QUEENSLAND URBAN UTILITIES

Bundamba Sewage Treatment Plant

Functional Specification
Final Effluent Disinfection System

Client
QUU

Document No
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REVISION H

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Associated Documents

Document ID	Description
BEG709-B-DWG-001	P&ID - Legend and Drawing Index
BEG709-B-DWG-002	P&ID - Chemical Storage and Dosing
BEG709-B-DWG-003	P&ID - Chlorine Contact Tank
14286-DS-001	Chlorine Dosing Functional Specification Chart
14286-DS-002	High Flow Chlorine Dosing Setpoint Signal Flow Diagram
14286-DS-003	Low Flow Chlorine Dosing Setpoint Signal Flow Diagram
486/5/5-0158-001	P&ID - Legend and Drawing Index
486/5/5-0158-002	P&ID - Chemical Storage and Dosing Building - Existing
486/5/5-0158-003	P&ID - Chlorine Contact Tank - Existing
486/5/5-0157-002	P&ID - Chemical Storage and Dosing Building - Proposed
486/5/5-0157-003	P&ID - Chlorine Contact Tank - Proposed
BEG709-S-DWG-001 to 020	General Structure Drawings
BEG709-M-DWG-001	Proposed V-notch Weir Plates
BEG709-E-DWG-001	Single Line Diagram
02202701-002-02 to 041-41	Electrical Drawings
320026-DF-002-0	SCADA Manual

Table of Contents

1 INTRODUCTION

This document provides a detailed description of the Control System for the Bundamba Waste Water Treatment Plant's Reclaimed Effluent and Chlorine Contact Tank Dosing.

2 Equipment & Instrument List

The following components of the Chlorine Dosing System interface with the Chlorine Dosing PLC for monitoring and control.

2.1 *Major Equipment List*

TAG	DESCRIPTION	TYPE	MAKE & MODEL
PU0710_010	Hypochlorite Dosing Pump 1 – Chlorine Contact Tank 1 - High Flow 1	Metering Pump	Grundfos Aldos - DME375
PU0710_011	Hypochlorite Dosing Pump 2 – Chlorine Contact Tank 1 - High Flow 2	Metering Pump	Grundfos Aldos - DME375
PU0710_007	Hypochlorite Dosing Pump 3 – Chlorine Contact Tank 1 - Low Flow 1	Metering Pump	Grundfos Aldos - DDI60
PU0710_008	Hypochlorite Dosing Pump 4 – Chlorine Contact Tank 1 or 2 - Low Flow 2	Metering Pump	Grundfos Aldos - DDI60
PU0710_009	Hypochlorite Dosing Pump 5 – Chlorine Contact Tank 2 - Low Flow 3	Metering Pump	Grundfos Aldos - DDI60
PU0710_012	Hypochlorite Dosing Pump 6 – Chlorine Contact Tank 2 - High Flow 1	Metering Pump	Grundfos Aldos - DME375
PU0710_013	Hypochlorite Dosing Pump 7 – Chlorine Contact Tank 2 - High Flow 2	Metering Pump	Grundfos Aldos - DME375
PU0710_001	Chlorine Contact Tank 1 Recirculation Pump 1	DOL	Centrifugal Pump (aprox 33L/s)
PU0710_002	Chlorine Contact Tank 1 Recirculation Pump 2	DOL	Centrifugal Pump (aprox 33L/s)
PU0710_003	Chlorine Contact Tank 2 Recirculation Pump 1	DOL	Centrifugal Pump (aprox 33L/s)
PU0710_004	Chlorine Contact Tank 2 Recirculation Pump 2	DOL	Centrifugal Pump (aprox 33L/s)
PU0710_005	Chlorine Contact Tanks Feed Pump 1	DOL	Centrifugal Pump (aprox 40 L/s)
PU0710_006	Chlorine Contact Tanks Feed Pump 2	DOL	Centrifugal Pump (aprox 40 L/s)
SV3700_412	Valve from Hypochlorite Dosing Pump 4 to CCT1	Actuated Valve	George Fisher – EA11
SV3700_423	Valve from Hypochlorite Dosing Pump 4 to CCT2	Actuated Valve	George Fisher – EA11
SV0710_010	Chlorine Storage Tank 1 Outlet Valve	Actuated Valve	George Fisher – EA11
SV0710_012	Chlorine Storage Tank 2 Outlet Valve	Actuated Valve	George Fisher – EA11
SV0710_014	Chlorine Storage Tank 3 Outlet Valve	Actuated Valve	George Fisher – EA11
VLV3700_710	Chlorine Contact Tank 1 Degassing valve	Solenoid Valve	Burkert - 0124
VLV3700_720	Chlorine Contact Tank 2 Degassing valve	Solenoid Valve	Burkert - 0124

2.2 *Control Instrumentation List*

TAG	DESCRIPTION	RANGE	TYPE	MAKE & MODEL / TYPE
FI3700_710	Chlorine Contact Tank 1 Hypo Concentrate Solution Flow	0-1000 L/Hr	Analogue	Endress & Hauser Promag 50H08
FI3700_720	Chlorine Contact Tank 2 Hypo Concentrate Solution Flow	0-1000 L/Hr	Analogue	Endress & Hauser Promag 50H08
LI0710_001	Chlorine Storage Tank 1 Level	0-100 %	Analogue	Endress & Hauser Prosonic M FMU 40
LI0710_002	Chlorine Storage Tank 2 Level	0-100 %	Analogue	Endress & Hauser Prosonic M FMU 40
LI0710_003	Chlorine Storage Tank 3 Level	0-100 %	Analogue	Endress & Hauser Prosonic M FMU 40
LI0710_100	Flow Splitter Tank Level	-4.71m to -0.25m	Analogue	Vega Vegapulse 61
LI0710_0055	Chlorine Contact Tank 1 Level 'North-North' channel.	0 – 100%	Analogue	Existing
LI0710_120	Chlorine Contact Tank 2 Level 'South-South' channel.	0 – 112.86%	Analogue	Vega Vegapulse 61
AI0710_011	Chlorine Contact Tank 1 Total Chlorine	0-5 mg/L	Analogue	Blue-I Water Technologies Hydroguard HG-702
AI0710_012	Chlorine Contact Tank 1 Free Chlorine	0-2 mg/L	Analogue	Blue-I Water Technologies Hydroguard HG-702
AI0710_013	Chlorine Contact Tank 2 Total Chlorine	0-5 mg/L	Analogue	Blue-I Water Technologies Hydroguard HG-702
AI0710_014	Chlorine Contact Tank 2 Free Chlorine	0-2 mg/L	Analogue	Blue-I Water Technologies Hydroguard HG-702
FI0710_002	Chlorine Contact Tank 1 Recirculation Flow	0-160 L/s	Analogue	ABB – WMP
FI0710_003	Chlorine Contact Tank 2 Recirculation Flow	0-160 L/s	Analogue	ABB – WMP
FI0710_001	Chlorine Contact Tanks Feed Flow	0-160 L/s	Analogue	ABB – WMP
LSH0710_001	Chlorine Storage Tank 1 High Level Switch	N/A	Digital	Chlorine Switch
LSL0710_001	Chlorine Storage Tank 1 Low Level Switch	N/A	Digital	Chlorine Switch
LSH0710_002	Chlorine Storage Tank 2 High Level Switch	N/A	Digital	Chlorine Switch
LSL0710_002	Chlorine Storage Tank 2 Low Level Switch	N/A	Digital	Chlorine Switch
LSH0710_003	Chlorine Storage Tank 3 High Level Switch	N/A	Digital	Chlorine Switch
LSL0710_003	Chlorine Storage Tank 3 Low Level Switch	N/A	Digital	Chlorine Switch
LSH0710_005	Chlorine Contact Tank 1 High Level Switch	N/A	Digital	Chlorine Switch
LSL0710_005	Chlorine Contact Tank 1 Low Level Switch	N/A	Digital	Chlorine Switch
LSH0710_006	Chlorine Contact Tank 2 High Level Switch	N/A	Digital	Chlorine Switch
LSL0710_006	Chlorine Contact Tank 2 Low Level Switch	N/A	Digital	Chlorine Switch
LSL3700_610	Chlorine Contact Tank 1 Carry Water Low Flow Switch	N/A	Digital	Magnetic Rotameter
LSL3700_620	Chlorine Contact Tank 2 Carry Water Low Flow Switch	N/A	Digital	Magnetic Rotameter
LSH0710_004	Chlorine Contact Tanks Flow Splitter High Level Switch	N/A	Digital	Float Switch
LSL0710_004	Chlorine Contact Tanks Flow Splitter Low Level Switch	N/A	Digital	Float Switch

2.3 *Miscellaneous Instrumentation List*

TAG	DESCRIPTION	RANGE	TYPE	MAKE & MODEL
AI0710_015	Chlorine Storage Tank Bund Conductivity Meter	0-1500 us	Analogue	DO 9766T-R1
CIT0710_001	Chlorine Storage Tank Bund Conductivity Switch	N/A	Digital	DO 9766T-R1
CIT0710_002	Pit near top side of road near CCT1	N/A	Digital	DO 9766T-R1
CIT0710_003	PIT between Flow Splitter and CCT1	N/A	Digital	DO 9766T-R1
FSL0710_001	Safety Shower Flow Switch	N/A	Digital	Flow Switch
FSL0710_002	Safety Shower Flow Switch	N/A	Digital	Flow Switch
FSL0710_003	Safety Shower Flow Switch	N/A	Digital	Flow Switch
FSL0710_004	Safety Shower Flow Switch	N/A	Digital	Flow Switch

3 Control Philosophy

3.1 Introduction

This section provides an understanding of how the Chlorine Dosing System is controlled in automatic mode. It is not intended to provide a description of the process operation.

3.2 System Overview

Effluent from Bundamba Waste Water Treatment Plant (WWTP) can be processed in two different ways, i.e. either discharged to the river or diverted to Advanced Water Treatment Plant (AWTP) Bundamba.

Effluent first goes through the Chlorine Contact Tanks (CCT), where it is chlorinated and after a retention time it is discharged to the river.

However, when effluent is diverted to Bundamba AWTP, flow does not enter the CCT's, causing the effluent in the CCTs to stagnate and chlorine to deplete. To resolve this problem, a Final Effluent Disinfection system consisting of the equipment listed above was installed. Below is a brief description of the functionality of the main equipment.

3.2.1 Recirculation Pumps

One duty / standby pair for each CCT.

These pumps recirculate effluent from the CCT 1 & 2 basins back to the Flow Splitter whilst the effluent flow over the weir falls below a pre-set amount.

The pumps can automatically change duty after each run when both pumps are available and in automatic mode and duty selection is set to Auto.

In automatic, the Duty Recirculation Pump runs while the flow rate over the associated weir falls below a setpoint (55L/s), and stops when the associated weir is above a setpoint (60L/s). In between these setpoints, hysteresis is applied to prevent nuisance starting and stopping.

Recirculation pumps are interlocked with the associated analog level transmitters to prevent the pumps from running dry in the event that CCT levels fall below the low-low limit (10%).

3.2.2 Feed Pumps

One duty / standby pair at Flow Splitter.

When secondary effluent from the plant stops flowing into the CCT the service water requirements of the plant will draw down the top water level in the CCTs.

The Feed Pumps draw effluent from the Flow Splitter and feed the effluent into the CCTs to maintain them between the two float switches in order to maintain a working level in the CCT's whilst the AWTP is drawing effluent. This reduced tank level is intended to maintain a minimum tank recirculation time in the order of 120 minutes to allow the maintenance of residual chlorine in the bulk of the water. This should prevent a decline in the water quality due to a loss of free chlorine during storage.

The pumps can automatically change duty after each run when both pumps are available and in automatic mode and duty selection is set to Auto.

In automatic, the Duty Feed Pumps start when a CCT is enabled and either the level is below the start level setpoint (60%) or a CCT low level float switch is active.

The pumps start when the level drops below the low float switch.
The pumps stop when the level reaches the high float switch or the Flow Splitter Low-Low float switch or Flow Splitter Low-Low analog level alarm or CCT1 or 2's analog high-high analog level alarm interlocks the pumps.
Starts: If CCT1 and CCT2 level is below the start level setpoint (60%) or if the CCT1 or CCT2 low level float switches are low provided the associated tank is enabled.
Stops: If both CCT1 and CCT2 level is above the stop level setpoint (70%) or if both CCT1 and CCT2 low level flow switches not low or if CCT1 or CCT2 level is above the stop level setpoint (70%). If a CCT is not enabled then the associated setpoints/level switches are not used.
(60% and 70% capacity)

3.2.3 Sodium Hypochlorite Dosing Pump Duty/Assist/Standby

One High Flow Duty/Assist set per CCT, and
One Low Flow Pump per CCT with a common Standby Low Flow pump shared between both CCT's

The Duty / Assist and Standby operation runs the pumps at a speed according to the calculated Sodium Hypochlorite Solution demand. Pump selection (refer table below) is based on the solution demand for each CCT and involves two High Flow pumps and one Low Flow pump.

	Low Flow	**High Flow**	
Calculated Chlorine Demand	**Duty/Standby Pump**	**Duty Pump**	**Assist Pump**
0	Stopped	Stopped	Stopped
1.5 to 40	Runs	Stopped	Stopped
40 to 50	*(Runs unless High Flow Pump Runs)*	*Hysteresis*	Stopped
40 to 300	Stopped	Runs	Stopped
300 to 325	Stopped	Runs	*Hysteresis*
325+	Stopped	Runs	Runs

Hysteresis including range and time is used for pumps change over. This prevents nascence pump change overs.

Duty shall rotate each day when duty is selected as Daily.

Hardcoded setpoints:

Stopped: <1.5 L/Hr
Low Flow: 50 L/Hr because the Grundfoss DDI60 dosing pump can go up to 55 L/Hr.
High Flow: 325 L/Hr because the Grundfoss DME375 dosing pump can go up to 374 L/Hr.

Note: 'Demand' terminology used below is as an abbreviation for the calculated Sodium Hypochlorite Solution Flow rate for the associated CCT.

The High Flow Assist Pump:

Starts when Demand is 10% over the High Flow Setpoint
Stops when Demand is 10% under High Flow Setpoint or the duty chemical storage tank low-low analog level alarm or the duty chemical storage tank low-low float switch.

Output Speed = Associated CCT Demand – 325.

The High Flow Duty Pump:

Starts when Demand is 10% over the Low Flow Setpoint.
Stops when Demand is 10% under Low Flow Setpoint or 10% above High Flow Setpoint or the duty chemical storage tank low-low analog level alarm or the duty chemical storage tank low-low float switch.

Output Speed = Associated CCT Demand limited to a maximum of 325.

The Low Flow Duty/Standby Pump:

Starts when Demand is greater than Stopped Setpoint.
Stops when Demand less than Stop Setpoint or when High Flow Duty Pump is running or the duty chemical storage tank low-low analog level alarm or the duty chemical storage tank low-low float switch.

Output Speed = Associated CCT Demand

The Standby Pump Valve Operation:
Normally the both valves will be closed. If first dosing pump becomes unavailable or the first Flowmeter indicates a low flow fault this, will cause the first valve to open. If another low flow dosing pump becomes unavailable or the other Flowmeter has a low flow fault the second valve will not automatically open – this situation requires the operator intervention to resolve associated problem(s).
When the pump becomes available again and the flow meter no longer indicates a low flow fault, the valve will close after a time period (ie 10 minutes) or sooner if the other valve needs to open.

3.2.4 Degassing

The purpose of the degassing valves is to relieve any pressure in the dosing pump back to the tank vent line at the beginning of dosing to prevent a vapour lock occurring in the dosing pump.

When in automatic, the Degassing valve for the associated CCT will open for a period of time (ie 5 second) when any pump starts.

3.3 Flow Calculations

The total flow of Effluent into the Chlorine Contact Tanks involves calculating the measured v-notched weir flow and combining with a portion of Feed Pump flow and Recirculation Pumps flow.

3.3.1 V-Notch Weir Equation:

The following V Notch weir Equation is appropriate for water discharged into an open channel such as a stream provided the outlet water level is lower than the bottom of the v-notch.

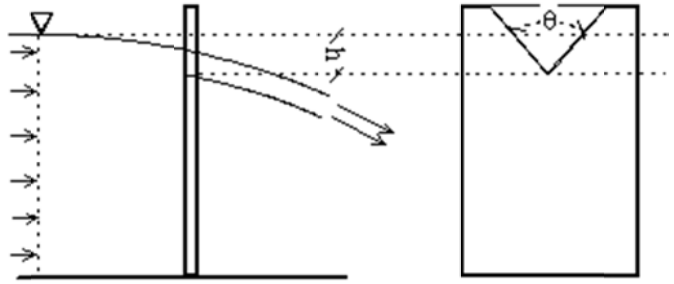

Image and Equation Source: http://www.engineeringtoolbox.com/weirs-flow-rate-d_592.html (2012)

Formula

$q = (8/15) \times C_d \times (2g)^{1/2} \times \tan(\varphi/2) \times h^{2.5}$

Where,

- q = Flow Rate (m^3/s)
- C_d = Discharge Constant (m^3/s)
- g = Gravity (9.81 m/s^2)
- φ = V-notch Angle (degrees)
- h = Head on the Weir (m)

3.3.2 V-Notch Weir Flow - PLC Implementation

The constants in the v-notch equation (above) can be pre-calculated for each CCT and hard coded into the PLC. The Weir head height is calculated on the fly using a hardcoded bottom of v-notch weir level. The v-notch flow is then multiplied out accordingly.

$h_{1a} = L_{us1} - L_{vnotch1btm}$

h_{1b} = Limit h_{1a} between 0 and ($L_{vnotch1top} - L_{vnotch1btm}$) = between 0 and 0.6 m

$K_1 = (1000\ [L/m^3] \times 1\ [m^3/s]) \times (8/15) \times C_{d1vnotch} \times (2g)^{1/2} \times \tan(\varphi_1 / 2)$

$F_{us1vnotch} = K_1 \times h_1^{2.5} = (0.5 \times h_{1b}) \times h_{1b} \times h_{1b} \times K_1$

$F_{us1total} = F_{us1total} + F_{us1vnotch}$ * sample period
$F_{us1totalTD} = F_{us1totalTD} + F_{us1vnotch}$ * sample period (reset at midnight)
$F_{us1totalYD} = F_{us1totalTD}$ just prior to reset at midnight.

Note: Similar for CCT2 calculations

Where
- $C_{d1vnotch}$ = Discharge Constant for CCT1 (m^3/s)
- $C_{d2vnotch}$ = Discharge Constant for CCT2 (m^3/s)
- g = Gravity = 9.81 m/s^2
- φ_1 = V-notch Angle (degrees) = 90 degrees
- φ_2 = V-notch Angle (degrees) = 90 degrees
- K_1 – Combination of Discharge Constant, V-notch Angle and Gravity constants hardcoded for CCT1 = aprox 4000 L/s
- K_2 – Combination of Discharge Constant, V-notch Angle and Gravity constants hardcoded for CCT2 = aprox 4000 L/s
- L_{us1} = Flow Splitter Ultrasonic Level, limited between bottom of Flow Splitter (0.0m) and top edge of concrete (5m)
- $L_{vnotch1btm}$ = Hardcoded bottom level of the CCT1 v-notch weir (m) = aprox -1.470 m.
- $L_{vnotch2btm}$ = Hardcoded bottom level of the CCT2 v-notch weir (m) = aprox -1.470 m.
- $L_{vnotch1top}$ = Hardcoded top level of the CCT2 v-notch weir (m) = aprox -0.870 m.
- $L_{vnotch2top}$ = Hardcoded top level of the CCT2 v-notch weir (m) = aprox -0.870 m.
- $h_{1a\&b}$ = Calculated Head on the V-notch Weir to CCT1
- $h_{2a\&b}$ = Calculated Head on the V-notch Weir to CCT2
- $F_{us1vnotch}$ = Calculated V-notch Flow Rate to CCT1 (L/s)
- $F_{us2vnotch}$ = Calculated V-notch Flow Rate to CCT2 (L/s)

Refer V-notch mechanical drawing BEG709-M-DWG-040 rev A.

3.3.3 Rectangular Weir Equation

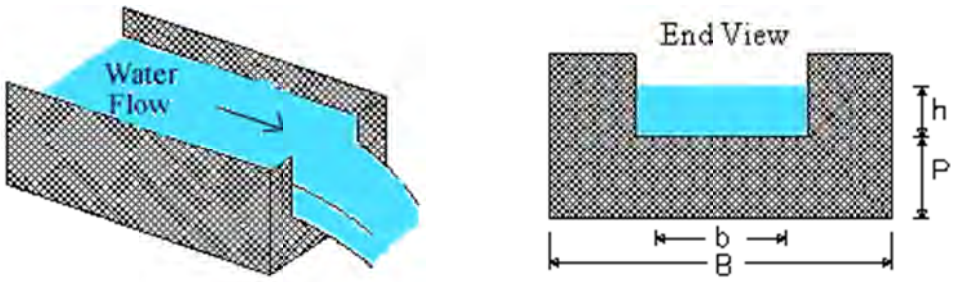

Image and Equation Source: http://www.lmnoeng.com/Weirs/RectangularWeir.htm (Accessed 2013)

The flow rate measurement is based on the Kindsvater-Carter rectangular weir equation (ISO, 1980) and can be expressed as:

Formula:
$Q = C_e \times 2/3 \times (2\,g)^{1/2} \times (b + K_b) \times (h + K_h)^{3/2}$

Where

Q = Flow Rate ($L^3/T = m^3/s$ for water)
C_e = Discharge Constant for the Weir – refer to standard value which is to be verified calibration tests.
h = Head on the Weir (m)
P = Height of Weir above channel (m)
b = Notch Width of the Weir (m)
B = Width of channel (m)
g = 9.81 (m/s^2) - Gravity
Kb = Accounts for effects of viscosity and surface tension.
Kh = Accounts for effects of viscosity and surface tension.

Approximate ISO standard values: Ce = 0.6, Kb = 2mm, Kh=1mm when h/P = 0.125, b/B = 1,
(Source: http://www.lmnoeng.com/Weirs/RectangularWeir.htm Accessed 2013)

3.3.4 Rectangular Weir Flow - PLC Implementation

The constants in the Rectangular Weir equation (above) can be pre-calculated for each CCT and hard coded into the PLC. The Weir head height is calculated on the fly using a hardcoded top of v-notch weir level. The Rectangular Weir flow is then multiplied out accordingly.

$h_{1c} = L_{us1} - L_{vnotch1top}$

h_{1d} = Limit h_{1c} between 0 and (0 - $L_{vnotch1top}$) = between 0 and 0.87 m

$K_3 = (1000\ [L/m^3] \times 1\ [m^3/s]) \times C_{e1rec} \times 2/3 \times (2g)^{1/2} \times (b_1 + K_b)$

$F_{us1rec} = K_3 \times (h_{1b} + K_h)^{3/2} = 0.5(h_{1b}) \times 0.5(h_{1b}) \times 0.5(h_{1b}) \times K_3$

Note: Similar for CCT2 calculations

Where

L_{us1} = Flow Splitter Ultrasonic Level, limited between bottom of Flow Splitter (0.0m) and top edge of concrete (5m)
$L_{vnotch1top}$ = Hardcoded top level of the CCT1 v-notch weir (m) = aprox -0.870 m.
$L_{vnotch2top}$ = Hardcoded top level of the CCT2 v-notch weir (m) = aprox -0.870 m.
$h_{1c\&d}$ = Calculated Head on the Rectangular Weir to CCT1
$h_{2c\&d}$ = Calculated Head on the Rectangular Weir to CCT2
K_3 – Combination of Discharge Constant, Weir Width and Gravity constants hardcoded for CCT1 = aprox 0.6 * 9154 L/s
K_4 – Combination of Discharge Constant, Weir Width and Gravity constants hardcoded for CCT2 = aprox 0.6 * 9154 L/s
C_{e1rec} = Discharge Constant for CCT1 (m^3/s)
C_{e2rec} = Discharge Constant for CCT2 (m^3/s)
g = Gravity = 9.81 m/s^2
b_1 = Width of weir (m) = aprox 3.1m
b_2 = Width of weir (m) = aprox 3.1m
Kb = Adjustment constant typically set to 2mm, change K_3 or K_4 to adjust in PLC.
Kh = Adjustment constant typically set to 1mm, change $L_{vnotch1top}$ or $L_{vnotch2top}$ to adjust in PLC.
F_{us1rec} = Calculated Rectangular Weir Flow Rate to CCT1 (L/s)
F_{us2rec} = Calculated Rectangular Weir Flow Rate to CCT2 (L/s)

Refer V-notch mechanical drawing BEG709-M-DWG-040 rev A.

3.3.5 CCT Effluent Flow

The combined flow into each CCT comprises one v-notch weir flow plus a portion of the Feed Pump Flow and a portion of both Recirculation Pumps flow.

$F_{us1} = F_{us1vnotch} + F_{us1rec}$
$F_{us1total} = F_{us1total} + F_{us1}$ * sample period
$F_{us1totalTD} = F_{us1totalTD} + F_{us1}$ * sample period (reset at midnight)
$F_{us1totalYD} = F_{us1totalTD}$ just prior to reset at midnight.

$F_1 = ((F_p + F_{recirc1} + F_{recirc2}) / n) + F_{us1}$
$F_2 = ((F_p + F_{recirc1} + F_{recirc2}) / n) + F_{us2}$

If CCT1 is offline then $F_1 = 0$ L/s.
If CCT2 is offline then $F_2 = 0$ L/s.

Where:
- F_{us1} – Calculated Flowrate over v-notch weir for CCT1 (L/s).
- F_{us2} – Calculated Flowrate over v-notch weir for CCT2 (L/s).
- F_p – Feed Pump Flow (L/s)
- $F_{recirc1}$ – Recirculation Pumps CCT1 Flow (L/s)
- $F_{recirc2}$ – Recirculation Pumps CCT2 Flow (L/s)
- F_1 – Calculated Flowrate into CCT1 (L/s)
- F_2 – Calculated Flowrate into CCT2 (L/s)
- n – Number of CCTs online with inlet penstocks opened.

3.3.6 Sodium Hypochlorite Demand

The Equation of the Sodium Hypochlorite Demand was provided in the SNQR Bundamba WWTP Enhancement of Chlorine Disinfection System Scope of Works and Project Specification document revision 1 approved 24/08/2012.

$D_1 = (D_{rate} \times F_1 \times 3600) / (C_{tank} \times 1{,}000{,}000)$

This formula can be expressed as three calculations one representing the amount of actual raw Sodium Hypochlorite chemical, the second is the same value but after limiting and the third representing the amount of solution to be dosed.

$D_{1a} = (D_{rate1} \times F_1 \times 3600) / (1000)$
$D_{1b} = D_{1a}$ limited to no less than D_{min} and no more than D_{max} unless CCT is offline in which case $D_{1b} = 0$ g/hr.
$D_{1c} = D_{1b} / (C_{tank} \times 1{,}000)$

Where:

- D_{min} - Minimum chlorine rate for each CCT between 0 and 2000 g/hr based on 24hr clock & lookup table for specific hour of day.
- D_{max} - Maximum chlorine rate for each CCT between 50,000 and 100,000 g/hr.
- D_{rate1} - CCT1 Effluent dosing rate between 0 and 15 mg/L.
- C_{tank} - Sodium Hypochlorite Storage Tank solution concentration between 1 and 15% (0.08 = 8%)
- F_1 - Calculated flow rate into CCT1 (L/s).
- F_2 - Calculated flow rate into CCT2 (L/s).
- D_{1a} - Calculated Sodium Hypochlorite Chlorine Demand for CCT1 (g/hr).
- D_{2a} - Calculated Sodium Hypochlorite Chlorine Demand for CCT2 (g/hr).
- D_{1c} - Flow rate of Sodium Hypochlorite Solution for CCT1 (L/hr)
- D_{2c} - Flow rate of Sodium Hypochlorite Solution for CCT2 (L/hr)

Worked Example:

Feed Pump Flow is 50L/s
Recirculation Pump Flows is 0L/s
V-notch Weir Flow for CCT1 is 20 L/s
Tank Concentration is 8%
D_{rate1} is 10mg/L
D_{min} is 1.5kg/hr
D_{max} is 75kg/hr
n is 2 because both penstocks are open and the CCTs are both online.

Calculate flow rate into CCT1:
$F_1 = 20$ L/s + (50 L/s + 0 L/s + 0 L/s) / 2 = 45 L/s

Calculate CCT1 Hypo Demand:
$D_{1a} = (10$ mg/L * 45 L/sec * 3600 sec/hr) / (1000mg/g) = 1,620 g/hr

Because 1.620kg/hr is between 2kg/hr and 100kg/hr, it doesn't need to be limited and hence $D_{1b} = D_{1a}$.

Calculate required Hypo Solution Flow rate for CCT1:
$D_{1c} = 1{,}620$g/hr / (8% * 1000g/L) = 20.25 L/hr

In the example above, the dosing pumps for CCT1 will need to run at 20.25 L/hr to dose the desired amount of raw Sodium Hypochlorite. A similar calculation would then be applied to obtain a dose rate for CCT2.

3.3.7 Common Control Settings

It is possible to enable or disable each CCT individually in Citect as shown in Figure 1 below.
When a CCT is disabled, the respective Recirculation Pumps and associated Hypo Dosing pumps do not operate.

When a Flow Splitter Penstock is put in SCADA Manual and sent a Close Command, the associated CCT becomes disabled. When the same Penstock is Open command the CCT becomes enabled.

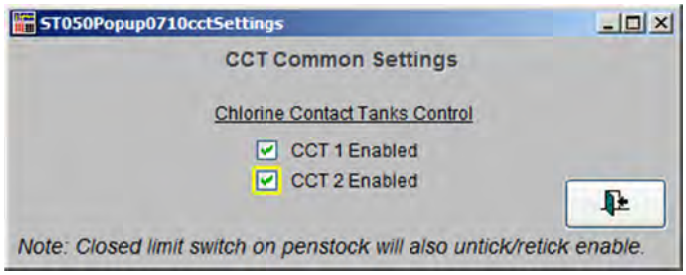

Figure 1 Common Control Settings

3.4 LIT710_100 – Flow Splitter Level

Bottom of Flow Splitter tank	= -4.710m = 0%
Highest measurement value	= -0.250m = 100%
Signal Averaging	= None
Measurement Mode	= Distance

No advanced configuration logic in level indicator.

Alarms:

High-High	= Cat 1 Alarm (aprox -0.500m)
High	= Cat 2 Alarm (aprox -0.900m)
Low	= Cat 2 Alarm (aprox -1.470m)
Low-Low	= Cat 1 Alarm (aprox -4.500m)
Signal Fault	= Cat 1 alarm
Rate of Change	= Cat 1 alarm

Note: The level from this instrument is used to calculate flow into both CCT1 and CCT2. Refer V-Notch weir calculations section of this document.

3.5 LIT710_110 – CCT1 Basin Level

Bottom of Basin tank	= 0%
Highest measuring level	= 100%
Signal Averaging	= None

No advanced configuration logic in level indicator.

Alarms:

High-High	= Cat 1 Alarm (aprox 95%)
High	= Cat 2 Alarm (aprox 75%)
Low	= Cat 2 Alarm (aprox 30%)
Low-Low	= Cat 1 Alarm (aprox 15%)
Signal Fault	= Cat 1 alarm
Rate of Change	= Cat 1 alarm

3.6 LIT710_120 – CCT2 Basin Level

Bottom of Flow Splitter tank = 0%
Highest measuring level = 110%
Signal Averaging = None

No advanced configuration logic in level indicator.

Alarms:
High-High = Cat 1 Alarm (aprox 95%)
High = Cat 2 Alarm (aprox 75%)
Low = Cat 2 Alarm (aprox 30%)
Low-Low = Cat 1 Alarm (aprox 15%)
Signal Fault = Cat 1 alarm
Rate of Change = Cat 1 alarm

3.7 Chlorine Storage Tanks

Bottom of Flow Splitter tank = 0%
Highest measuring level = 100%
Signal Averaging = None

No advanced configuration logic in level indicator.

Alarms:
High-High = Cat 1 Alarm (aprox 95%)
High = Cat 2 Alarm (aprox 75%)
Refill Level = Indication only (aprox 35%)
Low = Cat 2 Alarm (aprox 30%)
Low-Low = Cat 1 Alarm (aprox 15%)
Signal Fault = Cat 1 alarm
Rate of Change = Cat 1 alarm

3.8 Chlorine Storage Tanks - Auto Operation

The three Chlorine Storage Tanks operate in a Duty / Standby / Standby basis.

When a Chlorine Storage Tank's level drops below the associated Analog Level Low (or Low-Low) setpoint or the Low Level Switch Activates, the associated outlet valve (when the valve is in automatic mode) closes and the Chlorine Storage Tanks rotate duty.

The tanks also change duty when the associated Outlet Valve is not available for automatic.

4 Monitoring

The SCADA monitors the following:

- Each of the alarms listed
- Chlorine Storage Tank 1 Level (ST039LI0710_001asValue)
- Chlorine Storage Tank 2 Level (ST039LI0710_002asValue)
- Chlorine Storage Tank 3 Level (ST039LI0710_003asValue)
- Chlorine Contact Tank 1 Total Chlorine (ST039AI0710_011asValue)
- Chlorine Contact Tank 1 Free Chlorine (ST039AI0710_012asValue)
- Chlorine Contact Tank 2 Total Chlorine (ST039AI0710_013asValue)
- Chlorine Contact Tank 2 Free Chlorine (ST039AI0710_014asValue)
- Chlorine Contact Tank 1 Recirculation Flow (ST039FI0710_002asValue)
- Chlorine Contact Tank 2 Recirculation Flow (ST039FI0710_003asValue)
- Chlorine Contact Tanks Feed Flow (ST039FI0710_001asValue)

4.1.1 Chlorine Analysers

The chlorine analysers are used for indicative trending and raising alarms. The analysers are not used in the dosing control logic.

5 Set Points

The table below lists all the setpoints that are accessible to the operator through Citect. The Value column represents the values that were in effect at the time of preparation of this document.

TAG	DESCRIPTION	UNIT	MIN	MAX	VALUE
CCT Flow Splitter Settings					
ST039LI0710_100acEGUZero	Flow Splitter Distance to bottom of Tank	m	-5.0	0	-4.710
ST039LI0710_100acCCT1vNotchTop	CCT1 top of v-notch	m	0	10.0	3.840
ST039LI0710_100acCCT1vNotchBtm	CCT1 bottom of v-notch	m	0	10.0	3.240
ST039LI0710_100acCCT1vNotchK	CCT1 v-notch constant K (refer to v-notch formula / implementation)	-	0	10,000	1200.0
ST039LI0710_100acCCT1recNotchK	CCT1 rectangular-notch constant K (refer to rec-notch formula / implementation)	-	0	10,000	5492.0
ST039LI0710_100acCCT2vNotchTop	CCT2 top of v-notch	m	0	10.0	3.840
ST039LI0710_100acCCT2vNotchBtm	CCT2 bottom of v-notch	m	0	10.0	3.240
ST039LI0710_100acCCT2vNotchK	CCT2 v-notch constant K (refer to v-notch formula / implementation)	-	0	10,000	1200.0
ST039LI0710_100acCCT2recNotchK	CCT2 rectangular-notch constant K (refer to rec-notch formula / implementation)	-	0	10,000	5492.0
Common Settings – Chlorine Contact Tanks Control					
ST039SYS0710_00XdcCCT1On	CCT1 Enabled	-			Ticked
ST039SYS0710_00XdcCCT2On	CCT2 Enabled	-			Ticked
Dosing Pump Duty Settings					
ST039PU3700_0710acFlowSP01 ST039PU3700_0720acFlowSP01	SP01 – Minimum Flow one Low Flow Dosing Pump can output	l/hr	0	10,000	1.5
ST039PU3700_0710acFlowSP02 ST039PU3700_0720acFlowSP02	SP02 – Minimum Flow one High Flow Dosing Pump can output	l/hr	0	10,000	40.0
ST039PU3700_0710acFlowSP03 ST039PU3700_0720acFlowSP03	SP03 – Maximum Flow one Low Flow Dosing Pump can output	l/hr	0	10,000	50.0
ST039PU3700_0710acFlowSP04 ST039PU3700_0720acFlowSP04	SP04 – Minimum Flow two High Flow Dosing Pumps output	l/hr	0	10,000	365.0
ST039PU3700_0710acFlowSP05 ST039PU3700_0720acFlowSP05	SP05 – Maximum Flow one High Flow Dosing Pump output	l/hr	0	10,000	375.0
ST039PU3700_0710acFlowSP06 ST039PU3700_0720acFlowSP06	SP06 – High-High flow alarm. Alarm unlatches	l/hr	0	10,000	730.0
ST039PU3700_0710acFlowSP07 ST039PU3700_0720acFlowSP07	SP07 – High-High flow alarm. Maximum rate two High-Flow pumps can output.	l/hr	0	10,000	750.0
ST039PU3700_0710acHystSP01 ST039PU3700_0720acHystSP01	Hyst01 – Hysteresis where High => Low flow pump.	l/hr	0	10,000	10.0
ST039PU3700_0710acHystSP02 ST039PU3700_0720acHystSP02	Hyst02 – Hysteresis where two => one High flow pump.	l/hr	0	10,000	10.0
ST039PU3700_0710acHystSP03 ST039PU3700_0720acHystSP03	Hyst03 – Hysteresis for High-High flow alarm.	l/hr	0	10,000	20.0

(continues next page…)

Chlorine Solution Settings					
ST039LI0710_100asFrate10 ST039LI0710_100asFrate20	SP10 - Effluent Flow into CCT1 SP20 - Effluent Flow into CCT2	l/s	0	3,000	0
ST039LI0710_100asFrate11 ST039LI0710_100asFrate21	SP11 - Effluent Flow into CCT1 SP21 - Effluent Flow into CCT2	l/s	0	3,000	40
ST039FI3700_710asDrateA ST039FI3700_720asDrateA	SP0A - Effluent Dosing rate for CCTx	mg/L	0	15	10.5
ST039LI0710_100asFrate12 ST039LI0710_100asFrate22	SP12 - Effluent Flow into CCT1 SP22 - Effluent Flow into CCT2	l/s	0	3,000	80
ST039FI3700_710asDrateB ST039FI3700_720asDrateB	SP0B - Effluent Dosing rate for CCTx	mg/L	0	15	9.5
ST039LI0710_100asFrate13 ST039LI0710_100asFrate23	SP13 - Effluent Flow into CCT1 SP23 – Effluent Flow into CCT2	l/s	0	3,000	120
ST039FI3700_710asDrateC ST039FI3700_720asDrateC	SP0C - Effluent Dosing rate for CCTx	mg/L	0	15	9.0
ST039LI0710_100asFrate14 ST039LI0710_100asFrate24	SP14 - Effluent Flow into CCT1 SP24 - Effluent Flow into CCT2	l/s	0	3,000	3000
ST039FI3700_710asDrateD ST039FI3700_720asDrateD	SP0D - Effluent Dosing rate for CCTx	mg/L	0	15	9.0
ST039FI3700_710acDoseMin0000 to ST039FI3700_710acDoseMin2400 ST039FI3700_720acDoseMin0000 to ST039FI3700_720acDoseMin2400	Minimum Chlorine Rate for CCTx (all values in 24hr Table set to same value, potentially can be changed to suit typical rate for point in time)	Kg/Hr	0	2,000	0.30
ST039FI3700_710acDoseMax ST039FI3700_720acDoseMax	Maximum Chlorine Rate for CCTx	Kg/Hr	5.0	100.0	5.00
ST039FI3700_710acConcTank ST039FI3700_720acConcTank	Concentration of duty tank for CCTx	%	1	15	9.00

6 Alarms

The tables below list all alarms generated by the Chlorine Dosing PLC. All Category 1 (CAT1) alarms are dialled out through the SCADAphone alarm messaging system.

6.1 Digital Process Alarms

In the table below the Low Level Switches for the Chlorine Storage Tanks have been downgraded from CAT1 alarms to CAT3 alarms because they were originally installed higher than the Low Level Alarms derived from the level transmitters.

TAG	DESCRIPTION	STATE	CATEGORY
ST039FSL0710_001dsAlarm	Safety Shower 1 Flow Switch	On	CAT2
ST039FSL0710_002dsAlarm	Safety Shower 2 Flow Switch	On	CAT2
ST039FSL0710_003dsAlarm	Safety Shower 3 Flow Switch	On	CAT2
ST039FSL0710_004dsAlarm	Safety Shower 4 Flow Switch	On	CAT2
ST039LSH0710_001dsAlarm	Chlorine Storage Tank 1 High Level Switch	On	CAT1
ST039LSL0710_001dsAlarm	Chlorine Storage Tank 1 Low Level Switch	On	CAT3
ST039LSH0710_002dsAlarm	Chlorine Storage Tank 2 High Level Switch	On	CAT1
ST039LSL0710_002dsAlarm	Chlorine Storage Tank 2 Low Level Switch	On	CAT3
ST039LSH0710_003dsAlarm	Chlorine Storage Tank 3 High Level Switch	On	CAT1
ST039LSL0710_003dsAlarm	Chlorine Storage Tank 3 Low Level Switch	On	CAT3
ST039LSH0710_004dsAlarm	Chlorine Contact Tanks Flow Splitter High Level Switch	On	CAT3
ST039LSL0710_004dsAlarm	Chlorine Contact Tanks Flow Splitter Low Level Switch	On	CAT2
ST039FSL0710_005dsAlarm	Low Flow Dosing Line Flow Switch	On	CAT3
ST039FSL0710_006dsAlarm	CCT1 High Flow Dosing Line Flow Switch	On	CAT3
ST039FSL0710_007dsAlarm	CCT2 High Flow Dosing Line Flow Switch	On	CAT3

6.2 Analogue Process Alarms

TAG	DESCRIPTION	ALARM SETPOINT	UNITS	STATE	CATEGORY
ST039LI0710_001dsLoLo	Chlorine Storage Tank 1 Low Low Level	5	%	On	CAT1
ST039LI0710_001dsLo	Chlorine Storage Tank 1 Low Level	10	%	On	CAT3
ST039LI0710_001dsHi	Chlorine Storage Tank 1 High Level	80	%	On	CAT3
ST039LI0710_001dsHiHi	Chlorine Storage Tank 1 High High Level	90	%	On	CAT1
ST039LI0710_002dsLoLo	Chlorine Storage Tank 2 Low Low Level	5	%	On	CAT1
ST039LI0710_002dsLo	Chlorine Storage Tank 2 Low Level	10	%	On	CAT3
ST039LI0710_002dsHi	Chlorine Storage Tank 2 High Level	80	%	On	CAT3
ST039LI0710_002dsHiHi	Chlorine Storage Tank 2 High High Level	90	%	On	CAT1
ST039LI0710_003dsLoLo	Chlorine Storage Tank 3 Low Low Level	5	%	On	CAT1
ST039LI0710_003dsLo	Chlorine Storage Tank 3 Low Level	10	%	On	CAT3
ST039LI0710_003dsHi	Chlorine Storage Tank 3 High Level	80	%	On	CAT3
ST039LI0710_003dsHiHi	Chlorine Storage Tank 3 High High Level	90	%	On	CAT1
ST039AI0710_011dsLoLo	Chlorine Contact Tank 1 Total Chlorine Low Low Level	0.200	mg/L	On	CAT1
ST039AI0710_011dsLo	Chlorine Contact Tank 1 Total Chlorine Low Level	0.600	mg/L	On	CAT2
ST039AI0710_011dsHi	Chlorine Contact Tank 1 Total Chlorine High Level	3.000	mg/L	On	CAT2
ST039AI0710_011dsHiHi	Chlorine Contact Tank 1 Total Chlorine High High Level	4.750	mg/L	On	CAT1
ST039AI0710_012dsLoLo	Chlorine Contact Tank 1 Free Chlorine Low Low Level	0.050	mg/L	On	CAT2
ST039AI0710_012dsLo	Chlorine Contact Tank 1 Free Chlorine Low Level	0.090	mg/L	On	CAT3
ST039AI0710_012dsHi	Chlorine Contact Tank 1 Free Chlorine High Level	0.500	mg/L	On	CAT3
ST039AI0710_012dsHiHi	Chlorine Contact Tank 1 Free Chlorine High High Level	0.600	mg/L	On	CAT1
ST039AI0710_013dsLoLo	Chlorine Contact Tank 2 Total Chlorine Low Low Level	0.200	mg/L	On	CAT1
ST039AI0710_013dsLo	Chlorine Contact Tank 2 Total Chlorine Low Level	0.600	mg/L	On	CAT2
ST039AI0710_013dsHi	Chlorine Contact Tank 2 Total Chlorine High Level	3.000	mg/L	On	CAT2
ST039AI0710_013dsHiHi	Chlorine Contact Tank 2 Total Chlorine High High Level	4.750	mg/L	On	CAT1
ST039AI0710_014dsLoLo	Chlorine Contact Tank 2 Free Chlorine Low Low Level	0.050	mg/L	On	CAT1
ST039AI0710_014dsLo	Chlorine Contact Tank 2 Free Chlorine Low Level	0.090	mg/L	On	CAT3
ST039AI0710_014dsHi	Chlorine Contact Tank 2 Free Chlorine High Level	0.500	mg/L	On	CAT3
ST039AI0710_014dsHiHi	Chlorine Contact Tank 2 Free Chlorine High High Level	0.600	mg/L	On	CAT1
ST039FI0710_002dsLoLo	Chlorine Contact Tank 1 Recirculation Low Low Flow	3.0	L/s	On	CAT2
ST039FI0710_002dsLo	Chlorine Contact Tank 1 Recirculation Low Flow	-	L/s	On	CAT3
ST039FI0710_002dsHi	Chlorine Contact Tank 1 Recirculation High Flow	-	L/s	On	CAT3
ST039FI0710_002dsHiHi	Chlorine Contact Tank 1 Recirculation High High Flow	50.0	L/s	On	CAT2
ST039FI0710_003dsLoLo	Chlorine Contact Tank 2 Recirculation Low Low Flow	3.0	L/s	On	CAT2
ST039FI0710_003dsLo	Chlorine Contact Tank 2 Recirculation Low Flow	-	L/s	On	CAT3
ST039FI0710_003dsHi	Chlorine Contact Tank 2 Recirculation High Flow	-	L/s	On	CAT3
ST039FI0710_003dsHiHi	Chlorine Contact Tank 2 Recirculation High High Flow	50.0	L/s	On	CAT2

ST039FI0710_001dsLoLo	Chlorine Contact Tanks Feed Low Low Flow	-	L/s	On	CAT2
ST039FI0710_001dsLo	Chlorine Contact Tanks Feed Low Flow	-	L/s	On	CAT3
ST039FI0710_001dsHi	Chlorine Contact Tanks Feed High Flow	-	L/s	On	CAT3
ST039FI0710_001dsHiHi	Chlorine Contact Tanks Feed High High Flow	-	L/s	On	CAT2
ST050LI0710_0055dsLoLo	Chlorine Contact Tank 1 Chamber 1 Low Low Level	10.0	%	On	CAT1
ST050LI0710_0055dsLo	Chlorine Contact Tank 1 Chamber 1 Low Level	55.0	%	On	CAT3
ST050LI0710_0055dsHi	Chlorine Contact Tank 1 Chamber 1 High Level	105.0	%	On	CAT3
ST050LI0710_0055dsHiHi	Chlorine Contact Tank 1 Chamber 1 High High Level	110.0	%	On	CAT1
ST039LI0710_120dsLoLo	Chlorine Contact Tank 2 Chamber 4 Low Low Level	10.0	%	On	CAT1
ST039LI0710_120dsLo	Chlorine Contact Tank 2 Chamber 4 Low Level	55.0	%	On	CAT3
ST039LI0710_120dsHi	Chlorine Contact Tank 2 Chamber 4 High Level	105.0	%	On	CAT3
ST039LI0710_120dsHiHi	Chlorine Contact Tank 2 Chamber 4 High High Level	110.0	%	On	CAT1
ST050FI0780_0095dsLoLo	Outlet Channel Flow Low Low Level	-	L/s	On	CAT3
ST050FI0780_0095dsLo	Outlet Channel Flow Low Level	-	L/s	On	CAT3
ST050FI0780_0095dsHi	Outlet Channel Flow High Level	-	L/s	On	CAT3
ST050FI0780_0095dsHiHi	Outlet Channel Flow High High Level	-	L/s	On	CAT3
ST039FI3700_710dsLoLo	CCT1 Hypo Flow Low Low Level	1.0	L/hr	On	CAT1
ST039FI3700_710dsLo	CCT1 Hypo Flow Low Level	2.0	L/hr	On	CAT3
ST039FI3700_710dsHi	CCT1 Hypo Flow High Level	375.0	L/hr	On	CAT3
ST039FI3700_710dsHiHi	CCT1 Hypo Flow High High Level	858.0	L/hr	On	CAT1
ST039FI3700_720dsLoLo	CCT2 Hypo Flow Low Low Level	1.0	L/hr	On	CAT1
ST039FI3700_720dsLo	CCT2 Hypo Flow Low Level	2.0	L/hr	On	CAT3
ST039FI3700_720dsHi	CCT2 Hypo Flow High Level	375.0	L/hr	On	CAT3
ST039FI3700_720dsHiHi	CCT2 Hypo Flow High High Level	858.0	L/hr	On	CAT1

6.3 Instrument / Equipment Alarms

TAG	DESCRIPTION	STATE	PRIORITY
ST039PU0710_001dsF2Start	Contact Tank 1 Recirculation Pump 1 Fail to Start Alarm	On	CAT3
ST039PU0710_001dsF2Stop	Contact Tank 1 Recirculation Pump 1 Fail to Stop Alarm	On	CAT3
ST039PU0710_001dsMainsFault	Contact Tank 1 Recirculation Pump 1 Mains Fault	On	CAT3
ST039PU0710_001dsNoFlow	Contact Tank 1 Recirculation Pump 1 No Flow	On	CAT2
ST039PU0710_002dsF2Start	Contact Tank 1 Recirculation Pump 2 Fail to Start Alarm	On	CAT3
ST039PU0710_002dsF2Stop	Contact Tank 1 Recirculation Pump 2 Fail to Stop Alarm	On	CAT3
ST039PU0710_002dsMainsFault	Contact Tank 1 Recirculation Pump 2 Mains Fault	On	CAT3
ST039PU0710_002dsNoFlow	Contact Tank 1 Recirculation Pump 2 No Flow	On	CAT2
ST039PU0710_003dsF2Start	Contact Tank 2 Recirculation Pump 1 Fail to Start Alarm	On	CAT3
ST039PU0710_003dsF2Stop	Contact Tank 2 Recirculation Pump 1 Fail to Stop Alarm	On	CAT3
ST039PU0710_003dsMainsFault	Contact Tank 2 Recirculation Pump 1 Mains Fault	On	CAT3
ST039PU0710_003dsNoFlow	Contact Tank 2 Recirculation Pump 1 No Flow	On	CAT2
ST039PU0710_004dsF2Start	Contact Tank 2 Recirculation Pump 2 Fail to Start Alarm	On	CAT3
ST039PU0710_004dsF2Stop	Contact Tank 2 Recirculation Pump 2 Fail to Stop Alarm	On	CAT3
ST039PU0710_004dsMainsFault	Contact Tank 2 Recirculation Pump 2 Mains Fault	On	CAT3
ST039PU0710_004dsNoFlow	Contact Tank 2 Recirculation Pump 2 No Flow	On	CAT2
ST039PU0710_005dsF2Start	Contact Tanks Feed Pump 1 Fail to Start	On	CAT3
ST039PU0710_005dsF2Stop	Contact Tanks Feed Pump 1 Fail to Stop	On	CAT3
ST039PU0710_005dsMainsFault	Contact Tanks Feed Pump 1 Mains Fault	On	CAT2
ST039PU0710_005dsNoFlow	Contact Tanks Feed Pump 1 No Flow	On	CAT2
ST039PU0710_006dsF2Start	Contact Tanks Feed Pump 2 Fail to Start	On	CAT3
ST039PU0710_006dsF2Stop	Contact Tanks Feed Pump 2 Fail to Stop	On	CAT3
ST039PU0710_006dsMainsFault	Contact Tanks Feed Pump 2 Mains Fault	On	CAT2
ST039PU0710_006dsNoFlow	Contact Tanks Feed Pump 2 No Flow	On	CAT2
ST039SV0710_010dsF2Close	Chlorine Tank 1 Outlet Valve Fail to Close	On	CAT3
ST039SV0710_010dsF2Open	Chlorine Tank 1 Outlet Valve Fail to Open	On	CAT3
ST039SV0710_012dsF2Close	Chlorine Tank 2 Outlet Valve Fail to Close	On	CAT3
ST039SV0710_012dsF2Open	Chlorine Tank 2 Outlet Valve Fail to Open	On	CAT3
ST039SV0710_014dsF2Close	Chlorine Tank 3 Outlet Valve Fail to Close	On	CAT3
ST039SV0710_014dsF2Open	Chlorine Tank 3 Outlet Valve Fail to Open	On	CAT3
ST039LI0710_001dsInvalid	Chlorine Storage Tank 1 Level Invalid Signal	On	CAT3
ST039LI0710_002dsInvalid	Chlorine Storage Tank 2 Level Invalid Signal	On	CAT3
ST039LI0710_003dsInvalid	Chlorine Storage Tank 3 Level Invalid Signal	On	CAT3
ST039AI0710_011dsInvalid	Chlorine Contact Tank 1 Total Chlorine Invalid Signal	On	CAT3
ST039AI0710_012dsInvalid	Chlorine Contact Tank 1 Free Chlorine Invalid Signal	On	CAT3

ST039AI0710_013dsInvalid	Chlorine Contact Tank 2 Total Chlorine Invalid Signal	On	CAT3
ST039AI0710_014dsInvalid	Chlorine Contact Tank 2 Free Chlorine Invalid Signal	On	CAT3
ST039FI0710_001dsInvalid	Chlorine Contact Tanks Feed Flow Invalid Signal	On	CAT3
ST039FI0710_002dsInvalid	Chlorine Contact tank 1 Recirculation Flow Invalid Signal	On	CAT3
ST039FI0710_003dsInvalid	Chlorine Contact tank 2 Recirculation Flow Invalid Signal	On	CAT3

6.4 Derived Alarms

TAG	DESCRIPTION	STATE	CATEGORY
SYS0710_001dsCCT1PmpUnavail	Both CCT 1 Recirculation Pumps Unavailable	On	CAT1
SYS0710_001dsCCT2PmpUnavail	Both CCT 2 Recirculation Pumps Unavailable	On	CAT1
SYS0710_001dsFeedPmpUnavail	Both CCT Feed Pumps Unavailable	On	CAT1
SYS0710_001dsLoFlwPmpUnavail	All Low Flow Chlorine Dosing Pumps Unavailable	On	CAT1
SYS0710_001dsCCT1HiFlwPmpUnavail	CCT 1 High Flow Chlorine Dosing Pumps Unavailable	On	CAT1
SYS0710_001dsCCT2HiFlwPmpUnavail	CCT 2 High Flow Chlorine Dosing Pumps Unavailable	On	CAT1
SYS0710_001dsAllClStgTnkLoLvl	Chlorine Storage Tanks Low Level	On	CAT1
SYS0710_001dsClStgTnkSVUnavail	Chlorine Storage Tanks Outlet Valves Unavailable	On	CAT1
SB08_CD01_Comms_Fail	Communications between PLC SB08 and CD01 Failed	On	CAT1
SB08_CD01_FI0780_0095dsHealthy	Outfall Flow Signal from SB08 Healthy	Off	CAT1

7 Interlocks

DEVICE - DESCRIPTION	DEVICE - TAG	INTERLOCK - DESCRIPTION	INTERLOCK - TAG	INTERLOCK - RESPONSE
Storage Tank 1 Outlet Valve	SV0710_010	Chlorine Storage Tank 1 Low Level Alarm	LSL0710_001dsAlarm	On – Close
Storage Tank 2 Outlet Valve	SV0710_012	Chlorine Storage Tank 2 Low Level Alarm	LSL0710_002dsAlarm	On – Close
Storage Tank 3 Outlet Valve	SV0710_014	Chlorine Storage Tank 3 Low Level Alarm	LSL0710_003dsAlarm	On – Close
CCT1 Recirculation Pump 1	PU0710_001	CCT1 Low Level Alarm	LSL0710_005dsAlarm	On - Stop
CCT1 Recirculation Pump 2	PU0710_002	CCT1 Low Level Alarm	LSL0710_005dsAlarm	On - Stop
CCT2 Recirculation Pump 1	PU0710_003	CCT2 Low Level Alarm	LSL0710_006dsAlarm	On - Stop
CCT2 Recirculation Pump 2	PU0710_004	CCT2 Low Level Alarm	LSL0710_006dsAlarm	On - Stop
CCT Feed Pump 1	PU0710_005	Flow Splitter Low Level Alarm	LSL0710_004dsAlarm	On - Stop
CCT Feed Pump 2	PU0710_006	Flow Splitter Low Level Alarm	LSL0710_004dsAlarm	On - Stop
Low Flow Dosing Pump 1	PU0710_007	At least one Recirc / Feed Pump Running	PU0710_001/2/3/4/5/6	Off-Stop
Low Flow Dosing Pump 1	PU0710_007	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
Low Flow Dosing Pump 2	PU0710_008	At least one Recirc / Feed Pump Running	PU0710_001/2/3/4/5/6	Off-Stop
Low Flow Dosing Pump 2	PU0710_008	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
Low Flow Dosing Pump 3	PU0710_009	At least one Recirc / Feed Pump Running	PU0710_001/2/3/4/5/6	Off-Stop
Low Flow Dosing Pump 3	PU0710_009	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
High Flow Dosing Pump 1	PU0710_010	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
High Flow Dosing Pump 2	PU0710_011	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
High Flow Dosing Pump 3	PU0710_012	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
High Flow Dosing Pump 4	PU0710_013	Duty Chlorine Tank Outlet Valve Open	SV0710_010/12/14	Off-Stop
All equipment		CCT Emergency Stop Healthy	HS0710_001	Off – Stop/Close

8 Trends

Trends are displayed when their respective trend push buttons are selected while the device popup is open. Trend signals include Measured Value, Hours Run Continuous, Hour Run Yesterday, Total Today, and Total Yesterday.

- Chlorine Storage Tank 1 Level (LI0710_001),
- Chlorine Storage Tank 2 Level (LI0710_002),
- Chlorine Storage Tank 3 Level (LI0710_003),

- Chlorine Contact Tank 1 Total Chlorine (AI0710_011),
- Chlorine Contact Tank 1 Free Chlorine (AI0710_012),
- Chlorine Contact Tank 2 Total Chlorine (AI0710_013),
- Chlorine Contact Tank 2 Free Chlorine (AI0710_014),

- Chlorine Contact Tank 1 Recirculation Flow (FI0710_002),
- Chlorine Contact Tank 2 Recirculation Flow (FI0710_003),
- Chlorine Contact Tanks Feed Flow (FI0710_001)
- Chlorine Contact Tanks Calculated Chlorine Flow (FX0710_ 001)

9 Statistical Data

TAG	DESCRIPTION
ST039PU0710_007asRunHours	Low Flow Chlorine Dosing Pump 1 Run Hours
ST039PU0710_008asRunHours	Low Flow Chlorine Dosing Pump 2 Run Hours
ST039PU0710_009asRunHours	Low Flow Chlorine Dosing Pump 3 Run Hours
ST039PU0710_010asRunHours	High Flow Chlorine Dosing Pump 1 Run Hours
ST039PU0710_011asRunHours	High Flow Chlorine Dosing Pump 2 Run Hours
ST039PU0710_012asRunHours	High Flow Chlorine Dosing Pump 3 Run Hours
ST039PU0710_013asRunHours	High Flow Chlorine Dosing Pump 4 Run Hours
ST039PU0710_001asRunHours	Chlorine Contact Tank 1 Recirculation Pump 1 Run Hours
ST039PU0710_002asRunHours	Chlorine Contact Tank 1 Recirculation Pump 2 Run Hours
ST039PU0710_003asRunHours	Chlorine Contact Tank 2 Recirculation Pump 1 Run Hours
ST039PU0710_004asRunHours	Chlorine Contact Tank 2 Recirculation Pump 2 Run Hours
ST039PU0710_005asRunHours	Chlorine Contact Tanks Feed Pump 1 Run Hours
ST039PU0710_006asRunHours	Chlorine Contact Tanks Feed Pump 2 Run Hours

10 PLC to PLC Communications

SOURCE	TAG	DESTINATION	TAG	DESCRIPTION
SB08	FI0780_0095asValue	CD01	SB09_FI0780_0095asValue	Outfall Flow Meter Reading
SB08	FI0780_0095dsInvalid	CD01	SB08_CD01_FI0780_0095dsHealthy	Outfall Flow Signal Invalid
SB08	PT0710_8211dsClosed	CD01	ST050PT0710_8211dsClosed	CCT1 Inlet Penstock Closed
SB08	PT0710_8212dsClosed	CD01	ST050PT0710_8212dsClosed	CCT2 Inlet Penstock Closed
SB08	SB08_CD01_HBP	CD01	SB08_CD01_HBP	SB08 Heart Beat Pulse in CD01
CD01	CD01_HBP	SB08	DC01 Heart Beat Pulse	DC01 Heart Beat Pulse
SB11	BFP0450_0111dsRunning	CD01	SB11_BFP0450_0111dsRunning	BFP1 Running
SB11	BFP0450_0113dsRunning	CD01	SB11_BFP0450_0113dsRunning	BFP2 Running

11 *Additional Equipment*

Three additional external tank level indicating light systems as well as a flashing alarm beacon was installed on the outside of the Chlorine Dosing System Building. The level indicating lights show the status for each of the Chlorine Dosing Tanks by indicating the following:

- Green Light – tank level at High level or above
- Amber Light – tank level between High and Low levels
- Red Light – tank level at or below Low level

The Flashing Alarm Beacon 'flashes' red when any of the tanks have any High or Low level switch or alarm active. However, if a tank's outlet valve is selected 'Out of Service' from the SCADA, then that tank's High and Low level switches and alarms are disabled from the Flashing Alarm Beacon circuit.