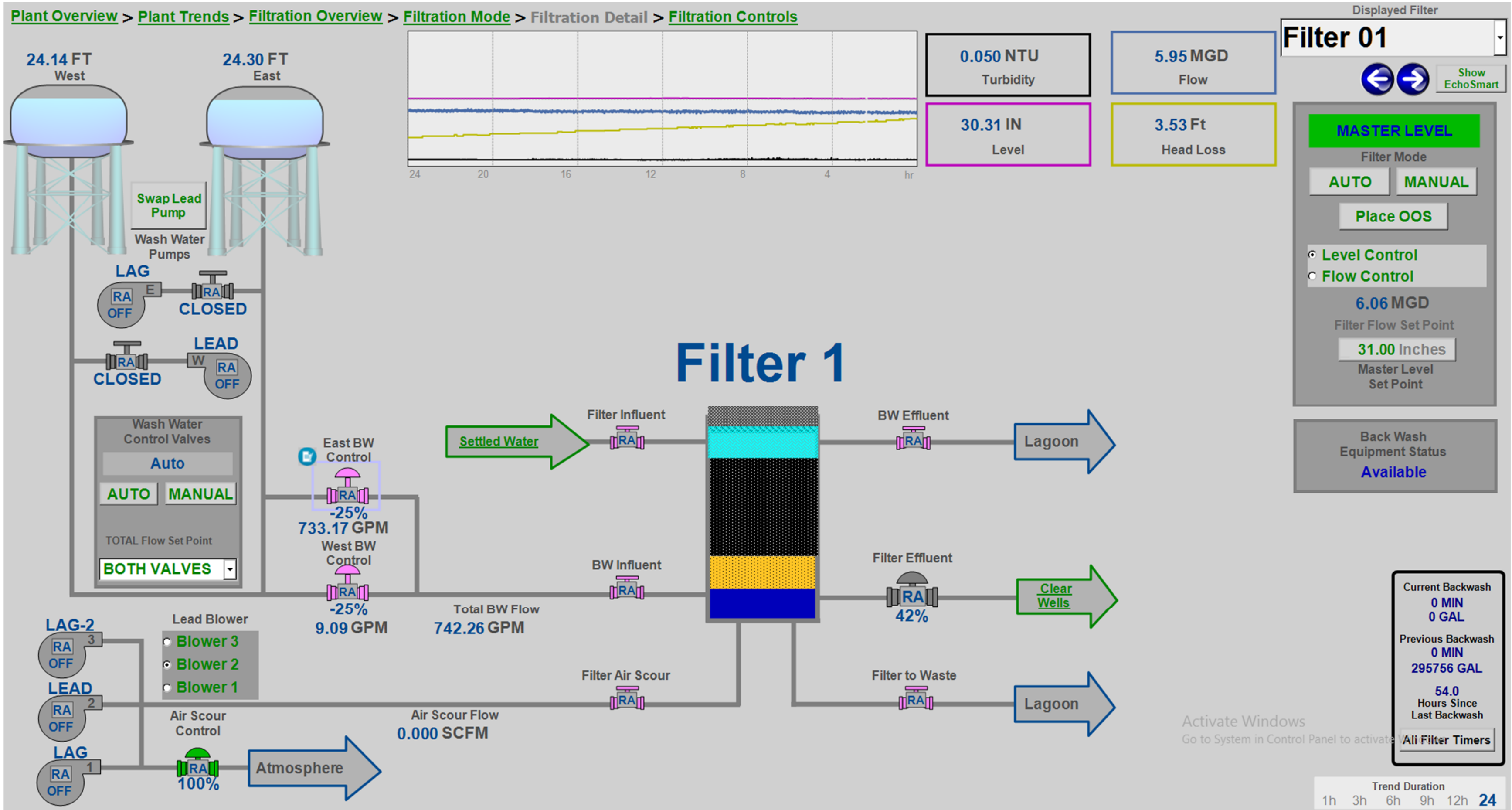
Filtration Overview



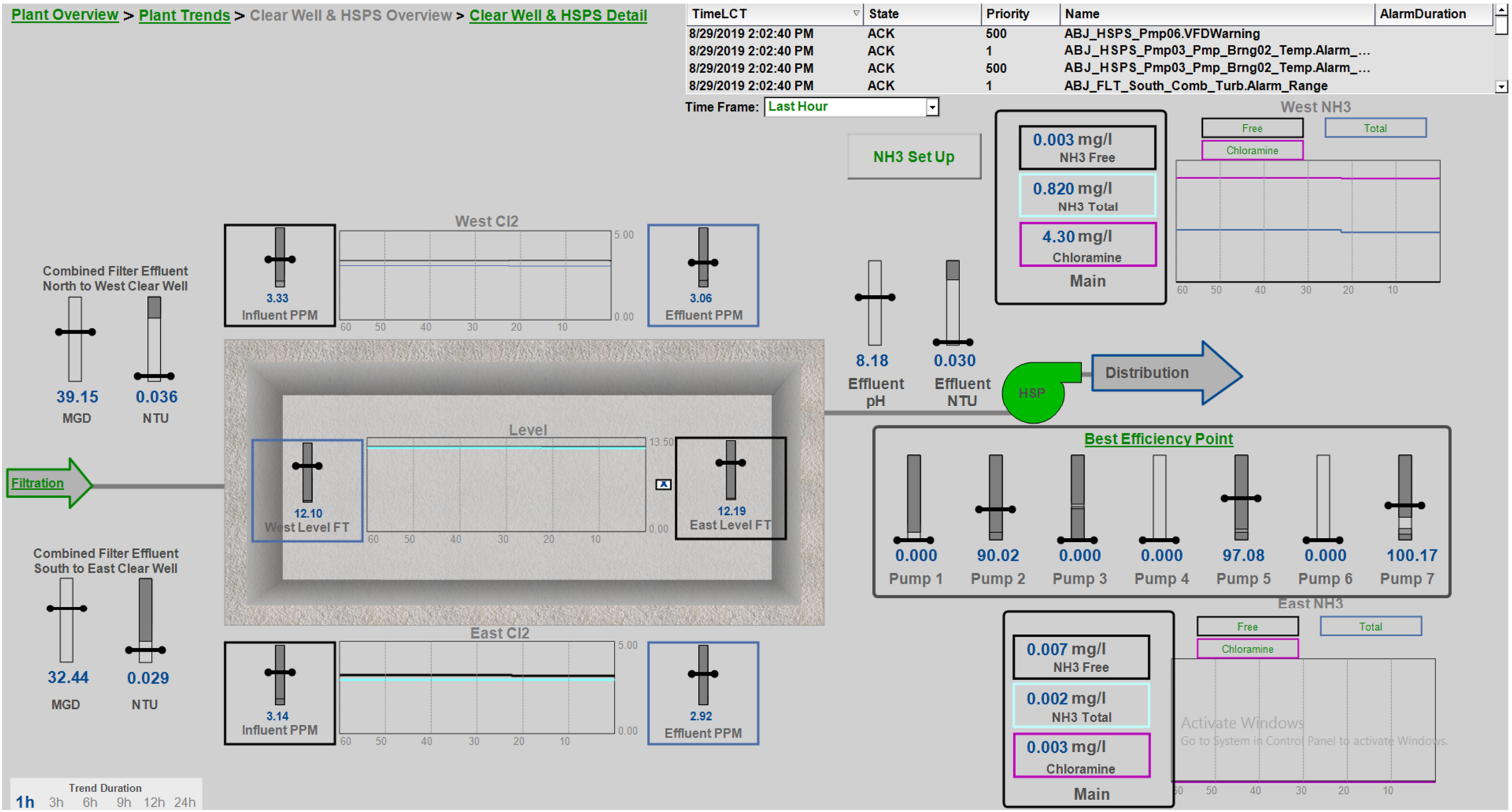
Filtration Modes



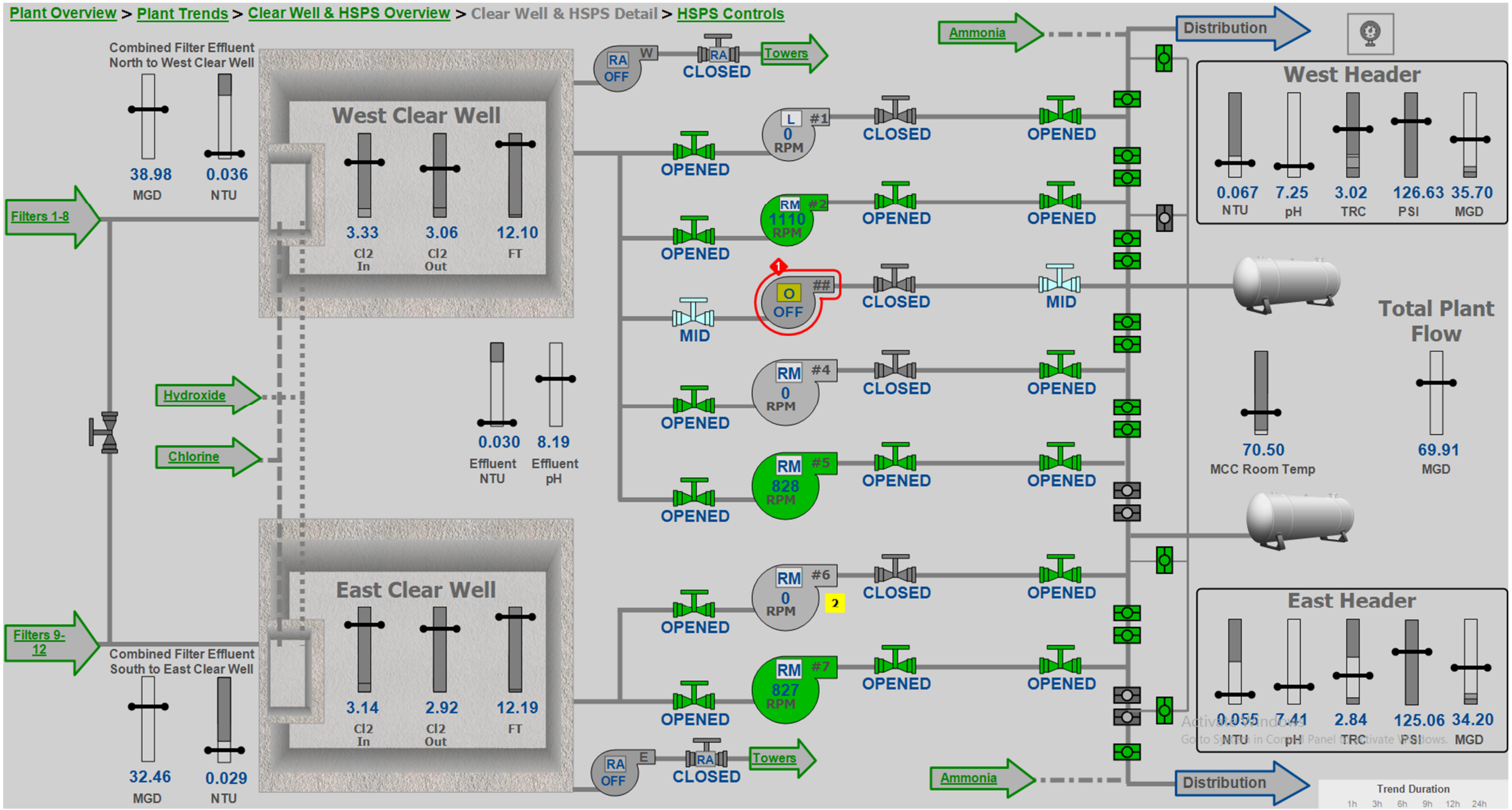
Filtration 1 Detail (Typical)



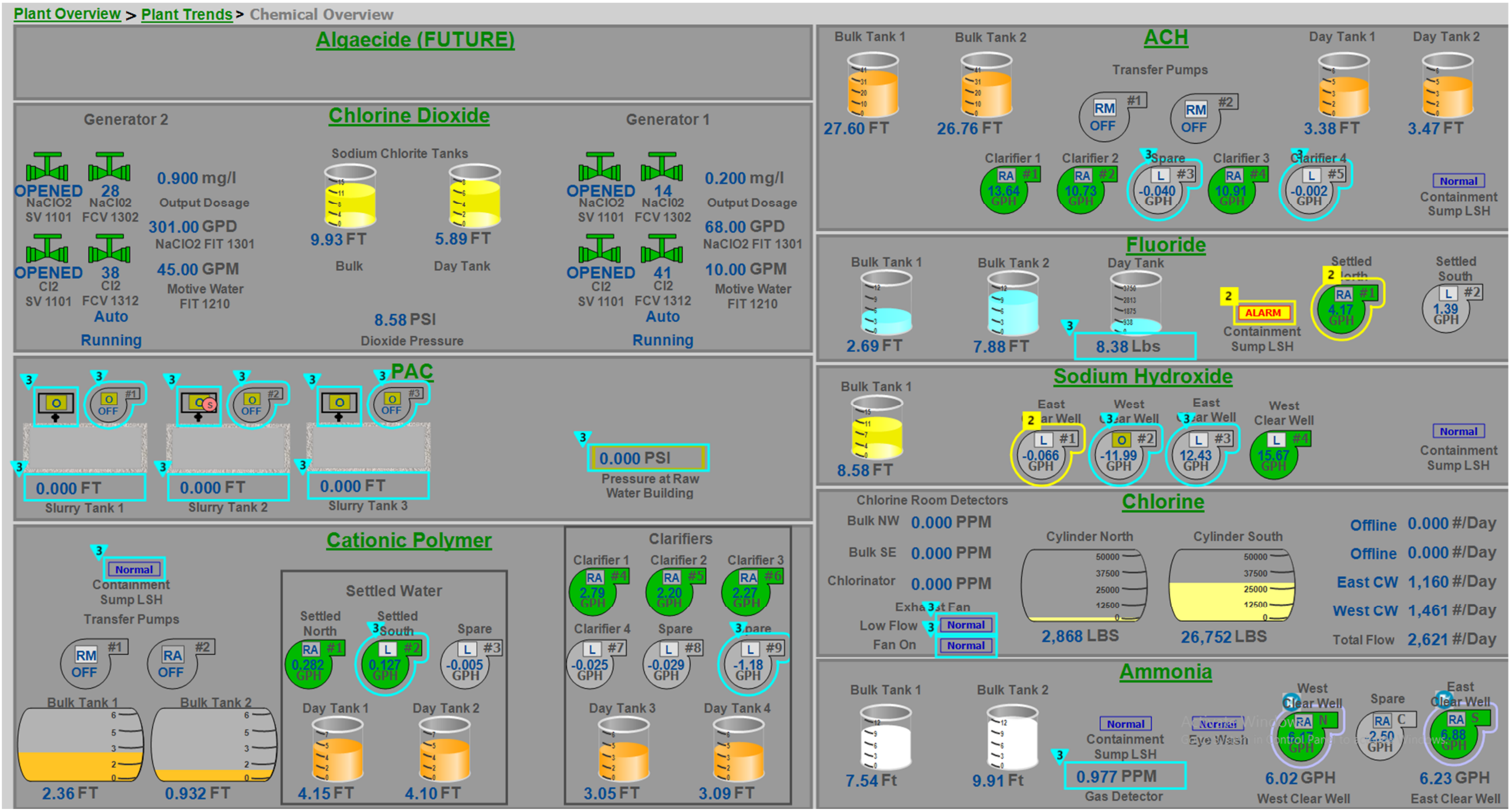
Clear Well and HSPS Overview



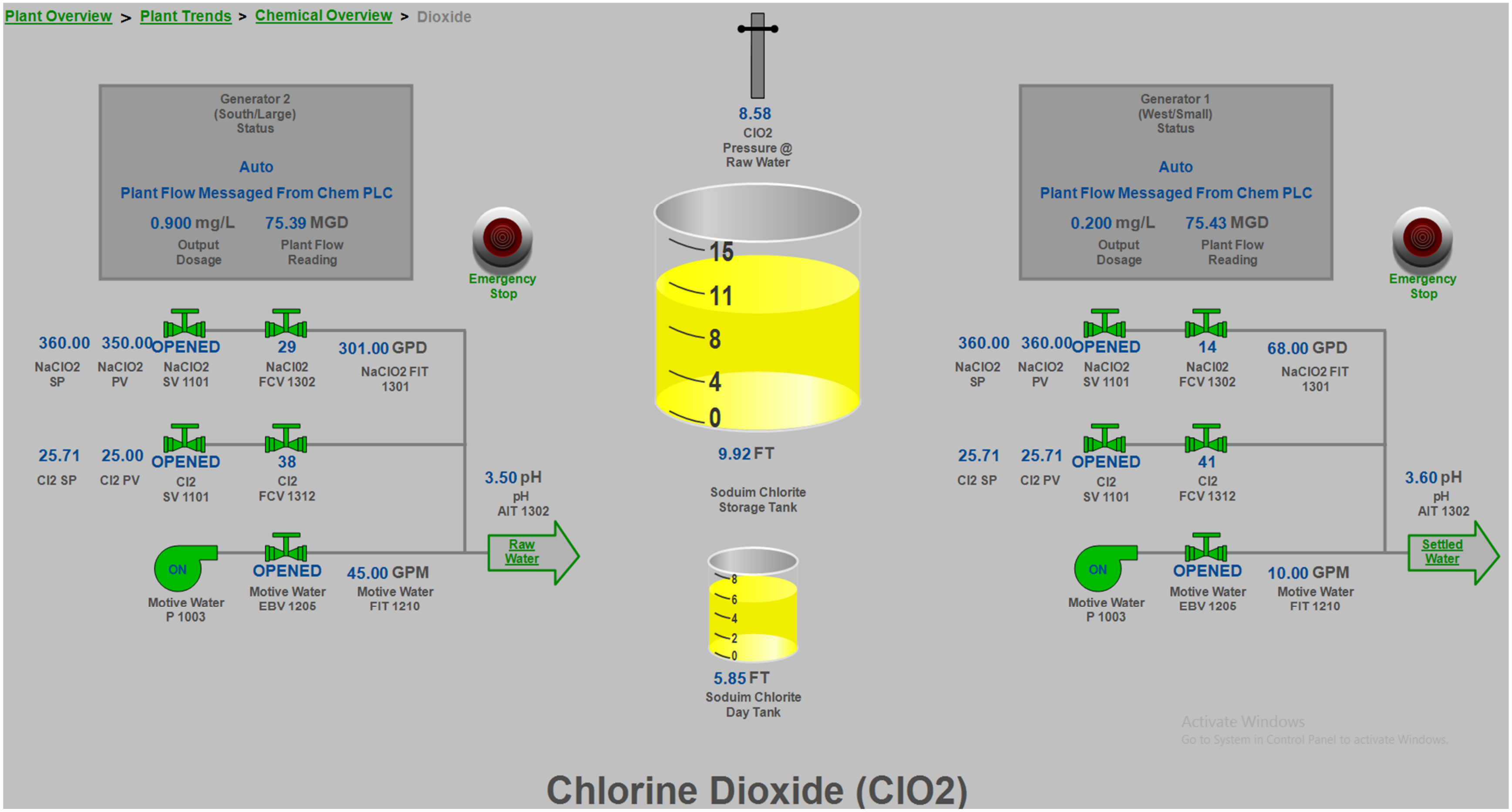
Clear Well and HSPS Detail



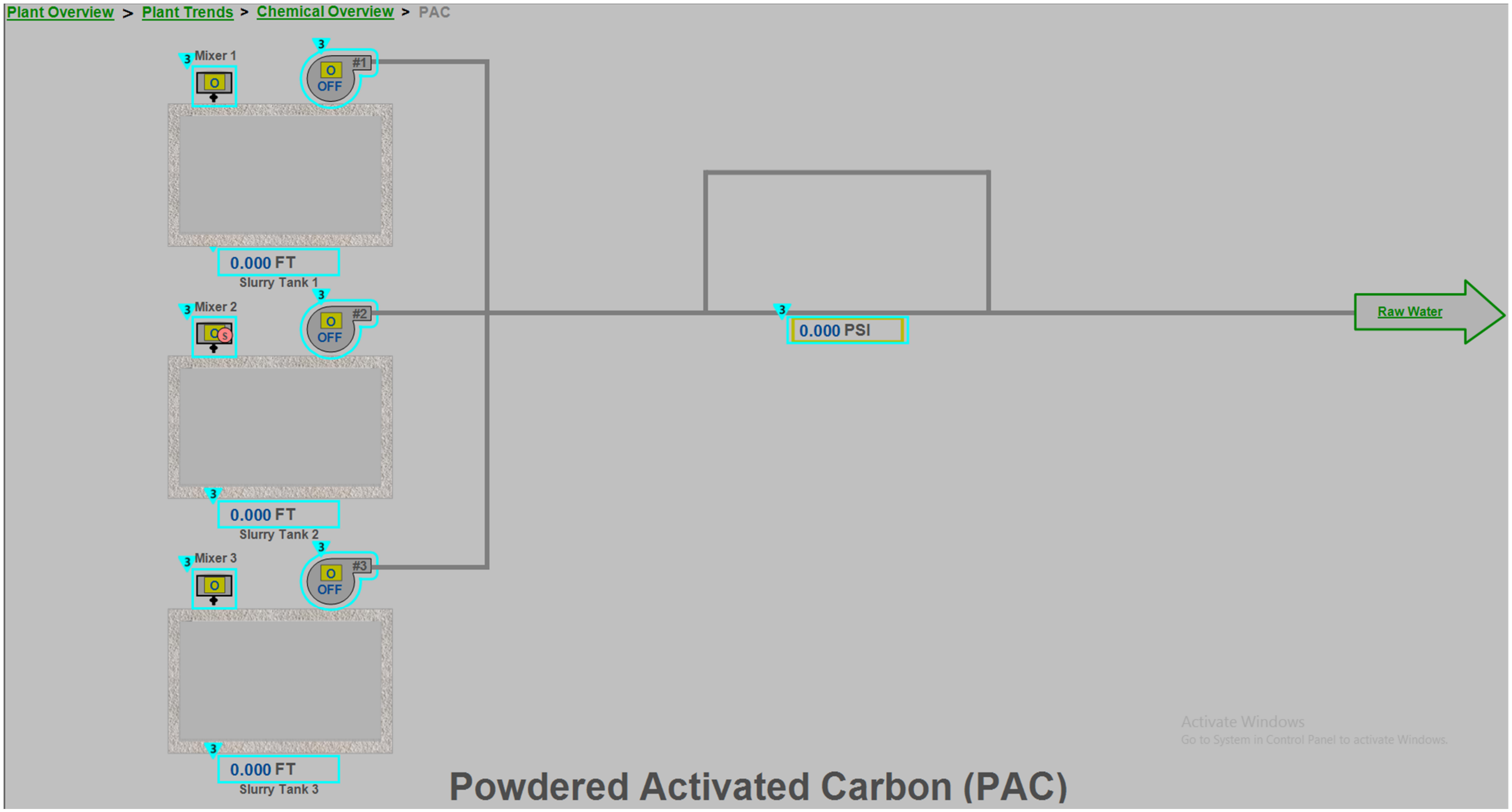
Chemical Overview



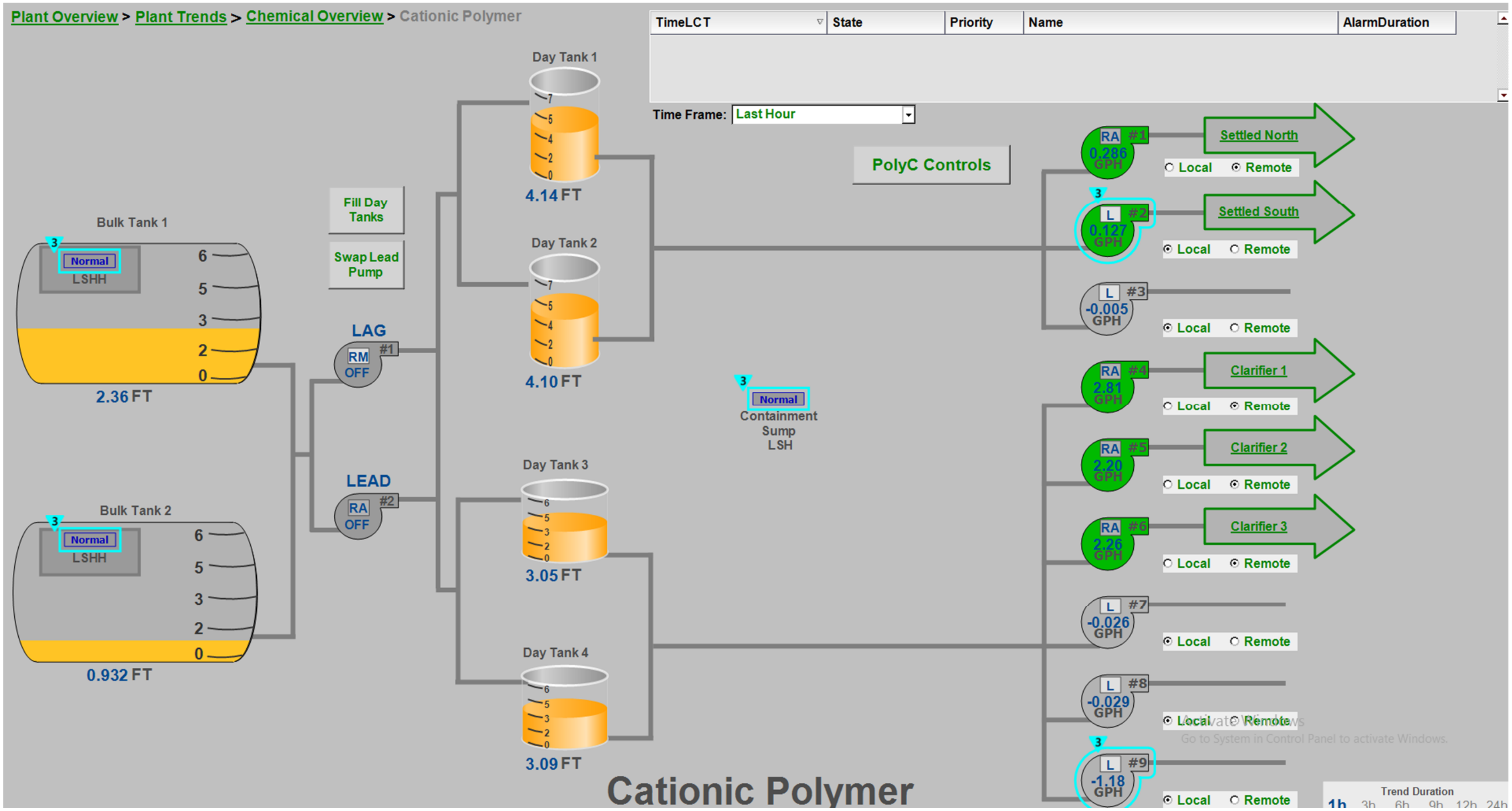
Chlorine Dioxide Detail



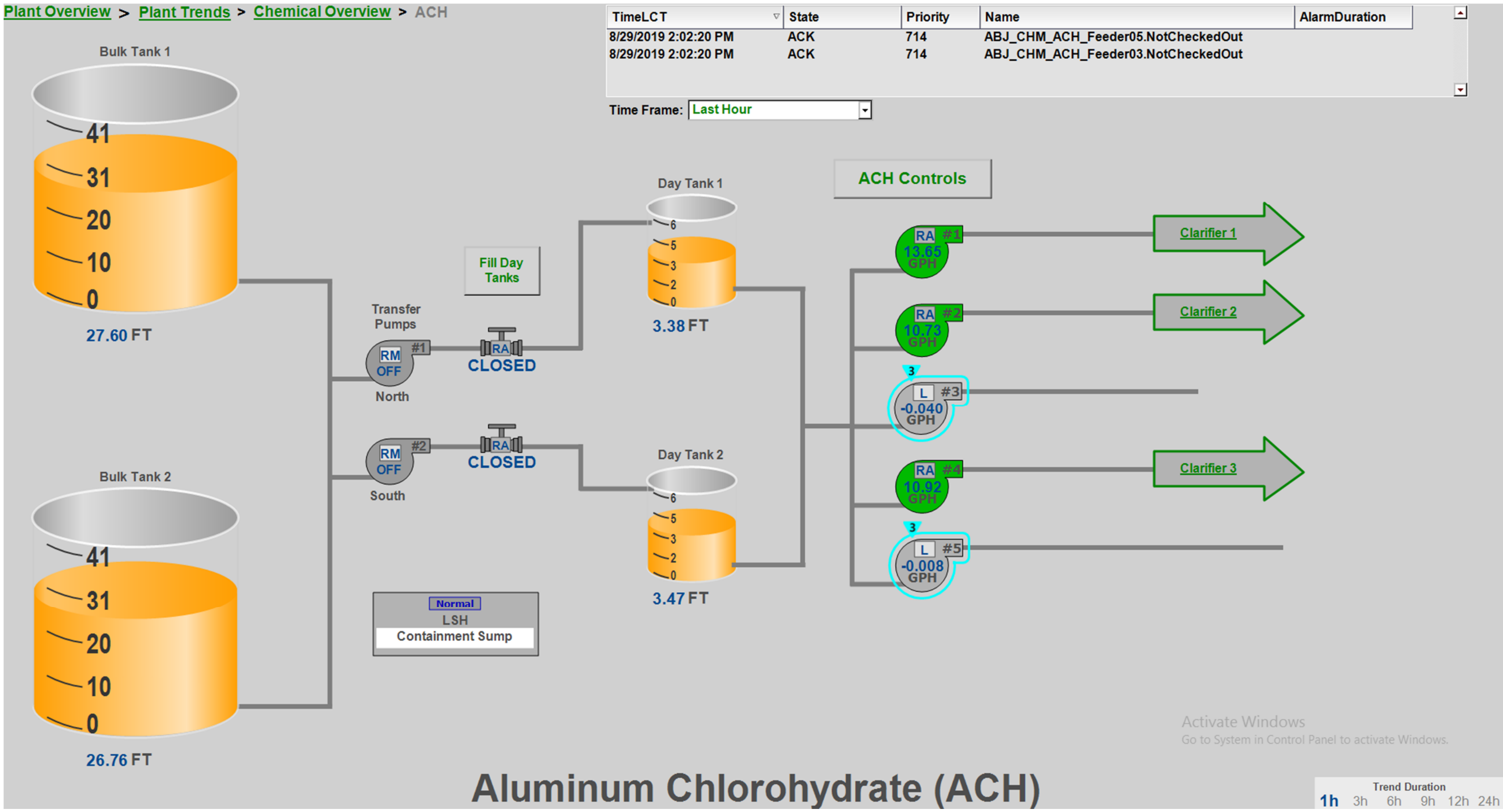
Powdered Activated Carbon Detail



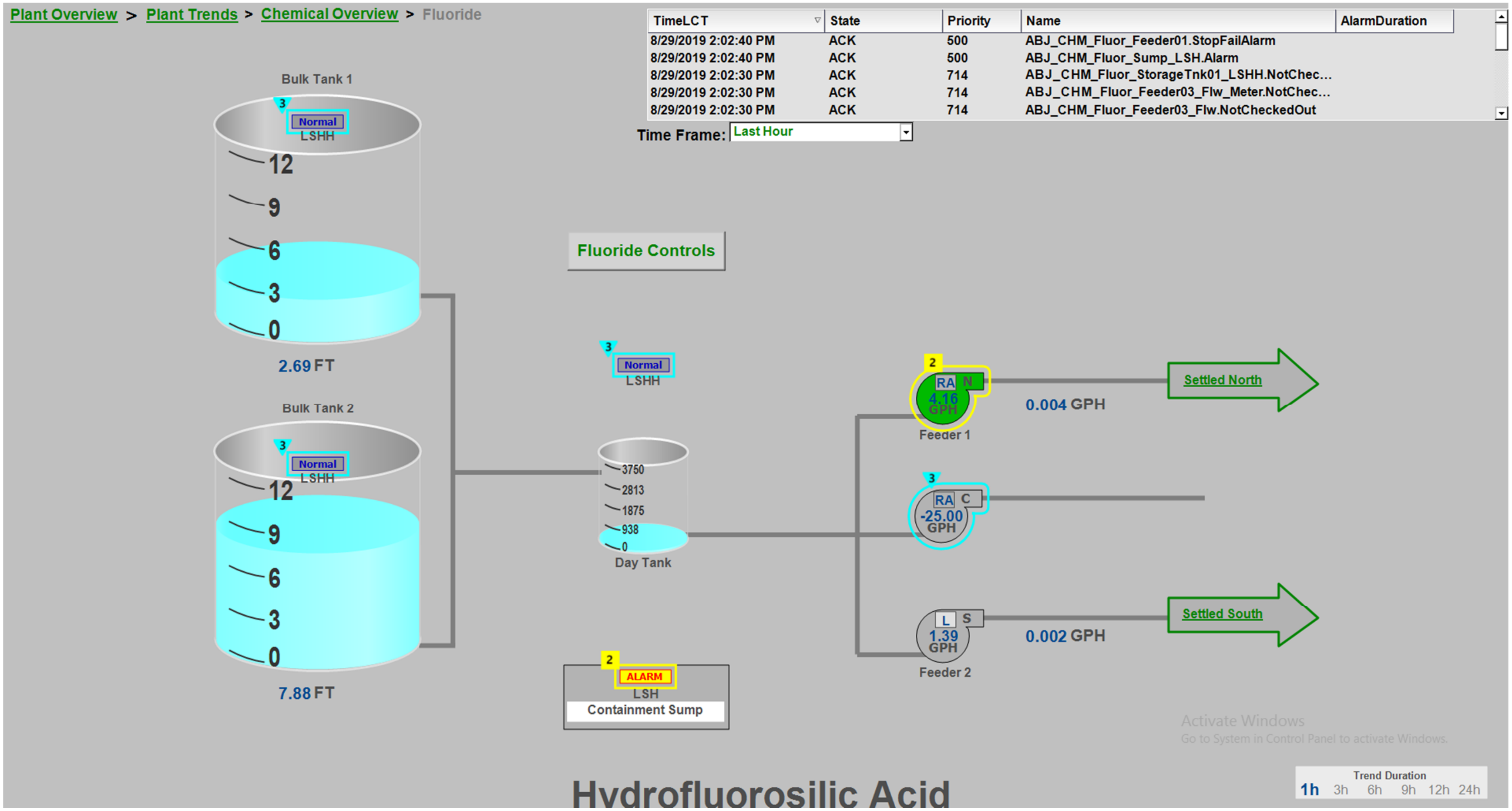
Cationic Polymer Detail



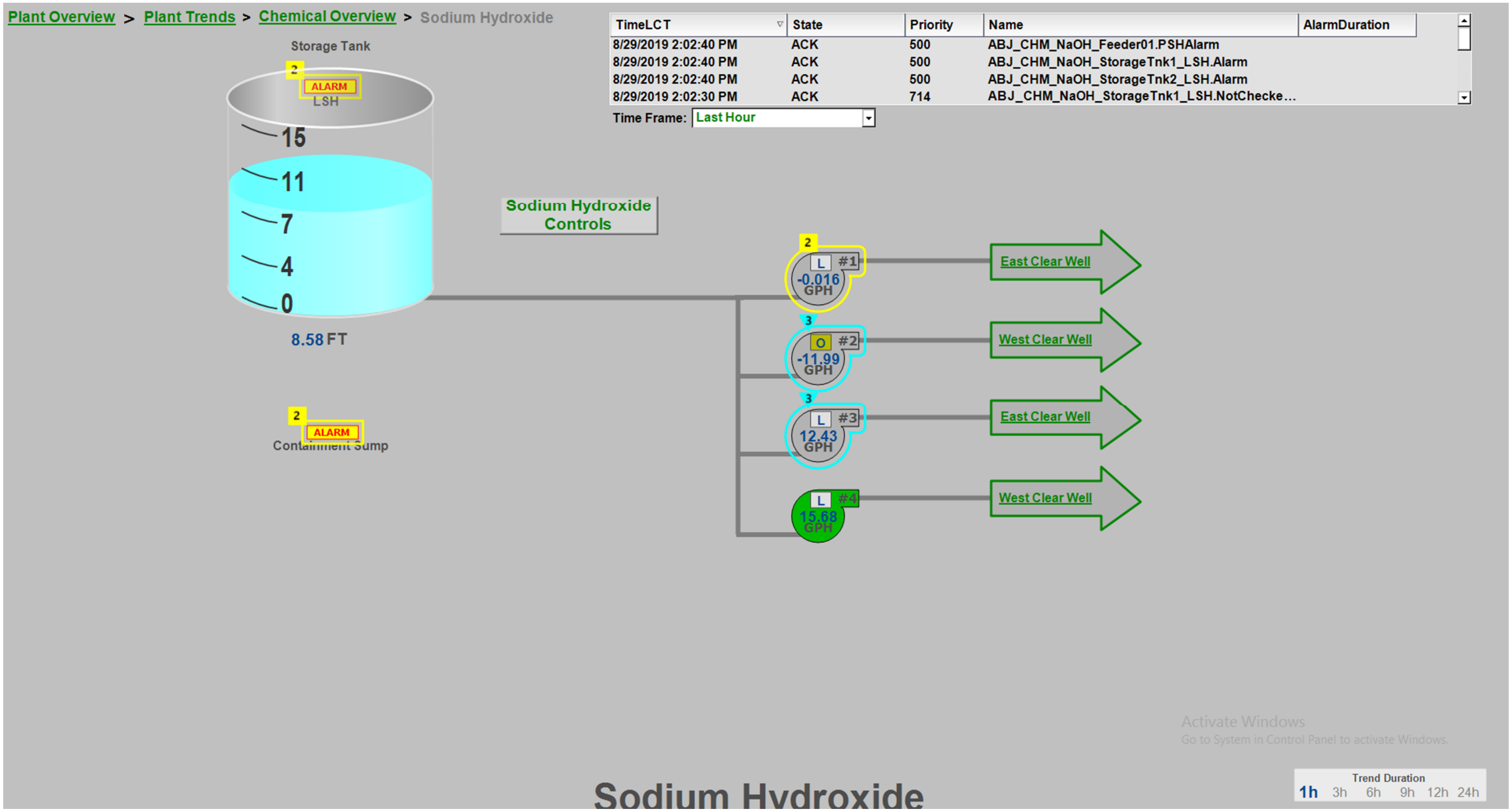
Aluminum Chlorohydrate Detail



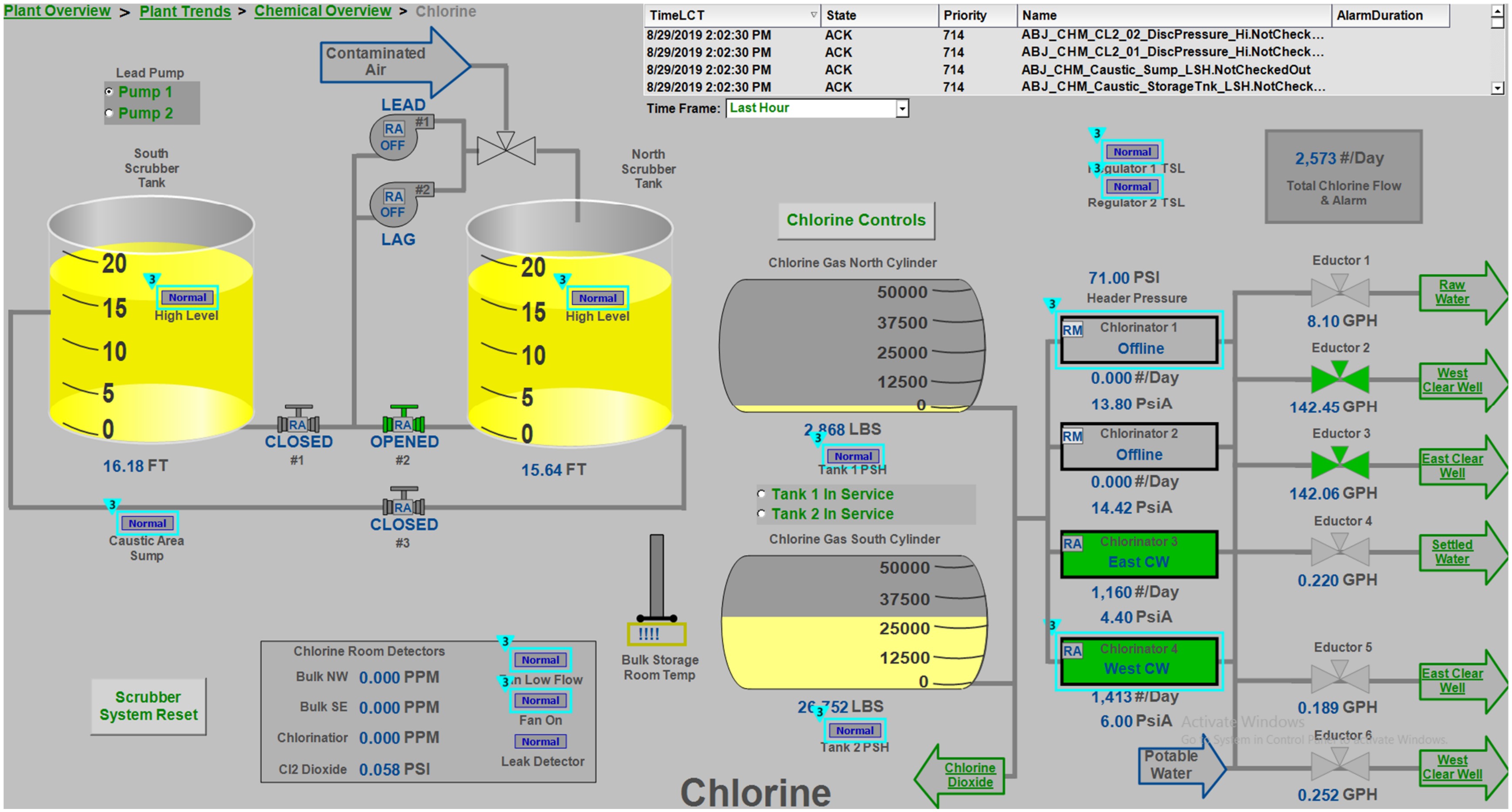
Fluoride Detail



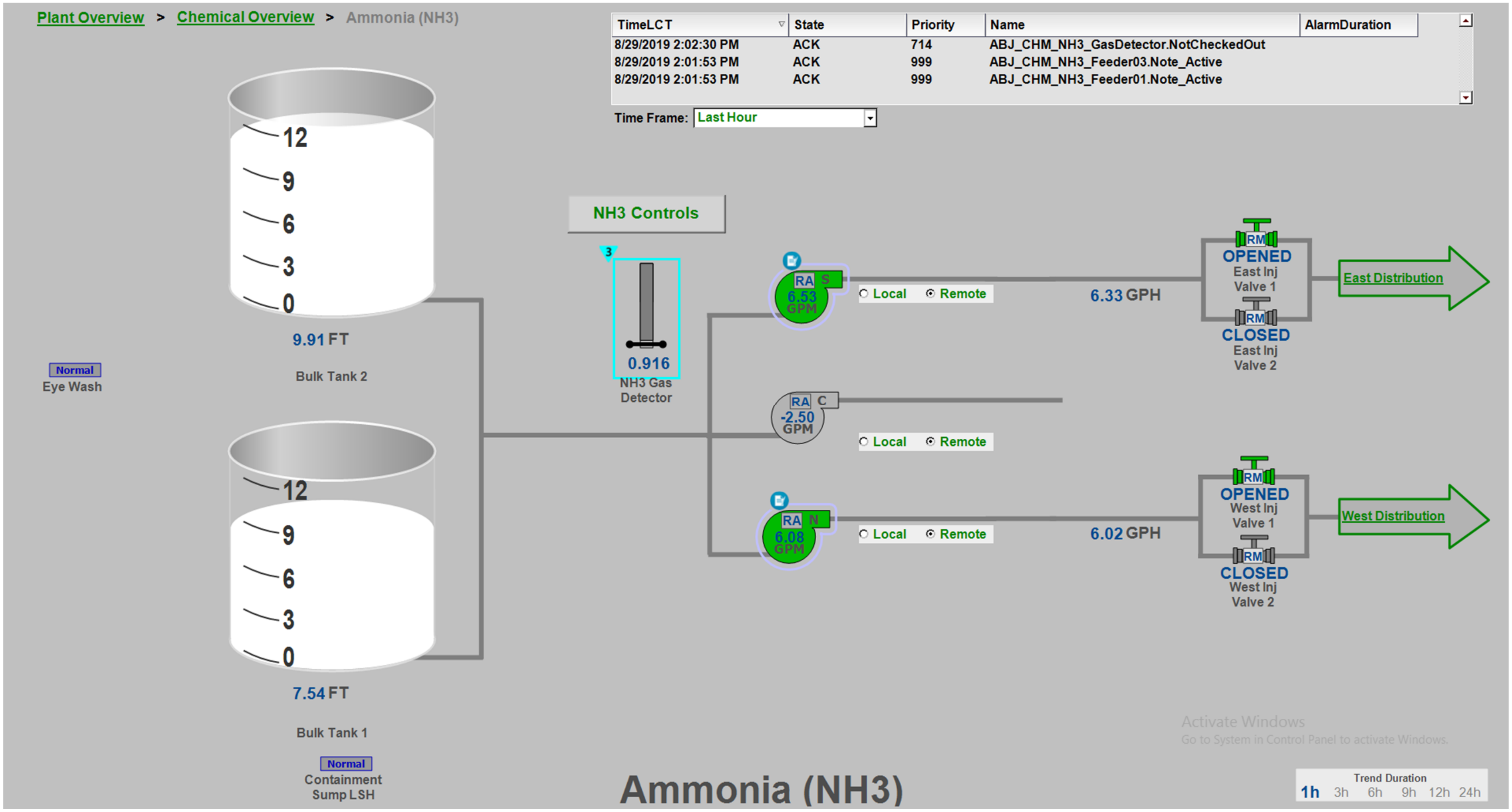
Sodium Hydroxide Detail



Chlorine Detail



Ammonia Detail



Recovered Water Overview