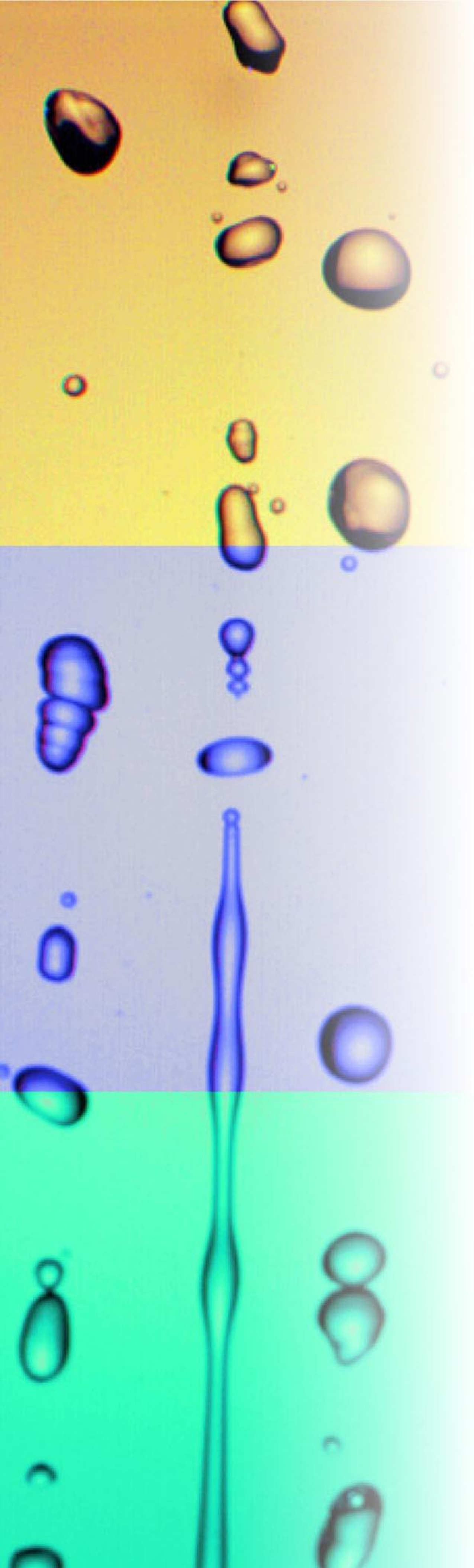
Appendix E

Water Treatment Plant User Requirement Specification



Winnipeg

THE CITY OF WINNIPEG WATER TREATMENT PLANT

USER REQUIREMENT SPECIFICATION – Revision 4

Project No. 79538–02

March 26, 2010

CH2MHILL

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WINNIPEG WTP
USER REQUIREMENT SPECIFICATION

RECORD OF AMENDMENTS

Issue	Date	Author	Checked	Approved	Amendment Details
00	19/10/07	Neal Toulson Becky Tang Salvador Banos			Issued for 159-2007 Preconstruction Meeting No. 1
01	23/11/07	Neal Toulson Becky Tang Salvador Banos			Issued for 159-2007 Revision 1
02		Neal Toulson			Potable Water Booster Pump Section Completed Dewatering Pump Station Section Completed DBPS Section updated Start up shutdown section completed Building Management System section completed Ozone Generation and Generator appendices added Chemical Storage Building Air Compressor section added
03		Neal Toulson			DBPS section expanded to include UV and open header description. Also to include revised tagging. Sodium Hypochlorite dosing sections 3.24 amended to include compound control loops for pump speed control

					Sodium Hydroxide dosing section amended to included compound control loop for pump speed control. **Air purge control description removed from Bulk Chemical unloading sections** **Description of level switch operation in section 3.1 RWPS deleted and additional level transmitter descriptions added.** **TSS/Turbidity analyzers removed from WRT tanks R200A, R300A and R400A and Gravity Thickener GT-R600A** **Clarification on different stages of Filter operation applied**
04		**Neal Toulson**			**As built following Commissioning of Plant DBPS section modified to describe Common Header Operation**

PREFACE

This document shall provide high level definition of the functionality of the complete works describing basic control functionality based upon process documentation together with plant and instrumentation as shown on the P&IDs.

Contents

1. Glossary

NB. The following terms are intended for general information and may not apply specifically to particular projects in all cases.

Assist operation:	Plant and equipment that shall automatically start in conjunction with the duty equipment
AS:	Air Scour
ASDS:	Alarm Summary Display System
Automatic Control:	In 'Automatic' the equipment shall run in accordance with instructions from the PLC or automatic control system
Available:	Plant is capable of operating if required
Banner Line:	Top three lines of the ASDS shown at the bottom part of most mimics
BAC:	Biological Activated Carbon
BWS:	Backwash Water Supply
BWW:	Backwash Wastewater
CBHL:	Clean Bed Headloss
Cleared:	An alarm state that has returned to the normal or 'healthy' state
C-O-H:	Computer-Off-Hand
Control Mode:	Remote manual, local manual or automatic control
DAF:	Dissolved Air Flotation
Database:	Part of the SCADA software where the parameters of the SCADA tag names are held. The database shall include Tag name, Description, Analogue ranges and engineering units etc.
DBPS:	Deacon Booster Pumping Station
Disable:	Prevent the automatic control of plant or process
Duty operation:	Plant and equipment that is selected to operate as priority
Emergency Stop:	Hardwired device arranged to bring plant and equipment to a safe condition as quickly as possible
Enable:	Allow the automatic control of plant or process

ETSW:	Extended Terminal Sub-fluidization Wash
Fault:	Individual equipment tripped conditions combined to form a single signal
FDS:	Functional Design Specification
Field:	Located in close proximity to plant or equipment
FIN:	Filter Influent
Flags:	A digital bit in the PLC software, which can have either, the value 1 'ON', or 0 'OFF'
FW:	Filtered Water
FTR:	Filter-to-Recycle
GAC:	Granular Active Carbon
Group Alarm:	A single alarm formed by a number of separate alarms
HMI:	Human Machine Interface - A device through which the Operator can monitor plant status and adjust parameters in the PLC
HMI/SCADA Set Points:	Set points and parameters that can be altered by the Operator via appropriate keystrokes at the HMI or SCADA
ICA:	Instrumentation, Control and Automation - relate to control equipment including PLC’s and associated hardware, instrumentation etc.
Icon:	A miniature picture on the SCADA mimic symbolising a function, or action of the SCADA system. Icons usually have an action, which is activated by 'clicking onto' the Icon using the mouse or via a Function Key
Inhibit:	A signal, which is required to ‘Disable’
Interlocks:	Inhibit/enable signals related to process conditions in plant or systems
I/O:	Inputs/Outputs - hardware associated with the PLC
Isolated:	The plant or equipment has been disconnected from the electrical supply
LCS:	Local Control Station
Latched:	A condition following tripped or fault conditions that requires a Reset to resume operation
Local:	Located in close proximity to plant or equipment
Logged:	Analogue, digital and alarm state information which is stored for future evaluation

Local Manual Control:	Control of plant using pushbuttons, switches etc.
MCC:	Motor Control Centre
Mimic:	Graphical image displayed on the HMI or SCADA
NOM:	Natural Organic Matter
NTU:	Nephelometric Turbidity Units
O-C-C:	Open-Close-Computer
OF:	Overflow
Out of Range:	The field instrument signal output is less than 3.5 mA or greater than 20.5 mA
Packaged Plant:	Stand alone groups of equipment, which, apart from a small number of supervisory control and monitoring I/O, are self, contained. Normal control of package elements is by the package control panel
PCS	Plant Control System
PCV:	Pump Control Valves
PDV:	Pump Discharge Valves
Permissive:	A signal that is required to 'Enable'
PID Control:	Proportional Integral and Derivative Control
P&ID:	Piping and Instrumentation Diagram
PLC:	Programmable Logic Controller
PLC Adjustable	Set points and parameters within the PLC that requires connection of a suitable programming device to facilitate alteration
RWPS:	Raw Water Pump Station
Remote:	Not at the location of Plant or Equipment
Remote Manual Control:	Control manually carried out at SCADA
Reset:	Action taken to reinstate control following tripped or fault conditions
Register:	A specific area of PLC memory, where data can be stored
SCADA:	Supervisory Control and Data Acquisition

Service	In service, the plant or equipment is functioning as part of the operating plant. Out of service, the plant or equipment is withdrawn from normal operation because of a fault or operator intervention
Standby operation:	Plant and equipment that shall automatically start if the duty equipment is unavailable If duty equipment is unavailable due to the actuation of an Emergency Stop pushbutton it may be determined that for safety or for process reasons the standby equipment should not start
Set point	A desired process condition such as a required dose rate entered into the control system either automatically or by the engineer/ operator
T&O:	Taste and Odour
Tag name:	A unique Alpha-Numeric name given to each point in the SCADA database used in the configuration of the SCADA system
Track:	The PLC shall monitor a specific signal/register and set the value of a different signal/register to the monitored value
Tripped:	A condition is present which has tripped the equipment e.g. overload, over-temperature, low flow and requires a reset
TSET:	Thickened Sludge Equalization Tanks
TSS	Total Suspended Solids
UFRV:	Unit Filter Run Volume
User:	General description for the Person or Group of people who shall use the completed system also referred to as the Client Different levels of user shall be defined typically as engineer and operator, the operator having less access to the system than the engineer
VFD:	Variable Frequency Drive
VSD:	Variable Speed Drive
WRT:	Washwater Recovery Tanks
WTP	Water Treatment Plant

2. Introduction

2.1 Plant Overview

The Winnipeg WTP is designed to produce between 200 and 418 ML/d of potable water. The raw water to the works is supplied from Shoal Lake in Ontario via the existing aqueduct and the storage cells at Deacon Reservoir.

The plant consists of the following treatment stages:

1. A raw water pumping station consisting of four variable speed vertical turbine pumps.
2. Sulphuric acid pH correction and ferric sulphate coagulant addition in two parallel flash mixer streams.
3. An equal flow split to the clarification plant comprising of eight parallel streams of flocculation and dissolved air flotation.
4. A recycle water saturation system comprising of compressors, saturation vessels and recycle pumps.
5. Collection of DAF float into four sumps.
6. Two Ozone contactors with hydrogen peroxide and sodium bisulphite dosing.
7. A three train ozone gas generation plant.
8. Mixing chamber before filter inlet channel with filter aid polymer dosing.
9. An equal flow split to eight BAC filters.
10. Two clean backwash water tanks.
11. A flow split to the filtered water chamber which feeds the chlorine contact tanks. Sodium hypochlorite is dosed before the contact tank.
12. Sodium hypochlorite and ammonia for disinfection and sodium hydroxide dosing for pH correction in a flash mixer stream.
13. Storage of treated water in a two cell Clearwell.
14. Distribution to City in town reservoirs with five pumps in DBPS.
15. UV treatment of water in DBPS.
16. Collection of backwash water, into four washwater recovery tanks.
17. Dosing and mixing of polymer into a flocculation chamber.
18. Thickening of dirty backwash water in two gravity thickeners.
19. Collection of sludge from thickeners and DAF float sumps into thickened sludge equalization tanks. Sludge is pumped to de-watering freeze thaw ponds.
20. Supernatent from thickeners collected in supernatant pump station and pumped back to Deacon Reservoirs as recycled water.
21. Chemical makeup and dosing facilities for pH correction (sulphuric acid and sodium hydroxide), coagulation (ferric sulphate), disinfection/oxidation (ozone gas, sodium hypochlorite and ammonia), thickening (polyelectrolyte), advanced oxidisation(hydrogen peroxide) and ozone quenching (hydrogen peroxide and sodium bisulphite).
22. Chemical delivery by either railcar or truck.

2.2 Control System Overview

2.2.1 General

An overview of the PLC/SCADA control system is shown on the following drawing numbers:

WH-A0100
WH-A0102
WH-A0103
WH-A0104
WH-A0105
WH-A0106

These drawings show all the PLC processors and racks associated with the control system along with the network servers, patch panels, interconnecting wiring etc.

Some of the PLC'S have been programmed as part of a pre-purchased package but these systems shall still be described in this document

2.2.2 UPS

Several UPS's around the plant shall provide backup electrical power to the following equipment.

- PLC/SCADA system including network patch panels and switches
- 24 VDC power supplies in panels
- 110 VAC instrumentation.

2.2.3 Modes of Control

All plant drives are provided with CPU/Off/Hand selection on the MCC drive starter doors or local to the drive.

The control system shall allow three modes of control for each plant item; these being:

- Automatic
- Remote Manual
- Local Control

In "automatic" mode, the PLC shall control the particular plant equipment based on the associated control logic and requirements

In "remote manual" mode the plant equipment shall be individually manually controlled at the SCADA system, via the respective PLC. In this mode, drives can be started/ stopped manually as required.

"Local manual control" of each individual drive shall be available via local controls on the individual motor starter compartment door. When operated in the local manual control mode all hardwired interlocks shall remain operative.

2.3 User Requirement Specification Format

This document shall be the source document for the control basis of all plant and equipment at the City of Winnipeg WTP.

Section 3 details the functionality for individual plant items and shall be complemented by the Standard Control Functionality contained within Appendix 1. Alarms and status points which are described in the Standard Control and Functionality specification are generally not listed again in Section 3 of this document. The functionality detailed in Appendix 1 shall be implemented wherever applicable unless specifically detailed otherwise within Section 3. The tables contained at the beginning of each section only show the main items of plant, for instance they do not show hand operated valves unless these are monitored by limit switches.

Section 4 details the sequencing of plant start-up and shutdown whilst Section 5 specifies the basis of the control system design.

Package Plant control philosophies are appended together with System Architecture drawings.

3. Control Description

3.1 Raw Water Pumping Station

3.1.1 Documentation

WI-P001 P&ID Inlet Works and Raw Water Pumping

WI-P002 P&ID Inlet Works and Raw Water Pumping

WI-P003 P&ID Inlet Works and Raw Water Pumping

WI-P004 P&ID Inlet Works and Raw Water Pumping

3.1.2 Plant and Instruments

Tag	Description	
SLG-I000	Raw Water Pumping Station Dividing Wall Sluice Gate	
LT-I000A	Raw Water Pumping Station Level Transmitter	
LT-I000C	Raw Water Pumping Station Level Transmitter	
HV-I001C	Raw Water Pump P-I001A Outlet Valve	
HV-I002C	Raw Water Pump P-I002A Outlet Valve	
FV-I000A	Raw Water Pumping Station Inlet Valve	
P-I001A	Raw Water Pump 1	
P-I002A	Raw Water Pump 2	
LT-I000B	Raw Water Pumping Station Level Transmitter	
LT-I000D	Raw Water Pumping Station Level Transmitter	
HV-I003C	Raw Water Pump P-I003A Outlet Valve	
HV-I004C	Raw Water Pump P-I004A Outlet Valve	
FV-I000B	Raw Water Pumping Station Inlet Valve	
P-I003A	Raw Water Pump 3	
P-I004A	Raw Water Pump 4	

3.1.3 General Operation

It is desirable to operate the WTP works as near to the average daily demand as practicable in order to minimise any adverse effects of sudden or large flow changes on any of the treatment process and chemical dosing systems.

At the Winnipeg WTP, the quantity of treated water required to be produced by the plant, shall be set as the total required flow in ML/D, and shall be a manually input variable via the SCADA/HMI system. To achieve and maintain the required quantity of treated water, the plant shall control the inlet flow to the DAF with four VSD Pumps in the Raw Water Station, and eight flow meters located in the raw water pipework going to each Flocculation Tank. The PLC shall calculate the sum of the flow meters and compare the total with the set point chosen by the operator. A PID control loop shall adjust the speed of the pumps until the flow set point is achieved. The maximum rate of increase of flow shall be set so that the rate of change of flow does not exceed

1.5% per minute of the maximum filter filtration rate. If treatment units are unavailable (not in service) then the flow into the works shall be limited. If this limited flow is less than the manually input required flow, then an alarm shall be raised and the limited figure used.

Raw water flows by gravity from the Deacon Reservoir Cells to feed the RWPS, hydraulically the high water level in the pumping station is the same as the high water level in Deacon Cells, so under normal circumstances it shall not be possible to flood the pumping station.

The operator shall be able to select through the SCADA/HMI system, which Cell (1 or 3) shall feed the RWPS by selecting and opening the corresponding Inlet Valve. If Inlet Valve FV-I000A is opened, the Raw Water Station Tank shall be filled by the Deacon Reservoir Cell 1. If Inlet Valve FV-I000B is opened, the Raw Water Station Tank shall be filled by the Deacon Reservoir Cell 3. Only one Inlet Valve should be open at any given time.

The RWPS Tank can be divided into two sections for maintenance purposes by closing the Dividing Wall Sluice Gate. The operator shall operate the Sluice Gate manually and then select the appropriate section as being out of service.

Water level in the RWPS shall be monitored by a two level transmitters in each side of the pumping station tank During normal operation (both sections in service, dividing wall sluice gate open) one level transmitter on each side of the tank shall operate as duty and the other one as standby. The average value as measured by the two duty transmitters will be displayed In case of failure of the duty level transmitter, the level readings shall automatically be taken from the standby level transmitter.

Raw Water Flow is supplied to the site through two raw water headers. At maximum plant capacity of 400 ML/d three Raw Water Pumps would be required to operate. The remaining pump shall be operated as a stand-by pump

The capacity of each pump can range from 70 ML/d (minimum speed) to 140 ML/d (maximum speed).

The Raw Water Pumps shall not be allowed to start up unless the level in the tank is above pump start level for a preset time and the corresponding outlet valves are open.

At initial plant start-up and after any event which has caused the branch aqueducts to drain down it may be required to fill the Clearwell to allow the aqueducts to be re-filled. In this event the operator can choose to start the plant as normal with a minimum flow rate of 100 ML/D, in which case the Clearwell would fill to the maximum level and the Raw Water Pumps would be shutdown. After the aqueduct recharging is complete it would then be necessary to restart the plant at the desired required treatment flow. See operations manual for further details.

3.1.4 Automatic Control Philosophy

3.1.4.1 Daily Treated Water Flow

The operator shall have the facility to adjust the treated water production of the works on a daily basis (24 hrs) using the following adjustable parameter “Daily Required Treated Water Flow”

The PLC shall monitor the time elapsed since the last set point change and raise an alarm 30 minutes (adjustable) before the next required change. If a new set point is not entered then the works shall continue to operate at the previous set point.

The Daily Required Treated Water Flow set point, shall be automatically modified if the number of treatment units change, or if a high level in the Clearwell is detected.

3.1.4.2 Clearwell Level Override

The water level in the WTP Clearwell shall be monitored and displayed on the SCADA/HMI system. The signals shall be used for alarms and to control as below;

Clearwell High Level – If the level in the Clearwell rises to a high level then the raw water flow to the works shall be reduced by a preset amount by reducing the speed of the Raw Water Pumps.

Clearwell High High Level – If the level in the reservoir reaches a high high level for a preset time, then the works shall enter an “Automatic Controlled Shutdown Sequence”, (see section 4.1.2.1).

The Clearwell process control is described in Section 3.13.

3.1.4.3 Raw Water Pumps

Raw water shall be pumped to the plant via four Raw Water Pumps P-I001A, P-I002A, P-I003A and P-I004A, these shall be VSD pumps. The speed of the pumps shall be controlled by using a magnetic coupling together with an actuator to adjust the gap in the magnetic coupling and hence the speed of the drive. During normal operation of the plant, a maximum of three and minimum of two pumps shall be running to provide the required WTP flow. The remaining pump shall be used as stand-by. The operator shall be able to select through the SCADA/HMI system, which pump shall operate as stand by. Should a duty pump fail while running the standby pump shall be started automatically in its place. Each pump shall have a local control panel, complete with a soft starter and protection relay. Various protection and monitoring devices as listed below shall be connected either to the protection relay or directly to the PLC.

Once the operator has provided the required daily flow set point, the PLC shall calculate how many pumps are required to run to and begin to start the pumps after an initiation by the operator. The duty pump shall be started and confirmed as running before another pump can be started, If two pumps are required to run the first pump started will start and run at the minimum speed, while the other pump is starting. Once both pumps are running, the PID controllers will bring both pumps to the same speed (RPM). When both pumps are running at the same speed a second flow control PID will start to control the speed of the running pumps to obtain the required flow. If three pumps are required to run then the same control strategy will be used. The pumps must start at minimum speed so before starting the system will check that the magnadrive is set accordingly.

As a minimum the following conditions shall be met before any of the pumps can be started.

- Raw Water pumping station level above pump start level.
- Corresponding pump discharge valve open.
- Raw Water Pipework Hand Valves HV-I016A, HV-I011A and HV-I012A open.

- Clearwell level not high.
- At least one Raw Water Inlet Valve Open.
- A minimum number of DAF tank inlet valves shall be open as follows.
  - Only one DAF tank inlet valve not closed, all pumps inhibited
  - Two DAF tank inlet valves not closed, one pump can start
  - Three DAF tank inlet valves not closed, two pumps can start
  - Six DAF tank inlet valves not closed, three pumps can start

3.1.4.4 Raw Water Flow Control MagnaDrive

The speed of the VSD Pumps P-I001A, P-I002A, P-I003A and P-I004A in conjunction with the flow transmitters FT-P100A, FT-P200A, FT-P300A, FT-P400A, FT-P500A, FT-P600A, FT-P700A and FT-P800A shall control the flow of raw water from the two raw water supply mains into the Flocculation Tanks in service.

To vary the output of the pumps a MagnaDrive VSD shall be installed between the motor and the load (pump).

The MagnaDrive components consist of a conductor assembly connected to the motor shaft and a magnet rotor assembly, connected to the pump. These assemblies never come in contact with each other as there is a narrow air gap between them.

To adjust the output of the load, the MagnaDrive varies the torque applied to the load, which is transmitted across the air gap, by increasing or decreasing the air gap. By varying the air gap, the amount of torque transmitted can be controlled, which in turn permits speed control. As the air gap is decreased, slippage between the conductor and the magnet is reduced and the torque applied to the load is increased; therefore, increasing the output of the pump. The opposite occurs when the air gap is increased. In controlling output speed, the third component of the MagnaDrive includes an actuator, which adjusts the air gap spacing between the magnet rotors and the conductor rotors. Actuation shall be controlled by the SCADA/HMI control system from a process signal.

3.1.4.5 Raw Water Station Inlet Valves FV-1000A, FV-1000B

The operator shall select which Inlet Valve to open. Opening the Inlet Valve FV-I000A shall feed water into the Raw Water Station Tank from the Deacon Cell 1. Opening the Inlet Valve FV-I000B shall feed water into the Raw Water Station Tank from the Deacon Cell 3. Only one valve shall be opened during plant operation.

3.1.4.6 Raw Water Pumping Station Tank Levels

Four level transmitters shall be installed in the Raw Water Pumping Station, two on either side of the dividing wall.

During normal operation, the Raw Water Pumping Station Dividing Wall Sluice Gate shall remain open. The SCADA/HMI control system shall verify the position of the gate and then allow the operator to select one level transmitter as duty and the other one as standby. The operator shall be able to switch the level transmitters between duty and standby as required. In case of failure of the duty transmitter, the SCADA/HMI system shall switch the standby level transmitter to duty. The average level as measured by the two duty instruments will be displayed.

If the water level in the Raw Water Pumping Station rises to the high level limit preset in the PLC for a preset time, a "High" alarm shall be raised on the SCADA/HMI.

In the event of the water level in the Raw Water Pumping Station rising to the 'High High' level for a preset time, an alarm shall be raised on SCADA/HMI and the PLC shall close the opened Inlet Valve and prevent both inlet valves from opening until the alarm is cleared.

If the water level in the Raw Water Pumping Station falls to the low level limit preset in the PLC for a preset time, a "Low" alarm shall be raised on the SCADA/HMI.

In the event of the water level in the RWPS falling to the 'Low Low' level for a preset time, an alarm shall be raised on SCADA/HMI and the PLC shall stop the VSD pumps and prevent them from starting until the alarm is cleared.

After 'High High' or 'Low Low' alarm has been cleared, the operator shall restore the plant operation manually.

If one section of the RWPS needs to be drained for maintenance purposes, the operator shall close manually the Dividing Wall Sluice Gate, and through the SCADA/HMI control system, the inlet valve corresponding to the RWPS Section to be taken out of service. The inlet valve from the section remaining in service must be or stay open. When the SCADA/HMI system receives the closed feedbacks both from the Sluice Gate and the corresponding inlet valve, it shall inhibit the level alarms from the section being drained.

3.1.4.7 Raw Water Station Discharge Valves HV-I0001C, HV-I0002C, HV-I0003C, HV-I0004C

There shall be a manually operated valve in the discharge pipework of each Raw Water Pump. Discharge valves must be opened prior to starting and during the operation of its respective pump. The SCADA/HMI system shall indicate the position of the outlet valves and verify that they are open before and during the operation of the Raw Water Pumps

3.1.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure; event and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
	Raw Water Tank high high level	Interlock	Raw Water Inlet Valves .Close Inlet Valves.
	Raw Water Tank return to normal working level after high high level reached	Event	Manually initiated start up of works after shutdown
LT-I000A LT-I000C	Loss or failure of Raw Water Tank level signal	Fault	If Sluice Gate open and Transmitter operating as Duty, automatic switchover to the stand by Transmitter. If Sluice Gate open and Transmitter operating as stand by, prevent switchover of the Duty Transmitter. Warn operator If Sluice Gate closed, warn operator.
LT-I000B LT-I000D	Loss or failure of Raw Water Tank level signal	Fault	If Sluice Gate open and Transmitter operating as Duty, automatic switchover to the stand by Transmitter. If Sluice Gate open and Transmitter operating as stand by, prevent switchover of the Duty Transmitter. Warn operator If Sluice Gate closed, warn operator.
	Raw Water Tank low low level	Interlock	Shutdown Raw Water Pumps
	Raw Water Tank return to normal working level after high high level reached	Event	Manually initiated start up of works after shutdown
	DAF effluent channel high high level switch activated	Interlock	Shutdown Raw Water Pumps
	Filter Inlet channel high high level	Interlock	Shutdown Raw Water Pumps
	Clearwell high level	Alarm	Reduce speed of Raw Water Pumps
	Clearwell high high level	Interlock	Shutdown Raw Water Pumps
LT-P980A LT-P980B	DAF Process Sump high level See section 3.31.4 for further details	Interlock	Shutdown Raw Water Pumps

3.1.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Raw Water Pumping Station Tank high level	0-100%
Raw Water Pumping Station Tank low level	0-50%
Raw Water Pump Speed ramp down value	0-50 ML/d

SCADA/HMI Operator Adjustable Set Points

Description	Range
Daily Required Treatment Flow	150-400 ML/d

SCADA/HMI Status Signals

None

The following signals shall be displayed for each VSD pump

Description	Range
Magnetic Coupling Position	
Top Bearing Temperature	
Bottom Bearing Temperature	
Motor Temperatures	
Raw Water Pump Vibration	
Raw Water Pump Speed	
Soft Start Bypass Position	

SCADA/HMI Alarm Signals

None

3.2 Parallel Flash Mixers Trains 1 & 2

3.2.1 Documentation

WP-P0001 P&ID Flocculation and DAF

3.2.2 Plant and Instruments

Tag	Description	
TT-I011A	Train1 Raw Water Temperature	
AT-I024B	Train1 Raw Water pH	
FS-I024B	Train1 Raw Water pH Low Sample Flow	
PT-I011B	Train1 Raw Water Main Pressure	
FS-I017D	Train1 Ferric Chloride Dosing Low Flow Switch	
AT-I025B	Train1 Post Flash Mixer Raw Water pH	
FS-I022E	Train1 Sulphuric Acid Dosing Low Flow Switch	
P-I013A	Train1 Duty Flash Mixing Pump #1	
HV-I013D	Train1 Flash Mixing Pump P-I013A Discharge Valve	
TT-I012A	Train2 Raw Water Temperature	
AT-I027B	Train2 Raw Water Turbidity	
FS-I027B	Train2 Raw Water Turbidity Low Sample Flow	
PT-I012B	Train2 Raw Water Main Pressure	
FS-I018D	Train2 Ferric Chloride Dosing Low Flow Switch	
AT-I026B	Train2 Post Flash Mixer Raw Water pH	
FS-I023E	Train2 Sulphuric Acid Dosing Low Flow Switch	
P-I015A	Train2 Duty Flash Mixing Pump #3	
HV-I015D	Train2 Flash Mixing Pump P-I015 Discharge Valve	
P-I014A	Common Standby Flash Mixing Pump #2	
FV-I014D	Common Standby Flash Mixing Pump Valve To Train 1	
FV-I014E	Common Standby Flash Mixing Pump Valve To Train 2	
HV-I011A	Train 1 Isolation Valve	
HV-I012A	Train 2 Isolation Valve	
HV-I016A	Train Crossover Valve	

3.2.3 General Operation

The operation of the two mixing Trains is identical.

Under normal conditions, raw water shall be pumped to the pre-treatment area of the WTP from the RWPS via two parallel 1,350 mm water mains. Each main feeds one DAF train consisting of four DAF tanks The DAF tanks are numbered 1 to 8 from west to east. Train 1 comprises DAF tanks 1 to 4 and Train 2 comprises DAF tanks 5 to 8.

The following devices are included along each of the two 1,350 mm mains:

- Sample draw off points for continuous raw water analysis of pH and turbidity
- Temperature and pressure measurement
- Two injectors for the injection of sulphuric acid, one duty and one standby along with two spare injection points
- One draw off point for the flash mix pumps
- One isolation valve
- One flash mixing system which includes three flash mixer pumps flash mix pump discharge and ferric chloride addition
- Sample draw off points for continuous analysis of pH after chemical addition
- Four 600 mm main which lead to each of the four DAF tanks in each train

In addition, a normally open 1,350 mm crossover butterfly valve (V-I016A) shall be installed between the two mains, just upstream of the sulphuric addition points, to allow for each main to operate as a back-up to the other main, should one be removed from service.

3.2.3.1 pH Adjustment

Prior to coagulation, 92% sulphuric acid shall be injected continuously for the purpose of depressing pH. Although it is important that the acid is properly mixed into the bulk raw water flow, it is not critical that true "flash" mixing is practiced, and a standard in-line pipe diffuser shall be used to inject the acid across the full width of the raw water pipeline.

The control of the injection of the sulphuric acid shall be flow proportional, based upon the totalized raw water flow for that train, as calculated by the summation from each of the four individual DAF tank inlet flow meters in that train. See Section 3.27 for chemical dosing details. There is one duty sulphuric acid metering pump one duty chemical feed line for each of the DAF trains.

3.2.3.2 Coagulant Injection and Flash Mixing

To ensure true "flash" mixing of the primary coagulant, jet flash mixing shall be used to mix ferric chloride into the raw water. A separate flash mix injector, MXR-I017A and MXR-I018A, shall be installed in each of the 1,350 mains feeding DAF Train 1 and 2 respectively. The flash mixers shall consist of a 250 mm nominal diameter, full cone titanium style spray nozzle, mounted within a 1,350 mm tee.

Each injector shall be served by a dedicated flash mix pump, which draws a sidestream flow of 3% of the maximum flow to each train. Each pump shall be a fixed speed horizontal axial impeller pump to ensure that flash mixing energy is constant and independent of bulk raw water flow or chemical dosage.

A 50 mm ferric chloride solution line shall deliver coagulant to each nozzle. The ferric chloride piping shall be installed so that the ferric chloride solution is delivered into the throat of the nozzle, the turbulence generated by the nozzle shall flash mix the ferric chloride across the diameter of the pipe within a projected 1.25 pipe diameters downstream of the nozzle.

The control of the injection of the ferric chloride solution shall be flow proportional, based upon the totalized raw water flow for that train, as calculated by the summation from each of the four individual DAF tank inlet flow meters in that train. See Section 3.21 for chemical dosing details. There is one duty ferric chloride metering pump one duty chemical feed line for each of the DAF trains.

3.2.4 Automatic Control Philosophy

3.2.4.1 Train in Service

For the following processes to take place certain checks shall be made by the control system to ensure that raw water is flowing in the trains for a preset time. If the checks confirm that water is flowing the train shall be considered "In Service".

For Train 1 the sum of the instantaneous flow totals from the following flow meters must be more that 65 ML/d for one minute before the train is "In Service".

FT-P100A, FT-P200A, FT-P300A, FT-P400A.

For Train 2 the sum of the instantaneous flow totals from the following flow meters must be more that 65 ML/d for one minute before the train is "In Service".

FT-P500A, FT-P600A, FT-P700A, FT-P800A.

3.2.4.2 Isolation Valve Monitoring

Each train has a manually operated isolation valve in the pipework; the valve shall have open and closed limit switches fitted so that the position of the valve can be monitored by the control system. During normal operation both of the isolation valves shall be open; if either of the valves are closed then the appropriate train shall be considered "Out of Service".

Train 1	HV-I011A
Train 2	HV-I012A

3.2.4.3 Crossover Valve Monitoring

If either of the mains needs to be isolated for any reason, then the cross connection between the mains can be used to isolate one main from the other. The normally open manually operated valve HV-I016A in the cross connection shall have its position monitored by the control system. If the crossover valve is closed the operator will have to make some operational decisions on limiting flows or disabling streams.

3.2.4.4 Duty Flash Mixing Pump Operation.

Whenever a train is confirmed as being in service, a flash mixer pump shall be required to run. Before a pump can be started, the train must have been in service for a pre-set time and the isolation valve in the pump discharge confirmed as open.

Each train shall have a dedicated duty pump as follows.

Train 1	P-I013A	HV-I013D
Train 2	P-I015A	HV-I015D

3.2.4.5 Common Standby Flash Mixing Pump Operation.

The common standby flash mixer pump P-I014A shall have electrically actuated valves in its discharge pipework so that if either duty pump fails the pump shall be started automatically and the appropriate valve shall open as described below.

If Train 1 duty pump P-I013A fails and the train is in service then valve FV-I014D shall be opened, when it is confirmed as open the common standby pump shall start.

If Train 2 duty pump P-I015A fails and the train is in service then valve FV-I014E shall be opened, when it is confirmed as open the common standby pump shall start.

During normal operation the common standby pump shall rotate to become a duty pump so that typically in the first week it shall be a standby pump, in the second week it shall be the Train 1 duty pump and in the third week it becomes the duty pump for Train 2. If during the rotation the other duty pump fails, the common standby pump shall revert to its standby duty.

3.2.4.6 Ferric Chloride Dosing

See Section 3.20

3.2.4.7 Sulphuric Acid Dosing

See Section 3.26

3.2.4.8 Temperature Monitoring

Both trains shall have temperature transmitters installed in the pipework to measure the raw water temperature. The temperature shall be monitored and displayed by the control system.

Train 1	TT-I011A
Train 2	TT-I012A

3.2.4.9 Pressure Monitoring

Both trains shall have pressure transmitters installed in the pipework to measure the raw water pressure. The pressure shall be monitored and displayed by the control system.

Train 1	PT-I011B
Train 2	PT-I012B

3.2.4.10 Turbidity Monitoring

Both trains shall have sample lines installed which shall take a water sample to a turbidity analyzer, the analyzer output shall be monitored and displayed by the control system if the train is in service. The sample flow to each analyzer shall be monitored by a flow switch, if the train is in service and a low sample flow is detected an alarm shall be raised on SCADA/HMI.

Train 1	AT-I024B	FS-I024B
Train 2	AT-I027B	FS-I027B

3.2.4.11 pH Monitoring

Both trains shall have sample lines installed which shall take a water sample to a pH analyzer, the analyzer output shall be monitored and displayed by the control system if the train is in service. The sample flow to each analyzer shall be monitored by a flow switch, if the train is in service and a low sample flow is detected an alarm shall be raised on SCADA/HMI.

Train 1	AT-I025B	FS-I025B
Train 2	AT-I026B	FS-I026B

3.2.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
Train No.1			
HV-I011A	Hand Valve Closed	Interlock	Train "out of service" Limit Raw Water Flow
Train No.2			
HV-I012A	Hand Valve Closed	Interlock	Train "out of service" Limit Raw Water Flow
HV-I016A	Crossover Valve Closed	Interlock	Operation of Raw Water Pumps fixed for each train.

3.2.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status signals

Description	Range
Train 1 In Service	
Train 2 In Service	
Crossover Operating	

SCADA/HMI Alarm Signals

None

3.3 Flow Distribution to DAF Tanks

3.3.1 Documentation

WP-P002 P&ID Inlet Flow Distribution to DAF Tanks 1-4

WP-P003 P&ID Inlet Flow Distribution to DAF Tanks 5-8

3.3.2 Plant and Instruments

Tag	Description	
DAF Stream No. 1		
FT-P100A	DAF Tank TNK-P100A Inlet Flowmeter	
FCV-P100A	DAF Tank TNK-P100A Inlet Flow Control Valve	
FT-P200A	DAF Tank TNK-P200A Inlet Flowmeter	
FCV-P200A	DAF Tank TNK-P200A Inlet Flow Control Valve	
FT-P300A	DAF Tank TNK-P300A Inlet Flowmeter	
FCV-P300A	DAF Tank TNK-P300A Inlet Flow Control Valve	
FT-P400A	DAF Tank TNK-P400A Inlet Flowmeter	
FCV-P400A	DAF Tank TNK-P400A Inlet Flow Control Valve	
FT-P500A	DAF Tank TNK-P500A Inlet Flowmeter	
DAF Stream No. 2		
FCV-P500A	DAF Tank TNK-P500A Inlet Flow Control Valve	
FT-P600A	DAF Tank TNK-P600A Inlet Flowmeter	
FCV-P600A	DAF Tank TNK-P600A Inlet Flow Control Valve	
FT-P700A	DAF Tank TNK-P700A Inlet Flowmeter	
FCV-P700A	DAF Tank TNK-P700A Inlet Flow Control Valve	
FT-P800A	DAF Tank TNK-P800A Inlet Flow Meter	
FCV-P800A	DAF Tank TNK-P800A Inlet Flow Control Valve	

3.3.3 General Operation

The operator has the facility to adjust the treated water production rate of the works on a daily basis, the production rate the operator selects shall be used to determine how many DAF streams and tanks are required to be in service. The DAF tank inlet valve and flow meter shall be used to control the flow rate to an individual tank and the summated flows from all the flow meters shall be used for plant monitoring and flow proportional control for chemical dosing.

There are two DAF trains; each DAF train consists of four DAF tanks. Each DAF train is designed to treat a range of flows of between 105 and 209 ML/d per train, or approximately 26 and 53 ML/d per tank. The number of tanks and streams in operation shall be selected so that the tanks operate between their 50 and 100% design treatment capacities of 26.13 and 52.25 ML/d per tank. In general, it is desirable to operate the tanks in pairs associated with a recycle pump and saturator. However, the selection of specific DAF tanks to be placed in operation is possible.

3.3.4 Automatic Control Philosophy

3.3.4.1 DAF Stream Operation and Daily Treated Water Flow

If the operator selected “Daily Required Treated Water Flow” is below 209 ML/d then it is possible to operate the plant with one DAF train in service (four DAF tanks). If the flow required is above 209 ML/d then depending on the flow required more than four tanks need to be in service.

To maintain efficient operation of the DAF Tanks it is required that the flow in a tank is between 26 and 53 ML/d, so depending on the Daily Treated Water Flow, the PLC shall select the optimum number of tanks to be in service from each stream.

The Daily Required Treated Water Flow set point shall be automatically modified if the number of treatment units change. An alarm shall be raised on the SCADA if this should occur.

3.3.4.2 DAF Tank Inlet Flow Control

The actuated valves on the DAF tank inlets in conjunction with their respective flow meters shall control the flow of raw water to each Flocculation tank which is selected for operation. The operator shall select the tanks to be put into operation depending on the treated water plant flow rate required and the flow rate to each tank shall be equally split across the selected tanks. A minimum amount of tanks need to be in service before the Raw Water Pumps shall start.

- Only one DAF tank inlet valve not closed, all pumps inhibited
- Two DAF tank inlet valves not closed, one pump can start
- Three DAF tank inlet valves not closed, two pumps can start
- Six DAF tank inlet valves not closed, three pumps can start

3.3.4.3 DAF Tank Inlet Valves

PID loop algorithms shall be used to determine the required valve position in order to maintain the desired flow as calculated by the PLC.

If a DAF tank is taken out of service by the operator then the respective Inlet Valve shall close.

3.3.4.4 DAF Tank Inlet Flow

The operation of the eight flow meters is identical.

The PLC shall monitor the raw water flow to each DAF tank in service and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 10,000 litres and the accumulated flow shall be displayed on the SCADA.

3.3.4.5 Works Total Raw Water Flow

The PLC shall summate the DAF Tank Inlet Flows (FI-P100A+ FI-P200A+ FI-P300A+ FI-P400A+ FI-P500A+ FI-P600A+ FI-P700A+ FI-P800A) and display the instantaneous value on the SCADA.

The PLC shall also summate the DAF Tank Inlet accumulated flows and display on the SCADA.

The instantaneous value shall be used as part of other algorithms to control chemical dosing and other plant functions.

Flow measurement and totalisation shall only take place when a Raw Water Pump is detected as running.

3.3.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
FT-P100A FT-P200A FT-P300A FT-P400A FT-P500A FT-P600A FT-P700A FT-P800A	DAF Tank Inlet Flow Meter	Fault	If the flow meter fails while its associated DAF tank is in service the PLC shall hold the signals (instantaneous and pulsed) at the last valid value until the fault is cleared or the tank is taken out of service. The PID loop associated with the valve/ flow meter shall switch to manual mode. When the fault is cleared the loop must be switched back to auto by the operator.
FT-P100A FT-P200A FT-P300A FT-P400A FT-P500A FT-P600A FT-P700A FT-P800A	DAF Tank Inlet Flow Meter	Alarm	If the flow meter detects a high or low flow an alarm shall be raised but no other action shall be taken
FCV-P100A FCV-P200A FCV-P300A FCV-P400A FCV-P500A FCV-P600A FCV-P700A FCV-P800A	Valve Failure	Fault	If the valve fails while the respective DAF tank is in service then the valve will go fully open until the fault is cleared or the tank is taken out of service.

3.3.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

Description	Range
DAF Stream 1 Duty	
DAF Stream 2 Duty	

SCADA/HMI Status Signals

Description	Range
Plant Raw Water Flow (instantaneous)	0-xx.xx ML/d
Plant Raw Water Flow (totalised)	0-xxxxxx ML/d

SCADA/HMI Alarm Signals

None

3.4 DAF Flocculation/Tanks 1 to 8

3.4.1 Documentation

WP-P0004 P&ID DAF Flocculation / Tank 1
WP-P0005 P&ID DAF Flocculation / Tank 2
WP-P0006 P&ID DAF Flocculation / Tank 3
WP-P0007 P&ID DAF Flocculation / Tank 4
WP-P0008 P&ID DAF Flocculation / Tank 5
WP-P0009 P&ID DAF Flocculation / Tank 6
WP-P0010 P&ID DAF Flocculation / Tank 7
WP-P0011 P&ID DAF Flocculation / Tank 8

3.4.2 Plant and Instruments

Tag	Description	
Flocculation Tank 1 TNK-P100A		
FLC-P101A	Tank 1 Flocculator VFD 1	
FLC -P102A	Tank 1 Flocculator VFD 2	
FLC -P103A	Tank 1 Flocculator VFD 3	
FLC -P104A	Tank 1 Flocculator VFD 4	
FLC -P105A	Tank 1 Flocculator VFD 5	
FLC -P106A	Tank 1 Flocculator VFD 6	
Dissolved Air Flotation Tank 1 TNK-P100B		
SLG-P140A	Modulating Gate Tank 1	
LIT-P100A	Level Sensor Tank 1	
FV-P110A	DAF Dispersion Valve Tank 1	
FV-P110B	DAF Dispersion Valve Tank 1	
DAF Skimmer Mechanism Tank 1 TNK-P100A		
DF-P100A	Tank 1 Skimmer VFD	
ZS-P100A	Skimmer Tank 1 Proximity Switch FWD	
ZS-P100B	Skimmer Tank 1 Proximity Switch REV	
SOL-P120A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P120B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 2 TNK-P200A		
FLC-P201A	Tank 2 Flocculator VFD 1	
FLC-P202A	Tank 2 Flocculator VFD 2	
FLC-P203A	Tank 2 Flocculator VFD 3	
FLC-P204A	Tank 2 Flocculator VFD 4	
FLC-P205A	Tank 2 Flocculator VFD 5	
FLC-P206A	Tank 2 Flocculator VFD 6	
Dissolved Air Flotation Tank 2 TNK-P200B		
SLG-P240A	Modulating Gate Tank 2	
LIT-P200A	Level Sensor Tank 2	
FV-P210A	DAF Dispersion Valve Tank 2	
FV-P210B	DAF Dispersion Valve Tank 2	
DAF Skimmer Mechanism Tank 2 TNK-P200A		
DF-P200A	Tank 2 Skimmer VFD	
ZS-P200A	Skimmer Tank 2 Proximity Switch FWD	
ZS-P200B	Skimmer Tank 2 Proximity Switch REV	
SOL-P220A	DAF Basin Float Trough Spray Wash Solenoid Valve	

Tag	Description	
SOL-P220B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 3 TNK-P300A		
FLC-P301A	Tank 3 Flocculator VFD 1	
FLC-P302A	Tank 3 Flocculator VFD 2	
FLC-P303A	Tank 3 Flocculator VFD 3	
FLC-P304A	Tank 3 Flocculator VFD 4	
FLC-P305A	Tank 3 Flocculator VFD 5	
FLC-P306A	Tank 3 Flocculator VFD 6	
LE-P300A	Tank 3 Level Meter	
Dissolved Air Flotation Tank 3 TNK-P300B		
SLG-P340A	Modulating Gate Tank 3	
LIT-P300A	Level Sensor Tank 3	
FV-P310A	DAF Dispersion Valve Tank 3	
FV-P310B	DAF Dispersion Valve Tank 3	
DAF Skimmer Mechanism Tank 3 TNK-P300A		
DF-P300A	Tank 3 Skimmer VFD	
ZS-P300A	Skimmer Tank 3 Proximity Switch FWD	
ZS-P300B	Skimmer Tank 3 Proximity Switch REV	
SOL-P320A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P320B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 4 TNK-P400A		
FLC-P401A	Tank 4 Flocculator VFD 1	
FLC-P402A	Tank 4 Flocculator VFD 2	
FLC-P403A	Tank 4 Flocculator VFD 3	
FLC-P404A	Tank 4 Flocculator VFD 4	
FLC-P405A	Tank 4 Flocculator VFD 5	
FLC-P406A	Tank 4 Flocculator VFD 6	
LE-P400A	Tank 4 Level Meter	
Dissolved Air Flotation Tank 4 TNK-P400B		
SLG-P440A	Modulating Gate Tank 4	
LIT-P400A	Level Sensor Tank 4	
FV-P410A	DAF Dispersion Valve Tank 4	
FV-P410B	DAF Dispersion Valve Tank 4	
DAF Skimmer Mechanism Tank 4 TNK-P400A		
DF-P400A	Tank 4 Skimmer VFD	
ZS-P400A	Skimmer Tank 4 Proximity Switch FWD	

Tag	Description	
ZS-P400B	Skimmer Tank 4 Proximity Switch REV	
SOL-P420A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P420B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 5 TNK-P500B		
FLC-P501A	Tank 5 Flocculator VFD 1	
FLC-P502A	Tank 5 Flocculator VFD 2	
FLC-P503A	Tank 5 Flocculator VFD 3	
FLC-P504A	Tank 5 Flocculator VFD 4	
FLC-P505A	Tank 5 Flocculator VFD 5	
FLC-P506A	Tank 5 Flocculator VFD 6	
LE-P500A	Tank 5 Level Meter	
Dissolved Air Flotation Tank 5 TNK-P500B		
SLG-P540A	Modulating Gate Tank 5	
LIT-P500A	Level Sensor Tank 5	
FV-P510A	DAF Dispersion Valve Tank 5	
FV-P510B	DAF Dispersion Valve Tank 5	
DAF Skimmer Mechanism Tank 5 TNK-P500A		
DF-P500A	Tank 5 Skimmer VFD	
ZS-P500A	Skimmer Tank 5 Proximity Switch FWD	
ZS-P500B	Skimmer Tank 5 Proximity Switch REV	
SOL-P520A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P520B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 6 TNK-P600A		
FLC-P601A	Tank 6 Flocculator VFD 1	
FLC-P602A	Tank 6 Flocculator VFD 2	
FLC-P603A	Tank 6 Flocculator VFD 3	
FLC-P604A	Tank 6 Flocculator VFD 4	
FLC-P605A	Tank 6 Flocculator VFD 5	
FLC-P606A	Tank 6 Flocculator VFD 6	
LE-P600A	Tank 6 Level Meter	
Dissolved Air Flotation Tank 6 TNK-P600B		
SLG-P640A	Modulating Gate Tank 6	
LIT-P600A	Level Sensor Tank 6	
FV-P610A	DAF Dispersion Valve Tank 6	
FV-P610B	DAF Dispersion Valve Tank 6	

Tag	Description	
DAF Skimmer Mechanism Tank 6 TNK-P600A		
DF-P600A	Tank 6 Skimmer VFD	
ZS-P600A	Skimmer Tank 6 Proximity Switch FWD	
ZS-P600B	Skimmer Tank 6 Proximity Switch REV	
SOL-P620A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P620B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 7 TNK-P700A		
FLC-P701A	Tank 7 Flocculator VFD 1	
FLC-P702A	Tank 7 Flocculator VFD 2	
FLC-P703A	Tank 7 Flocculator VFD 3	
FLC-P704A	Tank 7 Flocculator VFD 4	
FLC-P705A	Tank 7 Flocculator VFD 5	
FLC-P706A	Tank 7 Flocculator VFD 6	
LE-P700A	Tank 7 Level Meter	
Dissolved Air Flotation Tank 7 TNK-P700B		
SLG-P740A	Modulating Gate Tank 7	
LIT-P700A	Level Sensor Tank 7	
FV-P710A	DAF Dispersion Valve Tank 7	
FV-P710B	DAF Dispersion Valve Tank 7	
DAF Skimmer Mechanism Tank 7 TNK-P700A		
DF-P700A	Tank 7 Skimmer VFD	
ZS-P700A	Skimmer Tank 7 Proximity Switch FWD	
ZS-P700B	Skimmer Tank 7 Proximity Switch REV	
SOL-P720A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P720B	DAF Basin Headwall Spray Wash Header Valve	
Flocculation Tank 8 TNK-P800A		
FLC-P801A	Tank 8 Flocculator VFD 1	
FLC-P802A	Tank 8 Flocculator VFD 2	
FLC-P803A	Tank 8 Flocculator VFD 3	
FLC-P804A	Tank 8 Flocculator VFD 4	
FLC-P805A	Tank 8 Flocculator VFD 5	
FLC-P806A	Tank 8 Flocculator VFD 6	
LE-P800A	Tank 8 Level Meter	
Dissolved Air Flotation Tank 8 TNK-P800B		
SLG-P840A	Modulating Gate Tank 8	
LIT-P800A	Level Sensor Tank 8	

Tag	Description	
FV-P810A	DAF Dispersion Valve Tank 8	
FV-P810B	DAF Dispersion Valve Tank 8	
DAF Skimmer Mechanism Tank 8 TNK-P800A		
DF-P800A	Tank 8 Skimmer VFD	
ZS-P800A	Skimmer Tank 8 Proximity Switch FWD	
ZS-P800B	Skimmer Tank 8 Proximity Switch REV	
SOL-P820A	DAF Basin Float Trough Spray Wash Solenoid Valve	
SOL-P820B	DAF Basin Headwall Spray Wash Header Valve	
Common DAF Effluent Channel		
LIT-970A	Channel Level Transmitter	
LIT-971A	Channel Level Transmitter	
LS-P970A	Channel High High Level Switch	
LS-P971A	Channel High High Level Switch	
SLG-P970A	Channel Dividing Sluice Gate	
AE-975A	Turbidity Analyzer	
AE-976A	pH Analyzer	
FS-P975A	Flow Switch	

3.4.3 General Operation

The operation of the eight DAF tanks is identical.

The flocculation system for each DAF tank shall consist of three flocculation cells; each cell shall be equipped with two flocculators for a total of six flocculators per DAF tank. Water shall flow from Flocculation Cell No. 1 to Cell No. 2 and from Cell No. 2 to Cell No. 3 through walls perforated with 100 mm openings. Flocculated water flows over a submerged wall, approximately 500 mm below the liquid level, at the end of Cell No. 3 into the DAF injection zones of each DAF tank.

A local VFD control panel shall be provided for each DAF Tank which shall include seven VFDs consisting of six VFDs for the flocculators and one for the skimmer. Each VFD shall have a local digital display, and keypad, to allow operators to set the desired flocculator speed for each flocculator. It is intended that normally, each of the two flocculators mounted in parallel in a given flocculation cell shall be operated with the same speed, although flexibility is provided to alter this if required. Each VFD shall be controlled and monitored by its respective Main DAF control panel via an Ethernet network link.

All decisions regarding flocculator set point speeds are to be decided upon by the operators. Optimal flocculator speed may vary due to a variety of circumstances, including flow through a given tank, raw water quality, and temperature. It is intended that the operators shall leverage their operational experience with the process to optimize flocculation mixing under various conditions, to provide the ideal floc for flotation.

Each DAF tank shall have two DAF recycle injection manifolds used to disperse air saturated water into the tank. Each injection manifold is a different size so that different dispersion rates can be used depending on flow into the tank. The manifolds are fitted with electrically actuated valves so that depending on flow different configurations of manifolds can be used. The air saturated water shall be provided by the DAF Air Saturator System (section 3.5) Micro bubbles of air are released from the saturated water, which capture the floc particles. The rising floc particles float and collect on the water surface.

A reciprocating float scraper operates in a cyclic fashion to remove DAF float, where an array of scraper blades shall be driven forward to push the float towards a float "beach". Once the blades reach the forward limit of their cycle, all blades are then simultaneously lifted upwards and out of the sludge. After the blades have been lifted, the carriage is driven backwards to return to the starting point of the cycle. The blades are then lowered back into the float layer, ready for the next scraper cycle. Forward/reverse selection and Computer-Off-Hand selection are available on the local VFD control panel.

Each skimmer system shall be provided with forward and reverse proximity switches along with float trough and basin sidewall spray wash system headers. The water supply to the wash headers shall be controlled by two solenoid valves.

Normally the tanks are scraped intermittently to allow the float to collect and thicken, however flexibility shall be provided so that continuous operation of the scraper can be provided if required by the operator.

Water level in each tank shall be maintained by an effluent level control gate and level transmitter. It is important to maintain at least a minimum level because the scraper works at a fixed height in the tank.

Treated water shall flow from all the in service DAF tanks to a common effluent channel; the channel shall be equipped with duty/standby level transmitters and high level float switches. An isolation sluice gate shall be fitted at the centre of the channel to allow either side to be isolated if an Ozone Contactor needs to be taken out of service or for maintenance of the channel. Clarified effluent shall be analyzed continuously for turbidity and pH.

3.4.4 Automatic Control Philosophy

The PLC control program software for this section of the plant (except the DAF effluent channel) has been produced by the DAF Contractor (Leopold). All the main HMI control functions described in the following sections shall be duplicated on the SCADA system so that the plant can be operated by staff in the main control room.

The operation of all eight DAF tanks shall be identical.

3.4.4.1 DAF Tank Service Selection

As described in the previous section the amount of DAF tanks required to be in service largely depends on the required flow through the plant. However the operator shall have the option to select tanks for service and take tanks out of service if required.

3.4.4.2 Flocculation and DAF Systems

Operation of each flocculator shall be controlled via a C-O-H switch on the VFD keypad located on the local VFD control panel. Each of the eight DAF tanks has six flocculators (two flocculators per stage). Individual on/off and speed set point controls shall be provided for each flocculator drive.

A door mounted VFD keypad is provided to start, stop and adjust the local speed setting. The flocculators run continuously at a speed set at the respective local VFD panel.

With the VFD keypad in the COMPUTER position, the flocculator shall be controlled from its associated PLC. The on/off control and speed reference setting can be selected and adjusted from the HMI display on the Main DAF Control Panel and/or the Plant SCADA System. The motor shall not stop until the local VFD is switched to the OFF position, the operator selects OFF from the local HMI display or plant SCADA system, or a fault stops the flocculator.

3.4.4.3 Effluent Level Control Gate

A level transmitter measures the water level in each tank, and this level shall be used in a PID control loop to maintain a constant tank water level between 50 and 150% of nominal capacity to ensure proper operation of the skimmer mechanism. The effluent level control gate position shall modulate based on the liquid level to maintain the elevation. The operator shall set an adjustable level set point at the HMI/SCADA screen for each DAF tank. Both tank level and gate position shall be displayed on the SCADA/HMI.

3.4.4.4 DAF Skimmer Operation

Operation of each skimmer shall be controlled via VFD keypad selection and Forward/Reverse selection on the VFD keypad located on the local VFD control panel. Each of the eight DAF tanks has a dedicated skimmer.

A door mounted VFD keypad shall provide selection of forward/reverse direction until the end of travel limit switch is made. With the VFD keypad in the HAND position, the skimmer shall run continuously at a speed set at the respective Local VFD panel.

With the VFD keypad in the Computer position and the associated tank in service, the SKIMMER shall run as required by an internal PLC timer and shall make an operator adjustable number of passes. The skimmer shall travel from the “Reverse” position to the “Forward”, stop and wait a preset (operator adjustable) time and return to the “Reverse” position. The speed of the skimmer drive in this mode of operation is controlled from the PLC in reference to an operator-entered set point.

When an individual tank is taken out of service, the skimmer shall go into a shutdown sequence to remove any remaining sludge. After an adjustable number of skimmer cycles, the skimmer cycling sequence shall be stopped until the tank is placed back into service.

3.4.4.5 Spray Wash Valves

The operation of the spray wash valves shall be selected via O-C-C selection on the Main DAF control panel HMI.

With the O-C-C in the OPEN position, the valves shall be requested to open.

With the O-C-C in the CLOSE position, the valves shall be requested to close.

With the O-C-C in the COMPUTER position and the associated TANK IN SERVICE the spray valves shall automatically cycle open and closed based on operator entered set points and skimmer operation. When a skimmer cycle is initiated, the spray valves shall be requested to open for a set time period to pre-spray the DAF float channel. Then each time the skimmer reaches its forward limit switch, the valves shall be commanded to open for an operator adjustable set point time to wash down the accumulated sludge. Each spray valve can be operated independently of the other, for each tank.

3.4.4.6 DAF Effluent Channel Level Transmitters

Duty standby level transmitters shall be fitted to the channel, the operator shall select which transmitter is the duty instrument, and in the event of a failure of the duty instrument the standby shall become duty. If the isolation sluice gate is closed, then the operator shall select the duty instrument to be the one located on the "live" side of the channel.

The DAF recycle pumps are fed from the channel and so a minimum liquid level must be detected in the channel before any recycle pumps can be started.

Also for an Ozone Contactor to be in service there must be a minimum liquid level in the channel.

3.4.4.7 DAF Effluent Channel High High Level Float Switches

High high level float switches shall be installed in both sides of the effluent channel at just below the overflow level of the channel. In the event of an imminent overflow and either switch operating an alarm shall be raised on SCADA and the Raw Water Pumps shall shutdown until the level falls back to a pre-determined level. After the level has fallen back a panel restart shall be required.

3.4.4.8 DAF Effluent Channel Turbidity Analyzer

The effluent from the channel shall be continuously analyzed by an inline instrument. Samples to the analyzer shall normally be taken from both sides of the channel and a flow switch shall monitor the sample line flow.

In the event of high turbidity being measured an alarm shall be raised on SCADA.

3.4.4.9 DAF Effluent Channel pH Analyzer

The effluent from the channel shall be continuously analyzed by an inline instrument. Samples to the analyzer shall normally be taken from both sides of the channel and a flow switch shall monitor the sample line flow.

In the event of high and low pH being measured an alarm shall be raised on SCADA.

3.4.5 Failure and Interlock Conditions

Tag	Event	Type	Control System Action
MF-P*****A	Skimmer Forward Progress	Interlock	Open Solenoid Valve SOL-P***A
LIT-P****A	Level transmitter failure	Fault	If the instrument fails while its associated DAF tank is in service the PLC shall hold the signal at the last valid value until the fault is cleared or the tank is taken out of service.
LIT-P970A LIT-P971A	DAF Efffluent Level transmitter failure	Fault	If the instrument fails while selected as duty and the standby instrument is available, the standby shall become duty and an alarm raised on SCADA. In the event of both instruments being unavailable the PLC shall hold at the last value.
	High high Level	Alarm	Alarm on SCADA
LS-P970A LS-P971A	High high level	Interlock	Shutdown Raw Water Pumps
AIT-P975A	High turbidity	Alarm	Alarm on SCADA
AIT-P976A	High pH	Alarm	Alarm on SCADA

3.4.6 System Set Points, Status and Alarms

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

Description	Range
DAF TNK P100A	
Select tank in service	
Tank 1 Skimmer DF-P100A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 1 Trough Spray Wash System Valve SOL-P120A	
Spray Wash SOL-P120A / Down Time	0-60 s
Spray Wash SOL-P120A / Wash-Down Time	0-60 s
Valve Malfunction Time	120 s

Description	Range
Tank 1 Sidewall Spray Wash System Valve SOL-P120B	
Spray Wash SOL-P120B / Down Time	0-60 s
Spray Wash SOL-P120B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P200A	
Select tank in service	
Tank 2 Skimmer DF-P200A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 2 Trough Spray Wash System Valve SOL-P220A	
Spray Wash SOL-P220A / Down Time	0-60 s
Spray Wash SOL-P220A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 2 Sidewall Spray Wash System Valve SOL-P220B	
Spray Wash SOL-P220B / Down Time	0-60 s
Spray Wash SOL-P220B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P300A	
Select tank in service	
Tank 3 Skimmer DF-P300A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 3 Float Through Spray Wash System Valve SOL-P320A	
Spray Wash SOL-P320A / Down Time	0-60 s
Spray Wash SOL-P320A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 3 Sidewall Spray Wash System Valve SOL-P320B	
Spray Wash SOL-P320B / Down Time	0-60 s
Spray Wash SOL-P320B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s

Description	Range
DAF TNK P400A	
Select tank in service	
Tank 4 Skimmer DF-P400A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 4 Float Through Spray Wash System Valve SOL-P420A	
Spray Wash SOL-P420A / Down Time	0-60 s
Spray Wash SOL-P420A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 4 Sidewall Spray Wash System Valve SOL-P420B	
Spray Wash SOL-P420B / Down Time	0-60 s
Spray Wash SOL-P420B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P500A	
Select tank in service	
Tank 5 Skimmer DF-P500A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 5 Float Through Spray Wash System Valve SOL-P520A	
Spray Wash SOL-P520A / Down Time	0-60 s
Spray Wash SOL-P520A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 5 Sidewall Spray Wash System Valve SOL-P520B	
Spray Wash SOL-P520B / Down Time	0-60 s
Spray Wash SOL-P520B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P600A	
Select tank in service	
Tank 6 Skimmer DF-P600A	
Number of Passes	1-10

Description	Range
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 6 Float Through Spray Wash System Valve SOL-P620A	
Spray Wash SOL-P620A / Down Time	0-60 s
Spray Wash SOL-P620A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 6 Sidewall Spray Wash System Valve SOL-P620B	
Spray Wash SOL-P620B / Down Time	0-60 s
Spray Wash SOL-P620B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P700A	
Select tank in service	
Tank 7 Skimmer DF-P700A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s
Tank 7 Float Through Spray Wash System Valve SOL-P720A	
Spray Wash SOL-P720A / Down Time	0-60 s
Spray Wash SOL-P720A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 7 Sidewall Spray Wash System Valve SOL-P720B	
Spray Wash SOL-P720B / Down Time	0-60 s
Spray Wash SOL-P720B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
DAF TNK P800A	
Select tank in service	
Tank 8 Skimmer DF-P800A	
Number of Passes	1-10
Off Time	0-60 m
Forward Delay Time	0-5 s
Reverse Delay Time	0-5 s

Description	Range
Tank 8 Float Through Spray Wash System Valve SOL-P820A	
Spray Wash SOL-P820A / Down Time	0-60 s
Spray Wash SOL-P820A / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Tank 8 Sidewall Spray Wash System Valve SOL-P820B	
Spray Wash SOL-P820B / Down Time	0-60 s
Spray Wash SOL-P820B / Wash-Down Time	0-60 s
Valve Malfunction Time	0-120 s
Level Transmitter LIT-P970A Duty Select	
Level Transmitter LIT-P970A Duty Select	

SCADA/HMI Status Signals

Description	Range
Flocculation Tank 1 TNK-P100B	
Tank in Service	
Tank 1 Float Through Spray Wash System Valve SOL-P120A	
Time to Wash Down Remaining	
Tank 1 Sidewall Spray Wash System Valve SOL-P120B	
Time to Wash Down Remaining	
Flocculation Tank 2 TNK-P200B	
Tank in Service	
Tank 2 Float Through Spray Wash System Valve SOL-P220A	
Time to Wash Down Remaining	
Tank 2 Sidewall Spray Wash System Valve SOL-P220B	
Time to Wash Down Remaining	
Flocculation Tank 3 TNK-P300B	
Tank in Service	
Tank 3 Float Through Spray Wash System Valve SOL-P320A	
Time to Wash Down Remaining	
Tank 3 Sidewall Spray Wash System Valve SOL-P320A	
Time to Wash Down Remaining	
Flocculation Tank 4 TNK-P400B	
Tank in Service	
Tank 4 Float Through Spray Wash System Valve SOL-P420A	

Description	Range
Time to Wash Down Remaining	
Tank 4 Sidewall Spray Wash System Valve SOL-P420B	
Time to Wash Down Remaining	
Flocculation Tank 5 TNK-P500B	
Tank in Service	
Tank 6 Float Through Spray Wash System Valve SOL-P620A	
Time to Wash Down Remaining	
Tank 6 Sidewall Spray Wash System Valve SOL-P620B	
Time to Wash Down Remaining	
Flocculation Tank 7 TNK-P700B	
Tank in Service	
Tank 7 Float Through Spray Wash System Valve SOL-P720A	
Time to Wash Down Remaining	
Tank 7 Sidewall Spray Wash System Valve SOL-P720B	
Time to Wash Down Remaining	
Flocculation Tank 8 TNK-P800B	
Tank in Service	
Tank 8 Float Through Spray Wash System Valve SOL-P820A	
Time to Wash Down Remaining	
Tank 8 Sidewall Spray Wash System Valve SOL-P820B	
Time to Wash Down Remaining	

SCADA/HMI Alarm Signals

Description	Range
DAF Effluent Channel Overflow Imminent	

3.5 Recycle Pumps, Air Saturators and Compressors

3.5.1 Documentation

WP-P0012 P&ID Recycle System 1 of 2
WP-P0013 P&ID Recycle System 2 of 2
WP-P0014 P&ID Recycle System 1 of 2
WP-P0015 P&ID Recycle System 2 of 2
WP-P0016 P&ID DAF Compressors
WP-P0017 P&ID DAF Effluent Channel

3.5.2 Plant and Instruments

Tag	Description	
DAF Recycle System for Saturation Tanks 1 & 2		
P-P010A	Recycle Pump 1 (Duty)	
HV-P010C	Recycle Pump P-P010A Discharge Hand Valve	
P-P020A	Recycle Pump 2 (Standby)	
HV-P020C	Recycle Pump P-P020A Discharge Hand Valve	
P-P030A	Recycle Pump 3 (Duty)	
HV-P030C	Recycle Pump P-P030A Discharge Hand Valve	
FV-P020D	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve	
FV-P020E	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve	
Saturation Tank 1 TNK-P001A		
FIT-P001A	DAF Recycle Water to Saturator Flowmeter	
PT-P001A	Saturator Pressure Transmitter	
PS-P001A	Saturator Low Low Pressure Switch	
LIT-P001A	Saturator Level Transmitter	
LS-P001A	Saturator Low Low Level Switch	
TT-P001A	Saturator Temperature Transmitter	
FV-P001A	Saturator Outlet Control Valve	
Saturation Tank 2 TNK-P002A		
FIT-P002A	DAF Recycle Water to Saturator Flowmeter	
PT-P002A	Saturator Pressure Transmitter	
PS-P002A	Saturator Low Low Pressure Switch	
LIT-P002A	Saturator Level Transmitter	
LS-P002A	Saturator Low Low Level Switch	
TT-P002A	Saturator Temperature Transmitter	
FV-P002A	Saturator Outlet Control Valve	
DAF Recycle System for Saturation Tanks 3 & 4		
P-P040A	Recycle Pump 4 (Duty)	
HV-P040C	Recycle Pump P-P040A Discharge Hand Valve	
P-P050A	Recycle Pump 5 (Standby)	
HV-P050C	Recycle Pump P-P050A Discharge Hand Valve	
P-P060A	Recycle Pump 6 (Duty)	
HV-P060C	Recycle Pump P-P060A Discharge Hand Valve	
FV-P050D	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve	
FV-P050E	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve	
Saturation Tank 3 TNK-P003A		
FIT-P003A	DAF Recycle Water to Saturator Flowmeter	
PT-P003A	Saturator Pressure Transmitter	
PS-P003A	Saturator Low Low Pressure Switch	
LIT-P003A	Saturator Level Transmitter	

Tag	Description	
LS-P003A	Saturator Low Low Level Switch	
TT-P003A	Saturator Temperature Transmitter	
FV-P003A	Saturator Outlet Control Valve	
Saturation Tank 4 TNK-P004A		
FIT-P004A	DAF Recycle Water to Saturator Flowmeter	
PT-P004A	Saturator Pressure Transmitter	
PS-P004A	Saturator Low Low Pressure Switch	
LIT-P004A	Saturator Level Transmitter	
LS-P004A	Saturator Low Low Level Switch	
TT-P004A	Saturator Temperature Transmitter	
FV-P004A	Saturator Outlet Control Valve	
DAF Air System		
CMP-P910A	Duty Air Compressor	
CMP-P920A	Standby Air Compressor	
PV-P910A	Compressed Air Receiver	
PIT-P900A	Air Receiver Pressure Transmitter	

3.5.3 General Operation

A fundamental principle in the design of effective DAF recycle systems is to deliver the amount of air required for the process, using a minimum of water. The most effective and efficient system involves the combination of the use of a vertical, packed bed saturator, and variable frequency drives to control recycle pump speed.

Each saturator is designed to include approximately 1,200 mm depth of nominal diameter 25 mm polypropylene mass transfer packing Rauschert Rings. These pieces are individual plastic shapes intended to be of a very high surface area to volume ratio, so that recycle water trickling down through this packed bed forms a thin film throughout the bed, maximizing the efficiency of dissolution of air into the water. This bed of packing is supported above the floor of the saturator vessel using stainless steel grating. This allows for a reservoir of super-saturated water to form at the base of the vessel below the bed. A level transmitter shall be mounted external to the pressure vessel, intended to monitor the water level in the saturator. A visual level indication shall also be available using a sight glass.

The level signal shall be used to control the recycle pump speed to maintain a constant level of super-saturated water in the base of the saturator.

Each pair of DAF tanks shall be serviced by a duty recycle pump and duty saturator. In addition, one common recycle pump is provided for each DAF train and by a means of actuated valves, can service either saturator for that DAF train.

The flow of air into each saturator shall be controlled by manual adjustment of pressure reducing valves, which shall maintain a constant operating pressure in each saturator.

One duty air compressor system including oil lubricated, rotary screw compressor, dedicated air receiver and filters shall provide compressed air to all four saturators. A full standby system including compressor, dedicated air receiver and filters shall also be provided.

Post treatment of the air shall be provided on the discharge of each air receiver, as follows (in series)

- Particulate filters, sized to provide 70% remove of particles 1 micron or larger.
- Coalescing filters, sized to provide 99.999% remove of particles and oil droplets 0.25 micron or larger.
- Activated carbon filters, to reduce airborne oil content to below 0.003 ppm.

Pressure indicators shall be provided before and after and this post-treatment train, and between individual filters, to allow for the identification of filters requiring replacement.

The duty compressor shall operate to maintain air receiver pressure within a set point band. In the event of a failure of the duty compressor, the standby by compressor shall start. The selection of the duty and standby status shall be made manually by the Operator at the local control panel. The individual discharge lines of each compressor, downstream of the filters are equipped with check valves, thus, automated isolation valves are not required to ensure switch over to the duty compressor as the check valves shall prevent backflow of air towards the off-duty or failed compressor. A pressure transmitter located on a common line between the air receivers, shall be used to initiate the switch from the duty to the standby compressor, in the event of a low pressure.

3.5.4 Automatic Control Philosophy

3.5.4.1 DAF Saturator Overall Control

The operator can take individual saturators and/or tanks in and out of service based on flow requirements through the HMI unit on their respective Main DAF Control Panel or the SCADA. The individual "In Service/Out of Service" status shall be displayed on the HMI and the Plant SCADA System for each saturator and tank.

When a saturator is taken offline, the automated effluent valve shall close, the recycle pump feeding the saturator shall stop and the dispersion valves fed from that saturator shall close. The associated tank equipment such as the flocculators, the skimmers, the spray down valves, etc. shall remain operational until that tank is taken offline. Placing a particular saturator out of service shall stop the air saturated water flow to its associated tanks. Therefore, the influent flow control valves for these tanks shall be closed to prevent untreated water flow through the system.

Any individual tank may be taken out of service while the other tank associated with the saturator remains in-service. When an individual tank is taken out of service, the Dispersion valves to that tank shall close and the skimmer shall go into a shutdown sequence to remove any remaining sludge. After a remaining number of skimmer cycles, the skimmer cycling sequence shall be stopped. When a single tank is taken offline, the speed of the recycle pump feeding the saturator shall automatically adjust to maintain the saturator water level set point.

3.5.4.2 DAF Recycle Pumps

Operation of the recycle pumps shall be selected via a VFD keypad located on the recycle pump VFD control panel. Each DAF train has three (3) recycle pumps (two dedicated duty and one standby).

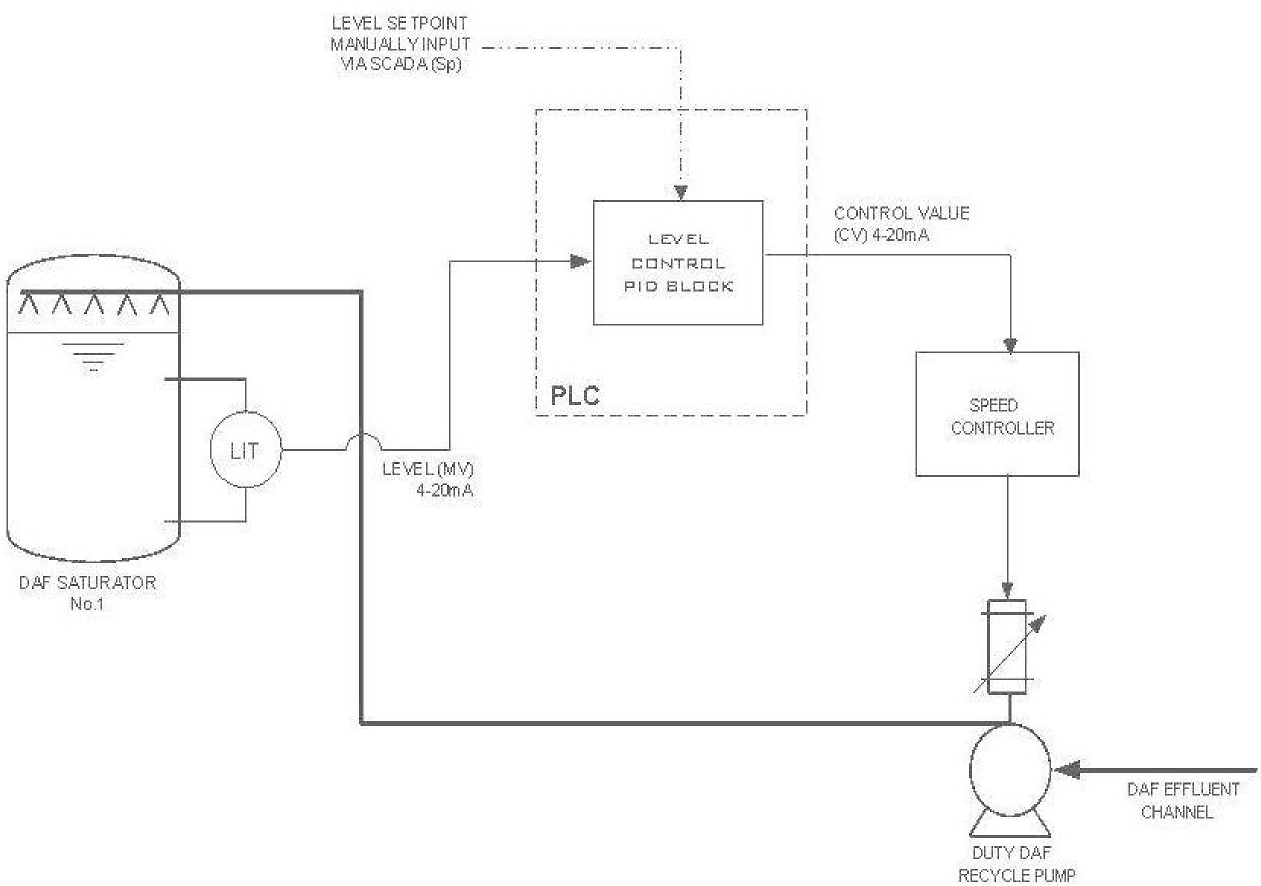
With the VFD keypad in the HAND position, the recycle pump will run continuously at a speed set at the respective Recycle Pump Control Panel. A door mounted VFD keypad is provided to adjust the local speed setting.

With the VFD keypad in the COMPUTER position and its respective SATURATOR IN SERVICE, the duty recycle pumps are controlled through the PLC. Each duty recycle pump shall be dedicated to a specific saturator, therefore, switching which saturator is in service shall also select which recycle pump is commanded to run.

In the event of a duty recycle pump failure, the automated recycle pump discharge valves shall automatically switch to permit operation of the standby pump. Once the discharge valves are verified as in the proper positions, the standby recycle pump shall be commanded to start. In the event that the standby pump is not available, the failure of a duty pump shall shut down operation of that saturator and associated DAF tanks.

Any operating recycle pump that is in the Computer position shall be permitted to run based on the DAF effluent channel level, the in service saturator and the duty/standby valve positions and the discharge hand valve position. A PID control loop internal to the PLC based on a saturator level signal controls the speed of the pumps.

See diagram below for typical control diagram.



3.5.4.3 DAF Recycle Pumps Pump Discharge Flow Meters

The PLC shall monitor the flow each recycle pump and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 1,000 litres and the accumulated flow shall be displayed on the SCADA.

3.5.4.4 Tank Dispersion Valve

The operation of the electrically-actuated, Tank Dispersion Valves is selected via the C-O-H switch located at the Main DAF HMI Panel.

With the C-O-H in the HAND position, the valve may be commanded to open or close locally at the valve actuator.

With the C-O-H in the OFF position, the valve shall be disabled.

With the C-O-H in the COMPUTER position, the respective TANK IN SERVICE and the respective air saturator in service, the Dispersion valves shall be requested to open and close to maintain a desired recycle flow rate at the proper percentage. Cycling of the Dispersion valves is based upon predetermined DAF influent tank flow rate (raw water).

3.5.4.5 Saturator Effluent Valve

The operation of the pneumatic-actuated Saturator Effluent Valves is selected via Open-Close-Computer selection on the Main DAF control panel HMI touchscreen unit.

With the O-C-C in the OPEN position, the valve shall be requested to open.

With the O-C-C in the CLOSE position, the valve shall be requested to close.

With the O-C-C in the COMPUTER position, the SATURATOR IN SERVICE, at least one tank in service, the recycle pump feeding the saturator running, tank pressure above a minimum set point, the saturator water level above a minimum set point and at least one associated tank in service, the saturator effluent valve shall be permitted to open delivering air saturated water to the tank Dispersion headers. If any of the above permissives are not satisfied, the saturator effluent valve shall be commanded to close until the situation is corrected.

3.5.4.6 Air Saturation Tank

The air saturation tank combines the water from the recycle pump with compressed air to produce air-saturated water that is then delivered to the DAF tank Dispersion header(s).

Adjusting the speed reference signal to the recycle pump feeding the tank controls the water level. As the saturator level increases, the pump speed shall decrease and vice-versa.

If a High-high level, in the saturator, is reached the recycle pump shall stop and an alarm is sent to the operator via the HMI and plant SCADA system. The alarm must be reset and the condition corrected before automatic operation can be resumed.

If a High level is reached, recycle pumps shall slow to minimum speed and an alarm shall be sent to the operator via the HMI and plant SCADA system. If the high condition corrects itself by lowering the level in the tank, the pumps shall again resume normal level control and the alarm shall be reset without operator interaction.

On Low level, an alarm is sent to the operator via the HMI and plant SCADA system indicating the recycle pump cannot maintain the required flow rate. If the low condition corrects itself by lowering the level in the tank, the pumps shall again resume normal level control and the alarm shall be reset without operator interaction.

On Low-low level, the saturator effluent valve shall close preventing the tank from fully emptying and an alarm is sent to the operator via the HMI and plant SCADA system. If the tank level then rises to above the low alarm set point, the alarm shall be reset without operator interaction.

If the saturator pressure exceeds the operator adjustable High or Low pressure alarm set point, an alarm is sent the operator via the HMI and plant SCADA system; no Valve or Pump states are changed.

A low-low pressure switch is included on each saturator tank to provide a hardwired interlock to the saturator effluent valve. If the saturator pressure drops below the pressure switch setting, the effluent valve shall close and an alarm sent to the operator via the HMI and plant SCADA system.

3.5.4.7 Air Compressor

Each Air Compressor has a local compressor control panel to start/stop the compressors. If a compressor fails, the standby compressor shall be started automatically.

3.5.5 Failure, Event and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
DAF Saturation Tank 1 TNK-P001A			
PS-P001A	Saturation Tank Low Low Pressure	Alarm & Interlock	A hardwired interlock closes the solenoid SOL-P001A, which closes corresponding saturator effluent valve, FV-P001A
DAF Saturation Tank 2 TNK-P002A			
PS-P002A	Saturation Tank Low Low Pressure	Alarm & Interlock	A hardwired interlock closes the solenoid SOL-P002A, which closes corresponding saturator effluent valve, FV-P002A
DAF Saturation Tank 3 TNK-P003A			
PS-P003A	Saturation Tank Low Low Pressure	Alarm & Interlock	A hardwire interlock closes the solenoid SOL-P003A, which closes corresponding saturator effluent valve, FV-P003A
DAF Saturation Tank 4 TNK-P004A			
PS-P004A	Saturation Tank Low Low Pressure	Alarm & Interlock	A hardwire interlock closes the solenoid SOL-P004A, which closes corresponding saturator effluent valve, FV-P004A

Tag	Event	Type	Control System Action
Recycle Pump P-P010A			
LIT-P001	Saturation Tank High Level	Alarm	Recycle pump for Saturation Tank 1 slows to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
	Saturation Tank High High Level	Alarm & Interlock	Recycle pump for Saturation Tank 1 is stopped. An alarm is sent to the operator via the HMI/SCADA.
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 1 increases to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
LS-P001A	Saturation Tank Low Level	Alarm	An alarm is sent to the operator via the HMI/SCADA.
HV-P010A	HV-P010A Open & Train 1 in Operation	Interlock	Recycle pump shall be allowed to run only if both signals are true
FIT-P001A	No Flow or Loss of Communication	Alarm & Interlock	If a duty recycle pump is running and no flow or loss of communication is detected, the standby recycle pump shall be started automatically
Recycle Pump P-P020A			
LIT-P001 or LIT-P002	Saturation Tank High Level	Alarm	If running, Recycle pump slows speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI.
	Saturation Tank High High Level	Alarm & Interlock	If running, Recycle pump stops. An alarm is sent to the operator via the HMI.
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 1 increases speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
LS-P001A	Saturation Tank Low Low Level	Alarm & Interlock	An alarm is sent to the operator via the HMI/SCADA and Saturator Effluent Valve closes. Valve opens once the level is reestablished in the saturator.
HV-P020A	HV-P020A Open	Interlock	Recycle pump shall be allowed to run only if the signal is true
UF-P010A or UF-P030A	Duty Pump Failure	Alarm & Interlock	Recycle Pump Commanded to Start if either signal is true.

Tag	Event	Type	Control System Action
Recycle Pump P-P030A			
LIT-P002A	Saturation Tank High Level	Alarm	Recycle pump for Saturation Tank 2 slows speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI.
	Saturation Tank High Level LSHH	Alarm & Interlock	Recycle pump for Saturation Tank 2 is stopped. An alarm is sent to the operator via the HMI.
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 2 increases speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
LS-P002A	Saturation Tank Low Low Level	Alarm & Interlock	An alarm is sent to the operator via the HMI/SCADA and Saturator Effluent Valve closes. Valve opens once the level is reestablished in the saturator.
HV-P030A	HV-P030A Open	Interlock	Recycle pump shall be allowed to run.
FIT-P002A	No Flow or Loss of Communication	Alarm & Interlock	If a duty recycle pump is running and no flow or loss of communication is detected, the standby recycle pump shall be started automatically
Recycle Pump P-040A			
LIT-P003A	Saturation Tank High Level	Alarm	Recycle pump for Saturation Tank 3 slows speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI
	Saturation Tank High Level	Alarm & Interlock	Recycle pump for Saturation Tank 3 slows speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI.
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 3 increases speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
LS-P003A	Saturation Tank Low Level	Alarm & Interlock	An alarm is sent to the operator via the HMI/SCADA and Saturator Effluent Valve closes. Valve opens once the level is reestablished in the saturator.
HV-P040A	HV-P040A Open &Train 2 in Operation	Interlock	Recycle pump shall be allowed to run only if both signals are true
FIT-P003A	No Flow or Loss of Communication	Alarm & Interlock	If a duty recycle pump is running and no flow or loss of communication is detected, the standby recycle pump shall be started automatically

Tag	Event	Type	Control System Action
Recycle Pump P-050A			
LIT-P003A or LIT-P004A	Saturation Tank High Level	Alarm	If running, Recycle pump slows to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA
	Saturation Tank High Level	Alarm & Interlock	If running, Recycle pump is stopped. An alarm is sent to the operator via the HMI/SCADA
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 3 increases to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
LS-P003A	Saturation Tank Low Low Level	Alarm & Interlock	An alarm is sent to the operator via the HMI/SCADA and Saturator Effluent Valve closes. Valve opens once the level is reestablished in the saturator.
HV-P050A	HV-P050A Open	Interlock	Recycle pump shall be allowed to run only if the signal is true
UF-P040A or UF-P060A	Duty Pump Failure	Alarm & Interlock	Recycle Pump Commanded to Start if either signal is true.
Recycle Pump P-060A			
LIT-P004A	Saturation Tank High Level	Alarm	Recycle pumps for Saturation Tank 1 slow to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI
	Saturation Tank High Level	Alarm & Interlock	Recycle pump for Saturation Tank 4 is stopped. An alarm is sent to the operator via the HMI
	Saturation Tank Low Level	Alarm	Recycle pump for Saturation Tank 4 increases to a predetermined speed until the alarm condition is corrected. An alarm is sent to the operator via the HMI/SCADA.
	Saturation Tank Low Low Level	Alarm & Interlock	Recycle pump for Saturation Tank 4 is stopped. An alarm is sent to the operator via the HMI/SCADA.
LS-P004A	Saturation Tank Low Low Level	Alarm & Interlock	An alarm is sent to the operator via the HMI/SCADA and Saturator Effluent Valve closes. Valve opens once the level is reestablished in the saturator.

Tag	Event	Type	Control System Action
HV-P060A	HV-P060A Open	Interlock	Recycle pump shall be allowed to run.
FIT-P004A	No Flow or Loss of Communication	Alarm & Interlock	If a duty recycle pump is running and no flow or loss of communication is detected, the standby recycle pump shall be started automatically

3.5.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
DAF Saturation Tank 1 TNK-P001A	
LIT-P001A Saturation Tank Operating Level	300 mm
LIT-P001A Saturation Tank Low Level	150 mm
LIT-P001A Saturation Tank High Level	500 mm
LIT-P001A Saturation Tank High High Level	550 mm
PIT-P001A Saturation Tank High Pressure	1000 kPa
DAF Saturation Tank 2 TNK-P002A	
LIT-P002A Saturation Tank Operating Level	300 mm
LIT-P002A Saturation Tank Low Level	150 mm
LIT-P002A Saturation Tank High Level	500 mm
LIT-P002A Saturation Tank High High Level	550 mm
PIT-P002A Saturation Tank High Pressure	1000 kPa
DAF Saturation Tank 3 TNK-P003A	
LIT-P003A Saturation Tank Operating Level	300 mm
LIT-P003A Saturation Tank Low Level	150 mm
LIT-P003A Saturation Tank High Level	500 mm
LIT-P003A Saturation Tank High High Level	550 mm
PIT-P003A Saturation Tank High Pressure	1000 kPa
DAF Saturation Tank 4 TNK-P004A	
LIT-P004A Saturation Tank Operating Level	300 mm
LIT-P004A Saturation Tank Low Level Alarm	150 mm
LIT-P004A Saturation Tank High Level Alarm	500 mm
LIT-P004A Saturation Tank High High Level Alarm	550 mm
PIT-P004A Saturation Tank High Pressure Alarm	1000 kPa

SCADA/HMI Operator Adjustable Set Points

Description	Range
Recycle Pump 1 P-010A	
MN-P010A Recycle Pump Start/Stop Command	0 - 1
SC-P010A Recycle Pump Speed Set point	0 - 1
Recycle Pump 2 P-020A	
MN-P020A Recycle Pump Start/Stop Command	0 - 1
SC-P020A Recycle Pump Speed Set point	0 - 1
Recycle Pump 3 P-030A	
MN-P030A Recycle Pump Start/Stop Command	0 - 1
SC-P030A Recycle Pump Speed Set point	0 - 1
Recycle Pump 4 P-040A	
MN-P040A Recycle Pump Start/Stop Command	0 - 1
SC-P040A Recycle Pump Speed Set point	0 - 1
Recycle Pump 5 P-050A	
MN-P050A Recycle Pump Start/Stop Command	0 - 1
SC-P050A Recycle Pump Speed Set point	0 - 1
Recycle Pump 6 P-060A	
MN-P060A Recycle Pump Start/Stop Command	0 - 1
SC-P060A Recycle Pump Speed Set point	0 - 1
Recycle Isolation Valve FV-P020D	
YD-P020D Recycle Isolation Valve Open Command	0 - 1
YB-P020D Recycle Isolation Valve Close Command	0 - 1
Recycle Isolation Valve FV-P020E	
YD-P020E Recycle Isolation Valve Open Command	0 - 1
YB-P020E Recycle Isolation Valve Close Command	0 - 1
Recycle Isolation Valve FV-P050D	
YD-P050D Recycle Isolation Valve Open Command	0 - 1
YB-P050D Recycle Isolation Valve Close Command	0 - 1
Recycle Isolation Valve FV-P050E	
YD-P050E Recycle Isolation Valve Open Command	0 - 1
YB-P050E Recycle Isolation Valve Close Command	0 - 1

SCADA/HMI Status Signals

Description	Range
Recycle Pump 1 P-010A	
MM-P010A Recycle Pump Running Status Indication	0 - 1
YS-P010A Recycle Pump Auto/ Manual Indication	0 - 1
SI-P010A Recycle Pump Speed Feedback	
IT-P010A Recycle Pump Current Indication	
ZD-P010C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
Recycle Pump 2 P-020A	
MM-P020A Recycle Pump Running Status Indication	0 - 1
YS-P020A Recycle Pump Auto/ Manual Indication	0 - 1
SI-P020A Recycle Pump Speed Feedback	
IT-P020A Recycle Pump Current Indication	
ZD-P020C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
Recycle Pump 3 P-030A	
MM-P030A Recycle Pump Running Status Indication	0 - 1
YS-P030A Recycle Pump Auto/ Manual Indication	0 - 1
SI-P030A Recycle Pump Speed Feedback	
IT-P030A Recycle Pump Current Indication	
ZD-P030C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
Recycle Pump 4 P-040A	
MM-P040A Recycle Pump Running Status Indication	0 - 1
YS-P040A Recycle Pump Auto/ Manual Indication	0 - 1
SI-P040A Recycle Pump Speed Feedback	
IT-P040A Recycle Pump Current Indication	
ZD-P040C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
Recycle Pump 5 P-050A	
MM-P050A Recycle Pump Running Status Indication	0 - 1
YS-P050A Recycle Pump Auto/ Manual Indication	0 - 1
SI-P050A Recycle Pump Speed Feedback	
IT-P050A Recycle Pump Current Indication	
ZD-P050C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
Recycle Pump 6 P-060A	
MM-P060A Recycle Pump Running Status Indication	0 - 1
YS-P060A Recycle Pump Auto/ Manual Indication	0 - 1

Description	Range
SI-P060A Recycle Pump Speed Feedback	
IT-P060A Recycle Pump Current Indication	
ZD-P060C Valve After Recycle Pump HV-P010C Open Indication	0 - 1
DAF Saturation Tank 1 TNK-P001A	
FI-P001A Flow After Recycle Pump 1	
PI-P001A Saturation Tank Pressure	0kPa-900kPa
LI-P001A Saturation Tank Level	
TI-P001A Saturation Tank Temperature	
DAF Saturation Tank 2 TNK-P002A	
FI-P002A Flow After Recycle Pump 3	
PI-P002A Saturation Tank Pressure	0kPa-900kPa
LI-P002A Saturation Tank Level	
TI-P002A Saturation Tank Temperature	
DAF Saturation Tank 3 TNK-P003A	
FI-P003A Flow After Recycle Pump 4	
PI-P003A Saturation Tank Pressure	0kPa-900kPa
LI-P003A Saturation Tank Level	
TI-P003A Saturation Tank Temperature	
DAF Saturation Tank 4 TNK-P004A	
FI-P004A Flow After Recycle Pump 6	
PI-P004A Saturation Tank Pressure	0kPa-900kPa
LI-P004A Saturation Tank Level	
TI-P004A Saturation Tank Temperature	

SCADA/HMI Alarm Signals

Description	Range
Recycle Pump 1 P-010A	
UF-P010A Recycle Pump Fault	0 - 1
Recycle Pump 2 P-020A	
UF-P020A Recycle Pump Fault	0 - 1
Recycle Pump 3 P-030A	
UF-P030A Recycle Pump Fault	0 - 1
Recycle Pump 4 P-040A	
UF-P040A Recycle Pump Fault	0 - 1

Description	Range
Recycle Pump 5 P-050A	
UF-P050A Recycle Pump Fault	0 - 1
Recycle Pump 6 P-060A	
UF-P010A Recycle Pump Fault	0 - 1
DAF Saturation Tank 1 TNK-P001A	
FQ-P001A Recycle Water Flow Alarm	
LIT-P001A Saturation Tank Low Level Alarm	150 mm
LIT-P001A Saturation Tank High Level Alarm	500 mm
LIT-P001A Saturation Tank High High Level Alarm	550 mm
LS-P001A Saturation Tank Low Low Level Alarm	50 mm
PS-P001A Saturation Tank Low Pressure Alarm	300 kPa
PIT-P001A Saturation Tank High Pressure Alarm	1000 kPa
DAF Saturation Tank 2 TNK-P002A	
FQ-P002A Recycle Water Flow Alarm	
LIT-P002A Saturation Tank Low Level Alarm	150 mm
LIT-P002A Saturation Tank High Level Alarm	500 mm
LIT-P002A Saturation Tank High High Level Alarm	550 mm
LS-P002A Saturation Tank Low Low Level Alarm	50 mm
PS-P002A Saturation Tank Low Pressure Alarm	300 kPa
PIT-P002A Saturation Tank High Pressure Alarm	1000 kPa
DAF Saturation Tank 3 TNK-P003A	
FQ-P003A Recycle Water Flow Alarm	
LIT-P003A Saturation Tank Low Level Alarm	150 mm
LIT-P003A Saturation Tank High Level Alarm	500 mm
LIT-P003A Saturation Tank High High Level Alarm	550 mm
LS-P003A Saturation Tank Low Low Level Alarm	50 mm
PS-P003A Saturation Tank Low Pressure Alarm	300 kPa
PIT-P003A Saturation Tank High Pressure Alarm	1000 kPa
DAF Saturation Tank 4 TNK-P004A	
FQ-P004A Recycle Water Flow Alarm	
LIT-P004A Saturation Tank Low Level Alarm	150 mm
LIT-P004A Saturation Tank High Level Alarm	500 mm
LIT-P004A Saturation Tank High High Level Alarm	550 mm
LS-P004A Saturation Tank Low Low Level Alarm	50 mm

Description	Range
PS-P004A Saturation Tank Low Pressure Alarm	300 kPa
PIT-P004A Saturation Tank High Pressure Alarm	1000 kPa

3.6 DAF Float Sumps 1, 2, 3 & 4

3.6.1 Documentation

WP-P0018 P&ID DAF Float Sumps sheet 1 of 2

WP-P0019 P&ID DAF Float Sumps sheet 2 of 2

3.6.2 Plant and Instruments

Tag	Description	
Float Collection Sump 1 S-P930A		
PIT-P930A	Float Collection Sump Level Transmitter	
PIT-P930B	Float Collection Sump Level Transmitter	
P-P931A	Float transfer Pump	
HV-P931E	Pump Discharge Isolation Hand Valve	
P-P932A	Float transfer Pump	
HV-P932E	Pump Discharge Isolation Hand Valve	
Float Collection Sump 2 S-P940A		
PIT-P940A	Float Collection Sump Level Transmitter	
PIT-P940B	Float Collection Sump Level Transmitter	
P-P941A	Float transfer Pump	
HV-P941E	Pump Discharge Isolation Hand Valve	
P-P942A	Float transfer Pump	
HV-P942E	Pump Discharge Isolation Hand Valve	
FIT-P990A	Float Collection Sumps 1&2 Discharge Flowmeter	
Float Collection Sump 3 S-P950A		
PIT-P950A	Float Collection Sump Level Transmitter	
PIT-P950B	Float Collection Sump Level Transmitter	
P-P951A	Float transfer Pump	
HV-P951E	Pump Discharge Isolation Hand Valve	
P-P952A	Float transfer Pump	
HV-P952E	Pump Discharge Isolation Hand Valve	
Float Collection Sump 4 S-P960A		
PIT-P960A	Float Collection Sump Level Transmitter	
PIT-P960B	Float Collection Sump Level Transmitter	
P-P961A	Float transfer Pump	

Tag	Description	
HV-P961E	Pump Discharge Isolation Hand Valve	
P-P962A	Float transfer Pump	
HV-P962E	Pump Discharge Isolation Hand Valve	
FIT-P993A	Float Collection Sumps 3&4 Discharge Flowmeter	

3.6.3 General Operation

Each float trough provided on the DAF tanks shall slope steeply towards one side of the DAF tank, to transport the float away from the tanks to a central float removal point. A float drain pipe shall then convey float from the trough into the float collection sumps. There shall be one sump per two DAF tanks for a total of four float collection sumps. Each sump shall be equipped with duty/standby flange mounted pressure transmitters which shall measure the level in the sump and provide all the pump control and monitoring to the plant control system.

Each of these sumps shall be provided with two screw centrifugal float transfer pumps (one duty, one standby) to pump the accumulated float away to the residuals handling area of the plant. The pumps shall alternate duty/standby status regularly based on an Operator adjustable time to ensure even wear of both pumps.

The float from each pair of float collection sump shall share a common header that discharges into the residuals handling area, for a total of two discharge lines from the float collection sumps into the residual handling tank, one from each DAF train. Flow meters shall be installed in each common discharge line to measure and monitor the flow of DAF float to the residuals area. In addition to pumping float to the residuals handling area, the float pumps can be used to recirculate float back into the float sumps, in the event that the float is settling and some form of mixing is required to facilitate pumping. The recirculation of float can be done by turning the float pumps to hand mode and opening and operating the appropriate hand valves on the recirculation line.

The drain lines for each DAF tank also empty into the corresponding float collection sumps. Each drain line is equipped with two mud valves, which allow for draining the flocculation basin and the DAF tank either separately or simultaneously.

3.6.4 Automatic Control Philosophy

3.6.4.1 Sump Level Transmitters

Duty/ standby level transmitters shall be installed in each sump. Duty/standby transmitter operation shall be selected at SCADA.

The duty sump level signal shall provide the process level control signal control of the DAF float transfer pumps.

Level control shall be automatically transferred to the standby transmitter if the duty transmitter becomes unavailable (because of transmitter failure or de-selection).

High and Low sump level alarms shall be raised as an early warning of abnormal process conditions. These are reset if the level rises above or falls below the alarm level.

3.6.4.2 DAF Float Transfer Pumps

Duty/Standby float transfer pumps shall pump the float from the sumps to the residuals area of the plant. In the vent of a failure or unavailability of the duty pump the standby pump shall be automatically started.

During normal operation when a duty pump has pumped the float level down to the pump stop level, the PLC shall then make the standby pump duty.

An interlock shall be provided between each set of float transfer pumps that discharge into a common header so that only one float collection sump per discharge header can be emptied at a time.

A hand valve shall be fitted in the discharge pipe of each pump, the valve shall be fitted with limit switches, the valve must be open before the associated pump shall be permitted to start.

3.6.4.3 Float Transfer Pump Discharge Flow Meters

The PLC shall monitor the flow each pair of DAF float sumps and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 1,000 litres and the accumulated flow shall be displayed on the SCADA.

3.6.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
PIT-P9**A	Instrument failure	Alarm	Automatic changeover to standby signal.
	High Level	Alarm	If the alarm occurs in a sump that is not in the process of being emptied, but the other sump in the pair is being emptied. Then the duty float transfer pump shall be stopped on the emptying sump and the duty pump started on the high level sump.
	Low level	Interlock	Stop duty pump if running
FIT-P9**A	Low or no flow	Interlock	If a duty pump is running, but no flow is detected, the duty pump shall stop and the standby started. If low flow is still detected the standby pump shall stop and an alarm shall be raised on SCADA
	Instrument failure	Alarm	

3.6.6

3.6.7 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

None

3.7 Ozone Contactors 1 & 2

3.7.1 Documentation

WO-P0010 P&ID Ozone Contactor No.1

WO-P0011 P&ID Ozone Contactor No.2

3.7.2 Plant and Instruments

Tag	Description	
Ozone Contactor No.1 (TNK-O210A)		
SLG-O210A	Ozone Contactor TNK-O210A Inlet Sluice Gate	
SLG-O210B	Ozone Contactor TNK-O210A Outlet Sluice Gate	
SLG-O210C	Ozone Contactor TNK-O210A Outlet Sluice Gate	
Ozone Contactor No.1 (TNK-O230A)		
SLG-O230A	Ozone Contactor TNK-O230A Inlet Sluice Gate	
SLG-O230B	Ozone Contactor TNK-O230A Outlet Sluice Gate	
SLG-O230C	Ozone Contactor TNK-O230A Outlet Sluice Gate	

3.7.3 General Operation

3.7.3.1 Ozone Contactors

Two independent ozone contactor tanks (each divided into seven cells) shall be provided. Each contactor shall have an independent inlet channel and the flow from the channel to the contactor shall be controlled by an electrically operated sluice gate. The gates shall open if a contactor is in service. Each contactor shall be designed to provide approximately 15 minutes of ozone contact time at the maximum plant flow rate of 400 ML/d.

A diffuser system shall dissolve the ozone gas into the process stream at Cell 1 of each contactor. Ozone flow rates to the contactors shall be determined by the Ozone master PLC, dependant on ozone residual measurement, flow pacing or manual input.

A vacuum/pressure relief valve that exhausts to atmosphere shall be located at Cell 7 to protect the contactor and off gas destruct system.

Hydrogen peroxide can be fed to either Cell 1 for advanced oxidisation or cell 6 for quenching. The decision regarding where the chemical is dosed is a manual function.

Sodium bisulphite can be dosed into Cell 6 of the contactors based on aqueous phase ozone concentration.

3.7.4 Automatic Control Philosophy

3.7.4.1 Ozone Contactor Operation (the description applies to both contactors)

During normal operation of the plant both contactors shall be used so the flow from the DAF effluent channel shall be equally divided between both contactors if they are both “in service” The operator shall be provided with the facility to take a contactor “out of service”. In the event of a contactor being “out of service” the flow through plant shall be restricted to 200 ML/d. Ozone generation shall be inhibited unless one of the contactors is “in service”.

A contactor shall be considered “in service” if the following conditions are met.

- The inlet sluice gate is open
- The outlet sluice gates are open.

At initial start up or following a shutdown the contactor inlet and outlet gates shall be closed. If the contactor was “in service” and is taken “out of service” or the plant shuts down the contactor inlet and outlet sluice gates shall be closed.

The contactor inlet and outlet gates shall not be opened until the liquid level in the DAF effluent chamber reaches a pre-set level.

3.7.4.2 Ozone Contactor Inlet Sluice Gates

These are open or shut sluice gates fitted with electrically actuators. During normal operation of the plant the valves shall be fully open. During a plant shutdown, or if a contactor is taken “out of service the sluice gates shall close.

3.7.4.3 Ozone Contactor Outlet Sluice Gates

These are open or shut sluice gates fitted with electrically actuators. During normal operation of the plant the valves shall be fully open. During a plant shutdown, or if a contactor is taken “out of service” the sluice gates shall close.

3.7.4.4 Ozone Dosing System

Refer to Section 3.19 for details

3.7.4.5 Hydrogen Peroxide Dosing System

Refer to Section 3.29 for details

3.7.4.6 Sodium Bisulphite Dosing System

Refer to Section 3.30 for details

3.7.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
SLG-O210A SLG-O230A	Contactor inlet sluice gate failure.	Alarm	Take contactor out of service. Restrict flow to plant to 200 ML/d
SLG-O210B SLG-O210C SLG-O230B SLG-O230C	Contactor outlet sluice gate failure.	Alarm	Take contactor out of service. Restrict flow to plant to 200 ML/d

3.7.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

<u>SCADA/HMI Engineer Adjustable Set Points</u>

None

<u>SCADA/HMI Operator Adjustable Set Points</u>

Description	Range
Select Contactor TNK-O210A out of service	
Select Contactor TNK-O230A out of service	

<u>SCADA/HMI Status Signals</u>

Description	Range
Contactor TNK-O210A in service	
Contactor TNK-O230A in service	

SCADA/HMI Alarm Signals

Description	Range
Contactor TNK-O210A out of service	
Contactor TNK-O230A out of service	

3.8 Pre-filter Mixing Chambers 1 & 2

3.8.1 Documentation

WO-P0010 P&ID Ozone Contactor No.1

WO-P0011 P&ID Ozone Contactor No.2

3.8.2 Plant and Instruments

Tag	Description	
Mixing Chamber No.1 (TNK-C701A)		
MXR-C701A	Pre-filter mixing chamber mixer	
LIT-C701A	Filter Inlet Channel (Filters 1-4) level	
Mixing Chamber No.1 (TNK-C702A)		
MXR-C702A	Pre-filter mixing chamber mixer	
LIT-C702A	Filter Inlet Channel (Filters 5-8)level	
SLG-F001A	Filter Inlet Channel Isolation Sluice Gate	

3.8.3 General Operation

3.8.3.1 Pre Filter Mixing Chambers 1 and 2

Water shall flow from the Ozone Contactors through four channels (two per contactor) to the pre-filter mixing Chamber No. 1 and No. 2. Chamber No. 1 shall feed water to filters 1 to 4 and Chamber No. 2 feeds filters 5 to 8. Each chamber shall contain a mixer to ensure that the filter aid polymer injected at this point is well mixed into the process stream.

The outlet of the chambers becomes the filter inlet channel where ultrasonic level measurement devices shall be installed, these instruments shall have two main functions, firstly to turn the mixers on and off and secondly to monitor the filter inlet channel levels.

The filter inlet channel can be manually divided in two by manual operation of the sluice gate in the middle of the channel.

3.8.4 Automatic Control Philosophy

3.8.4.1 Mixers MXR-C701A and MXR-C702A

The mixers shall be required to operate if the level in the mixing chamber exceeds the “enable mixer level “for a pre-set time (typically 1 minute).

The mixer shall continue to operate until the level in the chamber falls below the start level for a preset time "enable mixer level" for a pre-set time (typically 1 minute).

3.8.4.2 Pre Filter Mixing Chamber Level Monitoring

There shall be level transmitters LIT-C701A and LIT-C702A installed to measure the water level in the chamber. The instrument shall be used for the mixer control, Filter Inlet Channel and Filter Outlet Flow Control.

For filter control see the description in Section 3.9.

3.8.4.3 Filter Aid Polymer Dosing

See Section 3.22 for details

3.8.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
MXR-C701A MXR-C702A	Mixer failure.	Alarm	Alarm on SCADA
LIT-C701A LIT-C702A	Instrument Failure	Alarm	Instrument configured to fail low. PLC to hold signal at last valid value.

3.8.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

None

3.9 Biological Activated Carbon Filters 1 to 8

3.9.1 Documentation

WF-P0001 P&ID Filter No. 1

WF-P0002 P&ID Filter No. 2

WF-P0003 P&ID Filter No. 3

WF-P0004 P&ID Filter No. 4

WF-P0005 P&ID Filter No. 5

WF-P0006 P&ID Filter No. 6

WF-P0007 P&ID Filter No. 7

WF-P0008 P&ID Filter No. 8

3.9.2 Plant and Instruments

Tag	Description	
Filter No. 1 TNK-F100A		
LT-F100A	Filter Level	
PT-F100A	Filter Overall Filter Differential Pressure	
PI-F100B	Filter Top Filter Media Differential Pressure	
PI-F100C	Filter Bottom Filter Media Differential Pressure	
FV-F101A	Filter Inlet Valve	
FV-F102A	Filter Backwash Water Outlet Valve	
FCV-F103A	Filter Outlet Flow Control Valve	
FT-F103A	Filter Outlet Flow	
FV-F104A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F105A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F106A	Filter Backwash Water Inlet Valve	
FV-F107A	Filter Air Scour Valve	
AT-F110A	Filter Outlet Turbidity	
AT-F110B	Filter Outlet Particle Count	
FS-F110A	Filter Outlet Turbidity Sample Flow	
FS-F110B	Filter Outlet Particle Counter Sample Flow	
TNK-F110A	Degassing Column	
Filter No. 2 TNK-F200A		
LT-F200A	Filter Level	
PT-F200A	Filter Overall Filter Differential Pressure	
PI-F200B	Filter Top Filter Media Differential Pressure	
PI-F200C	Filter Bottom Filter Media Differential Pressure	
FV-F201A	Filter Inlet Valve	

Tag	Description	
FV-F202A	Filter Backwash Water Outlet Valve	
FCV-F203A	Filter Outlet Flow Control Valve	
FT-F203A	Filter Outlet Flow	
FV-F204A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F205A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F206A	Filter Backwash Water Inlet Valve	
FV-F207A	Filter Air Scour Valve	
AT-F210A	Filter Outlet Turbidity	
AT-F210B	Filter Outlet Particle Count	
FS-F210A	Filter Outlet Turbidity Sample Flow	
FS-F210B	Filter Outlet Particle Counter Sample Flow	
TNK-F210A	Degassing Column	
Filter No. 3 TNK-F300A		
LT-F300A	Filter Level	
PT-F300A	Filter Overall Filter Differential Pressure	
PI-F300B	Filter Top Filter Media Differential Pressure	
PI-F300C	Filter Bottom Filter Media Differential Pressure	
FV-F301A	Filter Inlet Valve	
FV-F302A	Filter Backwash Water Outlet Valve	
FCV-F303A	Filter Outlet Flow Control Valve	
FT-F303A	Filter Outlet Flow	
FV-F304A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F305A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F306A	Filter Backwash Water Inlet Valve	
FV-F307A	Filter Air Scour Valve	
AT-F310A	Filter Outlet Turbidity	
AT-F310B	Filter Outlet Particle Count	
FS-F310A	Filter Outlet Turbidity Sample Flow	
FS-F310B	Filter Outlet Particle Counter Sample Flow	
TNK-F310A	Degassing Column	
Filter No. 4 TNK-F400A		
LT-F400A	Filter Level	
PT-F400A	Filter Overall Filter Differential Pressure	
PI-F400B	Filter Top Filter Media Differential Pressure	

Tag	Description	
PI-F400C	Filter Bottom Filter Media Differential Pressure	
FV-F401A	Filter Inlet Valve	
FV-F402A	Filter Backwash Water Outlet Valve	
FCV-F403A	Filter Outlet Flow Control Valve	
FT-F403A	Filter Outlet Flow	
FV-F404A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F405A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F406A	Filter Backwash Water Inlet Valve	
FV-F407A	Filter Air Scour Valve	
AT-F410A	Filter Outlet Turbidity	
AT-F410B	Filter Outlet Particle Count	
FS-F410A	Filter Outlet Turbidity Sample Flow	
FS-F410B	Filter Outlet Particle Counter Sample Flow	
TNK-F410A	Degassing Column	
Filter No. 5 TNK-F500A		
LT-F500A	Filter Level	
PT-F500A	Filter Overall Filter Differential Pressure	
PI-F500B	Filter Top Filter Media Differential Pressure	
PI-F500C	Filter Bottom Filter Media Differential Pressure	
FV-F501A	Filter Inlet Valve	
FV-F502A	Filter Backwash Water Outlet Valve	
FCV-F503A	Filter Outlet Flow Control Valve	
FT-F503A	Filter Outlet Flow	
FV-F504A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F505A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F506A	Filter Backwash Water Inlet Valve	
FV-F507A	Filter Air Scour Valve	
AT-F510A	Filter Outlet Turbidity	
AT-F510B	Filter Outlet Particle Count	
FS-F510A	Filter Outlet Turbidity Sample Flow	
FS-F510B	Filter Outlet Particle Counter Sample Flow	
TNK-F510A	Degassing Column	

Tag	Description	
Filter No. 6 TNK-F600A		
LT-F600A	Filter Level	
PT-F600A	Filter Overall Filter Differential Pressure	
PI-F600B	Filter Top Filter Media Differential Pressure	
PI-F600C	Filter Bottom Filter Media Differential Pressure	
FV-F601A	Filter Inlet Valve	
FV-F602A	Filter Backwash Water Outlet Valve	
FCV-F603A	Filter Outlet Flow Control Valve	
FT-F603A	Filter Outlet Flow	
FV-F604A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F605A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F606A	Filter Backwash Water Inlet Valve	
FV-F607A	Filter Air Scour Valve	
AT-F610A	Filter Outlet Turbidity	
AT-F610B	Filter Outlet Particle Count	
FS-F610A	Filter Outlet Turbidity Sample Flow	
FS-F610B	Filter Outlet Particle Counter Sample Flow	
TNK-F610A	Degassing Column	
Filter No. 7 TNK-F700A		
LT-F700A	Filter Level	
PT-F700A	Filter Overall Filter Differential Pressure	
PI-F700B	Filter Top Filter Media Differential Pressure	
PI-F700C	Filter Bottom Filter Media Differential Pressure	
FV-F701A	Filter Inlet Valve	
FV-F702A	Filter Backwash Water Outlet Valve	
FCV-F703A	Filter Outlet Flow Control Valve	
FT-F703A	Filter Outlet Flow	
FV-F704A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F705A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F706A	Filter Backwash Water Inlet Valve	
FV-F707A	Filter Air Scour Valve	
AT-F710A	Filter Outlet Turbidity	
AT-F710B	Filter Outlet Particle Count	
FS-F710A	Filter Outlet Turbidity Sample Flow	

Tag	Description	
FS-F710B	Filter Outlet Particle Counter Sample Flow	
TNK-F710A	Degassing Column	
Filter No. 8 TNK-F800A		
LT-F800A	Filter Level	
PT-F800A	Filter Overall Filter Differential Pressure	
PI-F800B	Filter Top Filter Media Differential Pressure	
PI-F800C	Filter Bottom Filter Media Differential Pressure	
FV-F801A	Filter Inlet Valve	
FV-F802A	Filter Backwash Water Outlet Valve	
FCV-F803A	Filter Outlet Flow Control Valve	
FT-F803A	Filter Outlet Flow	
FV-F804A	Filter Outlet Flow Valve to Filtered Water Chamber (FW)	
FV-F805A	Filter Outlet Flow Valve to Backwash Tank (FTR)	
FV-F806A	Filter Backwash Water Inlet Valve	
FV-F807A	Filter Air Scour Valve	
AT-F810A	Filter Outlet Turbidity	
AT-F810B	Filter Outlet Particle Count	
FS-F810A	Filter Outlet Turbidity Sample Flow	
FS-F810B	Filter Outlet Particle Counter Sample Flow	
TNK-F810A	Degassing Column	

3.9.3 General Operation

3.9.3.1 Process Parameters for the BAC Filtration System

Item	Values	Units
DEEP BED GRANULAR MEDIA FILTER		
Design Flows and Loading Rates		
Filtration System Maximum Design Flow Rate	400	ML/d
Individual Filter Maximum Design Flow Rate (7 filters)	57	ML/d
Filtration System Average Design Flow Rate	258	ML/d
Individual Filter Average Design Flow Rate (7 filters)	36.9	ML/d
Filtration System Minimum Design Flow Rate	87	ML/d
Individual Filter Minimum Design Flow Rate (3 filters on-line)	29	ML/d
Maximum Design Water Temperature	22	degrees C
Minimum Design Water Temperature	0.5	degrees C

Item	Values	Units
Maximum Design Filtration Hydraulic Loading Rate	30	m/h
Average Design Filtration Hydraulic Loading Rate	19	m/h
Minimum Design Filtration Hydraulic Loading Rate	15	m/h
Number of Duty Filters at Maximum Design Flow Rate	7	#
Number of Standby Filters at Maximum Design Flow Rate	1	#
Total Number of Filters	8	#
Filter run time at maximum design flow rate	20.5	h
Unit Filter Run Volume (UFRV)	600	m^3/m^2
Filter Media and Underdrain Configuration		
Media Material	Granular Activated Carbon (Calgon Carbon F-820 or eqv.)	-
Media Depth	2.1	m
Media Effective Size	1.1	mm
Maximum Media Uniformity Coefficient	1.5	-
Underdrain System	Nozzle-Plenum	-
Backwash Method		
Air-Scour Loading Rate (water level below top of trough level)	0.91	Sm^3/m^2*min
Low-rate Water Wash	28.4	ML/d
Low-rate Water Wash Loading Rate (simultaneous air-water wash)	14.6	m/h
Air Loading Rate (simultaneous air-water wash)	0.91	Sm^3/m^2*min
Low-rate Water Wash Loading Rate (air purge wash)	14.6	m/h
Design Media Expansion During High-rate Water Wash	30	%
High-rate Water Wash (fluidization @ 22 oC)	99.7	ML/d
High-rate Water Wash Loading Rate (fluidization @ 22 oC)	51.3	m/h
High-rate Water Wash (fluidization @ 0.5 oC)	71.2	ML/d
High-rate Water Wash Loading Rate (fluidization @ 0.5 oC)	36.6	m/h
Low-rate Water Wash Loading Rate (during ETSW)	14.6	m/h
BWS Tank Total Active Volume (per tank)	1.2	ML
Physical Dimensions		
Individual Filter Effective Surface Area	81	m^2
Filtration System Effective Surface Area (7 Filters)	567	m^2
Filtration System Total Surface Area (8 Filters)	648	m^2
Individual Filter Box Width	9	m
Individual Filter Box Length	9	m
Normal operating water level	242.5	m
Operating Water Depth Above Top of Media	5.2	m

Item	Values	Units
Filter Box Depth (top of curb to bottom of underdrain)	10.75	m
Backwash trough / water level	240.6	m
Filter Box Bottom Elevation	234.4	m
Filter Influent Channel Bottom	240.74	m
Backwash Wastewater Channel Bottom	238.50	m
Distance from Bottom of Wash Trough to Top of Expanded Media	2	m
Distance from Top of Media to Top of Wash Trough	3.3	m
BWS Tank Length (per cell)	36.4	m
BWS Tank Width (per cell)	11	m
BWS Tank Active Depth (per cell)	3	m
Backwash Tank Active Volume (per cell)	1320	m^3
Backwash Tank Bottom	231.0	m
Backwash Tank HWL (LAH)	235.3	m
Backwash Tank LWL (LAL)	231.7	m
Air Scour Blowers (BLW-F010A, BLW-F020A)		
Maximum Air Scour Blower Flow Rate	4140	Sm^3/h
Blower Discharge Gauge Pressure (at Standard Conditions)	70.3	kPa
Air Scour Blower Type	Multi-stage centrifugal, fixed speed	-
Total Number of Air Scour Blowers (1 duty, 1 standby)	2	#
Air Scour Blower Power at Standard Conditions (per unit)	186	kW
Backwash Supply Pumps (P-F911A, P-F921A)		
Maximum Flow Rate	99.7	ML/d
Maximum Total Dynamic Head (TDH)	12.49	m
Pump Type	Horizontal split-case, VSD	-
Total Number of BWS Pumps (1 duty, 1 standby)	2	#
BWS Pump Power (per unit)	224	kW
Process Sump – Physical Dimensions		
Length	3.5	m
Width	1	m
Depth	1.5	m
Capacity	5.25	m3
Process Sump Pumps (P-F981A/982A)		
Maximum Flow Rate	2.5	ML/d
Maximum Total Dynamic Head (TDH)	10.4	m
Pump Type	Submersible	-
Power (per unit)	7.5	kW

Item	Values	Units
Process Sump Pumps (P-F983A)		
Maximum Flow Rate	14.1	ML/d
Maximum Total Dynamic Head (TDH)	10.4	m
Pump Type	Submersible	-
Power (per unit)	35	kW
Process Sump Pumps (P-F984A)		
Maximum Flow Rate	0.17	ML/d
Maximum Total Dynamic Head (TDH)	1.7	m
Pump Type	Submersible	-
Power (per unit)	0.37	kW

Note: The following definitions are used throughout this section:

Status	Description
Online	Filter is in run mode
Online Drain	Filter producing water but is draining in preparation for Backwashing
Offline Dirty	Filter is offline waiting to be washed
Backwash	Any point in the backwash sequence
Standby	Waiting to go to FTR
Offline Clean	Filter is backwashed and is available to go online
Maintenance mode	Means out of service. Out of service, means that the unit has been removed from service e.g. all filter inlet and outlet valves are closed for maintenance or because of a fault and is unavailable for filtration.
FIN	Filter influent
BWW	Backwash Waste Water
OF	Overflow
FW	Filtered Water
FTR	Filter to Recycle
BWS	Backwash Water Supply
AS	Air Scour

The overall objectives of the BAC filters are to provide a physical barrier to pathogens, physically remove particles remaining after the DAF clarification process, and provide biological removal of T&O compounds, NOM, and ozone by products.

The BAC filtration process shall be located downstream of the DAF clarification and Ozonation processes and upstream of the CCT. The operational goal of the filtration system is to produce a filtered water quality of less than 0.1 NTU and less than 20 particles/mL (> 2 µm).

There shall be a total of eight filters, designed for a maximum hydraulic loading rate of 30 m/h, to treat a maximum process flow of 400 ML/d. Normal operation shall consist of up to seven duty filters online and one standby filter, operated at varying hydraulic loading rates of between 29 and 57 ML/d, depending on system demand and the number of filters in service. The filters shall be operated using a constant rate effluent control assuming a constant total plant flow is maintained from the filter unit process. Overall filtration system flow changes shall be implemented slowly in response to system demand changes as per the design basis for the plant that indicated flows would likely be adjusted weekly for filling distribution system reservoirs and demand requirements. The plant flow rates for a given number of filters in service are shown in the following tables.

Filters in Operation #	Maximum Design Flow Rate (ML/d)	Minimum Design Flow Rate (ML/d)
1	57	29
2	114	58
3	171	87
4	228	116
5	285	145
6	342	174
7	400	203

The filters can be isolated into an east and a west train, both filter trains consist of four filters with the flow division being achieved by manually closing the 'normally open' manual isolation gate (SLG-F001A) in the centre of the FIN channel. The gate position shall be monitored by the control system. The BWS pumps are duty/standby operation and shall not be designated to half the plant, but can serve either filter train if required.

Each filter shall have an effective filtration area of 81 m^2 with dimensions of 9 m wide by 9 m long. The filter box shall be approximately 10 m deep. The filter boxes shall be designed with a nozzle-plenum type underdrain system (approximately 0.8 m total depth), suitable for simultaneous air-water backwashing. The filter media shall consist of a 2.1 m deep mono-media bed of GAC with an effective size of 1.1 mm.

The WTP primary flow control variable shall be the total raw water flow, based on the sum of the individual online DAF unit inlet flow meters. The plant operators shall determine the filtered water production rate by setting the total raw water flow to meet overall system demand, taking into account in-plant losses (Residuals, Backwash and FTR requirements), available Clearwell storage, the DBPS flow and available distribution storage. The plant flow control strategy has been developed to minimize the risk of sudden flow changes to the filtration process.

Water from the two Ozone Contactor trains shall flow into two filter inlet mixing chambers and then to a common filter influent channel. Each filter has an automated filter influent valve (e.g. FV-F101A), which shall be normally fully open when the filter is in production mode. All online filters shall have the same driving head from the water level in the common filter influent channel. The water level above the filters may fluctuate slightly to buffer small instantaneous flow variations, but should remain constant for stable filter flow performance.

Each filter shall have an effluent flow meter (e.g. FT-F103A) and modulating flow control valve (e.g. FCV-F103A) for individual filter flow rate control. Each individual filter flow rate set point shall be determined by the plant control system, based initially on the plant total filter flow set point divided by the number of online filters in production mode. Based on a relatively constant driving head (e.g. 242.50 m elevation ± 0.1 m), the individual effluent flow control valves shall be initially at a mostly closed position when the filter is clean and modulate to maintain their respective flow rate set points as the filters accumulate headloss due to build up of suspended solids within the media. Manual operation functions shall also be provided to allow the plant operators to manually input the flow rate set point for an individual filter if required.

Headloss accumulation across the filter media shall be measured using dedicated differential pressure transmitters for each filter. Filter No. 1 and Filter No. 8 shall have two additional differential pressure indicators e.g. PI-F100B/C and P1-F800B/C monitor where the headloss occurs throughout the filter media.

Electric valve actuators shall be used for both modulating and open/close applications. All filter valves shall have position switches or potentiometers integral to their electric actuators and monitored by the plant control system.

Filter performance and effluent quality shall be monitored based on the individual filter effluent turbidity and particle counts. Each filter shall have a dedicated effluent turbidimeter (e.g. AT-F110A) and particle counter (e.g. AT-F110B) for monitoring and optimizing filter performance. Continuous sampling shall be by gravity flow from the effluent piping on each filter to supply the dedicated analytical instruments. Filter effluent turbidity and particle count monitoring shall be used to optimize the filter ripening period, but the filter FTR cycle must produce enough water for the next backwash cycle. A filter shall not be put back into offline clean mode until the analytical instrumentation confirms that filter performance criteria has been met (filter is ripened). Until this occurs the filter shall remain in FTR mode and if necessary the backwash supply tanks shall overflow to the residuals area.

Downstream of the filters before the filtered water chamber, open/closed flow valves can be used to isolate filters 1 through 4 (FV-F051A) or filters 5 through 8 (FV-F052A), to isolate a treatment train.

Flow from the filtered water chamber (TK-F050A) shall normally go to the chlorine contact tank but can be diverted to the floodway by manual operation of sluice gates (SLG-F053A and SLG-F054A). The gate position shall be monitored by the control system

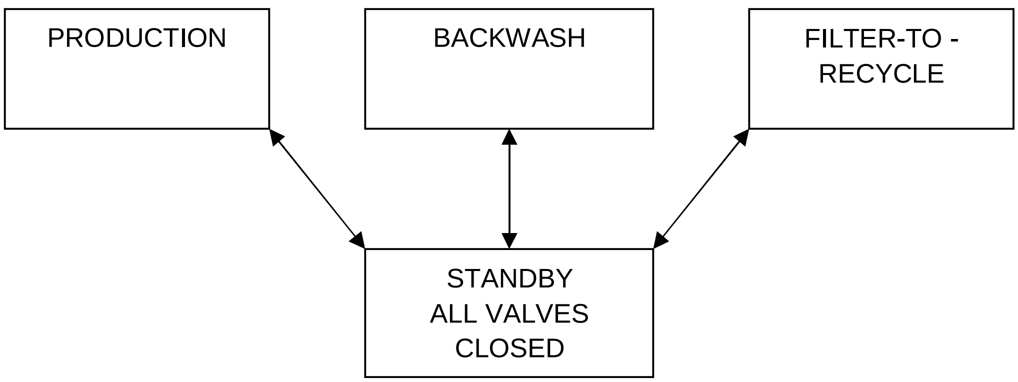
Filter Inlet Channel Level Monitoring and Filter Outlet Flow Control

The water level in the filter influent channel shall be monitored by two ultrasonic level transmitters (LT-C701A, LT-C702A). The operator shall be able to select the transmitters to work as one per train, one duty or an average of both signals.

The influent channel level shall normally operate within a defined operating range (38% to 45%) where no correction to filter effluent flow rate is required. If the influent channel level moves outside the control-band range, the plant control system shall adjust (increase or decrease) the individual filter flow rate set points uniformly to correct the level (i.e., cascade control) and bring it back inside the control band. In response to the set point adjustment, the individual filter flow control loops shall modulate their respective effluent flow control valves to achieve the new flow rate set point.

If the influent channel level falls below 20% then the filter outlet valves shall be closed to prevent drain down of the filters.

If the filter influent channel level transmitters detect a high-high alarm level, an interlock with the Raw Water Pumps shall reduce the plant primary raw water flow set point by a pre-determined value to prevent an overflow from the filter influent channel. If after the first adjustment the influent channel does not return to within the limits of the control band then a further reduction in raw water flow shall be made, if the high level still persists for a pre-set time period then the Raw Water pumps shall be shutdown and the operator must investigate and correct the problem before re-starting the plant.



3.9.3.2 Filter Operation and Wash Queuing

A filter shall be placed online after FTR (offline clean mode). When an online filter run is terminated, another filter in offline clean mode shall be brought online to ensure that the individual filter flow rate set points are maintained, thereby avoiding sudden hydraulic surges through the filters, and achieving a constant plant production rate. Each filter shall be cycled through the production and standby modes at a design frequency of once per 20 hours, corresponding to the design average unit online volume (UFRV) of 600 m^3/m^2. The initial filter run time shall be set at 18 hours, which means that every 2.25 hours, one filter shall be backwashed. Assuming the backwash cycle lasts 25 minutes, and the filter-to-recycle cycle lasts 20 minutes (total of 45 minutes), the recently backwashed filter would sit in offline clean mode for about 1.5 hours.

After backwashing (e.g. 25 minutes) and FTR (e.g. 20 minutes), all steps are completed (see details in Sections 4.2 and 4.3), and the filter shall be placed in offline clean mode again. The filter effluent flow control valve set point shall be set to zero flow (closed), and all other valves shall be closed. The filter can then go online when required (See Filter Run Start).

The decision to backwash a filter can be initiated by one of the following actions or process conditions. Depending on which action/condition causes the backwash instigation determines what priority is given to the filter backwash request as shown below.

- Effluent turbidity operational goal of 0.1 NTU or less is exceeded (alarm only), operator can instigate a backwash if required.
- Effluent turbidity shutdown level of 0.3 NTU is exceeded (stop filter run automatically and enter queue)

- Effluent particle count (> 2 µm) operational goal of 20 particles/mL or less is exceeded (alarm only), operator can instigate a backwash if required.
- Terminal headloss of 3.0 m above the CBHL is exceeded (stop filter run automatically and enter queue)
- Run time operator adjustable set point reached (e.g. 20 hours) (Alarm only), operator can instigate a backwash if required.
- Calculated Run time exceeds UFRV (of 600 m^3/m^2) (alarm only), operator can instigate a backwash if required.
- Operator manual intervention to initiate a backwash cycle.

If a filter has been sitting longer than 24 hours, a backwash cycle should be completed prior to putting the filter back in service.

(The operational set points for filter run termination shall be initially those presented above. As with other treatment unit processes, operational experience shall determine optimal set points and operating costs).

- Operator intervention (priority 1)
- High turbidity in filtered water outlet (priority 2)
- High differential head over filter (priority 3)
- Elapsed time (priority 4)

The control system shall only allow one filter to backwash at any one time. A wash queue system is employed and the filters are placed in the wash queue based on priority. Filters called to wash with a higher priority than filters already in the queue enter nearer the head of the queue. The filter queue is dynamic such that if a filter already in the wash queue develops a condition with a higher priority it shall move up the queue. Once a filter is at the head of the queue, it starts a backwash sequence. When a filter has entered a backwash sequence, it is unaffected by subsequent changes in the washing queue.

Before any backwash sequences can commence, checks shall be made to confirm that there is sufficient clean backwash water and sufficient capacity in the wash water recovery tanks to receive the dirty backwash water. (See Sections 3.10 and 3.14).

3.9.3.3 Description of Backwash Sequence

Backwashing of the media shall be achieved through a combination of air and water wash methods. The backwashing method shall be based on the collapse-pulsing technique, which utilizes an extended simultaneous air-water wash, followed by a short fluidization water wash for re-stratification and finished off with an ETSW.

The filters shall be equipped with media retaining wash troughs with baffles to prevent excessive media loss during the simultaneous air-water wash, and to provide the greatest operational flexibility in optimizing the filter cleaning sequence.

BWW from the backwashing of filters shall be conveyed by gravity to the Wash-water Recovery System via a common concrete channel.

The backwash sequence shall have the following discrete steps and Filter No. 1 is given for example.

1. Start from offline dirty mode with all valves closed
2. Open backwash waste water valve (FV-F102A)
3. Open air scour valve (FV-F107A) and backwash supply valve (FV-F106A)
4. Air scour for a preset period (operator adjustable) initially set for 1 minute by starting duty blower (manually throttled to constant flow set point with hand valve in blower inlet pipework)
5. Combined air scour/low rate wash terminating after a preset period (operator adjustable) initially set for 6 minutes. Backwash pump to slowly ramp speed up to low rate wash flow. Stop air scour at end of pre-set period and close air scour valve
6. Continue the low rate wash for a preset period (operator adjustable) initially set for 1 minute
7. High rate wash for a preset period (operator adjustable) initially set for 6 minutes. Increase backwash pump speed to high flow set point over 1 minute
8. Low rate wash for a preset period (operator adjustable) initially set for 6 minutes. Decrease backwash pump speed to low flow set point over 1 minute
9. Stop Backwash Pump and close backwash supply valve (FV-F106A)
10. Close BWW valve (FV-F102) when level is below waste water trough
11. Slowly open filter influent valve (FV-F101A) to refill filter to normal water level (242.5)
12. Close filter influent valve (FV-F101A) and go to standby mode
13. Proceed to FTR

Drain down is controlled by an ultrasonic level transmitter in each filter. If the ultrasonic level transmitter fails during a backwash, the filter shall be taken out of service, an alarm shall be raised and the maximum allowable flow through the plant shall be adjusted if required. A filter backwash shall be inhibited if there is insufficient capacity in the backwash supply water tank to complete a backwash cycle.

Progression to the next step in the cycle shall only be allowed on successful completion of each step otherwise a filter is taken out of service.

Backwash flow to each filter is controlled according to the position in the cycle (i.e. low rate wash cycle or high rate wash cycle) and raw water temperature. Backwash flow rate is set by the speed of the duty backwash pump to achieve the desired set point flow.

Set point ramp control for the Backwash pumps shall be incorporated to provide a gradual loading on the filter at the commencement of a backwash.

The minimum water level in a filter to start the backwash pumps shall be 240.000 m. The normal water level in a filter to start the backwash pumps shall be at trough overflow at 240.600 m. If the backwash pumps are started when the water level is below 240.000 m, the filter underdrains could be damaged.

Two fixed speed, air scour blowers, shall be operated in a duty/standby configuration with automatic duty rotation. A single blower can deliver the design air flow and pressure. Ambient air from the Filter Gallery shall be blown through piping to each filter underdrain system during the air-scour and simultaneous air-water wash periods with constant water levels overflowing at the filter backwash trough elevation. The centrifugal blowers shall provide a constant air flow rate, adjustable by means of a manual inlet throttling valve. A flow meter shall monitor the discharge air flow rate to the filter, based on a manually adjusted discharge pressure set point. The plant operator can adjust the air scour duration through a set point in the plant control system.

The intake air filter differential-pressure, and discharge pressure of each blower shall be monitored and recorded by the plant control system. Each blower shall also be fitted with motor and bearing temperature and vibration sensors for alarming and high temperature/vibration level shutoff. The blower air discharge temperature and pressure shall be monitored and recorded by the plant control system.

Two variable speed BWS pumps shall be operated in a duty/standby configuration with automatic duty rotation. A single pump shall supply the maximum design backwash flow rate with an identical pump acting as the standby unit. The system shall be designed to backwash one filter at a time. The backwash loading rate required for the design media expansion varies seasonally as a function of water temperature. The plant operators shall adjust the high-rate water-wash flow, as required seasonally, to prevent excessive GAC bed expansion when the water is cold (i.e., more dense). The VSD for the BWS pump shall control the BWS flow rate to the filter, based on the backwash sequence flow set points monitored by the BWS flow meter. The plant operator can optimize the various water-wash durations through a series of set points in the plant control system within prescribed ranges. High flow rate alarms shall shutdown the BWS pumps.

A pressure transmitter on each BWS pump discharge header shall monitor the system pressure. The control system shall include a high-pressure alarm for the individual BWS Pump discharge lines that shut down the pumping system in the event of high pressure. The US Filter pressure switch set point shall be field verified (e.g. 103-124 kPa). Both pumps shall be fitted with motor temperature sensors for alarming and high temperature level shutoff.

3.9.3.4 Description of Filter to Recycle Sequence

The FTR water sequence shall direct filter ripening water to refill the BWS Tanks for utilization as BWS water. Each of the two BWS Tanks is sized to hold about two backwash water volumes. Although adequate BWS storage may be available for consecutive filter backwashing, the system requires that each FTR cycle replaces the volume of water used in the previous backwash cycle.

An operator time delay in Standby mode between Backwash and FTR initiation shall be programmable with an initial value of 0.0 hours and adjustable between 0.0 and 2.0 hours.

The automated FTR sequence, from the end of the backwash, is as follows, Filter No. 1 used an example.

1. Start from standby mode
2. Open filter influent valve (FV-F101A)
3. Open FTR isolation valve (FV-F105A)
4. Slowly open filter effluent valve (FCV-F103A) until flow rate set point is reached (e.g. filter outlet flow rate is 50 ML/d)
5. Continue FTR for a preset period (operator adjustable) initially set for 15 minutes
6. Check that the filter has ripened (e.g. the turbidity and particle counts are within specified limits).
7. If ripening has been achieved change filter flow set point to desired average filter flow rate as calculated by control system.
8. Unless filter is required to go into production mode, go to offline clean mode.

Provision shall be made for chlorination of the BWS water for periodic control of beneficial biomass on the GAC filter media, if required. Chlorination would be performed by the addition of hypochlorite solution into the BWS Pump discharge header, using the BWS flow meter signal for chemical flow pacing control, see section 3.25 for details.

Normally, all BWS water used in backwashing shall be replaced during FTR, so the BWS tanks shall be refilled to a target level of 235.00 m. The minimum water level in the backwash tanks shall be (LAL) is 232.0 m and the maximum water level (LAH) is at 235.2 m.

The Plant Operators must optimize the FTR cycle time to balance either BWS demand or filter ripening time, whichever is limiting. Under abnormal operating conditions, where FTR water generation rates are not sufficient to meet BWS demands, FTR durations must be extended beyond what is required for filter ripening.

The FTR duration shall be set to match the totalized volume of backwash water used for one backwash, to maintain target levels in the backwash supply tanks. The filter ripening duration varies depending on the filter ripening flow rate, but should be a minimum of 15 minutes. The FTR flow rate set point can be adjusted within a range of 30 to 55 ML/d. The desired time and flow rate is calculated to check the balance needed for backwash volumes based on recent totalized flow volumes, and operator flow and time set points. Due to valve opening delays, etc. field refinements and optimization may be required.

	Summer	Winter	Units
Backwash Volume	729	574	m^3
FTR Flowrate	50	50	ML/d
FTR Duration	21	16.5	min

Under normal operating conditions the Wash-water Recovery System shall be designed to accept four consecutive backwash volumes (i.e., washing one complete filter train). The consecutive backwashing of four filters would not be limited by the BWS storage system, as each consecutive backwash is not normally started until the previous FTR cycle has been completed, which would replenish the BWS Tank storage.

For an abnormal operating condition where one of the two filter trains (i.e., four filters) is taken off line for inspection or maintenance and consecutive backwashing of this train's filters is required, the BWS tanks shall be replenished from the remaining online filter train. This scenario may require one of the online filters being temporarily placed into FTR mode to allow for more than three consecutive backwashes. As the plant has been designed to optionally operate as two separate trains from flocculation through to filtration, it is not likely that a full-plant shutdown would be required or desired, where all eight filters would be consecutively backwashed.

3.9.3.5 Raw Water Flow to Plant

The raw water flow to the works shall be related to the number of filters detected as online. The Raw Water Pump control shall ensure that the following flows are not exceeded.

Total Filter Flow Set Point Range (ML/d)	Possible Filters in Operation (#)	Possible Design Flow Range (ML/d)	Optimal No. of Filters in Operation (#)	Optimal Design Flow Range (ML/d)
100 - 150	2 to 3	58 - 171	3	87 – 171
150 - 200	3 to 5	87 - 228	4	116 – 208
200 - 250	4 to 6	116 – 342	5	145 – 285
250 - 300	5 to 7	145 – 400	6	174 – 342
300 - 350	6 to 7	174 – 400	7	203 – 400
350 - 400	7	203 - 400	7	203 - 400

3.9.4 Automatic Control Philosophy

3.9.4.1 Filter Inlet Channel Level Monitoring and Filter Outlet Flow Control

There shall be two level transmitters LT-C701A and LT-C702A installed to measure the water level in the Filter Influent Channel. The instruments shall be used to control the Influent Channel and Filter Effluent Flow Control. The operator shall be able to select the transmitters to work as one per train, one duty or an average of both signals.

Level control shall be automatically transferred to the other transmitter if either of the transmitters becomes unavailable (because of transmitter failure or de-selection).

A selected control band within the analogue level signal range shall be configured within the PLC to linearly represent the desired set point filter flow rate range such that the top of the level control band represents the maximum desired set point filter flow rate and the bottom represents zero set point flow.

All filter flow controllers shall be identically configured (i.e. all filters shall be operating to a common set point to ensure equal flow division). High and low channel level alarms are also generated from the analogue level signal.

3.9.4.2 Filter Outlet Turbidity

See Section 3.32 for details of water quality analyzer systems.

If the turbidity analyzer in the outlet of a filter detects a high level for a preset time then an alarm shall be raised on SCADA and the operator can initiate a backwash if required.

If the turbidity analyzer in the outlet of a filter detects a high high level for a preset time then the filter shall be placed in the backwash queue.

During filter ripening when the filter is in FTR mode, the turbidity of the filter effluent shall be monitored and if it remains above a pre-set limit after the FTR time period has expired, the filter shall continue in FTR mode and an alarm shall be raised on SCADA.

3.9.4.3 Filter Outlet Particle Count

If the particle count analyzer in the outlet of a filter detects a high level for a preset time then an alarm shall be raised on SCADA and the operator can initiate a backwash if required.

During filter ripening when the filter is in FTR mode, the particle count of the filter effluent shall be monitored and if it remains above a pre-set limit after the FTR time period has expired, the filter shall continue in FTR mode and an alarm shall be raised on SCADA.

3.9.4.4 Filter Run Start

Filter No.1 is used throughout for reference; the sequence applies to all other filters.

In this mode the filter is brought online from offline clean mode.

1. When the Filter No.1 Influent valve is confirmed opened, the outlet flow from the filter is gradually increased by ramping the PLC PID flow controller set point from zero at a preset ramp rate that ensures that the maximum rate of change of flow of 1.5% per minute is not exceeded.
2. When the actual flow equals the inlet channel level derived set point the ramp adjustment is stopped and the inlet channel derived, set point is applied to the PLC PID flow controller and the “Filter No. 1 Standby” signal is removed.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op	Cl.	Op.	Cl.	Op	Cl.	Op	Cl.
Filter Run Start	●		●		●			●		●		●		●

3.9.4.5 Filter Online (Filtration) Mode

In this mode the filter effluent valve shall modulate and control the flow through the filter to the set point, as determined by the filter inlet channel level. A PID loop shall be employed to control the valve position, in order to maintain the calculated filter outlet flow.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op	Cl.
Filtration	●		●[1]		●			●		●		●		●

Note: [1] Effluent valve performs flow control

3.9.4.6 Taking a Filter 'Out Of Service'

A facility shall be provided to take a filter out of service, and to return a filter back into service. A filter may be selected for return back into service with, or without an automatic backwash sequence. However, when an out of service filter is returned back into service, it shall normally first be backwashed.

When an out of service filter is returned to filtration mode without first being backwashed, the filter effluent flow shall be increased from zero to the set point level in accordance with the filter run start sequence slow start.

A filter is automatically taken out of service:

1. As a result of filter fault conditions
2. As a result of an operator request at SCADA

An operator would request that a filter is taken out of service for example, if the filter requires isolating for maintenance purposes.

Auto Procedure to take Filter 'Out of Service'

1. Request is made to take filter out of service by 1 or 2 above.
2. The filter is removed from the backwash queue
3. The filter effluent valve SP is set to zero and the valve is gradually closed.
4. The filter influent valve is closed.
5. If the filter is backwashing, then the backwash is aborted by closing all of the other valves and all drives are stopped.
6. The filter is tagged as 'Out of Service'

	Filter Influent Valve FV-F101A		Filter Effluent Control Valve FCV-F103A		Filter Effluent Isolation Valve FV-F104A		Backwash Supply Valve FV-F106A		Backwash Wastewater Valve FV-F102A		Air Scour Valve FV-F107A		FTR Isolation Valve FV-F105A	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op	Cl.
Out of Service		●		●		●		●		●		●		●

3.9.4.7 Description of Control of Backwash Stages

Each "In Service" filter can be selected at the SCADA for Auto/Manual control operation.

Auto Control

The filter is available for auto backwash sequence control, and the outlet flow is controlled in relation to the inlet channel level. This description applies to a filter that requires backwashing and enters the queue in the No.1 position. When more than one filter is in the queue, backwashing shall begin at the filter in offline dirty mode, in which case the filter shall have gone through the slow stop procedure and then all valves shall be closed.

The Backwash stages are as follows:

1. Slow Stop
2. Drain Down
3. Offline Dirty
4. Air Scour
5. Combined Air/Low Rate Backwash
6. High/Low Rate Backwash
7. Filter Refill and Standby
8. Filter to Recycle
9. Offline Clean

1. Wash Stage: 1 Slow Stop

1. The filter enters the wash queue.
2. The "Filter No.1 in Filtration Mode" signal shall be removed from SCADA
3. The SCADA "Filter Service" timer shall stop.
4. "Filter no.1 Backwashing" shall be displayed on SCADA
5. The Influent Valve (FV-F101A) shall close in stages based on the following parameters: 'Inlet Valve Close' and 'Inlet Valve Close Delay' times adjustable at SCADA. Full closure shall take approximately 11 minutes and ensures that the maximum rate of change of flow of 1.5% per minute is not exceeded.

	Filter Influent Valve FV-F101A		Filter Effluent Control Valve FCV-F103A		Filter Effluent Isolation Valve FV-F104A		Backwash Supply Valve FV-F106A		Backwash Wastewater Valve FV-F102A		Air Scour Valve FV-F107A		FTR Isolation Valve FV-F105A	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op	Cl.
Slow Stop	●[1]		●[2]		●			●		●		●		●

Note: [1] *Influent valve performs step closure*

[2] *Effluent valve continues under flow control*

2. Wash Stage 2: Drain Down

Filter No.1 Level is measured by LT-F100A with the following level control parameters:

Drain down level (backwash trough top): LT-F100AL1

1. When the Influent valve (FV-F10A) is confirmed closed
2. The Filter No. 1 Effluent Flow Control Valve (FCV-F103A) and the Filter Effluent Isolation Valve (FV-F104A) shall remain in level band control so that the filter drains down at the pre-backwash filter rate.
3. When LT-F100AL1 is reached, the Filter No. 1 Effluent Flow Control Valve (FCV-F103A) and the Filter No.1 Effluent Isolation Valve (FV-F104A) shall close as quickly as possible.
4. The filter shall go to Offline Dirty mode
5. The valves shall be in the states shown in the table below during the above processes.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op	Cl.
Level> LIT-F100AL1		•	•		•			•		•		•		•
Level< LIT-F100AL1 Standby		•		•		•		•		•		•		•

3. Wash Stage 3: Air Scour

1. When the filter occupies location No. 1 in the wash queue, a backwash shall be started if permitted and providing sufficient capacity is available in the Backwash Supply Tanks.
2. From the Offlline Dirty mode the Filter No. 1 Backwash Wastewater valve (FV-F102A) shall be opened, and the Filter No. 1 Air Scour Valve (FV-F107A) shall be opened.
3. A signal shall be sent requesting Air Scour Blower operation.
4. Confirm an Air Scour Blower running signal within a preset time.
5. When Air Scour Blower running signal is confirmed start 'Filter Air Scour Time' timer.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.
Air Scour		•		•		•		•	•		•			•

4. Wash Stage 4: Combined Air / Low Rate Backwash

1. When 'Filter Air Scour Time' timer expires, open clean backwash water inlet valve (FV-F106A) start "Max. Combined Air / Low Rate Wash Time" timer and send a signal to request a Low Rate Backwash flow (operation of variable speed BWS Pump P-F911A). Pump to ramp up to speed slowly.
2. Confirm "Low Rate Backwash Flow Established" signal is present within a preset time from FI-F911A.
3. When the "Max. Combined Air/Low Rate Wash Time" timer expires; a signal shall be sent to shutdown Air Scour Blower.
4. When Air Scour Blower is confirmed as stopped, close Filter No. 1 Air Scour Valve (FV-F107A).
5. Continue Low Rate Wash until "Max. Low Rate Wash after air scour Time" timer expires; a signal shall be sent to ramp up pump speed to high rate wash.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.
Combined Air / Low Rate Wash		•		•		•	•		•		•			•
Time > “Max Low Rate after air scour Wash Time”		•		•		•	•		•			•		•

5. Wash Stage 5: High Rate/Low Rate Backwash

1. When “Max. Low Rate Wash after air scour Time” timer expires, start “Max High Rate Wash Time” timer and send a signal to request a High Rate Backwash flow (operation of variable speed BWS Pump P-F911A). Pump to ramp up to speed slowly.
2. Confirm “High Rate Backwash Flow Established” signal is present within a preset time from FI-F911A.
3. When the “Max High Rate Wash Time” timer has expired ramp the backwash pump speed down to the low wash rate and start the “Max. Low Rate Wash Time” timer.
4. When “Max. Low Rate Wash Time” timer expires stop the backwash pump.
5. When the backwash water pump is confirmed as stopped, close the Filter No. 1 Backwash water Supply Valve (FV-F106A).
6. Close Filter No. 1 Backwash waste water Outlet valve (FV-F102A) after filter level falls below drain down level (backwash trough top): LT-F100AL1.

	Filter Influent Valve FV-F101A		**Filter Effluent Control Valve FCV-F103A**		**Filter Effluent Isolation Valve FV-F104A**		**Backwash Supply Valve FV-F106A**		**Backwash Wastewater Valve FV-F102A**		**Air Scour Valve FV-F107A**		**FTR Isolation Valve FV-F105A**	
Condition	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.
High rate back wash		•		•		•	•		•			•		•
Time > “Max High Rate Wash Time”		•		•		•	•		•			•		•
Time > “Max Low Rate Wash Time”		•		•		•	•		•			•		•
Time < “Max Low Rate Wash Time		•		•		•		•	•			•		•
Level< LI-F100AL1		•		•		•		•		•		•		•

6. Wash Stage 6: Filter Refill

1. When Filter No. 1 Backwash Supply Valve (FV-F106A) and Filter No. 1 BWW Valve (FV-F102A) are confirmed closed partially open Filter No. 1 Influent Valve (FV-F101A) and start “Refill Time” timer. The Influent Valve is partially opened by maintaining an open signal to the actuator for preset time.
2. PLC to check that Filter No. 1 Influent Valve (FV-F101A) closed signal is removed in a preset time.
3. When the filter is at normal water level (LIT-F100AL2) close the Filter No.1 Inlet Valve (FV-F101A).
4. The Filter is now in standby mode ready to proceed to FTR mode.

	Filter Influent Valve FV-F101A		Filter Effluent Control Valve FCV-F103A		Filter Effluent Isolation Valve FV-F104A		Backwash Supply Valve FV-F106A		Backwash Wastewater Valve FV-F102A		Air Scour Valve FV-F107A		FTR Isolation Valve FV-F105A	
Condition	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.
Filter Refill	●[1]			●		●		●		●		●		●
Filter Level> LIT-F100AL2		●		●		●		●		●		●		●

Note: [1] Influent Valve is partially opened for Refill period

7. Wash Stage 7: Filter to Recycle

1. When a filter has gone into standby mode (all valves closed) a “Max Time Standby to FTR” timer is started.
2. When the “Max Time Standby to FTR” timer is expired Filter No.1 Influent Valve (FV-F101A) is opened and the FTR isolation valve (FV-F105A) is opened.
3. The outlet flow from the filter is gradually increased by ramping open the Effluent Valve (FCV-F103A), the PLC PID flow controller set point from zero at a preset ramp rate that ensures that the maximum rate of change of flow of 1.5% per minute is not exceeded until the desired “FTR required flow rate” is reached.
4. Once the “FTR required flow rate” is reached timer “Max Time FTR” timer is started.
5. When the “Max Time FTR” timer is expired the control set point for the outlet valve (FV-F103A) shall revert to the common filter outlet valve set point.
6. If the filter is required to go into production then step 8 and 9 shall be execute, otherwise the filter shall go to standby mode (offline clean), all valves closed.
7. The operator can also make a selection to control the FTR period based on filter ripening, in which case the PLC shall monitor the turbidity and particle counts and when they are below acceptable limits the FTR cycle shall be ended as in step 6.
8. If the filter is required to go into production then when the actual flow equals the inlet channel level derived set point the ramp adjustment is stopped and the “Filter No. 1 Washing” signal is removed. The next filter at the top of the Wash Queue shall be permitted to start the Wash sequence.
9. Simultaneously close the FTR isolation valve (FV-F105A) and open the Filter Outlet Isolation Valve (FV-F104A).

	Filter Influent Valve FV-F101A		Filter Effluent Control Valve FCV-F103A		Filter Effluent Isolation Valve FV-F104A		Backwash Supply Valve FV-F106A		Backwash Wastewater Valve FV-F102A		Air Scour Valve FV-F107A		FTR Isolation Valve FV-F105A	
Condition	Op.	Cl.	Op	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op.	Cl.	Op	Cl.
Filter to FTR	●[1]		●			●		●		●		●	●	
Filter to FTR complete standby (offline clean)		●		●		●		●		●		●		●
Filter to FTR complete online	●[2]		●		●			●		●		●		●

Note: [1] Outlet valve performs flow control to FTR required flow rate

[2] Outlet valve performs flow control to common filter outlet set point

8. Wash Sequence Failure and Filter Isolation

Should the wash sequence fail for any reason, the PLC shall attempt to isolate (shutdown) the respective filter.

A Filter is Isolated when in a Wash Sequence by:

1. Raise an alarm i.e. 'Filter No. 1 Isolation Initiated'.
    1. Stop Air Scour Blower if running.
    2. Stop BWS Pump if running.
    3. Close Influent valve if open.
    4. Close Effluent Flow Control Valve if open.
    5. When BWS Pump is confirmed not running, close the Backwash water Valve if open and close BWW Valve if open.
    6. When Air Scour Blower is confirmed not running, close Air Scour Valve if open.
    7. Raise condition "Filter No. 1 Isolation Successful" or "Filter No. 1 Isolation Not Successful" as applicable.

If the Isolation has been successful, filters can continue to enter the Washing Sequence as required. If a preset number of successive filters have an "Isolation Initiated" signal e.g. 4 No., an "Excessive Filters Isolated" alarm shall be raised and no further filters shall be permitted to enter a Wash Sequence until the preset number is manually reset at SCADA.

If the isolation is not successful, the PLC shall determine if any further filters can enter the Wash Sequence by checking that the backwash inlet valve, backwash outlet valve and the air scour valve are closed. If any of these valves are not closed, no further backwashing shall be permitted and a high priority alarm shall be raised.

3.9.4.8 Filter Loss of Head Measurement

A differential pressure transmitter shall continuously monitor the total loss of head across each individual filter bed.

During filtration, if a high differential pressure is detected across the filter bed for a preset time, then a high head loss signal is set e.g. "Filter No. 1 High Loss of Head", and the filter enters the Wash Queue.

If more than a preset number of filters exhibit high loss of head at any one time then an alarm is initiated e.g. "Two Filters High Loss of Head", this does not inhibit further filters from entering the Wash Queue.

The operator can disable a high loss of head signal from initiating a wash via SCADA to allow instrument calibration.

3.9.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of appendix 1.

Tag No.	Event	Type	Control System Action
LT-C701A LT-C702A	Duty FIN channel level transmitter signal failure	Fault	Instrument to fail low. PLC to switch standby instrument
	Low Level in FIN channel	Interlock	Close filter outlet valves
	High level in FIN channel	Interlock	Reduce Raw Water flow by reducing pump speed
	High High level in FIN channel	Interlock	Stop Raw Water flow by stopping pumps.
Filter No. 1-8 The following list of actions applies to all filters.			
LT-F100A	Filter level transmitter signal failure	Fault	If filter in wash then abort wash. Take filter out of service.
		Fault	Instrument output shall go low; PLC shall hold last known value.
FV-F101A	Filter Influent Valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
FCV-F103A	Filter Effluent control valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
FV-F106A	BWS valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
FV-F107A	Air Scour valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
FV-F104A	Filter Effluent isolation valve failed/ unavailable	Fault	Alarm on SCADA, backwashing allowed to continue.
FV-F102A	Backwash Wastewater valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
FV-F105A	FTR valve failed/ unavailable	Fault	If filter in wash then abort wash. Take filter out of service.
	If BWS valve, Backwash wastewater valve or scour air valve not closed and filter not in wash	Interlock	Take filter out of service. Inhibit backwash sequence
	Filter selected to manual control	Interlock	Inhibit automatic backwash sequence

Tag No.	Event	Type	Control System Action
PT-F101A	Filter differential pressure transmitter fault/ out of limits	Fault	Instrument output shall go low; PLC shall hold last known value. If the filter is in the queue when instrument fails it shall stay in queue and be washed automatically. If the failure still exists at end of wash then manual operation required to remove 'disable' filter for loss of head backwash request.
	Filter loss of head high	Event	Filter placed in backwash queue if selection enabled
FT-F101A	Filter Effluent flow transmitter fault/ out of limits	Alarm	PLC to hold signal at last valid value. Hold flow control valve position.
	Excessive number of filters required for backwash	Event	Generate alarm to SCADA
AT-F110A	Turbidity analyzer fault/ out of limits	Fault	Instrument output shall go high, filter shall be taken out of service.
	Outlet turbidity high	Alarm	Alarm only, operator can manually Instigate filter backwash
	Outlet turbidity high high	Alarm	Automatically stop filter run, put in backwash queue
AT-F110B	Particle Counter fault/ out of limits	Fault	Instrument output shall go high, filter shall be taken out of service.
	Outlet particle count high	Alarm	Alarm only, operator can manually Instigate filter backwash

3.9.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
LT-C701A LT-C702A FIN Channel Control Low Band	38%
LT-C701A LT-C702A FIN Channel Control High Band	45%
LT-C701A LT-C702A FIN Channel High Level	60%
LT-C701A LT-C702A FIN Channel High High Level	75%
LT-C701A LT-C702A FIN Channel Low Level	20%
Filter Drain Down Level (LI-F100AL1)	5%
Filter Normal Water Level (LI-F100AL2)	38-45%
Filter Outlet Maximum Flow	60 ML/d
High Rate Backwash Total Flow	0-xxxxx TCMD

Description	Range
Filter Effluent High Flow	57 ML/d
Filter Effluent Low Flow	20 ML/d
Filters High Loss Of Head	40KPa
Filters Hi-Hi Loss Of Head	43KPa
Excessive Number Filters Detecting Loss Of Head	0-x
Filters 1-8 Wash Interval Time	0-xxxx min
Excessive backwash Queue Time	0-xxxx min
Max. Air Scour Time	0-xxxx min
Max. Combined Air / Low Rate Wash Time	0-xxxx min
Max. Low Rate Wash after Scour Time	0-xxxx min
Max. High Rate Wash Time	0-xxxx min
Max. Low Rate Wash Time	0-xxxx min
FTR Required Flow Rate	0-xxxx ML/d
Re-fill Influent Valve Open Time	0-xxxx min
Standby to FTR Time	0-xxxx min
FTR Time	0-xxxx min
Filter Outlet Valve Ramp Rate	0-x.x m^3/hr / min

SCADA/HMI Operator adjustable set points

Description	Range
Filters No. 1-8 Enable / Disable Loss Of Head Monitoring Selection	Toggle
Filters No. 1-8 Out Of Service Selection	Toggle
Filters No. 1-8 Return To Service (Filtration Mode) Selection	Toggle
Filters No. 1-8 Return To Service (Backwash Mode) Selection	Toggle
Filters No. 1-8 Automatic / Manual Control Selection	Toggle
Filters No. 1-8 Initiate Backwash Request Selection	Toggle

SCADA/HMI status signals

Description	Range
Filter Outlet Desired Flow	0-xx.xx l/s
Filters No. 1-8 Wash Interval Time (Actual)	0-xxxx min
Filters No. 1-8 Time In Service (Actual)	0-xxxx min
Backwash Queue Filter Nos.	1-8

Description	Range
Backwash Queue Filter Backwash Cause	1-4
Filters No. 1-8 Control Mode Status Automatic / Manual	
Filters No. 1-8 Service Status	
Filters No. 1-8 Filtration Mode Status	
Filters No. 1-8 Washing Status	
Filters No. 1-8 Slow Stop Status	
Filters No. 1-8 Drain Down Stage Status	
Filters No. 1-8 Air Scour Stage Status	
Filters No. 1-8 Combined Air /Low Rate Backwash Stage Status	
Filters No. 1-8 Low Rate Wash After Air Scour Stage Status	
Filters No. 1-8 High Rate Backwash Status	
Filters No. 1-8 Low Rate Backwash Status	
Filters No. 1-8 Refill Backwash Status	
Filters No. 1-8 Standby to FTR Status	
Filters No. 1-8 FTR Status	
Filters No. 1-8 Filter Run Start Status	

SCADA/HMI alarm signals

Description	Range
Filter No.1 High Turbidity	0-3 NTU
Filter No.1 High High Turbidity	0-3 NTU
Filter No.1 High Particle Count	
Filter No.2 High Turbidity	0-3 NTU
Filter No.2 High High Turbidity	0-3 NTU
Filter No.2 High Particle Count	
Filter No.3 High Turbidity	0-3 NTU
Filter No.3 High High Turbidity	0-3 NTU
Filter No.3 High Particle Count	
Filter No.4 High Turbidity	0-3 NTU
Filter No.4 High High Turbidity	0-3 NTU
Filter No.4 High Particle Count	
Filter No.5 High Turbidity	0-3 NTU
Filter No.5 High High Turbidity	0-3 NTU
Filter No.5 High Particle Count	

Description	Range
Filter No.6 High Turbidity	0-3 NTU
Filter No.6 High High Turbidity	0-3 NTU
Filter No.6 High Particle Count	
Filter No.7 High Turbidity	0-3 NTU
Filter No.7 High High Turbidity	0-3 NTU
Filter No.7 High Particle Count	
Filter No.8 High Turbidity	0-3 NTU
Filter No.8 High High Turbidity	0-3 NTU
Filter No.8 High Particle Count	

3.10 Filter Air Scour and Backwash

3.10.1 Documentation

WF-P0009 P&ID Backwash Supply Pumps

WF-P0010 P&ID Air Scour Blowers

WF-P0013 P&ID Backwash Supply Pumps (showing pump protection and control)

3.10.2 Plant and Instruments

Tag	Description	
Backwash Water Supply Tanks		
TNK-F910A	Backwash Water Supply Tank	
PT-F910A	Backwash Water Storage Tank TNK-F910A Level	
FV-F910A	Backwash Water Supply Tank TNK-F910A Outlet Valve	
FV-F912A	Backwash Water Supply Tank TNK-F910A Inlet Valve	
TNK-F920A	Backwash Water Supply Tank	
PT-F920A	Backwash Water Supply Tank TNK-F920A Level	
FV-F920A	Backwash Water Supply Tank TNK-F920A Outlet Valve	
FV-F922A	Backwash Water Supply Tank TNK-F920A Inlet Valve	
FV-F931A	Backwash Water Supply Tank Inlet Crossover Valve	
FV-F932A	Backwash Water Supply Tank Outlet Crossover Valve	
FV-J991A	Sodium Hypochlorite Dosing to Backwash Supply Tank TNK-F910A Valve	
FV-J992A	Sodium Hypochlorite Dosing to Backwash Supply Tank TNK-F920A Valve	
Backwash Water Supply Pumps (BWS) Duty/ Standby		
P-F911A	BWS Pump	
FT-F911A	BWS Pump P-F911A Outlet Flow	

Tag	Description	
TT-F911A	BWS Pump P-F911A Outlet Water Temperature	
PT-F911A	BWS Pump P-F911A Pressure	
PS-F911A	BWS Pump P-F911A Outlet Pressure High	
P-F921A	BWS Pump	
FT-F921A	BWS Pump P-F921A Outlet Flow	
TT-F921A	BWS Pump P-F921A Outlet Water Temperature	
PT-F921A	BWS Pump P-F921A Pressure	
PS-F921A	BWS Pump P-F921A Outlet Pressure High	
FV-F933A	BWS Pump Outlet Crossover Valve	
Air Scour Blowers Duty/ Standby		
BLW-F010A	Filter Air Scour Blower	
PT-F010A	Filter Air Scour Blower BLW-F010A Inlet Air Filter Differential Pressure	
FV-F010A	Filter Air Scour Blower BLW-F010A Outlet Control Valve	
PT-F010B	Filter Air Scour Blower BLW-F010A Outlet Pressure	
BLW-F020A	Filter Air Scour Blower	
PT-F020A	Filter Air Scour Blower BLW-F010A Outlet Pressure	
FV-F020A	Filter Air Scour Blower BLW-F010A Outlet Control Valve	
PT-F020B	Filter Air Scour Blower BLW-F020B Outlet Pressure	
TT-F030A	Filter Air Scour Blower Outlet Temperature	
FIT-F030A	Air Scour Blower Outlet Air Flow	

3.10.3 General Operation

Water for backwashing the BAC filters shall be held in two clean backwash supply tanks, each sized to hold two complete filter backwashes. The arrangement of the tank piping is such that under normal operation the tanks shall be hydraulically connected so that they shall fill and empty at the same rate. If the tanks need to be isolated from each other for any reason, then this can be done by operating actuated crossover valves in the inlet and outlet pipework. This shall require operator intervention and is not an automatic function.

The tanks shall be filled during the FTR stage of backwashing, this filling shall be carried out on a time basis as set by the operator to re establish the required level set point. If the level in either storage tank reaches a high level (overflow) during the FTR cycle, an alarm shall be raised. Overflows from the backwash storage tanks shall go the supernatant pumping station

Each tank shall have a pressure transmitter fitted which indicates the level of the tank. A filter wash shall not be allowed to commence unless there is sufficient water in the BWS tanks as measured by the level transmitters.

Duty/standby, variable speed, BWS pumps shall deliver backwash water to the filter via the BWW manifold. The flow rate shall be controlled according to the position in the backwash cycle (i.e. low rate wash cycle or high rate wash cycle). The pump motors shall have various protection and monitoring devices fitted such as bearing and winding temperature monitoring, VFD monitoring etc. Each pump shall have its protection relay and VFD connected to the control network so that it can be monitored by the plant operations staff.

Each pump shall normally be used to backwash any filter but once again actuated valves are available to isolate a pump and sections of pipework if required.

The Filter Air Scour system shall comprise of two packaged blowers which shall operate as duty / standby.

Each blower package comprises inlet silencer and filter and a motor driven blower. Pressure differential transmitters shall be provided on the inlet filters. Vibration switches, motor and bearing temperature monitoring shall also be provided to stop the blower on fault detection. These protection devices shall be connected to a relay which shall be connected to the control network so that it can be monitored by the plant operations staff.

The common blower outlet flow rate and temperature shall be monitored by instruments in the discharge pipework.

The blowers are started and stopped by the PLC as part of the automatic Filter Backwash Sequence. A “Running” signal is passed to Filter Wash sequence, if the “Running” signal is not maintained in accordance with the Filter Wash sequence the standby Air Scour Blower shall be requested to operate.

3.10.4 Automatic Control Philosophy

3.10.4.1 Backwash Water Storage Tank Level Transmitters PTF910A, PT-F920A

Whenever the tanks are hydraulically connected i.e., valves FV-F931A, FV-F932A, FV-F912A and FV-F922A are open, then the level transmitters shall operate in a duty/standby mode. Duty/standby/Off transmitter operation shall be selected at SCADA.

Level control shall be automatically transferred to the standby transmitter if the duty transmitter becomes unavailable (because of transmitter failure or de-selection).

The duty level transmitter shall be used to monitor the level in the tanks and determine the fill volume of the tanks; the level value shall be displayed on the SCADA.

If the level in the tank falls below the ’Insufficient Backwash Water Volume’ level for a preset period then filter backwashing shall be inhibited and an alarm shall be raised at SCADA. As long as the tank level remains between the ‘Normal Working’ level and the ‘Insufficient Backwash Water Volume’ backwashing will be allowed.

The tank “Low Low” level shall be used for backwash water pump protection. The pumps shall be enabled as long as the level in the tank is above the Low Low level point for a preset time. A Low Low level would consequently inhibit filter backwashing.

3.10.4.2 BWS Pumps P-F911A & P-F921A

The variable speed pumps shall operate in a duty/ standby regime. In the event of a failure or unavailability of the duty pump the standby pump shall be automatically started.

In general, the BWS pumps shall operate in conjunction with the filter backwash sequence. The pumps shall be called to operate during the following Backwash Stages (see previous section for further details):

- Wash Stage No.4 - 'Combined Air / Low Rate Backwash'
- Wash Stage No.5 – 'High/Low Rate Backwash'

The duty pump speed shall be controlled by the PLC using a PID loop, in order to achieve and maintain desired flow rate applicable to each Backwash stage.

The BWS flow shall be measured using the flowmeters in the discharge of each pump.

3.10.4.3 BWS Pumps Low Rate Backwash Control

Under this control the pump shall start on receipt of the 'Combined Air / Low Rate Backwash' signal from the PLC filter wash control.

A PID loop control shall then switch to 'Auto' and the loop algorithm shall modify the pump speed in order to maintain a 'Desired Low Rate Backwash' flow set point.

A check shall be made to ensure that the desired flow rate has been achieved within a 'Low Rate Backwash Established' time. Failure to achieve the flow-rate shall abort the wash sequence and an alarm shall be raised on SCADA.

The BWS pumps shall perform this control until the 'High Rate Backwash' signal is received from the filter wash control and then it shall begin again after the "Max. High Rate Wash Time' has expired and then they shall ramp down speed and stop.

3.10.4.4 BWS Pumps High Rate Backwash Control

Under this control the pump control shall start to change on receipt of the 'High Rate Backwash' signal from the filter wash control.

The duty pump shall be required to run at the current speed determined by the Low Rate backwash control for a preset time (typically 10 seconds.). This shall be achieved with the PID loop control in 'Manual'. The PID loop control shall then switch to 'Auto' and the loop algorithm shall modify the pump speed in order to maintain a calculated 'High Rate Backwash' flow set-point. The required flow set point shall be calculated as follows: -

Filter High Rate Backwash Flow set point (ML/d) = Qhwmin+ (Qhwmax-Qhwmin)* Tbw/22

Where:

Qhwmin = minimum winter high rate wash (e.g. 71.2 ML/d)

Qhwmax = maximum summer high rate wash (e.g. 94.9 ML/d)

Tbw= temperature of backwash water (°C), (default to 1°C if temperature transmitter signal is out of range

22= 22°C (constant)

It is important that the Qhwmax value of 94.9ML/d cannot be exceeded either by calculation or by operator override

The Backwash Water Temperature shall be the value of the temperature transmitter in the discharge of the running Backwash Pump in °C.

A check shall be made to ensure that the desired flow rate has been achieved within a 'High Rate Backwash Established' period. Failure to achieve the flow-rate shall abort the wash sequence and an alarm raised on SCADA.

The backwash water pumps shall perform this control until the desired 'Max. High Rate Wash Time 'timer has expired, at which point the pumps speed shall be ramped back down to the low rate wash.

The 'High Rate Backwash Flow' totalisation shall commence at the start of the 'High Rate Backwash' stage.

3.10.4.5 BWS Pump Outlet Flow FT-F911A& FT-F912A

The PLC shall monitor the backwash water flow and display the instantaneous value on the SCADA.

During the 'Low Rate' and 'High Rate' backwash stages, the flow shall be monitored. If the measured flow, while in Low Rate wash, exceeds a 'Low Rate Backwash High Flow' set-point for a period of time (60 seconds) then an alarm shall be raised on the SCADA. Similarly, if the measured flow while in High Rate Wash exceeds a 'High Rate Backwash High Flow' set-point for a period of time (60 seconds) then an alarm shall be raised on the SCADA.

During the 'High Rate Backwash' stage the PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The totalised flow shall be reset at the end of the associated filter wash sequence.

During the 'Low Rate Backwash' stage the PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The totalised flow shall be reset at the end of the associated filter wash sequence.

3.10.4.6 Backwash Pump Discharge Pressure Transmitters PT-F911A & PT-F921A

A pressure transmitter shall be fitted into the discharge pipework of each pump, to monitor the pressure if the pump is running. If a High pressure is detected for a pre-set time, (set lower than the underbed pressure switch in the next section) then an alarm shall be raised on SCADA.

If a High High pressure is detected for a pre-set time, (set at the same point as the underbed pressure switch in the next section) than the pump shall be stopped the filter being washed shall be taken out of service and an alarm raised on SCADA. All backwashing shall be prohibited until the problem is resolved by the operator and the pumps reset.

3.10.4.7 Filter Underbed Over Pressure Protection During Backwashing

To protect the filters from underbed damage due to high pressure backwash water a pressure switch (PS-F911A& PS-F921A) shall be fitted in the discharge pipe of each backwash water pumps. The switch shall be hardwired to the pumps. On detection of a high pressure, the pumps shall be tripped and an alarm raised on SCADA.

If any switch detects a high pressure, the pumps shall be tripped, the filter being washed shall be taken out of service and an alarm raised on SCADA. All backwashing shall be prohibited until the problem is resolved by the operator and the pumps reset.

3.10.4.8 Sodium Hypochlorite Dosing

See section 3.24 for details.

3.10.4.9 Air Scour Blower Control BLW-F010A, BLW-F020A

The fixed speed blowers shall operate in a duty / standby regime. In the vent of a failure or unavailability of the duty blower the standby shall be automatically started.

In general, the blowers shall operate in conjunction with the filter wash sequence. The blowers shall be called to operate during the following Wash Stages (see below for further details): -

Wash Stage No.3 - ‘Air Scour’

Wash Stage No.4 – ‘Combined Air / Low Rate Backwash’

3.10.4.10 Blower Air Scour Control

Under this mode of control, the duty blower shall start upon receipt of the ‘Perform Air Scour’ signal from the filter wash control.

The duty blower shall be required to run for the ‘Filter Air Scour’ time. Once this period has expired the filter wash sequence shall enter Wash Stage “Combined Air / Low Rate Backwash”.

3.10.4.11 Blower Combined Air / Low Rate Wash Control

Under this mode of control, the duty blower shall continue to run upon receipt of the ‘Combined Air’ signal from the filter wash control.

The duty blower shall be required to run until the ‘Combined Air’ signal has been removed from the filter wash control because the ‘Low Rate Wash’ time has expired, the blower shall then stop.

3.10.4.12 Blower Discharge Air Flow FT-F030A

The PLC shall monitor the blower discharge air flow and display the instantaneous value on the SCADA.

During the ‘air scour’ backwash stages, the flow shall be monitored. If the measured flow, exceeds the ‘Air Scour High Flow’ set-point for a period of time (60 seconds) then an alarm shall be raised on the SCADA.

3.10.4.13 Blower Discharge Air Temperature TT-F030A

The PLC shall monitor the blower discharge air temperature and display the value on the SCADA.

During the ‘air scour’ backwash stages, the temperature shall be monitored. If the measured temperature, exceeds the ‘Air Scour High Temperature’ set-point for a period of time (60 seconds) then an alarm shall be raised on the SCADA.

3.10.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
BWS Tanks			
PT-F910A			
	Insufficient water in backwash tank to allow backwashing	Fault	Inhibit backwashing; raise alarm on SCADA.
	Instrument failure	Fault	Instrument configured to fail low, PLC to switch to other instrument if selected as duty. If both instruments fail backwashing inhibited.
PT-F920A			
	Insufficient water in backwash tank to allow backwashing	Fault	Inhibit backwashing; raise alarm on SCADA.
	Instrument failure	Fault	Instrument configured to fail low, PLC to switch to other instrument if selected as duty. If both instruments fail backwashing inhibited
BWS Pumps			
FT-F911A FT-F921A	Instrument Failure	Fault	If the instrument fails during the low rate wash period, then the PLC value shall be set to zero, which would cause a backwash failure. If the instrument fails during the high rate wash period the signal shall be held at the last value. This would allow the backwash to complete and the filter would eventually return to filtration mode.

Tag	Event	Type	Control System Action
PS-F911A PS-F921A	BWS pump outlet pressure high	Fault	Trip pumps to protect underside of filter plenum
P-F911A P-F920A	Both pumps unavailable for auto control	Fault	Inhibit backwashing
TT-F911A TT-F921A	Backwash Pump discharge temperature transmitter failure/ out of limits.	Fault	Instrument configured to fail low. PLC to use default value 1 ^{o}C during high rate wash calculations.
Air Scour Blowers			
BLW-F010A BLW-F020A	Both blowers unavailable	Fault	Inhibit backwashing
FT-F030A	Air scour flow rate out of range	Alarm	Alarm on SCADA
	Instrument failure	Fault	The PLC shall hold the signal at the last value to allow air scour to complete.

3.10.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
BWS Tank Normal Working Level	0-100%
BWS Tank Insufficient Backwash Water Volume Level	0-100%
Low Rate Backwash Desired Flow	0-xxx TCMD
Low Rate Backwash Water Flow High	0-xxx TCMD
High Rate Backwash Water Flow High	0-xxx TCMD
Low Rate Backwash Flow Established Time	0-xxx sec
High Rate Backwash Flow Established Time	0-xxx sec
Filter Air Scour Flow High Range	0-xxxNm^3/hr
Filter Air Scour Flow Low Range	0-xxxNm^3/hr

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

Description	Range
Backwash Water Flow Accumulated Value (High Rate Wash)	0-xxx TCMD
Backwash Water Flow Accumulated Value (Low Rate Wash)	0-xxx TCMD
Air Scour Flow Rate	0-xxxNm^3/hr

SCADA/HMI Alarm Signals

Description	Range
Low Rate BWS Flow Not Achieved	
High Rate BWS Flow Not Achieved	
Backwash Water pump outlet pressure high	

3.11 Hypochlorite Mixing Pumps

3.11.1 Documentation

WF-P0014 P&ID Hypochlorite Mixing Pumps

3.11.2 Plant and Instruments

Tag	Description	
P-J701A	Hypochlorite Mixing Pump	
PS-J701A	Hypochlorite Mixing Pump P-J701A Discharge High Pressure Switch	
FV-J701A	Hypochlorite Mixing Pump P-J701A Discharge Valve	
FIT-J701A	Hypochlorite Mixing Pump P-J701A Discharge Flowmeter	
FS-C110A	Hypochlorite Mixing Pump P-J701A Sodium Hydroxide Dilution Low Flow Switch	
P-J702A	Hypochlorite Mixing Pump	
PS-J702A	Hypochlorite Mixing Pump P-J702A Discharge High Pressure Switch	
FV-J702A	Hypochlorite Mixing Pump P-J702A Discharge Valve	
FIT-J702A	Hypochlorite Mixing Pump P-J702A Discharge Flowmeter	
FS-C110B	Hypochlorite Mixing Pump P-J702A Sodium Hydroxide Dilution Low Flow Switch	
FV-J703A	Hypochlorite Mixing Pump Discharge Crossover Valve	

3.11.3 General Operation

To ensure proper mixing of sodium hypochlorite, ammonia and sodium hydroxide, jet flash mixing shall be used to mix the chemicals into the filtered water. Duty/Standby flash mix injectors shall be installed in the channel between the chlorine contact tank and the Clearwell.

Each injector shall be served by a dedicated fixed speed flash mix pump, which shall be fed by a sidestream from the chlorine contact tank. Normally only one flash mixer and its associated pump shall be in operation. Each pump shall have an open/ close actuated valve and flow meter in the discharge.

Sodium hypochlorite shall be delivered to the injection pipework before the nozzle, sodium hydroxide and ammonia dosing pipes shall be delivered to the throat of the nozzle, so that the turbulence generated by the nozzle shall flash mix the chemicals across the diameter of the channel.

Another sidestream shall be taken from the discharge pipework of the pumps and injected into the sodium hydroxide dosing pipe to provide dilution and prevent heating of the channel water. A flow indicator and switch shall be provided in the sidestream pipework to ensure operation of the process.

Although the injector and pumps are arranged in a duty/standby format, it shall be possible by operation of an actuated crossover valve to use either pump with either nozzle should the need arise.

The control of the injection of sodium hypochlorite shall normally be based on the filtered water flowrate, chlorine contact tank detention time, outlet free chlorine residual, and virus inactivation target. Dual signal control shall be flow proportional plus feedrate trim based on CT (contact time x residual chlorine) target.

The control of the injection of sodium hydroxide shall normally be based on the pH measurement in the Clearwell and the acid dosing shall be used to adjust the pH level to between 7.4 and 7.8.

The control of the injection of ammonia shall normally be based on the free chlorine residual at the chlorine contact tank outlet, the chlorine/ammonia feed ratio, and the free ammonia residual level at the Clearwell inlet.

3.12 Clearwell

3.12.1 Documentation

WT-P001 P&ID Clearwell Process and Instrumentation

3.12.2 Plant and Instruments

Tag	Description	
Sluice Gates		
SLG-T101A	Clearwell Cell No.1Inlet Chamber Sluice Gate	
SLG-T102A	Clearwell Cell No. 1 Outlet Chamber Sluice Gate	
SLG-T201A	Clearwell Cell No. 2 Inlet Chamber Sluice Gate	
SLG-T202A	Clearwell Cell No. 2 Outlet Chamber Sluice Gate	
SLG-T002A	Clearwell Cell No. 1 & 2 Dividing Wall Sluice Gate	
SLG-T003A	Clearwell Outlet Chamber Dividing Wall Sluice Gate	

Tag	Description	
Cell Level Transmitters		
LIT-T101A	Clearwell Cell No. 1 Level	
LIT-T101B	Clearwell Cell No. 1 Level	
LIT-T201A	Clearwell Cell No. 2 Level	
LIT-T201B	Clearwell Cell No. 2 Level	
Water Quality Analyzer Systems		
SP-T103A	Clearwell Sample Pump No. 1	
TNK-T103A	Degassing Column	
FS-T104A	Clearwell Chloramination Analyzer Sample Flow	
AIT-T104A	Clearwell Total Chlorine, Total Ammonia, Free Ammonia and Monochloramine	
FS-T105A	Clearwell Free Chlorine Analyzer Sample Flow	
AIT-T105A	Clearwell Free Chlorine	
FS-T106A	Clearwell pH Analyzer Sample Flow	
AIT-T106A	Clearwell pH	
FS-T107A	Clearwell Turbidity Analyzer Sample Flow	
AIT-T107A	Clearwell Turbidity	
SP-T203A	Clearwell Sample Pump No. 2	
TNK-T203A	Degassing Column	
FS-T205A	Clearwell Free Chlorine Analyzer Sample Flow	
AIT-T205A	Clearwell Free Chlorine	
FS-T206A	Clearwell pH Analyzer Sample Flow	
AIT-T206A	Clearwell pH	
FS-T207A	Clearwell Turbidity Analyzer Sample Flow	
AIT-T207A	Clearwell Turbidity	

3.12.3 General Operation

Treated water flows by gravity from the Chlorine Contact tank to the Clearwell. The Clearwell is a below ground concrete tank with a storage capacity of 22.6 ML which equates to 1.36 hours of storage when full at a plant flow rate of 400 ML/d. The water shall flow into the Clearwell over a weir structure. The Clearwell is divided diagonally into two cells; manually operated sluice gates shall be used to isolate the inlet and outlet flow and also to isolate each of the cells. All the sluice gates shall be provided with limit switches for position monitoring.

Each cell of the Clearwell shall have duty/standby ultrasonic level transmitters installed. The control system shall allow the operator to select the duty level transmitter in each cell and shall automatically change over to the standby transmitter on failure of the duty device. There shall be a facility on SCADA/HMI to take a treated water cell out of operation and automatically inhibit alarms from the associated level transmitter.

Under normal operating conditions the water level in the Clearwell shall remain within a pre-determined operating band, the level shall be maintained by operation of the pumps in DBPS. In the event of any abnormal operational conditions such as a high high level in the Clearwell due to pump failure in DBPS, the control system shall take the appropriate action i.e., reducing the speed or stopping of the Raw Water Pumps.

Treated water shall be analyzed continuously by two independent sets of instruments for turbidity, pH, free chlorine, the analyzers shall be housed in the Clearwell Inlet Building.

3.12.4 Automatic Control Philosophy

3.12.4.1 Treated Water Flow to Clearwell Cells CW-T101A, CW-T201A

When the WTP is being operated in fully automatic mode (normal conditions) a check shall be made by the control system to confirm that at least one of both the inlet and outlet sluice gates of the Clearwell are open before the Raw Water Pumps can start.

To allow cleaning and maintenance in either Cell No. 1 or Cell No. 2 the relevant sluice gates (inlet, outlet and dividing wall) can be manually closed to isolate the individual cells. The operator shall select the cell as ‘out of service’ at the SCADA/HMI before closing the manually operated sluice gates.

If a cell is selected ‘out of service’ then the associated level transmitters signals shall be inhibited and the in service cell transmitters shall remain active.

3.12.4.2 Clearwell Cell No. 1 and 2 Level Transmitters LIT-T101A, LIT-T201A, LIT-T101B, LIT-T201B

Duty/standby level transmitters shall be installed to measure the level in both Clearwell cells; the operator shall select which transmitter in each cell is the duty instrument. During normal operation, both cells shall be in service and the level in the cells shall be the same, so both duty level transmitter signals shall be monitored and used by the control system, the average of the two duty signals shall be displayed and used as the control parameter. In the event of a failure of either of the duty instruments the standby shall automatically become duty.

The pumps in DPBS shall be used to maintain the level in the Clearwell within a predetermined level control band. If the level goes outside the control band for a pre-set time period an alarm shall be raised, see diagram below.

High and low cell level alarms shall be raised as an early warning of abnormal process conditions. In the event of a high level alarm the Raw Water Pump speed shall be ramped down by a pre-determined amount, if the level continues to rise to the high high level then the Raw Water Pumps shall stop and the WTP shall be shut down. See section 4.0 for shut down procedures. Rate of change shall also be monitored, so that if the Clearwell level changes by more than 5% in 10 minutes (adjustable) an alarm shall be raised

In the event of the level in the Clearwell falling to the low level set point, the speed of the pumps in DBPS shall be ramped down by a pre-determined amount; if the level continues to fall to the low low level set point then the DBPS pumps shall be inhibited.

3.12.4.3 Water Quality Analyzer Systems

Two complete systems of water quality analytical instruments shall continuously monitor the water as it enters the Clearwell. The sample water shall be provided by a pump for each system.

- SP-T103A
- SP-T203A

Both pumps shall start as soon as the level in the Clearwell rises above the low level set point for a pre-set time. Once the pumps have started, the sample flow to the analyzers shall be monitored by flow switches installed on the rotameter of each instrument.

The analyzer systems shall work as a duty standby arrangement, so that if any individual duty analyzer fails and the standby analyzer is available, then the operator shall switch to the standby instrument. Both the duty and standby analyzer outputs shall be continuously displayed on the SCADA/HMI, the duty and standby designation shall be displayed to indicate the current status of each signal. A list of parameters measured is shown below.

- Turbidity
- pH
- Free Chlorine

The water quality signals shall be used to control the dosing of various chemicals as well as monitoring water quality. Refer to Sections 3.23 and 3.27 of this document for details on dosing control.

In the event where the measured level of pH, free chlorine or turbidity is out of range for a time period, an alarm shall be raised on SCADA. Raw water pumps shall be stopped, deacon pumps shall be stopped and the clearwell outlet sluice gates (SLG-T102A and SLG-T202A) shall be closed.

Refer to Section 3.32 Water Quality in this document for more details.

3.12.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LIT-T101A (Duty) LIT-T102A (Standby)	Instrument Fault	Fault	Instrument configured to automatically switch to standby instrument when failed and generate alarm on SCADA. If both instruments fail PLC to hold at last.
	High level	Alarm	Alarm on SCADA. Reduce speed of Raw Water Pumps
	High high level	Alarm	Alarm on SCADA. Shut down Raw water pumps
	Low level	Alarm	Alarm on SCADA. Reduce speed of DBPS pumps

Tag	Event	Type	Control System Action
	Low low level	Alarm & Interlock	Inhibit Deacon Booster Pumps. Alarm on SCADA.
LIT-T201A (Duty) LIT-T202A (Standby)	Instrument Fault	Fault	Instrument configured to automatically switch to standby instrument when failed and generate alarm on SCADA. If both instruments fail PLC to hold at last.
	High level	Alarm	Alarm on SCADA. Reduce speed of Raw Water Pumps
	High high level	Alarm	Alarm on SCADA. Shut down Raw water pumps
	Low level	Alarm	Alarm on SCADA. Reduce speed of DBPS pumps
	Low low level	Alarm & Interlock	Inhibit Deacon Booster Pumps. Alarm on SCADA.
AIT-T*04A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*05A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*06A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*07A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.

3.12.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Clearwell Cell No. 1 CW-T101A	
Cell No.1 Upper level of Operating Band	0-100%
Cell No.1 Lower level of Operating Band	0-100%
Rate of change set point	0-50%
Rate of change timer	0-30 mins
Clearwell Cell No. 1 CW-T201A	

Description	Range
Cell No.2 Upper level of Operating Band	0-100%
Cell No.2 Lower level of Operating Band	0-100%
Rate of change set point	0-50%
Rate of change timer	0-30 mins

SCADA/HMI Operator Adjustable Set Points

Description	Range
Clearwell Cell No.1 in Service	
Clearwell Cell No.2 in Service	
Level Transmitter LIT-T101A Duty/Standby	
Level Transmitter LIT-T101B Duty/Standby	
Level Transmitter LIT-T201A Duty/Standby	
Level Transmitter LIT-T201B Duty/Standby	

SCADA/HMI Status Signals

Description	Range
Clearwell Cell No. 1 CW-T101A	
Cell in Service	
Clearwell Cell No. 2 CW-T102A	
Cell in Service	
Level Transmitters	
Level Transmitter LIT-T101A Duty/Standby	
Level Transmitter LIT-T101B Duty/Standby	
Level Transmitter LIT-T201A Duty/Standby	
Level Transmitter LIT-T201B Duty/Standby	

SCADA/HMI Alarm Signals

None

3.13 Deacon Booster Pumps and UV System

3.13.1 Documentation

WD-P0001 Process Flow Diagram

WD-P0003 P&ID Deacon Booster Pumps P D001A and P D002A

WD-P0004 P&ID Deacon Booster Pumps P D001A and P D002A

WD-P0005 P&ID Deacon Booster Pumps P D003A, P D004A and P D005A

WD-P0006 P&ID Branch 2 Process and Instrumentation

WD-P0007 P&ID UV Reactor D100A Process and Instrumentation

WD-P0008 P&ID UV Reactor D200A Process and Instrumentation

WD-P0009 P&ID UV Reactor D300A Process and Instrumentation

WD-P0010 P&ID UV Reactor D400A Process and Instrumentation

WD-P0011 P&ID UV Reactor D500A Process and Instrumentation

WD-P0012 P&ID UV Reactor D600A Process and Instrumentation

WD-P0013 P&ID Branch 1 Process and Instrumentation

WD-P0014 P&ID Branch 1 and Branch 2 Valve Chambers Process and Instrumentation

3.13.2 Plant and Instruments

Tag	Description	
Clearwell Outlet Valves		
FV-T301A	Clearwell to DBPS Flow Control Valves	
LS-T301A	FV-T301A Valve Chamber Flood Switch	
FV-T302A	Clearwell to DBPS Flow Control Valves	
LS-T302A	FV-T302A Valve Chamber Flood Switch	
Deacon Booster Pumps and associated Valves		
HV-D001A	Pump P-D001A Inlet Valve	
P-D001A	Booster Pump	
VSD D001A	Booster Pump D001A Magnadrive Unit	
FV-D001B	Pump D001A Outlet Control Valve	
HV-D001C	Pump D001A Outlet Hand Valve	
PT-D001A	Pump D001A Differential Pressure	
HV-D002A	Pump P-D002A Inlet Valve	
P-D002A	Booster Pump	
VSD D002A	Booster Pump D002A Magnadrive Unit	
FV-D002B	Pump D002A Outlet Control Valve	
HV-D002C	Pump D002A Outlet Hand Valve	
PT-D002A	Pump D002A Differential Pressure	
HV-D003A	Pump P-D003A Inlet Valve	
P-D003A	Booster Pump	
FV-D003B	Pump D003A Outlet Control Valve	

Tag	Description	
HV-D003C	Pump D003A Outlet Hand Valve	
HV-D004A	Pump P-D004A Inlet Valve	
P-D004A	Booster Pump	
FV-D004B	Pump D004A Outlet Control Valve	
HV-D004C	Pump D004A Outlet Hand Valve	
HV-D005A	Pump P-D005A Inlet Valve	
P-D005A	Booster Pump	
FV-D005B	Pump D005A Outlet Control Valve	
HV-D005C	Pump D005A Outlet Hand Valve	
VSD Cooling Water Pumps		
P-D902A	Cooling Water Pump	
P-D921A	Cooling Water Pump	
SOL-D001A	Cooling Water to Pump P-D001A	
FS-D001A	Cooling Water to Pump P-D001A Flow Switch	
TT D001A	Cooling Water to Pump P-D001A Outlet Temperature	
SOL-D002A	Cooling Water to Pump P-D002A	
FS-D002A	Cooling Water to Pump P-D002A Flow Switch	
TT D002A	Cooling Water to Pump P-D002A Outlet Temperature	
UV Reactors		
FV D100A	UV Reactor D100A Suction Valve	
FE/FT D100A	UV Reactor D100A Flowmeter	
UVR D100A	UV Reactor	
FCV D100A	UV Reactor D100A Outlet Flow Control Valve	
FV D200A	UV Reactor D200A Suction Valve	
FE/FT D200A	UV Reactor D200A Flowmeter	
UVR D200A	UV Reactor	
FCV D200A	UV Reactor D200A Outlet Flow Control Valve	
FV D300A	UV Reactor D300A Suction Valve	
FE/FT D300A	UV Reactor D300A Flowmeter	
UVR D300A	UV Reactor	
FCV D300A	UV Reactor D300A Outlet Flow Control Valve	
FV D400A	UV Reactor D400A Suction Valve	
FE/FT D400A	UV Reactor D400A Flowmeter	
UVR D400A	UV Reactor	
FCV D400A	UV Reactor D400A Outlet Flow Control Valve	

Tag	Description	
FV D500A	UV Reactor D500A Suction Valve	
FE/FT D500A	UV Reactor D500A Flowmeter	
UVR D500A	UV Reactor	
FCV D500A	UV Reactor D500A Outlet Flow Control Valve	
FV D600A	UV Reactor D600A Suction Valve	
FE/FT D600A	UV Reactor D600A Flowmeter	
UVR D600A	UV Reactor	
FCV D600A	UV Reactor D600A Outlet Flow Control Valve	
Intermediate Header		
HV D010A	Hand Isolation Valve	
HV D010B	Hand Isolation Valve	
HV D010C	Hand Isolation Valve	
HV D010D	Hand Isolation Valve	
HV D010E	Hand Isolation Valve	
PT D010A	Intermediate Header Pressure	
PT D010B	Intermediate Header Pressure	
Discharge Header		
HV-D020A	Hand Isolation Valve	
HV D020B	Hand Isolation Valve	
HV D020C	Hand Isolation Valve	
HV D020D	Hand Isolation Valve	
FT/FE D021A	Branch I Discharge Flowmeter	
FV D021A	Branch I Isolation Valve	
FV D022A	Branch II Isolation Valve	
FV-Y305A	Branch I Surge Tower Outlet Valve	
FV-Y306A	Branch II Surge Tower Outlet Valve	
Analytical Instruments		
Branch I Discharge		
TNK-D900A	Degassing Column	
FS-D901A	DBPS Chloramination Analyzer Sample Flow	
FS-D902A	DBPS Free Chlorine Analyzer Sample Flow	
AIT-D902A	DBPS Free Chlorine Analyzer	
AIT-D903A	DBPS pH Analyzer	
Branch II Discharge		
TNK-D910A	Degassing Column	
FS-D911A	DBPS Chloramination Analyzer Sample Flow	

Tag	Description	
FS-D912A	DBPS Free Chlorine Analyzer Sample Flow	
AIT-D912A	DBPS Free Chlorine Analyzer	
AIT-D913A	DBPS pH Analyzer	

3.13.3 General Operation

3.13.3.1 Branch Aqueduct Refilling and Operation

The pump discharge valves shall be used to control the flow rate for refilling of the branch aqueducts following a shutdown. Using the PDVs for flow control during gravity flow will require a software switch (Gravity/Pump) to permit the valves to open when the pumps are not running. Using gravity mode to fill the aqueducts means that the Clearwell must be full.

A pump may be used during branch aqueduct refilling which will eliminate the need to have the Clearwell topped up before beginning the branch aqueduct refilling and will also eliminate the need to make a transition from gravity flow to pumped flow after refilling is complete. Using pumps shall be the normal method of refilling.

Following any unplanned shutdown of the flow through the DBPS such as an ESD or Station Flood, air can be drawn into the branch aqueducts. Whenever the branch aqueduct flows have been stopped, the operator must wait for any transient activity to cease and then determine by established protocol the quantity of air that may have been drawn into the branch aqueducts. Excess air must be expelled from the branch aqueducts in a controlled manner by refilling the branch aqueducts at a controlled flow rate.

The operator must correct the cause of the station shutdown, reset any remaining shutdown alarms, and close the city reservoir intake valves.

The operator must ensure that adequate flow paths are open, UV Reactors are ready, and pumps are ready, the operator must also ensure that water level in the Clearwell is above 235.3m or higher to ensure adequate gravity flow.

3.13.3.2 Branch Aqueduct Refilling by Gravity

Select “Gravity Mode” using the software switch as previously described. Manually close the pump discharge valves for P-D001A and P-D002A (the variable speed pumps) and switch the pump discharge valves for P-D003A, P-D004A, and P-D005A (the two-speed pumps) to computer – automatic.

Adjust the station “Target Flow Set Point” to 50 ML/d and switch the UV Reactor sequencer to Computer. The UV sequencer will initiate startup of the lead UV reactor which will require three to five minutes to warm up before its status will switch to Treating.

When the lead reactor status switches to Treating, the UVM PLC will begin modulating the PDVs to establish the Target Flow Set Point.

The Regional SCADA operator must determine when all of the air has been expelled from the branches; this point can be determined by monitoring the aqueduct air release valves and the water level readings in the

Tache, Branch 1, and Branch 2 surge towers. Water level readings of 235.0 or higher indicate that the air has been expelled. Depending on the city reservoir levels prior to the shut down, the refilling process could take up to approximately 1.5 hours.

As the last of the air is expelled from the branch aqueduct system, the operator must begin opening the city reservoir intake valves to establish flow into the city reservoirs. The goal is to establish a combined flow in the two branches approximately equal to the Target Flow Set Point noted above. Care must be taken to avoid re-introducing air into the branches by opening the intake valves too quickly. The water level in Tache surge tower must be carefully monitored and FV D021A (DHV-1) throttled as necessary to avoid Tache overflow to the river.

Manually initiate startup of the lead duty booster pump. The control system will close the pump discharge valve, start the pump, verify minimum differential pressure, then begin reopening the pump discharge valve. When the pump discharge valve is 5% or more open, the control system shall toggle the Gravity/Pump control mode selector to Pump control mode which will force the PDVs of the non-running pumps to close.

At this time, the Target Flow Set Point may be increased either in a single step or incrementally to the desired operating flow rate. The UV Reactor sequencer will initiate startup of one reactor at a time, waiting for each reactor to achieve Treating status before starting the next, until the requested treatment capacity has been achieved. The UVM PLC will continue to throttle the PDVs, gradually increasing the station flow rate as the UV reactors come on line. The operator must monitor the UV Reactor startup process and;

- Adjust flow split to the COW reservoirs as required using the Intake valve
- Adjust Deacon discharge valve FV-D021A as required to maintain Tache tower level.

During gravity flow operation, adjust the Target Flow Set Point as desired, the pump discharge valves will modulate to maintain the Target Flow Set Point except where the set point exceeds the gravity flow capacity of the station.

3.13.3.3 Branch Aqueduct Refilling and Operation using Pumps

Select “Pump Mode” using software switch as previously described. Manually close the pump discharge valves for P-D001A and P-D002A (the variable speed pumps) and switch the pump discharge valves for P-D003A, P-D004A, and P-D005A (the two-speed pumps) to computer – automatic.

Manually open FV D021A (DHV-1) on branch 1 to typical operating position and fully open FV D022A (branch 2).

Adjust the Target Flow Set Point to 50 ML/d and switch the UV Reactor sequencer to Computer. The UV sequencer will initiate startup of the lead UV reactor which will require three to five minutes to warm up before its status will switch to Treating.

The Regional SCADA operator must determine when all of the air has been expelled from the branches; this point can be determined by monitoring the aqueduct air release valves and the water level readings in the Tache, Branch 1, and Branch 2 surge towers. Water level readings of 235.0 or higher indicate that the air has been expelled. Depending on the city reservoir levels prior to the shut down, the refilling process could take up to approximately 1.5 hours.

As the last of the air is expelled from the system, the operator must begin opening the city reservoir intake valves to establish flow into the city reservoirs. The goal is to establish a combined flow in the two branches approximately equal to the Target Flow Set Point noted above. Care must be taken to avoid re-introducing air into the branches by opening the intake valves too quickly. The water level in Tache surge tower must be carefully monitored and FV D021A (DHV-1) throttled as necessary to avoid Tache overflow to the river.

At this time, the Target Flow Set Point may be increased either in a single step or incrementally to the target operating flow rate. The UV Reactor sequencer will initiate startup of one reactor at a time, waiting for each reactor to achieve Treating status before starting the next, until the requested treatment capacity has been achieved. The PLC will continue to throttle the PDVs, gradually increasing the station flow rate as the UV reactors come on line. The operator must monitor the UV Reactor startup process and;

- Adjust flow split to the COW reservoirs as required using the intake valves
- Adjust Deacon discharge valve FV-D021A as required to maintain Tache tower level.
- Start another pump if required to meet the Target Flow Set Point

3.13.3.4 Reducing Flow

If pumps are running, the operating pumps need to be stopped one at a time so that flow through the station is reduced gradually, avoiding transients. The Target Flow Set Point should be reduced only after a pump has been taken off line to avoid running pumps against throttled valves unnecessarily.

As each pump stop sequence is initiated, its discharge valve will close first, the pump will stop when the discharge valve is fully closed. Stopping the last remaining pump will reduce the station flow to zero taking the station out of service. The Target Flow Set Point should be reduced to zero and the UV sequencer switched off.

3.13.3.5 Power Failure

Under pumped flow, a power failure or brown-out will activate the pump drive PORT feature which will permit the pump to continue running. If however, the power failure is long enough to cause the UV Reactors to shut down, the UV sequencer will declare a power failure, stop the pumps, switch to Hand, and the pump discharge valves will close, stopping the flow through the station. In this circumstance, air will have been drawn into the branch aqueducts necessitating a cold restart of the station. If the power failure is sustained and the standby power system has been activated, the station may be restarted on standby power.

3.13.3.6 General Operation

The DBPS consists of five (5) split case centrifugal pumps designed to deliver potable water to the three reservoirs located within the City of Winnipeg. The three original pumps, P D003A, P D004A and P D005A are dual speed pumps which are controlled by an existing PLC system. The other two pumps P D001A and P-D002A are variable speed pumps, these new pumps along with a new PLC system have been installed as part of the WTP project.

DBPS with operate with Common Headers fed from the Clearwell, the term Common Headers means that isolation valves in the intermediate header and discharge header will be opened facilitating greater flexibility and redundancy in the operation of the station. With the introduction of Common Header operation, the DBPS will cease operation as separate Branch 1 and Branch 2 treatment systems and will now operate as a single integrated booster pump and UV disinfection facility.

Operation of the facility with common headers means that any combination of flow paths through the suction header, booster pumps, intermediate header, UV Reactors, and discharge header are now valid to meet flow demand created by the two branch aqueducts. This configuration enhances operating flexibility and redundancy by permitting former Branch 2 reactors and two-speed pumps to serve the Branch 1 aqueduct and similarly, the former branch 1 reactors and new variable speed pumps to serve the Branch 2 aqueduct. The UV Master PLC system shall be reprogrammed to control all six of the UV Reactors as one integrated system.

Under pumped flow conditions, the overall system flow rate will be set by the combination of pumps in service, the pump speed control setting, and the pump discharge valve positions. During pumped flow operation, the city reservoir intake valves should be used only to split the flow between active reservoir cells. Attempting to throttle pumped flow will waste energy and risk surge tower overflow.

Under normal operating conditions the water level in the Clearwell shall be maintained within a pre-determined operating band, by operation of the booster pumps in the DBPS. In the event of any abnormal operational conditions such as a high high level in the Clearwell due to pump failure in the DBPS, the plant control system shall take the appropriate action i.e., reducing the speed or stopping of the Raw Water Pumps. A low level in the Clearewell shall cause the flow set point for the DBPS pumps to be reduced, low low level in the Clearwell shall inhibit the booster pumps in the DBPS. DBPS pump operation is also dependant on the availability and operation of the existing UV treatment facility in the DBPS, sufficient flow paths through the UV reactors must be established before any pumps can be started. The amount of flow paths required will be determined by the plant flow set point (see Section 3.1) and will be initiated when the Clearwell level reaches a pre-determined set point (before the pump start level).

The variable speed pumps shall normally be used in computer mode to pump the treated water to the City and maintain the Clearwell level when the plant target flow is set below 280 ML/d and both pumps are available. For plant demand settings above 280 ML/d various different operating scenarios are available (involving VSD and two speed pumps) however they will all require operator intervention. When the VSD pumps are operating, if a pump fails and cannot be immediately restarted then an operator must start an alternative pump instead.

Treated water shall be analyzed continuously by two independent sets of instruments for turbidity, pH and free chlorine. The analyzers shall be housed in the Pumping Station.

3.13.3.7 Soft Start Operation

All of the pumps in the DBPS are now equipped with Benshaw soft start units as part of a station upgrade. The soft start units have a function called PORT (power outage ride through).

The PORT capability allows the Soft Starter to ride through short duration power disturbances, i.e. brown outs, single phase and total power loss conditions.

The Soft Starters are supplied with a Bypass Contactor, which allows the motor to run across the line when it reaches its full speed. Normal motor starting sequence starts with the Soft Starter gradually accelerating the motor to its rated speed by controlling the motor current and following a pre-programmed “Forward #1 Ramp

Profile”. Once the motor is running at its full speed the Bypass Contactor is energized and the Soft Starter is isolated from the motor.

When the system senses a power disturbance in a time frame greater than the Sense Time parameter, the power will be removed from the motor by de-energizing the Bypass Contactor to let the motor coast. The Fault Delay timer will begin to time.

The Bypass Contactor can be held in for a programmed Bypass Delay when the power disturbance is sensed, however caution must be taken when the Bypass Delay is set above 0.0 seconds because if power is restored during the Bypass Delay the resulting torque may exceed the design parameters and may damage the connected mechanical load (motor/pump). The Bypass Delay default value is set at 0.0 seconds.

If the power disturbance ends before the programmed Fault Delay time, the Soft Starter will re-accelerate the motor to its rated speed if a start command is still present. The re-acceleration sequence will follow the “Forward #2 Ramp Profile”. When the motor is up to its full speed again the Bypass Contactor is re-energized and the motor continues to run across the line at full speed.

If the outage lasts longer than the programmed Fault Delay time, the Soft Starter will issue a fault; “No Mains Power”.

If the Fault Delay timer is set to OFF, the starter will use the standard motor protection fault delay timers to sense power disturbances and will issue a corresponding fault.

3.13.3.8 Power Failure

In the event of a utility power failure and any running pumps stopping, hydraulic transient events would occur in the distribution network, these events would probably last around 5-10 minutes. The site standby generators should be online in approximately 15 to 30 seconds; reverse flow to the pumping station would probably start to occur in 1 minute after the pumps stopped. The PORT function must be set (in the soft start) so that if the generators (or utility) power is available within 20 seconds of the initial failure the pump can be re-accelerated. If the power is not restored within 20 seconds then the drive must not be re-accelerated. The pumps shall be stopped and not restarted until any hydraulic transient events are over, probably around 10 minutes. After the transient is over the pump discharge valves shall be closed and the pumps restarted if required.

3.13.4 Automatic Control Philosophy

3.13.4.1 Common Header Operation

The UV sequencer will normally operate in “pump control mode” except during refilling of the branch aqueducts when gravity flow can be used for refilling. Pump Control Mode means that the PDVs must be closed when the respective pump is not running and that each pump shall be started and stopped with the PDV closed. Gravity mode for branch refilling means that the PDVs are allowed to open when no pumps are operating. When gravity mode is being used for refilling the branch aqueducts, the control system shall modulate the PDVs to control station flow rate. The control mode shall automatically toggle back to “pump control Mode” when a pump is started and its discharge valve begins to reopen.

The UV Reactor sequencer control strategy shall use a "flow set point" strategy to facilitate integration of the DBPS with the water treatment plant and Clearwell. Simply stated; the number of UV reactors on line at a given time will be based on the operator adjustable "Target Flow Set Point" determined by water demand forecasting. The flow set point described above will be called the Target Flow Set Point and will be entered at the Regional SCADA and stored in the UVM PLC. The UVM PLC will use this set point to control the UV sequencer and UV reactors. The UVM PLC will generate a second set point called the Current Flow Set Point which will be based on the number of UV Reactors currently on line and in treating status. Both setpoints will be passed from the UVM PLC to the WTP PLC. The Current Flow Setpoint will be used by the UV Master PLC to control the station flow rate by modulating the PDV'S.

3.13.4.2 DBPS Emergency Shutdown (ESD) and Station Flood Strategy

The following is a list of equipment which will shutdown as part of the ESD strategy.

- Booster pumps P-D001A through P-D005A stop
- Booster pump discharge valves FV-D001B through FV-D005B close
- UV reactor suction valves FV-D100A through FV-D600A close
- UV reactors UVR-D100A through UVR-D600A shut down
- UV sequencer switches to Hand
- UV reactor discharge valves FCV-D100A through FCV-D600A close
- Discharge header valves FV-D021A and FV-D022A close

The following is a list of equipment which will shutdown in the event of a Station Flood

- East suction header valves DRV-301A and FV-T302A close
- West suction header valve DRV-308 closes
- Booster pumps P-D001A through P-D005A stop
- Booster pump discharge valves FV-D001B through FV-D005B close
- UV reactor suction valves FV-D100A through FV-D600A close
- UV reactors UVR-D100A through UVR-D600A shut down
- UV sequencer switches to Hand
- UV reactor discharge valves FCV-D100A through FCV-D600A close
- Discharge header valves FV-D021A and FV-D022A close

3.13.4.3 Pump Discharge Valve Operation

The existing pump discharge valves for the two-speed pumps shall be modified to facilitate automatic modulating control of the valves. These modifications are necessary to prevent cavitation in the pumps and to allow pump discharge flow rate to be controlled. The individual pump PLCs shall be programmed to control the PDV based on one of three set points as noted:

- Pump minimum pressure differential set point for Low Speed

- Pump minimum pressure differential set point for High Speed
- UV facility flow rate set point

The PDV shall be primarily controlled in response to the Current Flow Set Point unless the pump differential pressure drops too low; at which time, the appropriate Minimum Differential Pressure set point (Low speed or High speed) will override the flow set point to keep the pump on its curve.

The pump discharge valves for the variable speed pumps shall also being modified to facilitate modulating control. The degree of PDV throttling required for anti-cavitation control of these pumps will vary depending on the operating speed of the pump and will be determined during testing by operating the pump and PDV at incremental speeds. From the data collected, a look-up table will be developed for throttling the PDV. This look-up table will be stored in the respective pump PLC.

3.13.4.4 Booster Pumps

The two VSD pumps P D001A and P D002A were installed in 2008, the dual speed pumps had soft start units added also in 2008. The two different types of pumps have different starting functionality and so they will be described separately. Any combination of pumps can be used to achieve the Target Flow Set point as selected by the Operator.

3.13.4.5 VSD Pump Operation

The speed of the pumps shall be controlled by using a magnetic coupling together with an actuator to adjust the gap in the magnetic coupling and hence the speed of the drive. During normal operation of the plant, both pumps shall be running to provide the required WTP outlet flow. Flow through the WTP shall be determined by the operator, who shall select the desired throughput of the plant at any given time, so as a result the outlet pumping rate of the DBPS pumps shall closely match the outlet of the Raw Water pumps as there is very little waste in the plant.

Each pump has a local control panel equipped with a Local Pump HMI, which shall display the status and values of the various temperatures, speed and vibration monitors used to protect the pumps. These status and values shall also be displayed on the WTP SCADA and the Regional SCADA.

Each pump has a hand valve in both the suction side and discharge side pipework which shall have open and closed limit switches, both valves must be open before the pump can be started. The pumps also have pump discharge flow control valves, the operation of which is described later in this section, this valve shall be closed before a pump can start. Once a start is initiated the Magnadrive cooling water pumps must be started and flow established before the pump starter is energised.

3.13.4.6 DBPS Pump Speed Control (MagnaDrive) P-D001A, P-D002A

To vary the output flow of the pumps a MagnaDrive VSD is installed between the motor and the load (pump).

The MagnaDrive components consist of a conductor assembly connected to the motor shaft and a magnet rotor assembly, connected to the pump. These assemblies never come in contact with each other as there is a narrow air gap between them.

To adjust the output speed of the load, the MagnaDrive varies the torque applied to the load, which is transmitted across the air gap. By varying the air gap, the amount of torque transmitted can be controlled, which in turn permits speed control. As the air gap is decreased, slippage between the conductor and the magnet is reduced and the torque applied to the load is increased; therefore, increasing the output of the pump. The opposite occurs when the air gap is increased. In controlling output speed, the third component of the MagnaDrive is an electrically operated actuator the position of which is controlled by D21A PLC The actuator adjusts the air gap spacing between the magnet rotors and the conductor rotors. Actuation shall be controlled by the SCADA/HMI control system from a process signal.

3.13.4.7 Two Speed Pump Operation

Each of the pump Local Control Panels is provided with an Off/Computer/Local (OCL) switch and a Hand/ Maintenance (HM) switch that provides a control mode selection for the respective pump. A Low/High (LH) switch allows the selection of the desired pump operating speed, and a Stop/Start switch (SS) initiates the pump stop or start sequence. The HM, LH, and SS switches are only used when the OCL switch is in the Local position. Positions of all control switches are monitored by the pump PLC and are also displayed locally and on the SCADA Workstations. Each pump can be started in the HAND, COMPUTER, and MAINTENANCE modes. In low speed the pump capacity is approximately 135 ML/d, in high speed the pump capacity is approximately 160 ML/d.

HAND Mode - In this mode, the pump PLC controls the sequenced startup and shutdown of the pump and its respective discharge valve. With a pump's OCL switch in the "Local" position the HM switch in the “HAND” position, and the LH switch in the desired position, a pump start sequence is manually initiated by pressing the start switch. The start sends a permissive request to the UV system to ensure adequate reactors are treating before allowing the pump to start. When the sequence is initiated the local pilot light for the speed that has been selected will flash while the reactors are starting and the discharge valve closes. When both permissives are met the pump will start in the requested speed and the corresponding pilot light will be on steady state. Once differential pressure is satisfied (after few seconds) the discharge valve will open and the pump will be in service.

COMPUTER Mode - COMPUTER mode provides a manual remote control mode for each pump. In this mode, the Station PLC provides remote master control of the pumps while the respective pump PLC’s continue to provide pump specific interlocking and protection. With the OCL switch in the "COMPUTER" position and the SCADA workstations in "COMPUTER" selection, a low or high speed pump start sequence is manually initiated (as selected by either low or high speed using the Low/High switch) by the pump start on SCADA. Initiating the start sequence sends a permissive request to the UV system to ensure adequate reactors are treating before allowing the pump to start. When the sequence is initiated the local pilot light for the speed that has been selected will flash while the reactors are starting. When both permissives are met the pump will start in the requested speed and the corresponding pilot light will be on steady state. Once differential pressure is satisfied (a few seconds) the discharge valve will open and the pump will be in service.

MAINTENANCE Mode - With the OCL switch in the local position and the HM switch in the maintenance position, a pump may be started/stopped in the MAINTENANCE mode. There is no sequence initiated and the pump start/stop and discharge valve open/close are initiated manually and independently from the switches on the local panel.

3.13.4.8 VSD and Two Speed Pump Status and Indications

Indications of pump and discharge valve status and alarms are connected to the control system and displayed locally at the pump control panel, the WTP SCADA and Regional SCADAWorkstations. Each pump and motor is equipped with a temperature and vibration monitoring system. The system monitors temperatures and vibration at key locations on the pump and motor. A communication link continuously transmits temperature and vibration data to the control system. For the two speed pumps, three hard-wired alarm contacts (Point-in-alarm, system alarm & shutdown) are also connected to the station PLC as a backup.

3.13.4.9 Pump Shutdown conditions

Once a pump has been started, a pump stop sequence will be initiated at the pump PLC by any of the following conditions:

- When the pump is being operated in the HAND or maintenance modes, the operator may stop the pump manually using the stop switch on the local control panel or by selecting the off position with the OCL switch.
- When the pump is being operated in the COMPUTER mode, a manual stop command may be issued by an operator at one of the SCADA workstations.
- Loss of pump PLC power.
- A Lo Lo pump differential pressure alarm occurring during pump operation.
- Suction isolation valve not open.
- Discharge isolation valve not open.
- High temperature or vibration alarm at the pump or motor.
- Failure of the temperature and vibration monitoring system.
- Low or high speed electrical fault.
- Discharge valve fail to open.

The control system also monitors a number of conditions that will result in an immediate shutdown of the pumps.

- Low Low suction pressure
- Low Clearwell level interlock from WTP Control System
- Electrical supply fault
- Station flood
- Branch 2 ESD

3.13.4.10 Pump Discharge Flow Control Valve

The pump discharge valve performs pump flow control, anti cavitation, and check valve functions. The valve operation is controlled using two solenoid pilot valves and is powered by water pressure obtained from a separate constant water pressure source. A third solenoid valve called the Emergency Solenoid Valve is not required and will be disconnected. The use of separately controlled open and close solenoid valves permits modulating control and speed control of the main valve by controlling each solenoid valve intermittently to position the main valve. Manual speed control valves in the hydraulic lines permit local adjustment of the opening and closing speeds of the main valve. Closing time is currently set at approx 3-4 minutes and opening speed is currently set at approx 10 minutes. The slower opening speed was originally meant to reduce rapid flow increase through the UV reactors when starting pumps but will have to be re-tuned for operation with the Common Header strategy. The HMI on the LCP shall indicate valve position, open, close, and in transition. The HMI includes direction of travel indication ie: the open or closed indicator will flash when the valve is in transition towards the respective limit.

In the event of station power failure, or in the event of power failure to the control system, the solenoid valves shall de-energize causing the main valve to close. To prevent pressure surges in the aqueduct, pumps are always started and stopped with the respective discharge valve closed.

During steady state pump operation, the pump discharge valve will modulate to maintain a set point minimum differential pressure across the pump, The minimum differential set point is automatically adjusted based on the selected pump speed. The variable speed pump PDVs will require a look-up table to adjust PDV position relative to the operating speed of the pump.

Modulating capability of the pump discharge valves will also be used to control the discharge flow rate of the pumps based on the station flow rate set point.

3.13.4.11 Normal start sequence for the pump;

- Check Clearwell level is above pump start set point
- Check suction and discharge hand valves are open
- Check sufficient UV reactors are online and sufficient flow paths are open to meet required flow rates
- Check pump discharge valve is closed
- Start the pump motor and wait for pump differential pressure to rise to the target set point
- Open pump discharge valve
- Throttle pump discharge valve to maintain minimum differential pressure
- Throttle pump discharge valve in response to the Current Flow Set Point
- Continuously monitor pumps for alarm/shutdown conditions
- As soon as the first pump is running and in service (discharge valve at least 5% open) the next pump can start

Normal stop sequence for the pump:

- Close pump discharge valve
- Stop the pump motor

3.13.4.12 Emergency Stop Sequence for the Pump

For Emergency stop scenarios such as Station Waterflood and ESD which require immediate multiple pumps to stop simultaneously, all pump discharge valves will close simultaneously using the normal close solenoid valve. Note that based on hydraulic model predictions, the existing Emergency Solenoid Valves were determined to be unnecessary and will be disconnected. During an emergency stop scenario, hydraulic transients require some time to dissipate before any valves are closed and the normal valve closure speed will satisfy this requirement.

Position feedback transmitters are installed at the valve piston rod to indicate the valve position. The valve position feedback will be used by the pump PLC in the valve positioning control strategy for minimum differential pressure control and pump flow control. The valve position signal will also be displayed on the local Pump HMI (where available), the WTP SCADA, and the Regional SCADA.

3.13.4.13 Pump Differential Transmitters

Each pump is equipped with a differential pressure transmitter connected across the inlet and outlet. The differential signal will be used by the pump PLC in the valve positioning control strategy for minimum differential pressure control and pump flow control and will be displayed on the Local Pump HMI (where available), the WTP SCADA, and the Regional SCADA. Two set points are used to trigger the Low Pressure alarm and the Low-Low Pressure alarm/shut-down for each pump.

3.13.4.14 Pump Isolation Valves

Each pump has manually operated inlet and discharge isolation valves equipped with open and closed position switches. Valve positions are monitored by the control system and displayed on the Local Pump HMI (where available), the WTP SCADA, and the Regional SCADA. The isolation valves must be confirmed open before a pump start sequence can be initiated.

3.13.4.15 UV System Control

When the level in the Clearwell reaches the “UV required” set point, which will be just below the pump start set point, the control system will start all available UV reactors. The control system will provide an inhibit command to prevent actual pump start until all available UV reactors are on line to handle the anticipated flow as determined by the operator set point. Once the target flow rate is obtained the control system will close any excess flow paths not required. Flow rates for typical combinations of pumps and speeds (per operations practice) will be stored in a look-up table in the control system.

3.13.4.16 UVM PLC Logic

The UVM-PLC is configured to read and write all data to and from all UV Reactor CPP’s. It acts as a data concentrator and is the source of data (both read and write) from the local and remote RSView host HMI’s.

The PLC will determine that all intermediate and discharge header valves are open so that the headers are effectively common to all the reactors.

The PLC shall confirm that a valid flow path exists for each reactor prior to allowing the reactor to start. The open status of the appropriate valves will be used to determine this flow path. Alarms shall be generated if there are insufficient flowpaths as required by the control system.

3.13.4.17 UVM to Individual Reactor PLC Interface

The control interface between the UVM and individual reactor PLC’s consists of the following combination of hardwire and ‘soft’ points:

Hardwire statuses from the reactor PLC are as follows:

- Shutdown – currently activates only when a full reactor shutdown has occurred.
- Ready – this signal is active when the reactor shutdowns are clear, permissives are met and is available to run in any mode (Local/Remote/Auto/Manual).
- Alarm – this signal is active whenever there are reactor alarms which have caused the shutdown of at least one lamp bank. Alarms are latched and only when a reset is initiated from either the reactor local control panel or remotely via the SCADA workstations will they clear.
- Treating – this signal is active when a start has been initiated and the lamps have warmed up sufficiently to begin treatment. This takes approximately 5 minutes upon start request. Further, once warm-up has been completed flow has to be established within approx 4 minutes or reactor will shutdown on low flow.
- Hardwire Shutdown this signal is active when no Station Waterflood or Branch specific ESD condition exists. The main purpose of this is to allow an unconditional remote shutdown of the reactor which is not dependant on the integrity of the communication between the UVM and reactor PLC's.

Soft statuses from the reactor PLC that are required for remote operation are as follows:

- Local/Remote – this is status of the selection on the reactor control panels and if in Remote mode the reactor PLC will accept remote control requests from either the UVM or operator commands from the SCADA workstations. In Local mode the reactor PLC will ignore all remote commands with the exception of the remote Emergency Shutdown hardwired signal. Refer to UVMDATA_rev0.xls spreadsheet for complete list of points.
- Lamp Bank Auto/Manual(x3) – each reactor bank (3) has an independent Auto/Manual selection for its' control. All Banks will be required to be in auto for any station remote control.
- Low Dose Alarm – this alarm indicates that the desired treatment level is not being achieved by the reactor. The resultant action will be explained further in the station operating modes.
- Start/Stop – this request to remotely start/stop the reactor

3.13.4.18 Flow Modulating Valves

The Flow Modulating Valves located downstream of each UV Reactor have a local control switch in order to select either Local, Stop or Remote mode. In Off the valve will not move from its' current position. In Local the operator has the ability to manually change position of the valve and the valve will ignore the position command from the UVM PLC. In this mode the UVM-PLC tracks the position of the valve in order to provide bumpless transfer when the valve is switched back to Remote. Also, an alarm will activate on the UV SCADA and Regional SCADA workstations in Local mode to indicate that the control system no longer has control of the valve and if the reactor is treating the UV sequencer will switch to HAND mode. In Remote, the valve position will be set by the UVM PLC to required position to satisfy flow requirements. The remote closing rate of the FCV's shall be set for approx 10 minutes to help reduce the impact of large flow changes for the reactors. Normal operating mode will be Remote with the sequencer in COMPUTER mode. The valves will automatically close on an operator initiated ESD as well as individual reactor suction valves will close on an associated 'Moisture Detected" alarm.

3.13.4.19 Reactor Suction Valves

The suction valves have been wired to the UV Master PLC (UVM PLC).

The actuators have a switch which allows selection of either Local, Stop or Remote, the three modes of operation are described below. They also have an Open/Close switch to be used by the operator when in Local mode. The valves will automatically close on an operator initiated ESD as well as individual reactor suction valves will close on an associated 'Moisture Detected" alarm.

Local

In Local the operator has the ability to use the Open/ Close switch on the actuator to manually change the position of the valve, in local mode the actuator will ignore any commands sent to it from the PLC except the emergency close (ESD) and reactor moisture alarm. If the operator switches the actuator from Remote mode, an alarm will be activated on the workstations to indicate that the control system no longer has control of the valve, and if the associated UV reactor is treating the UV sequencer will be switched to Hand mode until the actuator is returned to Remote mode. If a reactor's suction valve is not in remote, it will not be considered in the "flow path available" logic and not be available for sequenced start and control.

Stop

In the Stop mode the actuator will remain in its last position until it is restored to either the Local/Remote mode and it is commanded to move by the control system or operator. An ESD command or reactor moisture alarm will cause the valve to go to the closed position even when it is in the Stop mode.

Remote

The normal position for the valves in Remote mode will be open, and the only occasions the valves will be required to close will be because of a station flood alarm, a "Moisture Detected" alarm for that reactor, a valve close operator action with the branch in Hand or an operator initiated ESD. None of the suction valves will be commanded to close until the associated Reactor FCV valve is fully closed. This applies to the station flood alarm, moisture detected, and the ESD command with the UV sequencer in either Hand or Computer mode If the valve is requested to close it will not open again until commanded to do so by the UVM PLC or an operator intiates the open command either locally or from the UV SCADA

It should be noted that the reason for using the actuator ESD as well as the normal close command is to ensure the valve can be closed in an emergency even if the Local/Stop/Remote switch is not in the Remote position.

3.13.4.20 Reactor Sequencer Control

A HAND-COMPUTER mode for station Reactor control is configured in the UVM PLC to be selectable through the UV SCADA. The transition between HAND and COMPUTER modes is bumpless and operator initiated (exceptions are noted under the COMPUTER description).

- HAND: No automatic start sequence control commands from the UVM-PLC will be sent to the Reactor CPP-PLC's. The UV SCADA (remote operator) can issue reactor start/stop if the reactor is in Remote mode and if the Reactor is available (valid flow path and Ready). In addition, the reactor will be able to operate from the Local Reactor HMI if the CPP Remote/Local switch is in Local. The flow modulating valves can be stroked fully open or close based on individual operator initiated commands from the UV SCADA workstations.

- COMPUTER: If the reactor Local/Remote switch on the CPP is in the 'Remote' position and the reactor is available for service (Remote, Ready and full auto) then the UVM-PLC will be able to issue start/stop sequence commands to the reactor CPP-PLC's to satisfy the treating capacity and flow rates based on the duty cycle setpoints and also for failovers. The following conditions will provide an automatic switch from COMPUTER to HAND.
  - If in COMPUTER and a reactor is treating and its' corresponding FCV is switched to local (not remote)
  - If in COMPUTER and a reactor is treating and communications fails between the UVM-PLC and the reactors' PLC.
  - Station Waterflood
  - Station Power Failure (if auto restart is selected for the power failure mode on the Regional SCADA system then after restart timer has timed out the branch will return to COMPUTER mode automatically)
  - Not Enough Reactors Available – this alarm will occur whenever the UV sequencer has called on more reactors than were available to treat automatically
  - ESD has been initiated (needs operator reset)
  - Closure of any intermediate or discharge header common valves

3.13.4.21 Off Specification Water Shutdown

If an off spec water event occurs then the plant would enter a controlled shutdown. Part of the shutdown action would be to close both Branch I and Branch II surge tower outlet valves (FV-Y305 and FV-Y306) over a period of about 10 minutes. The pump discharge valves shall not be closed until the off spec event is over and any transients have dissipated.

3.13.4.22 Branch I Discharge Flow Meter FE-D021A

The PLC shall monitor the Branch I discharge water flow and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres.

3.13.4.23 Branch 2 Flow

Branch 2 flow shall be determined by adding the flows from all online UV discharge flow meters and subtracting the Branch 1 instantaneous flow. The flow shall be monitored and displayed on SCADA.

3.13.4.24 Water Quality Analyzer Systems

Two complete systems of water quality analytical instruments shall continuously monitor the water as it leaves DBPS.

The analyzer systems shall work as a duty standby arrangement, so that if any individual duty analyzer fails and the standby analyzer is available, then the operator shall switch to the standby instrument. Both the duty and standby analyzer outputs shall be continuously displayed on the SCADA/HMI, the duty and standby designation shall be displayed to indicate the current status of each signal. A list of parameters measured is shown below.

- Free Chlorine

- Total Chlorine
- pH

Refer to section 3.32 Water Quality in this document for more details.

3.13.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag No.	Event	Type	Control System Action
AIT-D9*1A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-D9*2A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-D9*3A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
	Insufficient UV reactors available	Fault	Alarm on SCADA. Reduce flow at Raw Water pumps depending on operator flow set point
	Failure or unavailability of VSD pumps	Fault	Alarm on SCADA Reduce flow at Raw Water pumps depending on operator flow set point.
	Common header valves closed	Fault	Alarm on SCADA UV reactors to HAND mode

3.13.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

None

3.14 Washwater Recovery Tanks 1 to 4

3.14.1 Documentation

WR-P0001 P&ID Washwater Recovery Tanks Inlet Channel
WR-P0002 P&ID Washwater Recovery Tank 1
WR-P0003 P&ID Washwater Recovery Tank 2
WR-P0004 P&ID Washwater Recovery Tank 3
WR-P0005 P&ID Washwater Recovery Tank 4
WR-P0006 P&ID Washwater Recovery Tanks / Flocculation Chamber

3.14.2 Plant and Instruments

Tag	Description	
Washwater Recovery Inlet Channel		
LS-R010A	Washwater Recovery Tank Inlet Channel High Level	
LS-R010B	Washwater Recovery Tank Inlet Channel High Level	
SLG-R010A	Backwash Waste Water Channel Outlet Sluice Gate	
SLG-R010B	Backwash Waste Water Channel Outlet Sluice Gate	
SLG-R100A	Washwater Recovery Tank Inlet Sluice Gate	
SLG-R200A	Washwater Recovery Tank Inlet Sluice Gate	
SLG-R300A	Washwater Recovery Tank Inlet Sluice Gate	
SLG-R400A	Washwater Recovery Tank Inlet Sluice Gate	
Washwater Recovery Tank 1 WRT-R100A		
FV-R100A	Washwater Recovery Tank Supernatant Valve	
LS-R100A	Washwater Recovery Tank Low Low Level	
LS-R100B	Washwater Recovery Tank High High Level	
LIT-R100D	Washwater Recovery Tank Level	
LIT-R100E	Washwater Recovery Tank Turbidity/TSS	
P-R100C	Washwater Recovery Tank Solids Pump	
Washwater Recovery Tank 2 WRT-R200A		
FV-R200A	Washwater Recovery Tank Supernatant Valve	
LS-R200A	Washwater Recovery Tank Low Low Level	
LS-R200B	Washwater Recovery Tank High High Level	
LIT-R200D	Washwater Recovery Tank Level	
P-R200C	Washwater Recovery Tank Solids Pump	
Washwater Recovery Tank 3 WRT-R300A		
FV-R300A	Washwater Recovery Tank Supernatant Valve	

Tag	Description	
LS-R300A	Washwater Recovery Tank Low Low Level	
LS-R300B	Washwater Recovery Tank High High Level	
LIT-R300D	Washwater Recovery Tank Level	
P-R300C	Washwater Recovery Tank Solids Pump	
Washwater Recovery Tank 4 WRT-R400A		
FV-R400A	Washwater Recovery Tank Supernatant Valve	
LS-R400A	Washwater Recovery Tank Low Low Level	
LS-R400B	Washwater Recovery Tank High High Level	
LIT-R400D	Washwater Recovery Tank Level	
P-R400C	Washwater Recovery Tank Solids Pump	
Flocculation Chamber FC-R001		
AIT-R001A	Washwater Recovery Tanks Solids to Flocculation Chamber Suspended Solids Monitor	
FIT-R001B	Washwater Recovery Tanks Solids to Flocculation Chamber Flow	
LS-R001A	Washwater Recovery Tank Solids Flocculation Chamber Level	
MXR-R001C	Washwater Recovery Tank Solids Flocculation Chamber Mixer	
AIT-R010A	Washwater Recovery Tank Supernatant Suspended Solids Monitor	
FS-R010A	Washwater Recovery Tank Supernatant Suspended Solids Monitor Sample Pump Outlet Flow	
SP-R010A	Supernatant Sample Pump	

3.14.3 General Operation

The spent filter backwash stream shall be discharged into the WRT’s via the inlet channel at the north end of the WRTs. The WRT fill operation shall be sequential i.e. after one WRT is full, an empty WRT shall be ready to receive the discharged flow.

The spent backwash stream discharge rates are generally constant i.e. the same as the backwash pumping rate. However, the duration of flow could vary depending upon the duration of the backwash and accordingly the liquid fill time in the WRT would vary. Once the liquid level in the WRT approaches change over level (full) in one or multiple fill events, an empty WRT’s sluice gate (preference shall be adjacent tank, if available) shall start to open and the active WRT’s inlet sluice gate shall start to close. The solids in the spent filter backwash wastewater shall be allowed to settle in the active WRT for a pre-determined period. After the solids’ settling period is over, the supernatant shall be drained via gravity to the supernatant pump station by opening the supernatant decant valve. The settled solids in the WRTs shall be pumped to the two cell flocculation chamber, located in the north side of the supernatant pump station near the roof slab. Prior to discharging the solids into the flocculation chamber, polymer shall be injected into the solids stream. Polymer injection shall be flow paced and the solids stream flow shall be measured by an inline magnetic flow meter. A mixer shall be provided in the flocculation chamber for polymer mixing. The polymer mixed solids shall then be discharged into the gravity thickeners.

For the current maximum design conditions, there shall be seven WRT fill cycles within 20 hours of operation.

Each WRT shall be able to receive a minimum flow of 574 m^3/event to maximum flow of 864 m^3/event. Multiple events may be required to fill active WRT. After settling, approximately 664 m^3 (864-200) supernatant (above the decanting pipe) shall be decanted by opening the decant valve. Once the active WRT is full, the solids shall be allowed to settle for a minimum time of 200 minutes or time determined by the operation staff utilizing the TSS/turbidity monitor (immersion type) in WRT-R100A. At the beginning of each seasonal variation period, the operations staff shall review a time vs. decrease in turbidity graph representing the liquid characteristics near the decant pipe invert and based on this review, a suitable time required to achieve the targeted effluent turbidity criteria shall be input into the SCADA. The WRT settling period shall be adjustable at the SCADA system. Depending upon the filter backwash cycle frequency or backwash flow rate, the cycle time can be extended or shortened.

The minimum designed supernatant decant time is 40 minutes which means 16.6 m^3/min (664 m^3/40 min) supernatant discharge rate from the WRT.

Submersible pumps shall be installed in each WRT to remove settled solids (200 m^3) from below the supernatant decant stop level. The maximum solids discharge time is approximately 80 minutes for each tank.

Two overflow weirs shall be provided between the WRT and supernatant pump station with bottom elevation 237.80 m.

WRT Design Details

Parameter	Value	Units
Dimensions	24.95 (L) x 7.4 (W) x 4.7 (water depth)	m
Effective Volume	864	m^3
Supernatant Discharge Volume each Cycle	664	m^3
Solids Discharge Volume	200	m^3
Inlet Weir Invert	233.14	m
WRT to Adjacent WRT Overflow Invert	237.3	m
WRT to Adjacent WRT Overflow Length	17.5	m
WRT to Floodway Overflow Invert	238.2	m
WRT to Floodway Overflow Length	3	m
Decant Pipe Invert	233.34	m
Decant Pipe Diameter	600 mm (two bell mouth headers) combine into a 750 mm common header	mm
Hydraulic Loading: Min.	 1,566	m^3/hr m^3/hr

Parameter	Value	Units
Avg.	1,890	m^3/hr
Max.	2,332	
Each Event Max. Fill Cycle Duration	22	min.

3.14.4 Automatic Control Philosophy

3.14.4.1 Backwash Wastewater Outlet Channel

Backwash wastewater flows from the BWW channel via two manually operated sluice gates to the WRT inlet channel which is located at the north end of the WRTs. Each sluice gate shall be provided with limit switches to monitor their positions.

Each sluice gate controls the flow to two WRT tanks as follows.

SLG-R010A WRT100A, WRT200A
SLG-R010B WRT300A, WRT400A

During normal operation both sluice gates shall be open, if either of the gates are closed, then the WRT tanks associated with the closed sluice gates shall be removed from service.

If both sluice gates are closed then filter backwashing shall be inhibited, until either one or both gates are open and a WRT is available for filling.

3.14.4.2 Washwater Recovery Tanks Inlet Channel

The WRT inlet channel is divided into two sections as described above, each channel section shall have a high level switch installed (LS-R010A and LS-R010B) just below the channel overflow. If either of the two level switches detects a high level, an alarm shall be raised and displayed on SCADA and backwashing shall be inhibited.

Four electric actuated sluice gates shall be installed at the washwater inlet channel to control flow into the WRTs.

In the event of accidental or operational closure of all four sluice gates, overflow openings shall be provided at the WRT inlet channel.

The sluice gates at the inlet of the WRTs shall be controlled so that there is always at least one sluice gate open to enable spent backwash flow into an available WRT. The sluice gate shall be closed based on the water level in the active WRT. When the water level in the active WRT reaches a preset high water level (approximately 5 minutes to being full), the sluice gate shall start closing and the flow shall be diverted to an empty WRT by opening its sluice gate. The control system shall ensure that the available tank sluice gate is open before closing the active tank sluice gate. The empty status shall be determined by the water level sensor's reading in each WRT. The tank selection shall be sequential WRT-R100A, WRT-R200A, WRT-R300A, WRT-R400A, whenever possible. If required, an operator can manually select one WRT to be out of service. WRT service status shall be displayed on the HMI/SCADA.

3.14.4.3 Washwater Recovery Tank Operation

WRT's shall be operated in a sequencing batch pattern with four stages: inflow, settling, supernatant decanting and settled solids decanting; as described below.

1. WRT Inflow Stage: the WRT shall be "in service" (no faults or selected out of service) and there shall be sufficient spare volume in the tank to allow filling. The appropriate WRT inlet sluice gate shall be fully open and filling shall be allowed until the level in the WRT reaches the WRT high level (which shall be set so that the tank shall take approximately another 5 minutes to reach maximum capacity, high high level), when the next available WRT sluice gate shall open. The full WRT sluice gate shall not be closed until another sluice gate is fully opened or the level in the WRT rises to activate the high high level float switch.
2. Settling stage: when the WRT is full and the inlet sluice gate is closed, the settling timer (as set by the operator), shall start. When the timer has expired the next stage shall be allowed to start.
3. Supernatant Decant Stage: each WRT shall have a fixed invert supernatant decant header (c/w two 600 mm bell mouth outlets controlled by one common electric actuated decant valve). After expiration of the settling timer the decant valve shall open and the water in the WRT shall flow into the Supernatant tank. When the WRT liquid level has reached a predetermined low liquid level, the decant valve shall close and the WRT shall be ready to move to the next step.

   No supernatant decanting shall be allowed if an overflow event (high high in BWS tanks) in either of the backwash supply tanks is detected. If any of the decant valves are open they shall be closed and decanting shall be inhibited until the overflow alarm is cleared.

   If during the decant operation, (decant valve open) there is no change detected in the WRT water level for a pre-determined period (decant pipe blocked) an alarm shall be raised and the WRT shall be taken out of service.
4. Settled Solids Decanting: when supernatant decanting is complete. The submersible solids pump in the WRT shall be started to pump the settled solids to the flocculation chamber. The pump shall continue to run until a pre-set (pump stop) low water level is reached. A low low level float switch shall also be installed in each WRT to prevent pump dry running in the event of instrument failure.

   If a high high level is detected in the flocculation chamber by LS-R001C, the solids pumps shall be inhibited until the alarm is cleared.

3.14.4.4 Supernatant Quality

The supernatant quality from the WRT shall be monitored by a turbidity/TSS analyzer. The analyzer shall be supplied by a sample pump SP-R010A. The pump operation shall be interlocked with the decant valves in the WRTs so that it shall not run unless a decant valve is open. Whenever there are no decant valves open the reading from the analyzer shall be ignored by the control system.

3.14.4.5 Washwater Recovery Tank Level

The liquid level in the WRTs shall be measured by ultrasonic level transmitters in each WRT. The analogue signal from the transmitter shall be used by the control system to operate the decant fill, decant and solids removal stages described above.

As well as the transmitter a high high and low low float switch shall be installed in each tank. The low low level switch shall protect the solids pump from dry running in the event of transmitter failure. The high high level switch shall be installed above the high level as measured by the transmitter and shall close the WRT inlet sluice gate if activated.

Another level that shall be measured by the transmitter is the flow dampening level. This is an adjustable level by the operator. When water level has reached this set point, the speed of the supernatant variable speed pumps' speed shall be reduced to prevent solids carrying over from the WRTs to the supernatant pump station. More details to follow in Section 3.18 Supernatant Pump Station.

3.14.4.6 Washwater Recovery Tank WRT-R100A Turbidity/TSS Level

A TSS/turbidity monitor with adjustable sensor level shall be provided to record the supernatant and solids characteristics. The TSS/turbidity monitor shall capable of measuring either TSS or turbidity depending on how it is calibrated. The instrument shall have a raise and lower motor/cable assembly so that a profile of the required measurement parameter can be created. The intent is that the WRT TSS/turbidity equipment readings shall be utilized for solid settling time or solids concentration trend observation and manual input into the SCADA and not for online day to day control.

3.14.4.7 Flocculation Tank General Operation

Flocculation Tank Design Details

Parameter	Value	Units
Tank Dimensions	First Chamber 0.6 (L) X 2 (W) X 1.2 (D) Second Chamber 0.3 (L) x 2 (W) x 1.2 (D)	m
Inter Chamber Pipe Diameter	300	mm
Overflow Pipe Elevation and Diameter	238.81, 0.200	m
Inter Chamber Pipe Invert Elev.	237.81	m
Influent Pipe Diameter	200	mm
Influent Pipe Invert Elevation	237.0	m
Discharge Pipe Diameter	200	mm
Discharge Pipe Invert Elevation	238.5	m
Flow: Min. Avg. Max.	 120 150 150	 m^3/hr m^3/hr m^3/hr
Min. Duration of Flow Discharge	80	min.
Mixer Type and Power	Top Mount VFD, 1.5	HP

The settled solids from a WRT shall be pumped into the first chamber of the flocculation tank via 200 mm line either continuously or intermittently depending upon the operational requirements.

Prior to discharging the solids into the flocculation chamber, polymer shall be injected into the solids stream. Polymer injection shall be flow paced and the flow shall be measured by inline magnetic flow meter (FE-R001B). Please refer to polymer injection section 3.22 for details.

The overflow pipe within the first compartment shall drain into the gravity thickener GT-R500. A three point level switch LS-R001A shall be installed in the chamber to provide the control functions described below.

The discharge from the flocculation tank to either one of the two thickeners (GT-R500A or GT-R600A) shall be controlled by two manual butterfly valves (HV-R500A and HV-R600A).

3.14.5 Automatic Control Philosophy

3.14.5.1 Flocculation Chamber Level Switch LS-R001A

Level switch LS-R001A shall be a conductivity level switch with three probes set at low, high and high high levels. The functions associated with each level are described below.

Low level: if the liquid level in the chamber is below the low level the mixer shall be inhibited.

High level: if the liquid level is above the high level the solids pumps in the WRT'S shall be inhibited, alarm on SCADA.

High high level alarm on HMI/SCADA, overflow imminent to gravity thickeners.

3.14.5.2 Flocculation Chamber Mixer MXR-R001C

A turbine type, top entry mixer in the flocculation tank shall have variable speed control adjustable at the SCADA interface. The mixer shall start running if the chamber level is above the chamber low level set point. In the event of the mixer failure during operation, the solids pump shall be inhibited.

3.14.5.3 Turbidity/TSS Monitor AIT-R001A

For TSS monitoring, a TSS/turbidity monitor shall be installed upstream of the solids flow meter, the output of which shall be used for trending and monitoring. If the flow meter detects a flow, TSS/turbidity shall be recorded and displayed.

3.14.5.4 Sludge Flow Meter FIT-R001B

The PLC shall monitor the sludge inlet flow to the flocculation chamber and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to calculate the dosing rate of polymer

3.14.6 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LS-R010A LS-R010B	High Level in WRT inlet channel	Interlock & Alarm	Inhibit backwash Raise alarm on SCADA
LS-Rx00A	Low Level in WRT	Inhibit	Inhibit solid pumps and event on SCADA
LS-Rx00B	High High Level in WRT	Interlock	Close WRT inlet sluice gate. Alarm on SCADA
LIT-Rx00D	Instrument Failure WRT liquid level	Fault	Close corresponding WRT inlet sluice gate in the Inlet Channel. Take tank out of service. Alarm on SCADA Open sluice gate on next available WRT
	Flow Dampening Level	Interlock	Reduce supernatant pumps' speed.
FIT-R001B	Solids pump is running and no flow detected	Alarm	Stop pump, take tank out of service. Generate alarm on SCADA
	Instrument Fault	Alarm	Hold last value and generate alarm on SCADA
LS-R001A	Low level	Inhibit	Inhibit mixer.
	High Level	Inhibit	Inhibit solid pumps and generate alarm on SCADA
	High High Level	Alarm	Raise alarm on SCADA.

3.14.7 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Solids Pump Stop Level	0-xxx %
Solids Pump Start Level	0-xxx %
WRT Tank Full Level	0-xxx %
WRT Tank Settling Time	0-300- min

SCADA/HMI Operator Adjustable Set Points

Description	Range
Tank No.1 WRT-R100A In Service	0 – 1
Tank No.2 WRT-R200A In Service	0 – 1
Tank No.3 WRT-R300A In Service	0 – 1
Tank No.4 WRT-R400A In Service	0 – 1
Decant Stop Level	0-xxx %
Decant Start Level	0-xxx %
Flow Dampening Level	0-xxx %

SCADA/HMI Status Signals

Description	Range
Washwater Recovery Tank No. 1 In Service	0 – 1
Washwater Recovery Tank No. 1 Remaining Volume	0-xxxx.x m3
Washwater Recovery Tank No. 2 In Service	0 – 1
Washwater Recovery Tank No. 2 Remaining Volume	0-xxxx.x m3
Washwater Recovery Tank No. 3 In Service	0 – 1
Washwater Recovery Tank No. 3 Remaining Volume	0-xxxx.x m3
Washwater Recovery Tank No. 4 In Service	0 – 1
Washwater Recovery Tank No. 4 Remaining Volume	0-xxxx.x m3
Tank Settling Time	0-xxxx min

SCADA/HMI Alarm Signals

None

3.15 Gravity Thickeners No. 1 & 2

3.15.1 Documentation

WR-P0008 P&ID Gravity Thickeners

3.15.2 Plant and Instruments

Tag	Description	
Gravity Thickener No.1 GT-R500A		
LS-R500A	Gravity Thickener No.1 High Level	
VS-R500A	Gravity Thickener No.1 High Torque	
AT-R500B	Gravity Thickener No.1 TSS/Turbidity	
Gravity Thickener No.2 GT-R600A		
LS-R600A	Gravity Thickener No.2 High Level	
VS-R600A	Gravity Thickener No.2 High Torque	

3.15.3 General Operation

Once the polymer mixed solids are discharged into the gravity thickeners, the equally distributed solids shall be allowed to thicken in the two gravity thickeners. Supernatant from the gravity thickeners shall be discharged to the Supernatant Pump Station and the settled solids shall be discharged into the thickened sludge equalization tank where solids from the DAF process shall also be discharged.

The gravity thickeners shall have continuously rotating rake mechanisms. Torque monitors shall be provided on each rake, which shall trip the rake and raises an alarm on high torque detection.

Each gravity thickener shall have a high level switch installed just below the overflow level. Gravity Thickener GT-R500A shall have a TSS/turbidity analyzer installed. The instrument shall normally measure turbidity and shall give an alarm in the event of high turbidity. The instrument shall also have a raise and lower motor/cable assembly so that a profile of the required measurement parameter can be created.

Thickened solids shall flow to the thickened sludge equalization tank via a 200 mm diameter pipe from the thickener solids pit, located in the centre of the thickener. An electric actuated valve shall be installed at the solids discharge line that shall be controlled either by predetermined opening time period or high TSS values.

Design Details of Gravity Thickeners

Parameters	Value	Units
Total Flow to both Thickeners: Min. Avg. Max.	 60 75 75	 m^3/hr m^3/hr m^3/hr
Surface Area of Each Thickener	193.4	m^2
Each Thickener's Dimensions	14.80 (L) x 13.07 (W) x 6.59 (D) side water depth	m
Diameter of Rake Mechanism	12	m
Supernatant Decant Weir Elevation	238.07	m
Surface Loading Rate	0.4	m/s

3.15.4 Automatic Control Philosophy

3.15.4.1 Gravity Thickener High Level Switches

High level float switches shall be installed in each gravity thickener.

GT-R500A LS-R500A
GT-R600A LS-R600A.

In the event of the switch being activated an alarm shall be raised on the SCADA/HMI and operation of the solids pumps in the WRTs shall be inhibited.

3.15.4.2 Gravity Thickeners

There shall be two gravity thickeners GT-R500A and GT-R600A During automatic plant start up the rakes shall be started and shall run continuously once flow to the thickeners has been established and confirmed by flow meter FIT-R001B and level switch LS-R001A, unless the plant shuts down or the drive is tripped or manually stopped.

Under normal conditions, the Gravity Thickener shall run continuously. In the event of high torque being detected the thickener drive shall trip and an alarm shall be raised on the SCADA/HMI.

3.15.4.3 TSS/Turbidity Analyzer AT-R500B

For supernatant quality monitoring, an adjustable turbidity monitor shall be installed near the supernatant decant trough. In the event of high supernatant turbidity, an alarm shall be generated on SCADA.

The analyzer sensor can be used to measure the solids zone depth, and then be used to control the thickened sludge decant time. In the event of a high TSS value, the thickened sludge decant valve shall be opened until the TSS value falls below a pre-determined level when it shall be closed again.

3.15.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LS-R500A	High liquid level Gravity Thickener GT-R500A	Alarm & Interlock	Stop WRT solids pumps if running. Alarm sent to SCADA.
LS-R600A	High liquid level Gravity Thickener GT-R600A	Alarm & Interlock	Stop WRT solids pumps if running. Alarm sent to SCADA.
AT-R500B	High Turbidity	Interlock	Alarm on SCADA
VS-R500A	High Torque	Alarm	Stops rake operation. Generate alarm to SCADA

3.15.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

Description	Range
Gravity Thickener No. 1 GT-R500A	
Thickener No. 1 in Service	
Thickened Sludge Decant Time	0-200mins
Gravity Thickener No. 2 GT-R600A	
Thickener No. 2 in Service	
Thickened Sludge Decant Time	0-200mins

SCADA/HMI Status Signals

Description	Range
Gravity Thickener No. 1 GT-R500A	
Thickener No. 1 in Service	
Gravity Thickener No. 2 GT-R600A	
Thickener No. 2 in Service	

SCADA/HMI Alarm Signals

Description	Range
High Rake No. 1 Torque Alarm	
High Rake No. 2 Torque Alarm	
High Liquid Level in Gravity Thickener No. 1	
High Liquid Level in Gravity Thickener No. 2	
High TSS Level in Gravity Thickener No. 1	
High Turbidity Level in Gravity Thickener No. 1	

3.16 Thickened Sludge Equalization Tanks

3.16.1 Documentation

WR-P0009 P&ID Thickened Sludge Equalization Tanks

3.16.2 Plant and Instruments

Tag No.	Description	
HV-R700A	Isolation Valve for Thickened Sludge Equalization Tanks	
Thickened Sludge Equalization Tank TNK-R710		
FV-R710A	Gravity Thickener to Thickened Sludge Equalization Tank TNK-R710 Sludge Valve	
LS-R710B	Thickened Sludge Tank High Level	
P-R710B	Thickened Sludge Tank Sludge Pump	
MXR-R710C	Thickened Sludge Tank Mixer	
LIT-R710D	Thickened Sludge Tank Level	
Thickened Sludge Equalization Tank TNK-R720		
FV-R720A	Gravity Thickener to Thickened Sludge Equalization Tank TNK-R720 Sludge Valve	
LS-R720B	Thickened Sludge Tank High Level	
P-R720B	Thickened Sludge Tank Sludge Pump	
MXR-R720C	Thickened Sludge Tank Mixer	
LIT-R720D	Thickened Sludge Tank Level	
FIT-R730A	Thickened Sludge to Freeze Thaw Ponds Flow	
FV-R730A	Thickened Sludge to Freeze Thaw Ponds Pump Outlet Solenoid Valve	
PI-R730A	Thickened Sludge to Freeze Thaw Ponds Pressure	
AIT-R730B	Thickened Sludge to Freeze Thaw Ponds TSS	

3.16.3 General Operation

Thickened sludge shall flow from the gravity thickeners to the two TSETs. DAF float shall also be collected in the TSET. Level transmitters within the thickened sludge tanks shall control all aspects of the tank operation. A selector switch shall be provided at the SCADA/HMI enabling selection of the duty level transmitter for control purposes. High-level detection shall inhibit the WRT solids pumps and cause the tank inlet valves to close. The tank mixers shall run continuously in each tank as long as the level is above a predetermined set point.

The inter-chamber wall in the TSET tanks incorporates an overflow weir for relieving the liquid into the other side of the TSET tank in the event of overfilling.

Thickened sludge Equalization Tank Design Details

Item	Values	Units
Hydraulic Loading: Min. Avg. Max.	 5.1 28.8 83.0	m^3/hr
Number of Tanks	2	NA
Tank Dimensions (each)	3 X 1.85 x 8.76	m
Number of Mixers and Type	Two (one in each tank) VFD, Top mount	
Mixer Power	7	HP
Number of Pumps and Type	2, Submersible Screw Centrifugal	
Pump Power	30	HP

The thickened sludge pumps in the TSET shall pump the solids to the freeze that ponds via a dedicated forcemain. Surge anticipatory valve PRV-R730A shall be installed to relieve any potential high pressure waves coming back into the TSET sumps.

3.16.4 Automatic Control Philosophy

3.16.4.1 Thickened Sludge Equalization Tank Inlet Valves FV-R710A and FV-R720A

The valve open/close frequency each day and valve open period shall be manually entered into the SCADA by operation's staff. The operation's staff would observe the solids build up trends utilizing the TSS monitors in the gravity thickeners, and adjust the valve opened period at the SCADA/HMI. The valve control can also be controlled by the TSS level in the thickeners. The selection of control mode shall be made by the operator at the SCADA/HMI.

In the event of a high high level in the TSET tank the valves shall be closed (if open) until the level falls below the re-fill level. The DAF float sump pumps shall also be inhibited.

3.16.4.2 Thickened Sludge Tank Service Selection

It shall be possible to take a tank 'out of service' to allow cleaning and maintenance of the tank. The operator shall close the tank inlet valve and open the manually operated tank isolation valve (HV-R700A).

If a tank is selected 'out of service' then the associated instruments shall be disabled and the in service tank instruments shall automatically become the duty instruments

3.16.4.3 Thickened Sludge Tank Level Transmitters LIT-R710D, LIT-R720D

During normal operation, both tanks shall be in service and the level in the tanks shall be the same so, the level transmitters are able to operate in a duty/standby mode. Duty/standby/Off transmitter operation shall be selected at SCADA.

The duty tank level signal shall provide the set points for the control of all associated control aspects of the tanks.

Level control shall be automatically transferred to the standby transmitter if the duty transmitter becomes unavailable (because of transmitter failure or de-selection).

Thickened Sludge Tank High High Level Switches LS-R710B, LS-R720B

In the event that both level sensors fail, high high level switches have been provided as back up If a high high alarm is detected for a preset time in either tank, an alarm shall be raised on SCADA and the tank inlet valves FV-R710A & FV-R720A shall be closed. DAF float sump pumps shall also be inhibited.

3.16.4.4 Thickened Sludge Tank Mixer Operation MXR-R710C, MXR-R720C

The mixers shall be required to operate if the level in the tank exceeds a 'Start Mixer' set point for a preset time.

The mixer shall continue to operate until the level in the tank drops below the 'Start Mixer' set-point for a preset time.

3.16.4.5 Thickened Sludge Tank Solids Pumps

When the valve in the TSET dividing wall is open (HV-R700A), the pumps shall be in duty/standby operation. If the valve is closed for maintenance, depending on which side of the tank is still in service, the appropriate pump shall be operational.

Both solids pumps P-R710B and P-R720B shall have VFDs to control the solids pumping rate to the freeze thaw ponds. Pumps' speed can be adjusted according to the solids hydraulic retention time requirements in the TSET tanks as determined by the operations staff. Pump speed shall also adjust to the tank level, if the pump is running and the tank level is still rising, then the pump speed shall be ramped up to the max. In the event of a pump failure, the standby pump shall start with the preset pump start speed.

The pumps shall not be allowed to start unless FV-R730A is closed, this condition shall also apply in the event of a duty/standby pump changeover.

3.16.4.6 Pump Control Valve FV-R730A

The pump control valve FV-R730A shall be normally be closed unless a pump has been started by the control system, in which case, the solenoid which opens the valve shall be energised and the valve shall begin to open.

If a running pump is commanded to stop by the control system, the solenoid shall be de-energised and the valve shall close.

If at any time a reverse flow is detected by the flow meter FT-R730A, a running pump shall be stopped and the valve shall be closed.

In addition to anticipatory valve PRV-R730A, FV-R730A shall be installed as a backup check valve to prevent any backflow into the TSET tanks from the freeze thaw ponds. An interlock of the FE-R730A with FV-R730A is provided to de-energize solenoid in the event reverse flow is detected at the FE-R730A.

3.16.4.7 Thickened Sludge to Freeze Thaw Ponds Flow Meter FIT-R730A

The PLC shall monitor the Thickened Sludge Flow to the Freeze thaw ponds and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 10,000 litres and the accumulated flow shall be displayed on the SCADA.

The flow meter shall also monitor reverse flows and close FV-R730A if such an event is detected.

3.16.4.8 Thickened Sludge TSS Outlet Monitor AIT-R730B

For TSS monitoring, an adjustable TSS and Turbidity monitor shall be installed and shall be used for trending.

3.16.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag No.	Event	Type	Control System Action
LIT-R710X	Instrument failure	Fault	Switch to other instrument. If both instruments fail, inhibit thickened sludge transfer pumps. If both instruments fail, close inlet valve and raise alarm on SCADA.
LS-R710A	Low level in tank	Interlock & Alarm	Stop pumps P-R710B/ P-R720B and mixers. Raise alarm on SCADA
LS-R710B	High High level in tank	Interlock & Alarm	Close tank inlet valve FV-R710A/ FV-R720A. Inhibit WRT solids pumps Raise alarm on SCADA Inhibit DAF float pumps.

Tag No.	Event	Type	Control System Action
LIT-R720X	Instrument failure	Fault	Switch to other instrument. If both instruments fail, inhibit thickened sludge transfer pumps. If both instruments fail, close inlet valve and raise alarm on SCADA.
LS-R720A	Low level in tank	Interlock & Alarm	Stop pumps P-R710B/ P-R720B Raise alarm on SCADA
LS-R720B	High level in tank	Interlock & Alarm	Close tank inlet valve FV-R710A /FV-R720A. Inhibit WRT solids pumps Raise alarm on SCADA
FT-R730A	Reverse flow	Interlock & Alarm	Close valve FV-R730A and raise alarm on SCADA

3.16.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Thickened Sludge Equalization Tank TNK-R710 Rate of Change Set point	
Thickened Sludge Equalization Tank TNK-R720 Rate of Change Set point	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Thickened Sludge Equalization Tank No. 1 TNK-R710 in Service	
Thickened Sludge Equalization Tank No. 2 TNK-R720 in Service	
Thickened Sludge Pump No. 1 P-R710B Speed Set Point	
Thickened Sludge Pump No. 2 P-R720B Speed Set Point	
Level Transmitter LIT-R710D Duty/Standby	
Level Transmitter LIT-R720D Duty/Standby	
Level Switch LS-R710A Duty/Standby	
Level Switch LS-R710B Duty/Standby	
Level Switch LS-R720A Duty/Standby	
Level Switch LS-R720B Duty/Standby	

SCADA/HMI Status Signals

Description	Range
Thickened Sludge Equalization Tank No. 1 TNK-R710 in Service	
Thickened Sludge Equalization Tank No. 2 TNK-R720 in Service	
Level Transmitter LIT-R710D Duty/Standby	
Level Transmitter LIT-R720D Duty/Standby	
Level Switch LS-R710A Duty/Standby	
Level Switch LS-R710B Duty/Standby	
Level Switch LS-R720A Duty/Standby	
Level Switch LS-R720B Duty/Standby	

SCADA/HMI Alarm Signals

Description	Range
Thickened Sludge to Freeze Thaw Ponds Reverse Flow	

3.17 Supernatant Pumping Station

3.17.1 Documentation

WR-P0007 P&ID Supernatant Pump Station

3.17.2 Plant and Instruments

Tag	Description	
LS-R020C	Overflow Channel High Level	
LS-R020D	Overflow Channel High High Level	
LS-R020A	Supernatant Pump Station SPS-R020 Low Low Level	
LS-R020B	Supernatant Pump Station SPS-R020 High High Level	
LIT-R020A	Supernatant Pump Station SPS-R020 Level	
Supernatant Pump P-R021A		
FV-R021B	Supernatant Pump P-R021A Outlet Control Valve Solenoid Operator	
HV-R021A	Supernatant Pump P-R021A Outlet Manual Valve	
SE-R021A	Supernatant Pump P-R021A Speed Sensor	
ST-R021A	Supernatant Pump P-R021A Speed Transmitter	
SY-R021A	Supernatant Pump P-R021A Reverse Spin Relay	
Supernatant Pump P-R022A		
FV-R022B	Supernatant Pump P-R022A Outlet Control Valve Solenoid Operator	

Tag	Description	
HV-R022A	Supernatant Pump P-R022A Outlet Manual Valve	
SE-R022A	Supernatant Pump P-R022A Speed Sensor	
ST-R022A	Supernatant Pump P-R022A Speed Transmitter	
SY-R022A	Supernatant Pump P-R022A Reverse Spin Relay	
Supernatant Pump P-R023A		
FV-R023B	Supernatant Pump P-R023A Outlet Control Valve Solenoid Operator	
HV-R023A	Supernatant Pump P-R023A Outlet Manual Valve	
SE-R023A	Supernatant Pump P-R023A Speed Sensor	
ST-R023A	Supernatant Pump P-R023A Speed Transmitter	
SY-R023A	Supernatant Pump P-R023A Reverse Spin Relay	
FV-R024B	Supernatant Pump Station Pump Control Valve Solenoid Operator	
AIT-R024A	Supernatant Pump Station Outlet Turbidity/TSS	
FIT-R024A	Supernatant Pump Station Outlet Flow	

3.17.3 General Operation

Supernatant from the gravity thickeners shall be discharged to the Supernatant Pump Station and the settled solids shall be discharged into the TSET where solids from the DAF process shall also be discharged. The combined solids shall be pumped to the freeze thaw ponds via a dedicated forcemain. Both gravity thickener's supernatant and WRTs supernatant along with pilot plant effluent and other miscellaneous occasional drains and overflows (chlorine contact tank drain, ozone drain and backwash supply tank overflow, residuals area tankage overflows) shall be pumped from the supernatant pump station to Deacon Cell 2 or 4 via the aqueduct.

The triplex supernatant pump station is provided for pumping supernatant from WRT and gravity thickeners, pilot plant effluent, and misc. overflows and drains as identified on the P&IDs.

Supernatant Pump Station Design Details

Parameters	Value	Units
Flow: Min. Avg. (WRT, Thickener, Pilot Plant) Max. (Backwash OF, Pilot Plant, Thickener)	 68 1,052 2,051 (1,979 = backwash)	m^3/hr
Pump Station Dimensions	11.5 (L) x 4.0 (W) x 8.76 (D)	m
Single Pump Design Flow Rate	1,052	m^3/hr
Pump Discharge Header Diameter	750	mm

Parameters	Value	Units
Design TDH at Avg. Flow	13.8	m
TDH at Maximum Flow	14.5	m
Duty and Standby Arrangement	2, 1 (Normally)	NA
Each Pump Power	75	HP
Pump 1 Start Elevation	233.75	m
Pump 2 Start Elevation	235.75	m
All Pump Stop Elevation	232.75	m
High Water Level Alarm	237.61	m
Emergency Third Pump Run Elev.	236.50	m

A total of all flow streams (above listed and other misc. infrequent drains) would be a maximum of 4,427 m^3/hr, and this would exceed the pump station capacity and cause a surcharge into the WRTs and eventually to floodway overflow pipe. Therefore, the control system shall ensure that discharge from the WRT into the supernatant pump station during backwash supply storage tank overflow periods is prevented. Infrequent events such as ozone tank drain discharge and CCT tank discharge shall be manually administered.

3.17.4 Automatic Control Philosophy

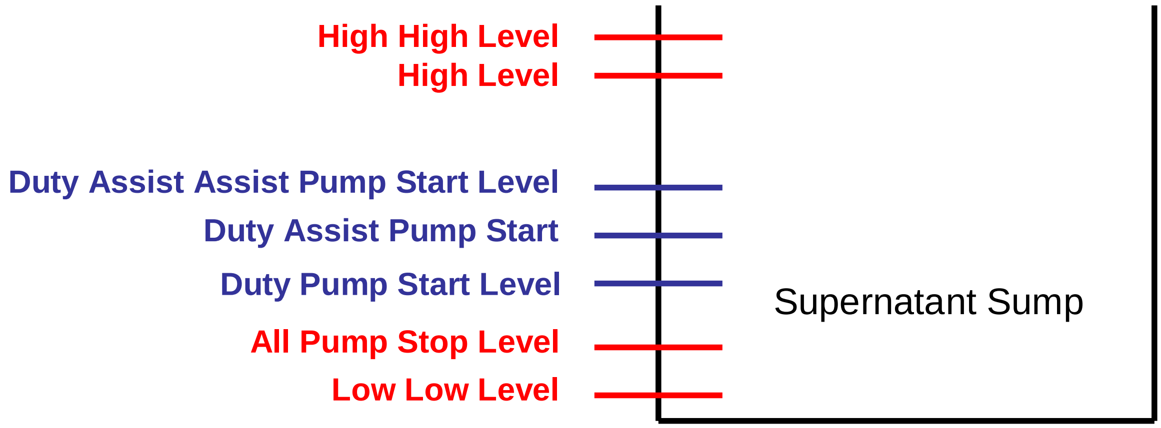
3.17.4.1 Overflow Channel

Level switches LS-R020C and LS-R020D shall be conductivity level switches. LS-R020C shall have its probe set at high level. While LS-R020D shall have its probe set at high high level. In the events of a high or high high level, alarms shall be generated to SCADA.

Supernatant Pump Station Level

Supernatant sumps shall be operated based on the water level which shall be monitored by level transmitter LIT-R020A. Backup float switches LS-R020A and LS-R020B shall be installed. There shall be seven (7) liquid monitoring levels which are:

- High high water level triggered by float switch
- High water level alarm based on ultrasonic sensor
- ‘Duty assist assist’ pump start, based on ultrasonic sensor
- ‘Duty assist’ pump start, based on ultrasonic sensor
- ‘Duty’ pump start, based on ultrasonic sensor
- All pumps stop level based on ultrasonic sensor
- Low low water level or minimum pump submergence level triggered by the float switch



In the event of a high water level, the two duty/duty assist pumps speed shall increase from pump start speed set point to maximum speed. The third pump (duty assist) pump shall start and all WRT supernatant decant valves shall be closed.

In the event of water level decreasing to the flow dampening level (pump speed reduced level) in the WRTs, the duty and duty assist supernatant pump speeds shall be reduced to the reduced speed set point (adjustable by the engineer). This shall automate the flow dampening process which may be required at times when the liquid level in the WRTs is near the decant pipe level and solids may have accumulated. With slower pump discharge rate, solids carry over from WRTs to the supernatant pump station should be prevented.

In the event of water level decreased to the pump stop level, all supernatant pumps shall be stopped; all supernatant pump control valves shall be closed.

In the event of the ultrasonic sensors failure, high high level and low low switches have been provided as backup. If a high high level is detected, an alarm shall be raised on SCADA and all WRT supernatant decant valves shall be closed.

If a low low level is detected, an alarm shall be raised on SCADA, all supernatant pumps shall be inhibited, and all supernatant pump control valves shall be closed.

3.17.4.2 Supernatant Pumps Operation

There shall be three supernatant pumps where two of the three pumps (duty and duty assist) shall be operated by variable speed drives to control flow discharge rate, if required. The pump run speed shall be infrequent manual adjustment and shall be implemented at the SCADA system.

The third supernatant pump shall be a fixed speed pump which shall work inline with the other two pumps as a ‘duty assist assist’.

The discharge from the supernatant pumps shall be controlled by inline PCV (FV-R021B, FV-R022B, and FV-R023B). The PCV is a pilot-operated valve which shall be designed for installation on the discharge of pumps to eliminate hydraulic pipeline surges caused by the starting and stopping of the pump. The pump starts against a closed valve. When the pump has started, the solenoid control is energized and the valve begins to open slowly until the valve is fully open and gradually increasing line pressure to full pumping head. When the pump is signalled to shut-off, the solenoid control is de-energized and the valve begins to close slowly, gradually reducing flow while the pump continues to run. When the pump control valve is detected as closed, the pump stops. The valve shall have built-in, lift type, check feature. It is hydraulically operated and diaphragm-actuated. A three-way solenoid valve controls the valve operation. Flow control valves located in the pilot control system provide regulation of both the opening and closing rate.

3.17.4.3 Pump Control Valve Operation FV-R024B

Another pump control valve shall also be provided at the common discharge header in the south DAF gallery area as a back up to control the potential backflow into the supernatant pump station. There shall be some delay in the valve closure as FV-R024B shall be installed as a backup system in case of PCV failure. This valve shall be interlocked with the supernatant pumps. Like the other pump control valves, this valve shall normally be closed. When a pump has started, the solenoid control is energized and the valve begins to gradually open and continues until it is fully open. When all pumps have been signalled to shut-off, the solenoid control is de-energized and the valve begins to gradually close.

3.17.4.4 Turbidity/TSS Monitor AIT-R024A

A turbidity/TSS monitor shall be provided to record the effluent characteristics.

3.17.4.5 Surge Anticipatory Valve PRV-R024A

A surge anticipatory valve shall be provided at the common discharge header in the south gallery area. The surge relief valve shall have two pressure control set-points. Sudden power failure to a pump could results in a down surge in pressure, followed by an up surge in pressure. The surge control valve opens on the initial low pressure wave, diverting the returning high pressure wave from the system. The valve shall anticipate the returning high pressure wave and shall open to divert the flow back to the sump. The valve shall then close slowly without generating any further pressure surges.

Pressure indicator shall be provided at the operating surface level to monitor the pump pressure. In addition one air/vacuum release valve shall also be provided at the pump discharge header.

The position of the valve shall be monitored on SCADA.

3.17.4.6 Supernatant Pump Station Outlet Flow Meter

The PLC shall monitor the Supernatant pump station outlet flow and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 10,000 litres and the accumulated flow shall be displayed on the SCADA.

3.17.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LIT-R020A	Instrument failure	Fault	If instrument fail, close WRT supernatant decant valves. Generate alarm on SCADA.
LS-R020A	Low low level in sump	Interlock & Alarm	Raise alarm on SCADA, all supernatant pumps shall be inhibited, and all supernatant pump control valves shall be closed.
LS-R020B	High high level in sump	Interlock & Alarm	Raise alarm on SCADA and all WRT supernatant decant valves shall be closed.

3.17.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Duty Supernatant Pump Start Level	
Duty Assist Supernatant Pump Start Level	
Duty Assist Assist Pump Start Level	
Supernatant Pump Reduce Speed Set Point	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Supernatant Pump P-R021A Speed Set Point	
Supernatant Pump P-R022A Speed Set Point	
Supernatant Pump P-R023A Speed Set Point	

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

Description	Range
Supernatant Pump P-R021A Reverse Spin	
Supernatant Pump P-R022A Reverse Spin	
Supernatant Pump P-R023A Reverse Spin	
Supernatant Pump Station Outlet Reverse Flow	

3.18 De-Watering Cell Pumping Station

3.18.1 Documentation

WL-P0002 P&ID Dewatering Pump Station

3.18.2 Plant and Instruments

Tag	Description	
P-L921A	Dewatering Pump	
P-L922A	Dewatering Pump	
LT-L920A	Dewatering Pumping Station Level Transmitter	
LS-L920A	Dewatering Pumping Station High High Level Switch	
LS-L920B	Dewatering Pumping Station Low Low Level Switch	
AT-L924A	Dewatering Pumping Station Discharge Turbidity/ Suspended Solids Analyzer	
FT-L924A	Dewatering Pumping Station Discharge Flow Transmitter	
TT-L924A	Dewatering Pumping Station Metering Chamber Ambient Temperature Transmitter	
LS-L924A	Dewatering Pumping Station Metering Chamber Flood Switch	
TT-L965A	Dewatering Pumping Station Electrical Cabinet Ambient Temperature Transmitter	
TT-L951A	Dewatering Pumping Station Transformer XMFR-PP-L11A Temperature	
TT-L952A	Dewatering Pumping Station Transformer XMFR-PP-L11B Temperature	
ZS-LS953A	Dewatering Pumping Station Transfer Switch Position Switch	
JS-L950A	Dewatering Pumping Station Site Power Monitoring Relay	
ES-L955A	Dewatering Pumping Station Site 24VDC PSU Monitoring Relay	
ES-L955B	Dewatering Pumping Station Site 24VDC PSU Monitoring Relay	
ES-L960A	Dewatering Pumping Station Site UPS Monitoring Relay	

3.18.3 General Operation

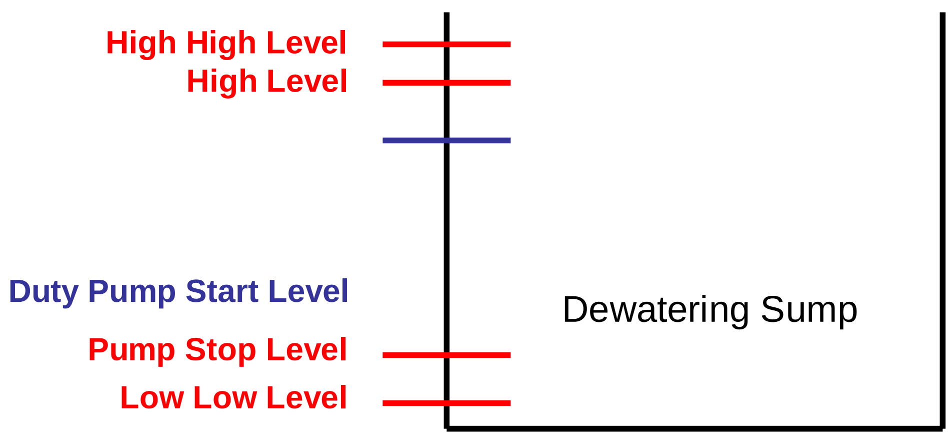
Freeze thaw pond supernatant, underdrains and sanitary waste from the water treatment plant shall be collected in the Dewatering pump station from where it shall be pumped to the City Sewer system. The fixed speed duty/standby pumps shall be controlled by a local PLC panel connected to the main plant control system by a fibre optic connection. As well as pump control the panel shall also measure flow from the pumping station, turbidity or suspended solids, wet well level and various other ambient temperatures and electrical equipment statuses.

3.18.4 Automatic Control Philosophy

3.18.4.1 Dewatering Pump Station Level

The Dewatering pumps shall be operated based on the liquid level which shall be monitored by level transmitter LIT-l920A. Backup float switches LS-L920A and LS-L920B shall be installed. There shall be five (5) liquid monitoring levels which are:

- High high water level triggered by float switch
- High water level alarm based on ultrasonic sensor
- 'Duty' pump start, based on ultrasonic sensor
- 'Duty' pumps stop level based on ultrasonic sensor
- Low low water level or minimum pump submergence level triggered by the float switch



In the event of an ultrasonic sensors failure, high high level and low low switches have been provided as backup. If a high high level is detected, an alarm shall be raised on SCADA and all WRT supernatant decant valves shall be closed.

If a low low level is detected, an alarm shall be raised on SCADA and all pumps shall be inhibited.

3.18.4.2 Dewatering Pump Operation

There shall be two fixed speed pumps operating in a duty standby mode controlled by the sump level as described above. In the event of a duty pump failure the standby pump shall start and an alarm raised on SCADA.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

3.18.4.3 Turbidity/TSS Monitor AIT-L924A

A turbidity/TSS monitor shall be provided to record the effluent characteristics.

3.18.4.4 Dewatering Pump Station Outlet Flow Meter

The PLC shall monitor the pump station outlet flow and display the instantaneous value on the SCADA.

The PLC shall totalise the flow using the digital pulse signal from the flow meter. Each pulse shall represent 10,000 litres and the accumulated flow shall be displayed on the SCADA.

3.18.4.5 Metering Chamber Ambient Temperature

The PLC shall monitor the metering chamber ambient temperature the instantaneous value on the SCADA.

If the temperature in the chamber falls below the low set point an alarm shall be raised on SCADA.

3.18.4.6 Electrical Cabinet Ambient Temperature

The PLC shall monitor the electrical cabinet ambient temperature the instantaneous value on the SCADA.

If the temperature in the chamber falls below the low set point an alarm shall be raised on SCADA.

If the temperature in the chamber rises above the high set point an alarm shall be raised on SCADA.

3.18.4.7 Electrical systems monitoring

Because of the remote nature of the Dewatering Pumping Station the PLC shall monitor the electrical systems on site and in the event of any transformer failure, changeover switch operation etc. alarms shall be raised on SCADA

3.18.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LIT-L920A	Instrument failure	Fault	If instrument fail, inhibit pumps. Generate alarm on SCADA.
LS-L920B	Low low level in sump	Interlock & Alarm	Raise alarm on SCADA, all pumps shall be inhibited.
LS-L920A	High high level in sump	Interlock & Alarm	Raise alarm on SCADA and all WRT supernatant decant valves shall be closed.

3.18.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Duty Pump Start Level	
Duty Pump Stop Level	

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

None

3.19 Ozone Generation and Dosing

Refer to Appendix 6

3.20 Ferric Chloride Storage and Dosing Plant

3.20.1 Documentation

WS-P004 P&ID Bulk Ferric Chloride Offloading and Storage

WS-P005 P&ID Ferric Chloride Feed System 1 of 3

WS-P006 P&ID Ferric Chloride Feed System 2 of 3

WS-P007 P&ID Ferric Chloride Feed System 3 of 3

3.20.2 Plant and Instruments

Tag	Description	
LCP-S100A	Local Control Panel for Bulk Ferric Chloride Rail Car Fill Side	
SOL-S100A	Fill Valve for Bulk Ferric Chloride Rail Car Fill Side	
LCP-S105A	Local Control Panel for Bulk Ferric Chloride Truck Fill Side	
SOL-S105A	Fill Valve for Bulk Ferric Chloride Truck Fill Side	
FV-S107A	Ferric Chloride Spill Containment to North Sump Inlet Flow Valve	
P-S160A	Ferric Chloride Feed Duty Pump	
P-S170A	Ferric Chloride Feed Standby Pump	
P-S180A	Ferric Chloride Feed Duty Pump	

Tag	Description	
FV-S170A	Ferric Chloride Feed Standby Pump Outlet Control Valve	
FV-S170B	Ferric Chloride Feed Standby Pump Outlet Control Valve	
FT-S165A	Ferric Chloride Feed Pump P-S160A Flow Meter	
FT-S185A	Ferric Chloride Feed Pump P-S180A Flow Meter	
LA-S190C	Bulk Ferric Chloride Containment High Level Alarm Lamp	
LA-S190D	Bulk Ferric Chloride Containment High Level Alarm Lamp	
LS-S190A	Ferric Chloride Spill Containment Switch South Sump	
LS-S190B	Ferric Chloride Spill Containment Switch North Sump	
FS-S757A	Emergency Shower/Eyewash Station EES-S757A	
Ferric Chloride Bulk Storage Tank 1 TK-S110A		
LT-S110A	Ferric Chloride Tank Level Transmitter	
PT-S110A	Ferric Chloride Tank Pressure Transmitter	
FV-S110A	Ferric Chloride Storage Tank Inlet Flow Valve Rail Car Fill Side	
FV-S110B	Ferric Chloride Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S110C	Ferric Chloride Storage Tank Outlet Flow Valve	
Ferric Chloride Bulk Storage Tank 2 TK-S120A		
LT-S120A	Ferric Chloride Tank Level Transmitter	
PT-S120A	Ferric Chloride Tank Pressure Transmitter	
FV-S120A	Ferric Chloride Storage Tank Inlet Flow Valve Rail Car Fill Side	
FV-S120B	Ferric Chloride Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S120C	Ferric Chloride Storage Tank Outlet Flow Valve	
Ferric Chloride Bulk Storage Tank 3 TK-S130A		
LT-S130A	Ferric Chloride Tank Level Transmitter	
PT-S130A	Ferric Chloride Tank Pressure Transmitter	
FV-S130A	Ferric Chloride Storage Tank Inlet Flow Valve Rail Car Fill Side	
FV-S130B	Ferric Chloride Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S130C	Ferric Chloride Storage Tank Outlet Flow Valve	
Ferric Chloride Bulk Storage Tank 4 TK-S140A		
LT-S140A	Ferric Chloride Tank Level Transmitter	
PT-S140A	Ferric Chloride Tank Pressure Transmitter	
FV-S140A	Ferric Chloride Storage Tank Inlet Flow Valve Rail Car Side	
FV-S140B	Ferric Chloride Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S140C	Ferric Chloride Storage Tank Outlet Flow Valve	

3.20.3 General Operation

Ferric Chloride shall be dosed into the raw water stream, downstream of the raw water pumps and upstream of the DAF tanks to improve coagulation. The chemical shall normally be dosed into both raw water trains and mixing is ensured by injection into the jet flash mixers located in each train. The ferric chloride storage and dosing plant shall be located in the Bulk Chemical building and the chemical shall be pumped to the injection point via two dosing pipelines (one per train). There shall be a spare dosing pipeline installed, changeover to the standby line shall be a manual operation.

The ferric chloride Feed storage and dosing system shall include four ferric chloride bulk storage tanks and a ferric chloride pump skid which shall contain three feed pumps (two duty and a common standby). Tanks TK-S110A, TK-S120A, shall feed though their respective outlet flow valves one stream going to the ferric chloride pump skid common suction line. Tanks TK-S130A and TK-S140A shall feed though their respective outlet flow valves a second stream to the ferric chloride pump skid common line. Only one storage tank outlet valve shall be open during normal operation. Each tank shall have a duty/standby level transmitter/indicators for monitoring purposes, which shall generate status signals and alarms at tank full, high high level, low level and ‘refill’ level. The high level alarm shall also generate an audible and visual warning to warn of overfilling of the tank.

Ferric chloride shall be delivered to the site by either rail car or road tanker, the rail car delivery point shall be located on the north side of the building and the road tanker delivery point shall be located on the south side of the building. The delivery operation shall be controlled by the operator at a local control panel located at each delivery point.

Ferric chloride shall be delivered to the two ferric chloride mixer train dosing points by variable speed, dosing pumps (1 duty per stream plus a common standby). The control of the injection of the ferric chloride solution shall be flow proportional, based upon the totalized raw water flow for that train, as calculated by the summation from each of the four individual DAF tank inlet flow meters in that train. Dosing to either train shall be inhibited until the train is considered “in service”, see Section 3.2 for details. Failure of a duty dosing pump shall automatically cause the appropriate valve on the standby dosing pump delivery line to open and start the standby pump.

If all the dosing pumps become unavailable, the plant shall begin a controlled shutdown.

Flow switches shall be provided on each dosing line at the point of application, and these switches along with flow meters at the pump discharge shall provide pump no flow protection and detect a possible burst pipe (i.e. flow at the pump but not at the point of injection) and shall automatically start the standby pump and raise an alarm.

Level switches shall be provided in the leak containment sumps; these shall be used to monitor pump pressure relief valve operation or spills and pipe leaks.

3.20.4 Automatic Control Philosophy

3.20.4.1 Ferric Chloride Storage Tank Operation

The operation of all four tanks is identical.

Duty/standby Level and pressure transmitters shall be used to monitor the level in each storage tank and display the level on the SCADA/HMI. The operator shall select which transmitter in each tank is the duty instrument, in the event of a failure of the duty instrument the standby shall automatically become duty. One of the transmitters is a pressure transmitter, a calculation shall be made using a operator entered figure to provide level correction for changes in specific gravity.

When the level in any tank reaches the “tank full” level during a filling operation then the tank inlet valve shall be closed and the tank fill valve (SV-S100A) shall be closed .If the level in any tank reaches a ‘high high’ level then an alarm shall be raised at the SCADA/HMI. A high high level alarm shall also generate an audible and visual warning at the respective local Filling Control Panel.

The tanks shall operate so that only one tank is supplying ferric chloride to the pumps at any given time. To ensure that the chemicals are stored and used in a sequential manner a queuing system shall be employed. So initially when the tanks are all filled at the same time tank TK-S110A shall be the duty tank and the other three tanks shall be standby in sequential order. A tank shall be placed in the queue when it is at the “tank full” level and it shall become the duty tank when the tank level in front of it in the queue falls to the “re-fill” level. The status of all the tanks and the queue positions shall be displayed on the SCADA/HMI. The operator shall have the ability to override the queue sequence and select a tank for duty.

If the level in the tank in operation drops to below a ‘Re-Fill’ level, the next available tank level shall be checked and if the level is above the ‘tank full’ level, the level in the tank containment is not ‘High’ and the outlet valve is available, then the corresponding tank outlet valve shall be required to open, if not, the next following tank shall be checked. Once the new operating tank outlet valve is opened, the previous operating tank outlet valve shall be allowed to close.

All tank levels shall also be monitored for rate of emptying, so that if the level in the tank is falling at an excessive rate an alarm shall be raised on the SCADA/HMI.

In addition, if the level in any tank continues to and goes below a ’Low’ level then an alarm shall be raised at SCADA/HMI.

There shall be one emergency shower/eyewash station for operators. A flow switch shall indicate when the emergency shower is operating.

3.20.4.2 Ferric Chloride Tank Local Fill Panel

Each ferric tank can be filled either by Rail Car or by Truck through separate paths. Dedicated local control panels are used when a tank is being filled from a Rail Car of from a Truck. Both local control panels operate in the same way and have the same commands, feedbacks and indications. The panel functions shall all be controlled by the PLC. All fill panel alarm lamp and sounder operation shall be hardwired through relays to provide fail-safe operation.

Each Fill Panel consists of:

- Tank Level Readout
  0-16m^3 Digital Display.
- Beacon/ Sounder alarm
  The Beacon/Sounder alarm shall operate if any the High Level alarm for any Tank is activated
- Tank Alarm Accept (mute) push button
  A button press shall silence the audible alarm and beacon and signal to the PLC that the alarm has been accepted. The appropriate alarm lamp shall continue to operate until the alarm is cleared.
- High Level Alarm Lamp for each Tank
  Lamp shall be lit while the tank high level alarm condition is active.
- Command Open lamp for each Tank inlet valve
  Lamp shall be lit while the command to open certain Tank inlet valve is active.
- Tank Selector push button for each Tank
  The operator shall be able to select through push buttons, which Tank is to be filled. Each Tank shall have its own push button
- Start Fill push button
  The operator shall be able to start filling the selected Tank, by pressing the Start Fill push button.
- System Emergency Stop push button
  A button press shall close all valves and stop the filling of the tanks.

3.20.4.3 Ferric Tank Delivery Valves V22101, V22201

The ferric tank delivery fill valves shall be located on each of the separate paths going to the tanks. Fill Valve SOL-S100A shall be opened to fill from a Rail Car, while fill valve SOL-S105E shall be opened to fill from a truck.

The operator selects via push buttons on the respective local control panel, which tank is to be filled. Once selected, the fill sequence is initiated by pressing the Start Fill push button located also on the local control panel.

The fill sequence shall open the respective fill valve to allow compressed air flow into the Rail Car or Truck. At the same time, the inlet flow valve to the selected tank shall open. Once the tank is full, the respective fill valve and the inlet flow valve to the selected tank shall close.

Any spillage in either of the chemical delivery areas is drained to its respective containment area. The normally closed valve FV-S107A can be opened by the operator through the SCADA/HMI system to drain the containment areas to the north sump.

3.20.4.4 Raw Water Ferric Dosing Pump Operation

There shall be a variable speed duty ferric dosing pump for each stream with a common standby pump serving both streams. Each pump shall also have standby dosing lines available in case of bursts or blockages. The protection systems on the dosing lines shall be described later.

Stream 1 Ferric Chloride Dosing Pump	P-S160A
Stream 2 Ferric Chloride Dosing Pump	P-S180A
Common Standby Pump	P-S170A

The duty pump shall be required to operate if the appropriate stream is in service. If the duty pump becomes unavailable then the standby pump shall be started. The discharge from the pump shall be directed to the correct dosing lines by opening a valve in the discharge line.

Stream 1	FV-S170A
Stream 2	FV-S170B

3.20.4.5 Ferric Dosing Pump Speed Control

The speed of the pump shall be proportional to the flow in the in service stream and shall be calculated by the PLC.

The required pump speed shall be calculated based on a “Zero” speed at “Zero” flow and “Maximum” speed with “Maximum” flow.

The operator shall be able to adjust the speed of the pump manually through the SCADA/HMI system.

3.20.4.6 Pump and Dosing Line Protection

The south containment sump shall receive ferric chloride in the event of any dosing pump pressure relief valve operation. The north containment sump shall receive ferric chloride in the event of any storage tanks overflow. The sumps shall be monitored by level switches wired to local I/O as shown below. If a high level is detected, an alarm shall be raised, the appropriate duty pump shall stop and the standby shall start.

North Sump	LS-S190B
South Sump	LS-S190A

Each pump and its associated dosing line shall also be fitted with one flow meter and one flow switch, the first fitted in the discharge of the pump and the second fitted in the dosing line as near to the point of dose as possible. If flow is detected by the flow meter at the pump discharge, but not by the respective flow switch at the dosing point, the SCADA/HMI system shall interpret it as a no flow protection condition, and shall automatically raise an alarm, and inhibit the respective pump operation.

The pump discharge flow, the dosing line flow switch signal and the containment sump level shall be wired to local I/O. The flow signal inputs shall be overridden on pump start up for a preset time until flow is established. After initial start up, activation of the discharge flow protection devices, operation of the dosing line flow or containment sump level device shall inhibit the pump, and shall cause the standby pump to start if available and an alarm shall be raised on SCADA/HMI.

3.20.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
	Failure of all ferric dosing pumps	Interlock	Shutdown works
	Failure of a stream 1 duty P-S160A pump and standby pump P-S170A	Interlock	Limit raw water flow to works
	Failure of a stream 2 duty P-S180A pump and standby pump P-S170A	Interlock	Limit raw water flow to works
LT-S110A PT-S110A LT-S120A PT-S120A LT-S130A PT-S130A LT-S140A PT-S140A	High Level	Alarm	Alarm on SCADA/HMI and at local fill panel
	Refill Level	Event	Alarm on SCADA/HMI, tank in operation switches to next available tank.
	Low Level	Alarm	Alarm on SCADA/HMI
	Instrument failure	Alarm	Alarm on SCADA If operating as duty transmitter, switch to standby transmitter. If operating as standby transmitter, inhibit transmitter from operating. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks. If both duty and standby instruments fail, and the tank is in operation, then change over to the next available tank. If both duty and standby instruments fail, and the tank is not in operation then inhibit tank from operating.

3.20.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Ferric Chloride Storage Tanks High Level	0-xxx%
Ferric Chloride Storage Tanks Re-fill Level	0-xxx%
Ferric Chloride Storage Tanks Low Level	0-xxx%
Ferric Chloride Dosing Pumps Required Speed	0-100.0 %

SCADA/HMI Operator Adjustable Set Points

Description	Range
T-S110A Ferric Chloride Storage Tank No.1 in Operation	Toggle
T-S120A Ferric Chloride Storage Tank No.2 in Operation	Toggle
T-S130A Ferric Chloride Storage Tank No.3 in Operation	Toggle
T-S130A Ferric Chloride Storage Tank No.4 in Operation	Toggle

SCADA/HMI Status Signals

Description	Range
T-S110A Ferric Chloride Storage Tank No.1 in Operation	
T-S120A Ferric Chloride Storage Tank No.2 in Operation	
T-S130A Ferric Chloride Storage Tank No.3 in Operation	
T-S140A Ferric Chloride Storage Tank No.4 in Operation	
Ferric Chloride Dosing Pumps Actual Speed	

SCADA/HMI Alarm Signals

Description	Range
T-S110A Ferric Chloride Storage Tank No.1 Refill Required	
T-S120A Ferric Chloride Storage Tank No.2 Refill Required	
T-S130A Ferric Chloride Storage Tank No.3 Refill Required	
T-S130A Ferric Chloride Storage Tank No.4 Refill Required	
All Ferric Chloride Dosing Pumps Failed	
Stream 1 Ferric Chloride Dosing Pump and Standby Failed	
Stream 2 Ferric Chloride Dosing Pump and Standby Failed	

3.21 Sludge Polymer Handling and Dosing Plant

3.21.1 Documentation

WC-P0005 P&ID Dry Polymer Bulk Bag Unloading and Conveyance
WC-P0006 P&ID Polymer Preparation System DAF / Filter
WC-P0007 P&ID Polymer Preparation Systems Residuals
WC-P0009 P&ID Polymer Feed Tanks Residuals
WC-P0015 P&ID Polymer Sludge Feed Pumps
WR-P0006 P&ID Washwater Recovery Tanks / Flocculation Chamber

3.21.2 Plant and Instruments

Tag No.	Description	
LS-C005A	Containment Level Switch	
Sludge Polymer Bulk Bag Unloading and Conveyance Unit		
BLW-C030A	Low Pressure Blower	
CFR-C030B	Power Ejector	
CRN-C030C	Polymer Bulk Bag Unloading and Conveyance Unit	
LS-C030A	Hopper Low Level Switch	
LS-C030B	Polymer Transport Line Pressure Switch	
WIT-C030A	Weight Transmitter	
Sludge Polymer Preparation Unit PPU-C021		
FV-C031A	Sludge Polymer Preparation Unit Outlet	
LS-C031A	Sludge Polymer Preparation Unit Level Switch	
PS-C031A	Sludge Polymer Preparation Unit Inlet Valve Pressure Switch	
MXR-C031A	Filter Aid Polymer Preparation Unit Mixer	
SOL-C031B	Heated Plant Service Water System to Filter Aid Polymer Preparation Unit	
Sludge Polymer Feed Tank TNK-C032		
LIT-C032A	Sludge Polymer Feed Tank Level	
LI-C032B	Sludge Polymer Feed Tank – Sight Glass Level	
Sludge Polymer Feed Pump #1 P-C071A (Duty)		
FI-C071B	Plant Service Water System Flow	
FS-C071A	Plant Service Water System Low Flow Switch	
FV-C071A	Plant Service Water System to Pump Discharge Line	
FIT-C071A	Sludge Polymer Feed Pump P-C061A Discharge Flow Meter	
PI-C071A	Sludge Polymer Feed Pump P-C061A Discharge Line Pressure	
PS-C071A	Sludge Polymer Feed Pump P-C061A Pressure Switch	
TS-C071A	Sludge Polymer Feed Pump P-C061A Temperature Switch	
Sludge Polymer Feed Pump #2 P-C072A (Standby)		
FI-C072B	Plant Service Water System Flow	
FS-C072A	Plant Service Water System Low Flow Switch	
FV-C072A	Plant Service Water System to Pump Discharge Line	
FV-C073A	Sludge Polymer to Residuals Standby Valve	
FIT-C072A	Sludge Polymer Feed Pump P-C062A Discharge Flow Meter	

Tag No.	Description	
PI-C072A	Sludge Polymer Feed Pump P-C062A Discharge Line Pressure	
PS-C072A	Sludge Polymer Feed Pump P-C062A Pressure Switch	
TS-C072A	Sludge Polymer Feed Pump P-C062A Temperature Switch	
Standby Emulsion Polymer System		
HV-C001K	Standby Emulsion Polymer Preparation Unit Inlet Valve	
HV-C001J	Standby Emulsion Polymer Preparation Unit Outlet Valve	
FIT-C001B	Standby Emulsion Polymer Preparation Unit Discharge Flow	
P-C001A	Standby Emulsion Polymer Preparation Unit Pump	
PPU-C001	Standby Emulsion Polymer Preparation Unit	
WIT-C001A	Standby Emulsion Polymer Weight	

3.21.3 Automatic Control Philosophy

3.21.3.1 Control Room and Local Operation

Control of the Polymer System can be from either the Control Room or local using the HMI on the local control panel. Transfer of control is done at the HMI page in the Control Room.

3.21.3.2 Sludge Polymer Bulk Bag and Conveyance Unit Operation

There shall be a power feeder that is equipped with a double screw type 182 Poly with a worm-geared motor. The feeder shall have an outlet gate, which effectively stops moisture from reaching the polymer powder. Depending on the polymer concentration that is needed, the polymer concentration shall be controlled by the feeder running time. The feeder run time can be adjusted by the operator.

In the event where the unit fails, generate alarm and stop the unit. The standby emulsion system shall be started manually by the operator.

3.21.3.3 Sludge Polymer Bulk Bag and Conveyance Unit Level

There shall be a powder level switch located in the powder hopper. It shall give signals to start the arch breaking system. In the event where no powder is detected for a pre-set time, an alarm shall be raised to SCADA. The current preparation shall be finished but the next batch shall not begin until the powder hopper has been filled and the alarm has been reset.

3.21.3.4 Sludge Polymer Bulk Bag and Conveyance Unit Pressure Switch

There shall be a pressure switch to ensure the polymer transport line is not clogged. In the event of high pressure, an alarm shall be generated to SCADA.

3.21.3.5 Sludge Polymer Bulk Bag and Conveyance Unit Blower

There shall be a low pressure type blower which shall transfer the polymer to the AeroMix wetting system in conjunction with the powder ejector.

3.21.3.6 Sludge Polymer Bulk Bag and Conveyance Unit Weight Transmitter

There shall be a weight sensor fitted to the unit underneath the polymer tote. The weight sensor shall allow the SCADA system to measure remaining polymer in the tote.

3.21.3.7 Sludge Polymer AeroMix Wetting System

There shall be an AeroMix wetting system at the inlet of the preparation tank. Heated plant service water shall enter the top of the AeroMix system with high effective water nozzles to increase speed/shear before meeting the polymer. After water suction has formed into the AeroMix, the electromagnet opens and the feeding starts. After the first contact between polymer and water, the mixing shall begin inside the preparation tank.

3.21.3.8 Heated Plant Service Water System to Sludge Polymer Tank Temperature

In the event where the water temperature drops below 10°C, an alarm shall be raised to SCADA.

3.21.3.9 Sludge Polymer Preparation Tank Operation

There shall be a preparation tank with a slow rotating agitator with motor, which shall gently agitate the polymer solution. There shall be a level switch installed inside the tank.

The concentration required is achieved by adding the correct amount of polymer for each batch. This shall be controlled by the PLC and the concentration shall be entered by the operator.

When the sludge polymer preparation system is enabled by the operator, the system process shall be initiated. This automatic batch mode shall start and stop the polymer preparation by the tank level start set points, stop set points and mixture maturing time. Once the batch has exceeded the “maturing time”, the batch shall be automatically transferred to the feed tank provided that there is enough room in the feed tank. The tank outlet valve shall also open automatically. The mixture maturing time shall be adjustable by the operator.

In the event where the tank operation fails, generate alarm and stop the operation. The standby emulsion system shall be started manually by the operator.

3.21.3.10 Sludge Polymer Preparation Tank Mixer

The mixer in the tank shall begin with water at the beginning of a new sequence/batch. Once the operator predetermined time has been met, the mixer shall be stopped. The “mixing time” shall always be equal or higher than the “maturing time”. In the event where the “mixing time” has not been completed, the “maturing time” is complete, and there is room in the dosing tank, the mixer shall be stopped in order for the batch to be transferred.

3.21.3.11 Sludge Polymer Preparation Tank Level Switch

Level switch LS-C031A shall be a conductivity level switch with two probes set at low and high levels. The functions associated with each level are described below.

Low level: if the liquid level in the tank is low, a signal shall be sent to SCADA to start the polymer preparation and open the tank inlet valve SOL-C031B. The preparation tank outlet valve shall be closed.

High level: if the liquid level is reaches the high level, the preparation tank inlet valve shall be closed.

3.21.3.12 Sludge Polymer Preparation Tank Inlet Valve Pressure Switch

There shall be a pressure switch which shall stop the preparation tank if the inlet water pressure is too low. As soon as the water pressure rises, the preparation cycle shall continue on automatically.

3.21.3.13 Sludge Polymer Feed Tank

There shall be a feed tank with a level transmitter. The polymer solution from the preparation tank shall be automatically transferred to the feed tank when there is enough room in the feed tank to accept a complete batch. However, even if there is enough room in the feed tank, the polymer solution batch cannot be transferred over if the maturing time is not complete.

3.21.3.14 Sludge Polymer Feed Tank Level

There shall be an ultrasonic level detector in the sludge feed tank. Once the tank level reaches the refill level set point, the polymer solution from the preparation tank shall be automatically transferred to the feed tank once the polymer solution has matured. In the event where the tank level reaches the low level set point, the system shall stop all the dosing pumps. In the event where the tank level reaches the high level set point, the system shall close the preparation tank outlet valve.

There shall also be a sight glass connected to the tank. The current tank levels shall also be shown through the sight glass.

3.21.3.15 Sludge Polymer Feed Pumps Operation

There shall be duty and standby variable speed metering pumps dosing sludge polymer solution to the sludge mixing chambers. Both metering pumps shall have VFDs to control the solution pumping rate to mixing chambers. The polymer dosing rate shall be flow paced according to the sludge flow meter FIT-R001B.

The dosing rate shall be controlled by the PLC and preset by the operator.

If the operating duty pump becomes unavailable then the standby pump shall be started, and the corresponding standby pump outlet valve shall be automatically opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA system if required.

During normal operation the duty and standby pumps shall perform the duty/standby pump rotation according to the operator manually adjustable ‘duty cycle’ time periods. The PLC shall monitor the actual hours run for the respective duty pump and when this exceeds the allocated ‘duty cycle’ time period automatic duty rotation shall occur.

If both pumps fail, alarm shall be generated to SCADA.

Each pump shall have a temperature switch and a pressure switch which detects if there is polymer solution blockage within the pump. Flow blockage can also be detected if the pump is rotating and no flow is detected by the flow meter at the discharge line. In the event of a detected blockage, the pump shall be shutdown and the standby pump shall start. An alarm shall be generated to SCADA.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages. Flow valve FV-C073A shall be able to be controlled locally and remotely for system flexibility.

3.21.3.16 Sludge Polymer Solution to Sludge Mixing Chamber Flow Meters

The PLC shall monitor the outlet flow from the metering pumps to the sludge mixing chambers and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to verify the dosing rate of sludge polymer solution.

3.21.3.17 Plant Service Water System to Sludge Feed Pump Discharge Line

When the duty dosing pumps start, the corresponding plant service water system to pump discharge line solenoid valve FV-C07*A shall be opened. In the event where low flow is detected, the system shall stop the current duty dosing pump and start the standby dosing pump. An alarm shall also be generated to SCADA.

3.21.3.18 Standby Emulsion System

There shall be standby emulsion system for use in the event where either the filter aid polymer bulk bag unloading and conveyance unit, filter aid polymer preparation unit, sludge polymer bulk bag unloading and conveyance unit, sludge polymer preparation unit and/or any of the combination above. The system shall be initiated by the operator and once the hand valve HV-C001K has been opened. The mixing shall start once the pump is started and the heated plant service water has entered the preparation unit PPU-C001.

There is a flow meter at the standby emulsion polymer preparation unit discharge line. The PLC shall monitor the outlet flow to either the filter aid polymer feed tank or to the sludge polymer feed tank and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to verify the dosing rate of filter aid polymer solution or the sludge polymer solution.

The hand valve HV-C001E shall be manually opened if polymer solution is to the filter polymer feed tank. The hand valve HV-C001F shall be manually opened if the polymer solution is to the sludge polymer feed tank.

3.21.4 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag No.	Event	Type	Control System Action
BLW-C030A	Blower fault	Alarm & Interlock	Shutdown system and generate alarm.
LS-C030A	Low powder level	Alarm	Raise an alarm to SCADA.
PS-C030A	High pressure	Alarm	Raise an alarm to SCADA.
TS-C030A	Low water temperature	Alarm	Raise an alarm to SCADA.
LS-C031A	Low solution level in preparation tank	Alarm & Interlock	Raise an alarm to SCADA and open valve SOL-C021B.
	High solution level in preparation tank	Alarm & Interlock	Raise an alarm to SCADA and close valve FV-C021A.
PS-C031A	Preparation tank inlet valve pressure low	Alarm & Interlock	Raise alarm to SCADA and stop preparation tank until pressure has risen.
LIT-C032A	Low solution level in feed tank	Interlock	Restart polymer solution production, stop all dosing pumps, and open preparation tank outlet valve.
	High solution level in feed tank	Interlock	Close preparation tank outlet valve.
FIT-C07*A	Sludge polymer progressive cavity pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
PS-C07*A	Sludge polymer progressive cavity pump pressure high	Alarm & Interlock	Stop pump and take pump out of service. Generate alarm on SCADA.
TS-C07*A	Sludge polymer progressive cavity pump temperature high	Alarm & Interlock	Stop pump and take pump out of service. Generate alarm on SCADA.
FS-C07*A	Low flow	Alarm & Interlock	Raise an alarm to SCADA, stop duty dosing pump and start standby dosing pump.
P-C07*A	Duty and standby pumps fail	Alarm	Generate alarm on SCADA.

3.21.5

3.21.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Sludge Polymer Bulk Bag Unloading and Conveyance Unit Level	
Sludge Polymer Preparation Tank Level	
Sludge Polymer Feed Tank Level	
Water Temperature	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Sludge Polymer Dosing Rate	
Sludge Polymer Solution Mixing Time	
Sludge Polymer Solution Maturing Time	

SCADA/HMI Status Signals

Description	Range
Sludge Polymer Bulk Unloading and Conveyance Unit in Service	
Sludge Polymer Bulk Unloading and Conveyance Unit Blower in Service	
Sludge Polymer Preparation Tank in Service	
Sludge Polymer Feed Tank in Service	
Sludge Polymer Feed Pump P-C071A in Service	
Sludge Polymer Feed Pump P-C072A in Service	
Standby Emulsion Polymer Preparation Unit PPU-C001 in Service	

SCADA/HMI Alarm Signals

None

3.22 Filter Aid Polymer Handling and Dosing Plant

3.22.1 Documentation

WC-P0005 P&ID Dry Polymer Bulk Bag Unloading and Conveyance

WC-P0006 P&ID Polymer Preparation System DAF / Filter

WC-P0008 P&ID Polymer Feed Tanks DAF / Filters

WC-P0014 P&ID Polymer Filter Feed Pumps

WO-P0010 P&ID Ozone Contractor No. 1

WO-P0011 P&ID Ozone Contractor No. 2

3.22.2 Plant and Instruments

Tag	Description	
Filter Aid Polymer Bulk Bag Unloading and Conveyance Unit		
BLW-C020A	Low Pressure Blower	
CFR-C020B	Power Ejector	
CRN-C020C	Polymer Bulk Bag Unloading and Conveyance Unit	
LS-C020A	Hopper Low Level Switch	
LS-C020B	Polymer Transport Line Pressure Switch	
WIT-C020A	Weight Transmitter	
Filter Aid Polymer Preparation Unit PPU-C021		
FV-C021A	Filter Aid Polymer Preparation Unit Outlet	
LS-C021A	Filter Aid Polymer Preparation Unit Level Switch	
PS-C021A	Filter Aid Polymer Preparation Unit Inlet Valve Pressure Switch	
MXR-C021A	Filter Aid Polymer Preparation Unit Mixer	
SOL-C021B	Heated Plant Service Water System to Filter Aid Polymer Preparation Unit	
TS-C020A	Heated Plant Service Water System Water Temperature Low	
Filter Aid Polymer Feed Tank TNK-C022		
LIT-C022A	Filter Aid Polymer Feed Tank Level	
LI-C022B	Filter Aid Polymer Feed Tank – Sight Glass Level	
Filter Aid Feed Pump #1 P-C061A (Duty)		
FI-C061B	Plant Service Water System Flow	
FS-C061A	Plant Service Water System Low Flow Switch	
FV-C061A	Plant Service Water System to Pump Discharge Line	
FIT-C061A	Filter Aid Polymer Feed Pump P-C061A Discharge Flow Meter	

Tag	Description	
PI-C061A	Filter Aid Polymer Feed Pump P-C061A Discharge Line Pressure	
PS-C061A	Filter Aid Polymer Feed Pump P-C061A Pressure Switch	
TS-C061A	Filter Aid Polymer Feed Pump P-C061A Temperature Switch	
Filter Aid Feed Pump #2 P-C062A (Duty)		
FI-C062B	Plant Service Water System Flow	
FS-C062A	Plant Service Water System Low Flow Switch	
FV-C062A	Plant Service Water System to Pump Discharge Line	
FIT-C062A	Filter Aid Polymer Feed Pump P-C062A Discharge Flow Meter	
PI-C062A	Filter Aid Polymer Feed Pump P-C062A Discharge Line Pressure	
PS-C062A	Filter Aid Polymer Feed Pump P-C062A Pressure Switch	
TS-C062A	Filter Aid Polymer Feed Pump P-C062A Temperature Switch	
Filter Aid Feed Pump #3 P-C063A (Standby)		
FI-C063B	Plant Service Water System Flow	
FS-C063A	Plant Service Water System Low Flow Switch	
FV-C063A	Plant Service Water System to Pump Discharge Line	
FIT-C063A	Filter Aid Polymer Feed Pump P-C063A Discharge Flow Meter	
PI-C063A	Filter Aid Polymer Feed Pump P-C063A Discharge Line Pressure	
PS-C063A	Filter Aid Polymer Feed Pump P-C063A Pressure Switch	
TS-C063A	Filter Aid Polymer Feed Pump P-C063A Temperature Switch	
FV-C064B	Filter Aid Polymer Feed Pump P-C063A Discharge to Filter Aid Mixing Chamber	
FV-C065B	Filter Aid Polymer Feed Pump P-C063A Discharge to Filter Aid Mixing Chamber	

3.22.3 Automatic Control Philosophy

3.22.3.1 Control Room and Local Operation

Control of the Polymer System can be from either the Control Room or local using the HMI on the local control panel. Transfer of control is done at the HMI page in the Control Room.

3.22.3.2 Filter Aid Polymer Bulk Bag and Conveyance Unit Operation

There shall be a power feeder that is equipped with a double screw type 182 Poly with a worm-geared motor. The feeder shall have an outlet gate, which effectively stops moisture from reaching the polymer powder. Depending on the polymer concentration that is needed, the polymer concentration shall be controlled by the feeder running time. The feeder run time can be adjusted by the operator.

In the event where the unit fails, generate alarm and stop the unit. The standby emulsion system shall be started manually by the operator.

3.22.3.3 Filter Aid Polymer Bulk Bag and Conveyance Unit Level

There shall be a powder level switch located in the powder hopper. It shall give signals to start the arch breaking system. In the event where no powder is detected for a pre-set time, an alarm shall be raised to SCADA. The current preparation shall be finished but the next batch shall not begin until the powder hopper has been filled and the alarm has been reset.

3.22.3.4 Filter Aid Polymer Bulk Bag and Conveyance Unit Pressure Switch

There shall be a pressure switch to ensure the polymer transport line is not clogged. In the event of high pressure, an alarm shall be generated to SCADA.

3.22.3.5 Filter Aid Polymer Bulk Bag and Conveyance Unit Blower

There shall be a low pressure type blower which shall transfer the polymer to the AeroMix wetting system in conjunction with the powder ejector.

3.22.3.6 Filter Aid Polymer Bulk Bag and Conveyance Unit Weight Transmitter

There shall be a weight sensor fitted to the unit underneath the polymer tote. The weight sensor shall allow the SCADA system to measure remaining polymer in the tote.

3.22.3.7 Filter Aid Polymer AeroMix Wetting System

There shall be an AeroMix wetting system at the inlet of the preparation tank. Heated plant service water shall enter the top of the AeroMix system with high effective water nozzles to increase speed/shear before meeting the polymer. After water suction has formed into the AeroMix, the electromagnet opens and the feeding starts. After the first contact between polymer and water, the mixing shall begin inside the preparation tank.

3.22.3.8 Heated Plant Service Water System to Filter Aid Polymer Tank Temperature

In the event where the water temperature drops below 10°C, an alarm shall be raised to SCADA.

3.22.3.9 Filter Aid Polymer Preparation Tank Operation

There shall be a preparation tank with a slow rotating agitator with motor, which shall gently agitate the polymer solution. There shall be a level switch installed inside the tank.

The concentration required is achieved by adding the correct amount of polymer for each batch. This shall be controlled by the PLC and the concentration shall be entered by the operator.

When the filter aid polymer preparation system is enabled by the operator, the system process shall be initiated. This automatic batch mode shall start and stop the polymer preparation by the tank level start set points, stop set points and mixture maturing time. Once the batch has exceeded the "maturing time", the batch shall be automatically transferred to the feed tank provided that there is enough room in the feed tank. The mixture maturing time shall be adjustable by the operator.

In the event where the tank operation fails, generate alarm and stop the operation. The standby emulsion system shall be started manually by the operator.

3.22.3.10 Filter Aid Polymer Preparation Tank Mixer

The mixer in the tank shall begin with water at the beginning of a new sequence/batch. Once the operator predetermined time has been met, the mixer shall be stopped. The "mixing time" shall always be equal or higher than the "maturing time". In the event where the "mixing time" has not been completed, the "maturing time" is complete, and there is room in the dosing tank, the mixer shall be stopped in order for the batch to be transferred.

3.22.3.11 Filter Aid Polymer Preparation Tank Level Switch

Level switch LS-C021A shall be a conductivity level switch with two probes set at low and high levels. The functions associated with each level are described below.

Low level: if the liquid level in the tank is low, a signal shall be sent to SCADA to start the polymer preparation and open the tank inlet valve SOL-C021B. The preparation tank outlet valve shall be closed.

High level: if the liquid level is reaches the high level, the preparation tank inlet valve shall be closed.

3.22.3.12 Filter Aid Polymer Preparation Tank Inlet Valve Pressure Switch

There shall be a pressure switch which shall stop the preparation tank if the inlet water pressure is too low. As soon as the water pressure rises, the preparation cycle shall continue on automatically.

3.22.3.13 Filter Aid Polymer Feed Tank

There shall be a feed tank with a level transmitter. The polymer solution from the preparation tank shall be automatically transferred to the feed tank when there is enough room in the feed tank to accept a complete batch. However, even if there is enough room in the feed tank, the polymer solution batch can not be transferred over if the maturing time is not complete.

3.22.3.14 Filter Aid Polymer Feed Tank Level

There shall be an ultrasonic level detector in the sludge feed tank. Once the tank level reaches the refill level set point, the polymer solution from the preparation tank shall be automatically transferred to the feed tank once the polymer solution has matured. In the event where the tank level reaches the low level set point, the system shall stop all the dosing pumps. In the event where the tank level reaches the high level set point, the system shall close the preparation tank outlet valve.

There shall also be a sight glass connected to the tank. The current tank levels shall also be shown through the sight glass.

3.22.3.15 Filter Aid Polymer Feed Pumps Operation

There shall be two duty pumps with a common standby variable speed metering pumps dosing filter aid polymer solution to the filter aid mixing chambers. All three metering pumps shall have VFDs to control the solution pumping rate to mixing chambers.

Chemical dose is automatically calculated and controlled via control logic within the PLC. The dose delivered mixing chamber TK-C701A and TK-C702A of ozone contactor no. 1 (TNK-O210A) and no. 2 (TNK-O230A) is flow paced and adjustable by the operator.

Flow pacing shall be achieved through the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters.

Filter aid polymer feed pump P-C061A shall be flow paced by the Qtotal of DAF units 1 to 4:

Qtotal = FE-P100A + FE-P200A + FE-P300A + FE-P400A

Filter aid polymer feed pump P-C062A shall be flow paced by the Qtotal of DAF units 5 to 8:

Qtotal = FE-P500A + FE-P600A + FE-P700A + FE-P800A

If the operating duty pump becomes unavailable then the standby pump shall be started, the duty pump outlet valve shall be manually closed, and the corresponding standby pump outlet valve shall be automatically opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA system if required.

During normal operation the duty and standby pumps shall perform the duty/standby pump rotation according to the operator manually adjustable ‘duty cycle’ time periods. The PLC shall monitor the actual hours run for the respective duty pump and when this exceeds the allocated ‘duty cycle’ time period automatic duty rotation shall occur.

If all pumps fail, alarm shall be generated to SCADA.

Each pump shall have a temperature switch and a pressure switch which detects if there is polymer solution blockage within the pump. Flow blockage can also be detected if the pump is rotating and no flow is detected by the flow meter at the discharge line. In the event of a detected blockage, the pump shall be shutdown and the standby pump shall start. An alarm shall be generated to SCADA.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages.

3.22.3.16 Filter Aid Polymer Solution to Filter Aid Mixing Chamber Flow Meters

The PLC shall monitor the outlet flow from the metering pumps to the filter aid mixing chambers and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to verify the dosing rate of filter aid polymer solution.

3.22.3.17 Plant Service Water System to Filter Aid Polymer Feed Pump Discharge Line

When the duty dosing pumps start, the corresponding plant service water system to pump discharge line solenoid valve FV-C06*A shall be opened. In the event where low flow is detected, the system shall stop the current duty dosing pump and start the standby dosing pump. An alarm shall also be generated to SCADA.

3.22.4 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
BLW-C020A	Blower fault	Alarm & Interlock	Shutdown system and generate alarm.
LS-C020A	Low powder level	Alarm	Raise an alarm to SCADA.
PS-C020A	High pressure	Alarm	Raise an alarm to SCADA.
TS-C020A	Low water temperature	Alarm	Raise an alarm to SCADA.
LS-C021A	Low solution level in preparation tank	Alarm & Interlock	Raise an alarm to SCADA and open valve SOL-C021B.
	High solution level in preparation tank	Alarm & Interlock	Raise an alarm to SCADA and close valve FV-C021A.
PS-C021A	Preparation tank inlet valve pressure low	Alarm & Interlock	Raise alarm to SCADA and stop preparation tank until pressure has risen.
LIT-C022A	Low solution level in feed tank	Interlock	Restart polymer solution production, stop all dosing pumps, and open preparation tank outlet valve.
	High solution level in feed tank	Interlock	Close preparation tank outlet valve.
FIT-C06*A	Filter aid polymer progressive cavity pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
PS-C06*A	Filter aid polymer progressive cavity pump pressure high	Alarm & Interlock	Stop pump and take pump out of service. Generate alarm on SCADA.
TS-C06*A	Filter aid polymer progressive cavity pump temperature high	Alarm & Interlock	Stop pump and take pump out of service. Generate alarm on SCADA.
FS-C06*A	Low flow	Alarm & Interlock	Raise an alarm to SCADA, stop duty dosing pump and start standby dosing pump.
P-C06*A	Both duty and standby pumps fail	Alarm	Generate alarm to SCADA.

3.22.5 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Filter Aid Polymer Bulk Bag Unloading and Conveyance Unit Level	
Filter Aid Polymer Preparation Tank Level	
Filter Aid Polymer Feed Tank Level	
Water Temperature	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Filter Aid Polymer Dosing Rate	
Filter Aid Polymer Solution Mixing Time	
Filter Aid Polymer Solution Maturing Time	

SCADA/HMI Status Signals

Description	Range
Filter Aid Polymer Bulk Unloading and Conveyance Unit in Service	
Filter Aid Polymer Bulk Unloading and Conveyance Unit Blower in Service	
Filter Aid Polymer Preparation Tank in Service	
Filter Aid Polymer Feed Tank in Service	
Filter Aid Polymer Feed Pump P-C061A in Service	
Filter Aid Polymer Feed Pump P-C062A in Service	
Filter Aid Polymer Feed Pump P-C063A in Service	

SCADA/HMI Alarm Signals

None

3.23 Hypochlorite Generation and Storage Plant

3.23.1 Documentation

CPG0465-I-01 Sheet 4 of 7 P&ID On-Site Sodium Hypochlorite Generation System
CPG0465-I-01 Sheet 5 of 7 P&ID On-Site Sodium Hypochlorite Generation System
CPG0465-I-01 Sheet 6 of 7 P&ID On-Site Sodium Hypochlorite Generation System
CPG0465-I-01 Sheet 7 of 7 P&ID On-Site Sodium Hypochlorite Generation System

3.23.2 Plant and Instruments

Tag	Description	
AT-J001B	Hardness Monitor	
FT-J001A	Softened Water Flow	
TIT-J003A	Softened Water Temperature	
LS-J550A	Sodium Hypochlorite Containment Sump High Level	
LS-J550A	Sodium Hypochlorite Containment Sump High Level	
AI-J450A	Hydrogen Gas Level Detector in Storage Room	
AI-J450B	Hydrogen Gas Level Detector in Storage Room	
AI-J550A	Hydrogen Gas Level Detector in Generation Room	
AI-J550B	Hydrogen Gas Level Detector in Generation Room	
Brine Tank TNK-J100A		
FV-J100A	Brine Tank Inlet Valve	
LIT-J100A	Brine Tank Brine Level	
LIT-J100B	Brine Tank Salt Level	
TT-J100A	Brine Tank Temperature	
Brine Tank TNK-J200A		
FV-J200A	Brine Tank Inlet Valve	
LIT-J200A	Brine Tank Brine Level	
LIT-J200B	Brine Tank Salt Level	
TT-J200A	Brine Tank Temperature	
Hydrogen Dilution and Venting System		
FS-J450A	Standpipe Blower Flow Low	
PS-J450A	Standpipe Blower Pressure High	
BLW-J450A	Standpipe Blower Hydrogen Dilution Blower	
BLW-J450B	Standpipe Blower Hydrogen Dilution Blower	
Sodium Hypochlorite Generator EL-J400		
FS-J400C	Pressure Relief Valve Flow Switch	
FT-J400A	Generator Cell Flow	
FT-J400B	Generator Cell Flow	
LS-J400A	Electrolyser Low Cell Level	
LS-J400B	Electrolyser Low Cell Level	
PI-J400A	Brine Softened Water Pressure to Electrolyser	
PS-J400A	Electrolyser Cell Pressure	
PS-J400B	Electrolyser Cell Pressure High	
RT-J400A	Electrolyser Rectifier	

Tag	Description	
SOL-J400A	Softened Water Solenoid Valve	
TS-J400A	Electrolyser Rectifier High Temperature	
TS-J400B	Electrolyser Cell EL-J400B Temperature	
TS-J400C	Electrolyser Cell EL-J400A Temperature	
Sodium Hypochlorite Generator EL-J420		
FS-J420C	Low Brine Flow to Electrolyser	
FT-J420A	Generator Cell Flow	
FT-J420B	Generator Cell Flow	
LS-J420A	Electrolyser High Cell Level	
LS-J420B	Electrolyser Low Cell Level	
PI-J420A	Brine Softened Water Pressure to Electrolyser	
PS-J420A	Electrolyser Cell Pressure	
PS-J420B	Electrolyser Cell Pressure High	
RT-J420A	Electrolyser Rectifier	
SOL-J420A	Water Softener Solenoid Valve	
TS-J420A	Electrolyser Rectifier High Temperature	
TS-J420B	Electrolyser Cell EL-J420B Temperature	
TS-J420C	Electrolyser Cell EL-J420A Temperature	
Sodium Hypochlorite Generator EL-J440		
FS-J440C	Low Brine Flow to Electrolyser	
FT-J440A	Generator Cell Flow	
FT-J440B	Generator Cell Flow	
LS-J440A	Electrolyser High Cell Level	
LS-J440B	Electrolyser Low Cell Level	
PI-J440A	Brine Softened Water Pressure to Electrolyser	
PS-J440A	Electrolyser Cell Pressure	
PS-J440B	Electrolyser Cell Pressure High	
RT-J440A	Electrolyser Rectifier	
SOL-J440A	Water Softener Solenoid Valve	
TS-J440A	Electrolyser Rectifier High Temperature	
TS-J440B	Electrolyser Cell EL-J440B Temperature	
TS-J440C	Electrolyser Cell EL-J440A Temperature	
Sodium Hypochlorite Storage Tank TNK-J500A		
FV-J500A	Sodium Hypochlorite Storage Tank Inlet Valve	
FV-J500B	Sodium Hypochlorite Storage Tank Outlet Valve	
FS-J500A	Sodium Hypochlorite Storage Tank Ventilation Flow Low	

Tag	Description	
LIT-J500A	Sodium Hypochlorite Storage Tank Level	
PS-J500A	Sodium Hypochlorite Storage Tank Ventilation Pressure High	
BLW-J500A	Hydrogen Dilution Blower	
BLW-J500B	Hydrogen Dilution Blower	
Sodium Hypochlorite Storage Tank TNK-J520A		
FV-J520A	Sodium Hypochlorite Storage Tank Inlet Valve	
FV-J520B	Sodium Hypochlorite Storage Tank Outlet Valve	
FS-J520A	Sodium Hypochlorite Storage Tank Ventilation Flow Low	
LIT-J520A	Sodium Hypochlorite Storage Tank Level	
PS-J520A	Sodium Hypochlorite Storage Tank Ventilation Pressure High	
BLW-J520A	Hydrogen Dilution Blower	
BLW-J520B	Hydrogen Dilution Blower	
Sodium Hypochlorite Storage Tank TNK-J540A		
FV-J540A	Sodium Hypochlorite Storage Tank Inlet Valve	
FV-J540B	Sodium Hypochlorite Storage Tank Outlet Valve	
FS-J540A	Sodium Hypochlorite Storage Tank Ventilation Flow Low	
LIT-J540A	Sodium Hypochlorite Storage Tank Level	
PS-J540A	Sodium Hypochlorite Storage Tank Ventilation Pressure High	
BLW-J540A	Hydrogen Dilution Blower	
BLW-J540B	Hydrogen Dilution Blower	
Sodium Hypochlorite Storage Tank TNK-J560A		
FV-J560A	Sodium Hypochlorite Storage Tank Inlet Valve	
FV-J560B	Sodium Hypochlorite Storage Tank Outlet Valve	
FS-J560A	Sodium Hypochlorite Storage Tank Ventilation Flow Low	
LIT-J560A	Sodium Hypochlorite Storage Tank Level	
PS-J560A	Sodium Hypochlorite Storage Tank Ventilation Pressure High	
BLW-J560A	Hydrogen Dilution Blower	
BLW-J560B	Hydrogen Dilution Blower	

3.23.3 General Operation

The on-site hypochlorite generation system operates by feeding softened water into the brine tanks to maintain a 30% salt (NaCl) solution. Brine solution travels to the electrolytic cells, as it enters the cells, additional softened water shall be mixed to the brine solution to further reduce the brine concentration to 3%. The diluted brine solution is then sent through electrolytic cells where a low voltage DC current is applied to produce the 0.8% sodium hypochlorite solution. The resultant hypochlorite solution shall then flow into the hypochlorite storage tanks.

Sodium hypochlorite solution is held in storage for 24 to 48 hours as a backup to the generation process to allow for maintenance and repair before being dosed using metering pumps.

A PLC shall monitor each aspect of the system operation, report on operating parameters, system status and alarm conditions. There shall also be local control panels to control the inlet and outlet valves of the sodium hypochlorite tanks. All local control panels shall operate in the way and shall be controlled by the PLC.

There shall be ultrasonic level detectors in each of the sodium hypochlorite tanks. Once any hypochlorite tank level reaches the low level set point, the system shall automatically restart the sodium hypochlorite production again.

During the generation of sodium hypochlorite, hydrogen (H_2) is formed as a by-product. Hydrogen is a colorless, odourless, non-toxic gas. Hydrogen is flammable and may form mixtures with air that are flammable or explosive. It should be noted that the concentrations at which flammable or explosive mixtures form are much lower than the concentration at which asphyxiation risk is significant. There shall be two hydrogen detectors located in each of the sodium hypochlorite generation and storage rooms.

The ClorTec electrolytic cells and the hypochlorite storage tanks are designed to safely contain and vent hydrogen from the cell directly into the atmosphere. The dilution and dispersal process is managed by the system's proprietary hydrogen dilution system, which incorporates a blower that provides ventilation of both the sodium hypochlorite storage tank and the cell assembly vent stack.

3.23.4 Automatic Control Philosophy

3.23.4.1 Hardness Monitor

The hardness monitor shall continuously monitor the sample softened water inlet flow to the brine tanks. Equipment readings shall be an input into the SCADA and, an alarm shall be raised when the total hardness exceeds the set point after two “hard” readings. When the capacity of the water softener is exhausted, regeneration shall automatically start. The alarm is automatically cancelled after one “soft” reading from the hardness monitor.

3.23.4.2 Brine Tanks

There shall be two brine tanks in the system to produce brine solution by dissolving salt with softened water.

The control system shall monitor the brine level in both tanks. Once the brine level reaches the start level set point the corresponding inlet valve shall open and begin filling the tank. Once the brine level reaches the stop level set point the inlet valve shall close and remain closed until the level drops to the start level and then the cycle repeats.

3.23.4.3 Brine Tanks Brine Level Transmitters

Brine solution level in the brine tanks shall be measured by the ultrasonic sensors. At low level, an alarm shall be generated and stop the running generator. The generator shall restart once additional softened water has filled the tanks. At high level, an alarm shall be generated; the tank inlet valves shall be closed but the operation of the generator shall not be affected.

3.23.4.4 Brine Tanks Salt Level Transmitters

Salt level in the brine tanks shall be measured by a salt level sensor. When the salt level drops to the reorder set point, a road tank shall be connected to the salt fill line and fill the tank with salt. When the salt level in the tank drops to low level, alarm is sent to SCADA and the inlet valve shall be closed for the salt refill.

3.23.4.5 Brine Tanks Temperature Transmitters

The intent of this temperature switch is to shutdown the system process if the solution ever reaches temperatures above 55ºC. The temperature switch is also used as an alarm allowing the system to proceed through for stage 1 if the switch remains normally closed.

3.23.4.6 Electrolyser Rectifiers

The rectifiers shall provide DC current to the electrolysers to produce the 0.8% sodium hypochlorite solution. The rectifier is enabled at the beginning of stage 4. Once the rectifier is enabled, the current is monitored and slowly increased to achieve the desired current set point. There are five interlocks associated with the rectifier which allows the system to proceed to running status.

1. Rectifier is monitored for a high voltage interlock.
2. Rectifier is monitored for a low voltage interlock.
3. Rectifier is monitored for a a high current interlock.
4. Rectifier is monitored for a produce a low current interlock.
5. The final interlock associated with the rectifier is a rectifier fault. This fault is a combination of safety devices connected in series in the rectifier.

If the rectifier does not reach proper current or voltage, nor has a rectifier fault in the given time, the unit shall not proceed to running status and shall fault on a stage 4 fault.

3.23.4.7 Sodium Hypochlorite Generators

The diluted brine solution is sent through electrolytic cells which apply a low voltage DC current to produce 0.8% solution of sodium hypochlorite. There are five stages to this process: stages 1 – 4 and running.

- **Stage 1:** Once stage 1 is requested, the system shall turn on the blowers to the tanks that are in service and the standpipe blower. The system shall monitor the following alarms specific to each generator:

TS-J400B	Cell High Temperature
TS-J400C	Cell High Temperature
ZS-J400B	Product Ball valve Limit Switch
ZS-J400A	Hydrogen Vent Ball Valve Limit Switch
PS-J400B	Rupture Disk
PS-J400A	Cell Inlet Pressure Switch

FS-J400C Pressure Relief Valve Flow Switch
AI-J450A Hydrogen Detector
AI-J550A Hydrogen Detector

If any of the alarms listed above occur during stage 1 or any later stages, the generator shall shutdown and attempts a restart with the exception of hydrogen detector alarms. The following blower interlocks must be met before the generator can proceed to stage 2. They are:

Closed FS-J450A Standpipe STP-J450A Air Flow Switch
Closed PS-J450A Standpipe STP-J450A Pressure Differential Switch
Closed FS-J500A Sodium Hypochlorite Storage Tank TNK-J500A Air Flow Switch
Closed PS-J500A Sodium Hypochlorite Storage Tank TNK-J500A Pressure Differential Switch
Closed FS-J520A Sodium Hypochlorite Storage Tank TNK-J520A Air Flow Switch
Closed PS-J520A Sodium Hypochlorite Storage Tank TNK-J520A Pressure Differential Switch
Closed FS-J540A Sodium Hypochlorite Storage Tank TNK-J540A Air Flow Switch
Closed PS-J540A Sodium Hypochlorite Storage Tank TNK-J540A Pressure Differential Switch
Closed FS-J560A Sodium Hypochlorite Storage Tank TNK-J560A Air Flow Switch
Closed PS-J560A Sodium Hypochlorite Storage Tank TNK-J560A Pressure Differential Switch

If the blowers interlocks have been meet for fifteen seconds then the system shall go to stage 2. If the blowers interlock are not met within sixty seconds the unit shall fault on a stage 1 fault.

- **Stage 2:** Once stage 2 is reached, the water solenoid valve SOL-J400A opens allowing water and brine to mix and fill the cells. The blower interlocks from stage 1 have not become individual active alarms and therefore if any of the stage 1 interlocks fail, the system shall stop and go back to stage 1. The following cell level interlocks must be met before the generator can proceed to stage 3. They are:

Closed LS-J400A Cell Level Switch
Closed LS-J400B Cell Level Switch

If the cell level interlock has been met for 15 seconds the system shall advance to stage 3. If the cell level interlock is not achieved within 180 seconds the unit shall fault on stage 2 fault.

- **Stage 3:** Once stage 3 is reached, the system shall verify that each cell EL-J400A and EL-J400B have proper flow. In the event of any of the stage 2 interlocks failures, the system shall stop and go back to stage 1. The following cell flow interlocks must be met before the generator can proceed to stage 4:

FT-J400A Cell Flow Low Flow
FT-J400A Cell Flow High Flow
FT-J400B Cell Flow Low Flow
FT-J400B Cell Flow High Flow

The interlock is a limit test on cell flows FT-J400A and FT-J400B Low/High.

If the cell flows are within operating range for 15 seconds, the system shall advance to stage 4. If proper cell flow is not achieved within sixty seconds, the unit shall fault on stage 3 fault.

- **Stage 4:** Once stage 4 is reached, rectifier RT-J400 is started. In the even of any stage 3 interlocks failure, the system shall stop and go back to stage 1. In addition to the four cells low flow alarm set points there shall be a low low flow alarm set point for both FT-J400A and FT-J400B that shall function in the same manner as the above listed. The following rectifier interlocks must be met before the generator can proceed to running. Part of the interlock is a limit test on the rectifiers current and voltage output. The rectifier interlocks are:

RT-J400	Rectifier Fault
RT-J400	Rectifier Low Current
RT-J400	Rectifier High Current
RT-J400	Rectifier Low Voltage
RT-J400	Rectifier High Voltage

  If the rectifiers current and voltage are within operating range and there is not a rectifier fault (rectifier interlocks have been met) for five seconds, then the system shall advance to running stage. If the rectifier interlocks are not achieved with 120 seconds, then the unit shall fault on a stage 4 fault.

- **Running:** Once the running stage is reached, the system is fully operational and shall produce sodium hypochlorite. The rectifier interlocks from stage 4 have now become active alarms and in the event of an alarm the system shall inhibit the generator and then attempt a restart when in alarm.

  If at any time while the generator is starting up or running and an alarm or fault condition is experienced, the unit shall turn off and attempt to restart for total of (any combination) for (4) alarm/faults. There is a time delay of sixty seconds between the alarm occurrence and the alarm being cleared. At the expiration of the sixty seconds time delay, the alarm is cleared and the system shall proceed to stage 1 or be in standby mode. The alarm/fault counter is cleared by the reset button on the operator interface or by the selected hypochlorite storage tank stop set point being reached.

  Upon the forth alarm, the unit shall go into shutdown mode and shall remain until reset by an operator.

3.23.4.8 Hypochlorite Generation System States and Interlocks

The operator interface shall contain a menu to display the current states of the generator. The sodium Hypochlorite Generation system process shall consist of nine (9) states. These states are: disabled, standby, stages 1 – 4, running, restarting and shutdown.

- **Disabled/Enabled:** During the disabled state, the system does not run under any circumstances. Alarms pertaining to the generator are not active. The only alarms are monitored are displayed at this time are for the in service sodium hypochlorite tanks. During the enabled state, the system process operation shall start.
- **Standby:** This stage occurs when the generator is enabled but is not operating. The selected hypochlorite storage tank level is between the start and stop set points.
- **Stages 1 – 4:** When the generator has received the request to start from the selected hypochlorite storage tank, stage 1 shall be initiated. Upon meeting the interlocks for stage 1, the system shall proceed to stage 2 and continue verifying interlocks proceeding through the remaining stages until the system enter the running stage.
- **Running:** The generator has completed interlock stages 1 – 4 and is producing sodium hypochlorite.

- **Restarting:** If at any time while the generator is starting up or running and an alarm of fault occurs, the unit shall turn off and attempt to restart. If a total of any combination of four (4) alarm/faults occurred, unit shall shutdown. There is a time delay of sixty seconds (60s) between the alarm occurrence and the alarm being cleared. At the expiration of the sixty second (60s) time delay, the alarm is cleared and the system shall proceed to stage 1 or standby. The alarm/fault counter is cleared by the reset button on the operator interface or by the selected hypochlorite storage tank stop set point being reached.
- **Shutdown:** Upon the fourth (4^{th}) alarm the unit shall go into shutdown mode and shall remain until reset by an operator.

3.23.4.9 Hypochlorite Storage Tank Operation

When the hypochlorite generation system is enabled by the operator, the system process shall be initiated by the selected hypochlorite storage tank (either tank TNK-J500A, TNK-J520A, TNK-J540A, or TNK-J560A) or operator intervention. While controlled by the selected hypochlorite storage tank level, the generator shall maintain a desired hypochlorite storage tank level without operator intervention. This automatic batch mode shall start and stop the generator by the way of the tank level start and stop set points.

The control system shall monitor the level of the in service tank and when any of the in service tank levels fall below the start level, the duty generator shall start and the tank shall begin to fill until it reaches the stop level. In the event of the tank(s) stop level is reached, the duty generator shall continue to run if there is any other in service tanks that have dropped to the start level. If there are no other tanks that are being filled then the duty generator shall stop.

While under operator intervention there are three situations where the hypochlorite storage tank levels shall affect the operation and usage of the start, stop, and enable/disable buttons.

1. Occurs when the selected hypochlorite tank level is below the generator start set point. The generator shall be called into stage 1 upon the expiration of a ten (10s) timer. The timer is enabled by the hypochlorite storage tank level being below the generator start set point. The start button is active and if pushed, shall only supersede the hypochlorite storage tank level timer. The stop button shall reset the process to stage 1.
2. Occurs when the selected hypochlorite storage tank level is between the generator start and stop set points. The start button is active and shall initiate stage 1 if the generator is in standby stage. The stop button is active and shall place the unit back into standby stage.
3. Occurs when the selected hypochlorite storage tank level is above the generator stop set point and is below the hypochlorite storage tank high alarm set point. The start button is active and shall initiate stage 1 if the generator is in standby. The system shall then run for 3 minutes and go back into standby mode. The stop button is active and shall place the unit into standby mode.

3.23.4.10 Hypochlorite Storage Tank Valving

Tank valving shall require the operator to select the position of the tank inlet and outlet valves. For each tank a valve position selector switch shall be displayed on the operator interface to make the selection for the opened/closed position of the inlet and outlet valves. If either the inlet or outlet valves are in the open position the tank is considered in service. If the inlet and outlet valve on a tank are both closed then the tank shall be considered out of service. There are many configurations in which the tanks can be valved; the following are two scenarios:

1. Under normal operation all four tanks could be filled and drained at the same time, meaning that the inlet and outlet valve would all be in the open position.
2. Maintenance on tank TNK-J540A and the tank was completely full, tank TNK-J540A would have its inlet valve in the closed position and tanks TNK-J500A, TNK-J520A, and TNK-J560A would have the outlet valves in the closed option.

It is the responsibility of the operator to properly valve the system according to the desired configuration. The control panel PLC shall monitor the inlet valve position of the tank lead tank; the valve must be in the open position before the generator is allowed to move into stage 1.

A tank's valving configuration shall determine whether its alarms are active or not. When the tank is in service the alarms are active and when the tank is out of service the alarms shall not be active.

3.23.4.11 Hypochlorite Storage Tank Level Transmitters

Level transmitters shall be installed and monitor all four hypochlorite storage tanks. On a low level, an alarm shall be displayed on the operator interface and generate an alarm to SCADA. On a low level alarm, it shall not affect the operation of the generator. On a high level, an alarm shall be displayed on the operator interface, generate an alarm to SCADA and inhibit the generator. The generator shall not be allowed to operate under any conditions white a tank high level alarm is active.

There are two other set points which are tank start and tank stop. The set points shall control the generator's production to maintain adequate storage for chlorine demand.

3.23.4.12 Standpipe STP-J450A Blowers

The standpipe blower pair shall always be called on if any generator is in stage 1. The control panel operator interface shall provide a blower control screen that shall contain the selector switches for choosing whether a blower is in hand/off/auto mode. The blowers have been set up into pair of duty/standby:

Duty/Standby Blowers BLW-J450A / BLW-J450B

Each pair is designed to operate with both blowers in auto under normal conditions. With each blower in auto, one of the blowers shall be designated as duty and the other as standby. The duty/standby designation shall switch upon blower alarm and/or hours of operation.

With the blower in auto, the blower is enabled at the beginning of stage 1 and shall remain on for five minutes after the process has stopped. If an air flow switch or differential pressure switch alarm is present, the process shall shutdown and the blower enable shall remain on. Upon completing the restart, the blower enable shall be removed and the standby blower shall be enabled. In hand mode, the blowers are enabled and shall run until put into auto or off mode. In off mode, the blowers shall not be enabled.

3.23.4.13 Standpipe STP-J450A Air Flow Switch:

The air flow switch is used as an interlock permissive allowing the system to proceed to stage 2 when the air flow switch is in the closed position. The flow switch shall be monitored by the PLC when the blowers are running. In the event of no positive airflow moving through the standpipe then the system process shall be shutdown and an alarm is generated.

3.23.4.14 Standpipe STP-J450A Differential Pressure Switch:

The differential pressure switches are used as an interlock permissive allowing the system to proceed to stage 2 when the differential pressure switches are in the closed position. In the event of no positive air pressure in the standpipe hydrogen vent or if the pressure is greater than atmospheric present in the blower piping then the system process shall be shutdown. An alarm shall also be generated on SCADA.

3.23.4.15 Sodium Hypochlorite Storage Tanks Blowers:

The control panel operator interface shall provide a blower control screen that shall contain the selector switches for choosing whether a blower is in hand/off/auto mode The blowers has been set up into four (4) pairs of duty/standby for each of the following:

Sodium Hypochlorite Storage Tank TNK-J500A:	Duty/Standby Blowers BLW-J500A / BLW-J500B
Sodium Hypochlorite Storage Tank TNK-J520A:	Duty/Standby Blowers BLW-J520A / BLW-J520B
Sodium Hypochlorite Storage Tank TNK-J540A:	Duty/Standby Blowers BLW-J540A / BLW-J540B
Sodium Hypochlorite Storage Tank TNK-J560A:	Duty/Standby Blowers BLW-J560A / BLW-J560B

Each pair is designed to operate with both blowers in auto under normal conditions. With each blower in auto, one of the blowers shall be designated as duty and the other as standby. The duty/standby designation shall switch upon blower alarm and or hours of operation.

With the blower in auto, the blower is enabled at the beginning of stage 1 and shall remain on for five minutes after the process has stopped. It does not matter how the process stops whether by tank level, alarm/fault conditions, or by the stop button the HMI, the blower shall remain on for five minutes to clear the tanks of any remaining hydrogen. If the generator state is in stage 2 or above and the blower is placed into the hand or off position, the process shall shutdown and alarm is generated. In hand mode, the blowers are enabled and shall run until put into auto or off mode. In off mode, the blowers shall not be enabled.

3.23.4.16 Sodium Hypochlorite Storage Tank Pressure Switches:

The pressure switches are used as an alarm allowing the system to proceed to stage 2 if the pressure switch remains normally closed. In the event of either the inlet or outlet pressure is too high then the system process shall be shutdown. Ana alarm shall be generated as well.

3.23.4.17 Sodium Hypochlorite Storage Tank Flow Switches:

The pressure relief valve flow switches are used as an alarm allowing the system to proceed to stage 2 if the pressure relief valve flow switch remains normally closed. In the event of flow is detected downstream of the pressure relief valve the system process shall be shutdown.

3.23.4.18 Hydrogen Detectors

In the event that hydrogen level exceeds 50% of the lower explosive limit, alarm is raised to SCADA and the system shall shutdown. The shutdown shall remain as long as the hydrogen level remains above 25% of the lower explosive limit. Operator intervention to restart when in alarm shall be required.

3.23.4.19 Sodium Hypochlorite Containment Sump

The containment sump shall be monitored by a level switch. If a high level is detected, an alarm shall be raised to SCADA and the sodium hypochlorite system generation shall shutdown.

3.23.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
AT-J1001B	High hardness level	Alarm	After two “hard” readings, generate alarm to SCADA.
LIT-JX00A	Low solution level in brine tanks	Alarm & Interlock	Raise alarm to SCADA and shutdown generator.
	High solution level in brine tanks	Alarm & Interlock	Raise alarm to SCADA and close brine tank inlet valve.
LIT-JX00B	Low salt level in brine tanks	Alarm & Interlock	Raise alarm to SCADA and close brine tank inlet valve.
	Salt level at reorder level in brine tanks	Interlock	Road tank to connect to brine tank salt fill line and fill brine tank with salt.
TT-JX00A	Sodium hypochlorite tank temperature exceeds 55ºC	Alarm & Interlock	Shutdown system process and generate alarm.
LIT-JX00A	Low solution level in sodium hypochlorite storage tanks	Alarm	Raise alarm to SCADA.
	High solution level in sodium hypochlorite storage tanks	Alarm & Interlock	Shutdown generator and raise alarm on SCADA.
BLW-J450A/ BLW-J450B	Blower in hand/off position while generator in stage 2	Alarm & Interlock	Shutdown system and generate alarm.
FS-J450A	No positive airflow moving through standpipe	Alarm & Interlock	Shutdown system and generate alarm.

Tag	Event	Type	Control System Action
PS-J450A	No positive air pressure in the standpipe hydrogen vent or if the pressure is greater than atmospheric present in the blower piping	Alarm & Interlock	Shutdown system and generate alarm.
BLW-J5X0A/ BLW-J5X0B	If generator state is in stage 2 or above and the blower is placed into the hand /off position	Alarm & Interlock	Shutdown system and generate alarm.
FS-J400C	Flow is detected downstream of the pressure relief valve	Alarm & Interlock	Shutdown system and generate alarm.
PS-J5X0A	Inlet or outlet pressure is too high	Alarm & Interlock	Shutdown system and generate alarm.
LS-J550A	Containment sump level high	Alarm & Interlock	Shutdown system and generate alarm.

3.23.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Rectifier Current	1275 Amps Nominal +/- 10 Amps
Rectifier Voltage	100 VDC Nominal-within alarm ranges
Water Cell Flow 1	3200 L/H
Water Cell Flow 2	3200 L/H
Brine Cell Flow	640 L/H
Hypochlorite Tank TNK-J500A Level	60-90%
Hypochlorite Tank TNK-J520A Level	60-90%
Hypochlorite Tank TNK-J540A Level	60-90%
Hypochlorite Tank TNK-J560A Level	60-90%
Brine Tank TNK-J100A Level	10-20%
Brine Tank TNK-J200A Level	10-20%
Water Temperature	15-27ºC

SCADA/HMI Operator Adjustable Set Points

Description	Range
Brine Tank TNK-J100A in Service	
Brine Tank TNK-J200A in Service	
Hypochlorite Tank TNK-J500A in Service	
Hypochlorite Tank TNK-J520A in Service	
Hypochlorite Tank TNK-J540A in Service	
Hypochlorite Tank TNK-J560A in Service	

SCADA/HMI Status Signals

Description	Range
Brine Tank TNK-J100A in Service	
Brine Tank TNK-J200A in Service	
Generator EL-J400 Stage	
Generator EL-J420 Stage	
Generator EL-J440 Stage	
Hypochlorite Tank TNK-J500A in Service	
Hypochlorite Tank TNK-J520A in Service	
Hypochlorite Tank TNK-J540A in Service	
Hypochlorite Tank TNK-J560A in Service	

SCADA/HMI Alarm Signals

None

3.24 Hypochlorite Dosing System

3.24.1 Documentation

P-01 **P&ID Sodium Hypochlorite Generation System**
WF-P0009 **P&ID Backwash Supply Pumps**
WF-P0011 **P&ID Filtration**
WF-P0014 **P&ID Filtration**

3.24.2 Plant and Instruments

Tag	Description	
Sodium Hypochlorite Metering Pump P-J610A		
ZS-J610A	Sodium Hypochlorite Pump Revolution Sensor	
LS-J610A	Sodium Hypochlorite Pump Case High Level (Leak Detector)	
FV-J610A	Sodium Hypochlorite Pump Outlet Valve	
PI-J610A	Sodium Hypochlorite Pump Outlet Pressure	
Sodium Hypochlorite Metering Pump P-J620A		
ZS-J620A	Sodium Hypochlorite Pump Revolution Sensor	
LS-J620A	Sodium Hypochlorite Pump Case High Level (Leak Detector)	
FV-J620A	Sodium Hypochlorite Pump Outlet Valve	
PI-J620A	Sodium Hypochlorite Pump Outlet Pressure	
Sodium Hypochlorite Metering Pump P-J640A		
ZS-J640A	Sodium Hypochlorite Pump Revolution Sensor	
LS-J640A	Sodium Hypochlorite Pump Case High Level (Leak Detector)	
FV-J640A	Sodium Hypochlorite Pump Outlet Valve	
PI-J640A	Sodium Hypochlorite Pump Outlet Pressure	
Sodium Hypochlorite Metering Pump P-J660A		
ZS-J660A	Sodium Hypochlorite Pump Revolution Sensor	
LS-J660A	Sodium Hypochlorite Pump Case High Level (Leak Detector)	
FV-J660A	Sodium Hypochlorite Pump Outlet Valve	
PI-J660A	Sodium Hypochlorite Pump Outlet Pressure	
Common Discharge Chlorine Contact Tank Influent Stream		
FT-J610A	Sodium Hypochlorite Common Discharge Flow Meter	
HV-J665A	Sodium Hypochlorite Dosing Duty Stream Line	
HV-J665B	Sodium Hypochlorite Dosing Standby Stream Line	
Common Discharge Filtered Water Channel Stream		
FT-J640A	Sodium Hypochlorite Common Discharge Flow Meter	
HV-J670A	Sodium Hypochlorite Dosing Duty Stream Line Hand Valve	
HV-J670B	Sodium Hypochlorite Dosing Standby Stream Line Hand Valve	
Sodium Hypochlorite Dosing Stream Line to Backwash Supply		
HV-J600J	Sodium Hypochlorite to Chlorine Contact Tank Metering Pumps Selection Hand Valve	

Tag	Description	
HV-J675A	Sodium Hypochlorite to Filtered Water Channel Metering Pumps Selection Hand Valve	
FV-J665A	Sodium Hypochlorite to Backwash Supply Enable Valve	
HV-J665E	Sodium Hypochlorite Dosing Duty Stream Line Hand Valve	
HV-J665F	Sodium Hypochlorite Dosing Standby Stream Line Hand Valve	

3.24.3 General Operation

The sodium hypochlorite dosing system shall have two main dosing streams; one to the chlorine contact tank influent and the other to filtered water channel upstream of flash mixers. Each of these dosing streams shall consist of two variable speed metering pumps (duty/standby) with a common meter in discharge line which can be controlled by a local control panel.

There shall also be a third option which is dosing to the backwash tanks. This option can only be enabled by an operator with only one of the two streams used as the duty stream for dosing to the backwash tanks. If this option is enabled, then dosing to the chlorine contact tank and filtered water channel shall be disabled. The raw water pumps shall also be stopped during this time.

3.24.4 Automatic Control Philosophy

3.24.4.1 Chlorine Contact Tank Inlet Hypochlorite Metering Pump Operation

There shall be duty/ standby variable speed metering pumps dosing hypochlorite prior to the inlet of the chlorine contact tanks. Both metering pumps P-J610A and P-J620A shall have VFDs to control the sodium hypochlorite pumping rate to chlorine contact tanks.

A compound loop process controller with feed forward (based on filtered flow rate calculated by the summation of the eight individual BAC filter outlet flow meters) and feedback (based on the chlorine residual level measured at the contact chamber outlet AI-F056A) shall provide speed control of the duty metering pump.

If the operating duty pump becomes unavailable then the standby pump shall be started, the duty pump outlet valve shall be closed, and the standby pump outlet valve shall be opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA/HMI system if required.

During normal operation the duty and standby pumps shall perform the duty/standby pump rotation according to the operator manually adjustable ‘duty cycle’ time periods. The PLC shall monitor the actual hours run for the respective duty pump and when this exceeds the allocated ‘duty cycle’ time period automatic duty rotation shall occur.

If both pumps fail, plant shut down shall be initiated.

Each pump shall have pump case leak detector. Leak can also be detected if the pump is rotating and no flow is detected by the flow meter at the common discharge line. In the event of a detected leak, the pump shall be shutdown and standby pump shall start. An alarm shall be generated to SCADA.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages.

3.24.4.2 Sodium Hypochlorite to Chlorine Contact Tank Flow Meter FIT-J610A

The PLC shall monitor the outlet flow from the metering pumps to the chlorine contact tank and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to verify the dosing rate of sodium hypochlorite.

3.24.4.3 Filtered Water Channel Hypochlorite Metering Pump Operation

There shall be duty/ standby variable speed metering pumps dosing hypochlorite to the filtered water channel. Both metering pumps P-J640A and P-J660A shall have VFDs to control the sodium hypochlorite pumping rate to filtered water channel.

A compound loop process controller with feed forward (based on filtered flow rate calculated by the summation of the eight individual BAC filter outlet flow meters) and feedback (based on the chlorine residual level measured at the contact chamber outlet AI-F056A and the Clearwell AI-T105A/AI-T205A) shall provide speed control of the duty metering pump.

If the operating duty pump becomes unavailable then the standby pump shall be started, the duty pump outlet valve shall be closed, and the standby pump outlet valve shall be opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA/HMI system if required.

During normal operation the duty and standby pumps shall perform the duty/standby pump rotation according to the operator manually adjustable ‘duty cycle’ time periods. The PLC shall monitor the actual hours run for the respective duty pump and when this exceeds the allocated ‘duty cycle’ time period automatic duty rotation shall occur.

In the event of both pumps failing their duties, plant shut down shall be initiated.

Each pump shall have pump case leak detector. Leak can also be detected if the pump is rotating and no flow is detected by the flow meter at the common discharge line. In the event of a detected leak, the pump shall be shutdown and standby pump shall start. An alarm shall be generated to SCADA.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages.

3.24.4.4 Sodium Hypochlorite to Filtered Water Channel Flow Meter FIT-J640A

The PLC shall monitor the outlet flow from the metering pump to the filtered water chamber and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to verify the dosing rate of sodium hypochlorite.

3.24.4.5 Backwash Tank Hypochlorite Metering Pump Operation

This operation can only be manually enabled and manually operated by an operator. Once this operation is selected, dosing to filtered water chamber and chlorine contact tank shall be disabled with valves HV-J665A, HV-J665B, HV-J670A, and HV-J670B manually closed by the operator and raw water pumps stopped. To enable this operation, valve FV-J665A shall be opened and one of the dosing streams shall be select as the duty stream.

There are two sets of metering pumps to choose from – the chlorine contact tank influent or the filtered water channel. If the metering pumps dosing to the chlorine contact tank influent are chosen then valve HV-J600J shall be manually opened by the operator. If the metering pumps dosing to the chlorine contact tank influent are chosen then valve HV-J675A shall be manually opened by the operator.

There shall be duty/ standby variable speed metering pumps dosing hypochlorite to the backwash tank. Both metering duty/standby pumps shall have VFDs to control the sodium hypochlorite pumping rate. The pumps' speed flow paced accordingly to the backwash water pump outlet flow rate. If the operating duty pump becomes unavailable then the standby pump shall be started, the corresponding duty pump outlet valve shall be closed, and the standby pump outlet valve shall be opened.

At all cases, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA/HMI system if required.

Each pump shall have leak detector. In the event of a detected leak, the pump shall be shutdown and standby pump shall start. An alarm shall be generated to SCADA.

Each dosing stream shall also have standby dosing line available in case of bursts or blockages.

3.24.4.6 Sodium Hypochlorite to Backwash Tank Flow Meter FIT-J610A/FIT-J640A

Depending on which dosing stream the operator selects, the associated flow meter shall be in use while the other flow meter shall be disabled until the standby dosing stream is selected for operation.

The PLC shall monitor the outlet flow from the metering pump to the filtered water chamber and display the instantaneous value on the SCADA.

The PLC shall totalise the flow from the pulse signal from the flow meter. Each pulse shall represent 1000 litres. The accumulated flow shall be displayed on the SCADA.

The flow rate shall be used by the control system to calculate the dosing rate of sodium hypochlorite.

3.24.4.7 Pump Discharge Valves Operations

There are three different dosing stream operations:

1. **Dosing sodium hypochlorite to the chlorine contact tank influent**

   The dosing stream lines shall have a duty/standby setup. In normal operation, the duty stream line shall have valve HV-J665A open and HV-J665B closed. At the event of any blockage or leaks, the duty stream line shall be closed by manually closing valve HV-J665A and the standby valve HV-J665B shall be manually opened

2. **Dosing sodium hypochlorite to filtered water channel upstream of flash mixers**

   The dosing stream lines shall have a duty/standby setup. In normal operation, the duty stream line shall have valve HV-J670A open and HV-J670B closed. At the event of any blockage or leaks, the duty stream line shall be closed by manually closing valve HV-J670A and the standby valve HV-J670B shall be manually opened

3. **Dosing sodium hypochlorite to backwash tanks**

   There are two dosing stream lines to choose from – the chlorine contact tank influent or the filtered water channel.

   If the chlorine contact tank influent dosing line is selected, valve FV-J665A shall be opened, valve HV-J600J shall be manually opened; valves HV-J665A, HV-J665B, HV-J670A, and HV-J670B shall all be manually closed. The dosing stream lines shall have a duty/standby setup. In normal operation, the duty stream line shall have valve HV-J665E open and HV-J665F closed. At the event of any blockage or leaks, the duty stream line shall be closed by manually closing valve HV-J665E and the standby valve HV-J665F shall be manually opened.

   If the filtered water channel dosing line is selected, valve FV-J665A shall be opened, valve HV-J675B shall be manually opened; valves HV-J665A, HV-J665B, HV-J670A, and HV-J670B shall all be manually closed. As described (above), the dosing stream lines shall have a duty/standby setup. In normal operation, the duty stream line shall have valve HV-J665E open and HV-J665F closed. At the event of any blockage or leaks, the duty stream line shall be closed by manually closing valve HV-J665E and the standby valve HV-J665F shall be manually opened.

3.24.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag No.	Event	Type	Control System Action
FV-J665A	If valve is open	Interlock	Stop raw water pumps.
FIT-J610A	Sodium hypochlorite metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
FIT-J640A	Sodium hypochlorite metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
P-J610 / P-J620	Duty and standby pumps fail	Interlock	Plant shutdown.
P-J640 / P-J660	Duty and standby pumps fail	Interlock	Plant shutdown.

3.24.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

Description	Range
Sodium Hypochlorite Dosing to Backwash Tank Selection	
Sodium Hypochlorite to Backwash Tank Dosing Rate	

SCADA/HMI Status Signals

Description	Range
Sodium Metering Pump P-J610A in Service	
Sodium Metering Pump P-J620A in Service	
Sodium Metering Pump P-J630A in Service	
Sodium Metering Pump P-J640A in Service	

SCADA/HMI Alarm Signals

None

3.25 Ammonia Storage and Dosing Plant

3.25.1 Documentation

WS-P0012 P&ID Bulk Ammonia Offloading and Storage

WS-P0013 P&ID Bulk Ammonia Offloading and Storage

WS-P0014 P&ID Ammonia Feed System

3.25.2 Plant and Instruments

Tag	Description	
LCP-S401A	Bulk Ammonia Fill Local Control Panel	
SOL-S400A	Bulk Ammonia Fill Valve	
P-S430A	Bulk Ammonia Feed Duty Pump	
P-S440A	Bulk Ammonia Feed Standby Pump	
FV-S440A	Bulk Ammonia Feed Pump Outlet Control Valve	
FT-S430A	Bulk Ammonia Feed Pump P-S430A Flow Meter	
FT-S440A	Bulk Ammonia Feed Pump P-S440A Flow Meter	
GT-S450A	Ammonia Gas Analyzer	
LA-S450B	Ammonia Containment Level High Alarm or Gas Visual Alarm Lamp	
LS-S371A	Bulk Ammonia Spill Containment Level Switch	
FS-S572A	Emergency Shower/Eyewash Station EES-S752A	
Ammonia Bulk Storage Tank 1 TK-S410A		
LT-S410A	Bulk Ammonia Storage Tank Level Transmitter	
LT-S410B	Bulk Ammonia Storage Tank Level Transmitter	
LS-S405A	Bulk Ammonia Storage Tank Water Column Water Switch	
SOL-S405A	Bulk Ammonia Storage Tank Solenoid Valve	
PS-S410A	Bulk Ammonia Storage Tank Pressure Switch	
FV-S410A	Bulk Ammonia Storage Tank Inlet Flow Valve	
FV-S410B	Bulk Ammonia Storage Tank Vent Drain Valve	
FV-S410C	Bulk Ammonia Storage Tank Outlet Flow Valve	
Ammonia Bulk Storage Tank 2 TK-S420A		
LT-S420A	Bulk Ammonia Storage Tank Level Transmitter	
LT-S420B	Bulk Ammonia Storage Tank Level Transmitter	
LS-S405B	Bulk Ammonia Storage Tank Water Column Water Switch	
SOL-S405B	Bulk Ammonia Storage Tank Solenoid Valve	
PS-S420A	Bulk Ammonia Storage Tank Pressure Switch	

Tag	Description	
FV-S420A	Bulk Ammonia Storage Tank Inlet Flow Valve	
FV-S420C	Bulk Ammonia Storage Tank Outlet Flow Valve	
FV-S420B	Bulk Ammonia Storage Tank Vent Drain Valve	
LT-S420A	Bulk Ammonia Storage Tank Level Transmitter	

3.25.3 General Operation

Water shall flow by gravity from the chlorine contact tanks to the Clearwell. Ammonia shall be dosed through Duty/Standby flash mix injectors located on the channel, downstream of the chlorine contact tank and upstream of the Clearwell tank. The control of the injection of ammonia shall normally be based on the free chlorine residual at the chlorine contact tank outlet, the chlorine/ammonia feed ratio, and the free ammonia residual level at the Clearwell inlet.

Ammonia dosing pipes shall be delivered to the throat of the nozzle, so that the turbulence generated by the nozzle shall flash mix the chemicals across the diameter of the channel.

The ammonia storage and dosing plant shall be located in the Bulk Chemical building and the chemical shall be pumped to the injection point via one of the two dosing pipelines operating as duty and standby. Changeover to the standby line shall be a manual operation.

The ammonia storage and dosing system shall include two ammonia bulk storage tanks in a duty/standby arrangement, and an ammonia pump skid which shall contain two feed pumps (one duty and one standby). Tank TK-S410A, shall feed though its respective outlet flow valve to a common header going to the ammonia pump skid common suction line. Tank TK-S420A shall feed though its respective outlet flow valve to a second header going to the ammonia pump skid common suction line. Only one storage tank outlet valve shall be open during normal operation. Each tank shall have duty standby level transmitter/indicators for monitoring purposes, which shall generate status signals and alarms at tank full, high high level, low level and ‘refill’ level.

Containment level and ammonia gas concentration in the building shall be monitored. An audible and visual alarm shall warn of high containment level or ammonia gas detection.

Ammonia shall be delivered to the site by road tanker. The delivery operation shall be controlled by the operator at a local control panel located at the delivery point. During tank filling, tank vapours shall be vented to the atmosphere through a vent pipeline (each tank shall have its own). A water column in the vent pipeline shall help reduce the amount of ammonia vented to the atmosphere. After filling a tank, the vent shall be drained back to the tank through the respective vent drain valve (FV-S410B for tank TK-410A and FV-S420B for tank TK-420A).

Pressure in the ammonia tanks shall not exceed 15 psi. Each tank shall be equipped with a mechanical activated vacuum/pressure relief valve to ensure that the pressure remains below 15 psi, and a pressure switch that shall indicate when the relief valve is operating.

Ammonia shall be delivered to the ammonia mixer dosing point by variable speed dosing pumps (one duty plus one standby). The control of the injection of the ammonia solution shall be flow proportional, based upon the totalized filtered water flow, as calculated by the summation from each of the eight individual BAC filter outlet flow meters. It's necessary that the BAC filter Outlet Flow Valve to the filtered water chamber is opened in order for its flow meter measurement to be considered for the total filtered water flow calculation. The PLC shall calculate the total filtered water flow going to the filtered water chamber. Dosing to the water stream shall be inhibited until there's flow detected in the filtered water chamber, see section 3.9 for details. Failure of a duty dosing pump shall automatically cause the ammonia feed pump outlet control valve FV-S440A to open and standby pump P-S440A to start.

If both dosing pumps become unavailable, the plant shall begin a controlled shutdown.

Flow switches shall be provided on each dosing line at the point of application to ensure that ammonia is being dosed at the correct injection point. These switches along with flow meters at the pump discharge shall provide pump no flow protection and detect a possible burst pipe (i.e. Flow at the flow meter but not at the flow switch).

Level switches shall be provided in the leak containment sumps; these shall be used to monitor pump pressure relief valve operation or spills and pipe leaks.

3.25.4 Automatic Control Philosophy

3.25.4.1 Ammonia Storage Tank Operation

The operation of the two tanks is identical

Duty/standby Level transmitters shall be used to monitor the level in each storage tank and display the level on the SCADA/HMI. The operator shall select which transmitter in each tank is the duty instrument, in the event of a failure of the duty instrument the standby shall automatically become duty.

When the level in any tank reaches the "tank full" level during a filling operation then the respective tank inlet valve and the tank fill valve (SOL-S400A) shall be closed. If the level in any tank reaches a 'high high' level then an alarm shall be raised at the SCADA/HMI. A high high level alarm shall also generate an audible and visual warning at the respective local Filling Control Panel.

The tanks shall operate so that only one tank is supplying ammonia to the pumps at any given time. Initially when the tanks are all filled at the same time tank TK-S410A shall be the duty tank and the other tank TK-S420A shall be standby.

If the level in the duty tank in operation drops to below a 'Re-Fill' level, the standby tank level shall be checked and if the level is above the 'tank full' level, the level in the tank containment is not 'High' and the outlet valve is available, then the standby tank outlet valve shall be required to open, if not, an alarm shall be raised on the SCADA/HMI. Once the standby tank outlet valve is opened, the previous operating tank outlet valve shall be allowed to close.

All tank levels shall also be monitored for rate of emptying, so that if the level in the tank is falling at an excessive rate an alarm shall be raised on the SCADA/HMI.

In addition, if the level in any tank continues to and goes below a 'Low' level then an alarm shall be raised at SCADA/HMI.

Each of the tanks shall be equipped with a vent drain valve, a water column level switch, a water solenoid valve (SOL-S405A for tank TK-5410A and SOL-S405B for tank TK-420A) and a pressure switch that indicates that the relief valve is operating. The relief valves shall operate to keep ammonia tanks pressure to less than 15psi. The operation of these devices shall be explained later.

There shall be one emergency shower/eyewash station for operators. A flow switch shall indicate when the emergency shower is operating.

3.25.4.2 Ammonia Tank Local Fill Panel

A dedicated local control panels is used when a tank is being filled from a road tanker. The panel functions shall all be controlled by the PLC. All fill panel alarm lamp and sounder operation shall be hardwired through relays to provide fail-safe operation.

Each Fill Panel consists of:

- Tank Level Readout
  0-37.5m^3 Digital Display.
- Beacon/ Sounder alarm
  The Beacon/Sounder alarm shall operate if any the High Level alarm for any Tank is activated
- Tank Alarm Accept (mute) push button
  A button press shall silence the audible alarm and beacon and signal to the PLC that the alarm has been accepted. The appropriate alarm lamp shall continue to operate until the alarm is cleared.
- High Level Alarm Lamp for each Tank
  Lamp shall be lit while the tank high level alarm condition is active.
- Command Open lamp for each Tank inlet valve
  Lamp shall be lit while the command to open certain Tank inlet valve is active.
- Tank Selector push button for each Tank
  The operator shall be able to select through push buttons, which Tank is to be filled. Each Tank shall have its own push button.
- Start Fill push button
  The operator shall be able to start filling the selected Tank, by pressing the Start Fill push button.
- System Emergency Stop push button
  A button press shall close all valves and stop the filling of the tanks.

Ammonia Tank Delivery Three Way Fill Valve SOL-S400A

The Ammonia tank delivery fill valve shall be located at the delivery point. Fill Valve SOL-S400A shall be opened to fill from a road tanker.

The operator selects via push buttons on the local control panel, which tank is to be filled. Once selected, the fill sequence is initiated by pressing the Start Fill push button located also on the local control panel.

The fill sequence shall open the respective fill valve to allow compressed air flow into the Truck. At the same time, the inlet flow valve to the selected tank shall open. During the fill sequence, ammonia vapour in the tank shall be vented to the atmosphere through a vent pipeline. A water column shall be installed in the vent pipeline to reduce the amount of ammonia content vented to the atmosphere. Water level in the water column shall be monitored by a low level switch. If the water level falls below the low level, an alarm shall be raised in the SCADA/HMI system and the respective water solenoid valve shall open. Water solenoid valve shall remain open until the water column level returns to its normal operating level.

Once the tank is full, the fill valve and the inlet flow valve to the selected tank shall close, and the vent pipeline shall be drained back to the ammonia tank by opening the respective vent drain valve. Once the vent pipeline is drained, the valve shall close.

3.25.4.3 Ammonia Dosing Pump Operation

Ammonia shall flow from the operating ammonia storage tank to the ammonia pump skid where the flow shall be split into two streams. There shall be one variable speed ammonia dosing pump per stream. One dosing pump shall operate as duty, and one as standby serving both streams. Ammonia shall be dosed into the jet flash mixer through one of the two ammonia streams operating as duty/standby streams. The operator shall manually open hand valves HV-S430H and HV-S430OI and close hand valves HV-S440H and HV-S440OI to operate stream 1 as duty and stream 2 as standby. Stream changeover shall be done manually by inverting the position of the hand valves at each stream. The protection systems on the dosing lines shall be described later.

Stream 1 Ammonia Duty Dosing Pump	P-S430A
Stream 2 Ammonia Standby Dosing Pump	P-S440A

The duty pump corresponding to the dosing stream in operation shall be required to operate once flow to the filtered water chamber is detected. If the operating duty pump becomes unavailable then the feed pump outlet control valve FV-S440A shall open and the standby pump shall be started.

If the two pumps become unavailable, flow from the works shall be limited, and a plant controlled shut down shall be initiated.

3.25.4.4 Ammonia Dosing Pump Speed Control

The speed of the pump shall be proportional to the flow in the filtered water chamber and shall be calculated by the PLC.

The operator shall be able to adjust the speed of the pump manually through the SCADA/HMI system in case the dosing

3.25.4.5 Pump and Dosing Line Protection

The containment sump shall receive ammonia in the event of any dosing pump pressure relief valve operation or in the event of any storage tanks overflow. The sump shall be monitored by a level switch LS-S450A wired to local I/O. If a high level is detected, an alarm shall be raised, the appropriate duty pump shall stop and the standby shall start.

Each pump and its associated dosing line shall also be fitted with one flow meter and one flow switch, the first fitted in the discharge of the pump and the second fitted in the dosing line as near to the point of dose as possible. If flow is detected by the flow meter at the pump discharge, but not by the respective flow switch at the dosing point, the SCADA/HMI system shall raise a no flow protection alarm and take the proper action according depending on the following situations.

Stream in Operation	Pumps in Operation	Action
Stream 1	Duty Pump P-S430A	Stop Duty Pump P-S430A Confirm manual change over to standby dosing pipe. Open outlet control valve FV-S440A Start Duty Pump P-S430A
Stream 1	Standby Pump P-S440A	Stop Standby Pump P-S440A Close outlet control valve FV-S440A Confirm manual change over to standby dosing pipe. Start Standby Pump P-S440A
Stream 2	Standby Pump P-S440A	Stop Standby Pump P-S440A Confirm manual change over to standby dosing pipe. Open outlet control valve FV-S440A Start Standby Pump P-S440A
Stream 2	Duty Pump P-S430A	Stop Duty Pump P-S430A Close outlet control valve FV-S440A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S430A

In the case that the duty pump is running and there's no flow detected by the corresponding flow meter, the duty pump shall be stopped, the corresponding outlet control valve shall open and the standby pump P-S440A shall be started.

The pump discharge flow, the dosing line flow switch signal and the containment sump level shall be wired to local I/O. The flow signal inputs shall be overridden on pump start up for a preset time until flow is established. After initial start up, activation of the discharge flow protection devices, operation of the dosing line flow or containment sump level device shall inhibit the pump, and shall cause the standby pump to start if available and an alarm shall be raised on SCADA/HMI.

3.25.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
	Failure of duty ammonia dosing pump	Interlock	Open ammonia feed pump outlet control valve FV-S440A and start standby pump
	Failure of all ammonia dosing pumps	Interlock	Start Plant Controlled Shutdown
LT-S410A LT-S420A	High Level	Alarm	Alarm on SCADA and at local fill panel
	Refill Level	Event	Alarm on SCADA, tank in operation switches to the standby tank.
	Low Level	Alarm	Alarm on SCADA
	Instrument failure	Alarm	Alarm on SCADA, switchover to standby transmitter. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks
LT-S410B LT-S420B	High Level	Alarm	Alarm on SCADA and at local fill panel
	Refill Level	Event	Alarm on SCADA, tank in operation switches to the standby tank.
	Low Level	Alarm	Alarm on SCADA
	Instrument failure	Alarm	Alarm on SCADA. If operating as standby transmitter, switchover must be inhibited. If operating as duty transmitter and standby transmitter is ok, switchover to standby transmitter. If both transmitters fail, and tank is in operation and the standby is available then they shall changeover. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks. If both instruments fail then the outlet valves shall open, ensuring dosing continues. The pumps have additional protection.

3.25.6

3.25.7 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Ammonia Storage Tanks High Level	0-xxx%
Ammonia Storage Tanks Re-fill Level	0-xxx%
Ammonia Storage Tanks Low Level	0-xxx%
Ammonia Storage Tanks Low Temperature	0-xxx%
Ammonia Dosing Pumps Required Speed	0-100.0 %

SCADA/HMI Operator Adjustable Set Points

Description	Range
TK-S410A Ammonia Storage Tank in Operation	Toggle
TK-S420A Ammonia Storage Tank in Operation	Toggle

SCADA/HMI Status Signals

Description	Range
TK-S410A Ammonia Storage Tank in Operation	
TK-S420A Ammonia Storage Tank in Operation	
Ammonia Dosing Pumps Actual Speed	
Dosing stream 1 or 2 in Operation	

SCADA/HMI Alarm Signals

Description	Range
TK-S410A Ammonia Storage Tank Refill Required	
TK-S410A Vacuum/Pressure Relief Valve in Operation	
TK-S410A Column Water Level Low	
TK-S420A Ammonia Storage Tank Refill Required	
Both Ammonia Dosing Pumps Failed	
Ammonia gas detection or Containment high level	

3.26 Sulphuric Acid Storage and Dosing Plant

3.26.1 Documentation

WS-P0001 P&ID Bulk Sulphuric Acid Offloading and Storage

WS-P0002 P&ID Sulphuric Acid Feed System 1 of 2

WS-P0003 P&ID Sulphuric Acid Feed System 2 of 2

3.26.2 Plant and Instruments

Tag	Description	
LCP-S200A	Local Control Panel for Bulk Sulphuric Acid Rail Car Fill Side	
SOL-S200A	Fill Valve for Bulk Sulphuric Acid Rail Car Fill Side	
LCP-S204A	Local Control Panel for Bulk Sulphuric Acid Truck Fill Side	
SOL-S204A	Fill Valve for Bulk Sulphuric Acid Truck Fill Side	
LS-S206	Sulphuric Acid Spill Containment Manhole High Level Switch	
FV-S206A	Sulphuric Acid Spill Containment Manhole Outlet Flow Valve	
FV-S207A	Sulphuric Acid Spill Containment to North Sump Inlet Flow Valve	
P-S230A	Sulphuric Acid Feed Duty Pump	
P-S240A	Sulphuric Acid Feed Standby Pump	
P-S250A	Sulphuric Acid Feed Duty Pump	
FV-S240A	Sulphuric Acid Feed Standby Pump Outlet Control Valve	
FV-S240B	Sulphuric Acid Feed Standby Pump Outlet Control Valve	
FT-S235A	Sulphuric Acid Feed Pump P-S230A Flow Meter	
FT-S250A	Sulphuric Acid Feed Pump P-S250A Flow Meter	
LA-S200A	Bulk Sulphuric Acid Tank Overfill Audible Alarm	
LA-S260C	Bulk Sulphuric Acid Containment High Level Alarm Lamp	
LA-S260D	Bulk Sulphuric Acid Containment High Level Alarm Lamp	
LS-S260A	Sulphuric Acid Spill Containment Switch South Sump	
LS-S260B	Sulphuric Acid Spill Containment Switch North Sump	
FS-S750A	Emergency Shower/Eyewash Station Rail Car Side	
FS-S759A	Emergency Shower/Eyewash Station Truck Side	
Sulphuric Acid Bulk Storage Tank 1 TK-S210A		
LT-S210A	Sulphuric Acid Tank Level Transmitter	
PT-S210A	Sulphuric Acid Tank Pressure Transmitter	
FV-S210A	Sulphuric Acid Storage Tank Inlet Flow Valve Rail Car Fill Side	
FV-S210B	Sulphuric Acid Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S210C	Sulphuric Acid Storage Tank Outlet Flow Valve	
Sulphuric Acid Bulk Storage Tank 2 TK-S220A		
LT-S220A	Sulphuric Acid Tank Level Transmitter	
PT-S220A	Sulphuric Acid Tank Pressure Transmitter	
FV-S220A	Sulphuric Acid Storage Tank Inlet Flow Valve Rail Car Fill Side	
FV-S220B	Sulphuric Acid Storage Tank Inlet Flow Valve Truck Fill Side	
FV-S220C	Sulphuric Acid Storage Tank Outlet Flow Valve	

3.26.3 General Operation

Sulphuric Acid shall be dosed into the raw water stream, downstream of the raw water pumps and upstream of the DAF tanks to improve coagulation. The chemical shall normally be dosed into both raw water trains. The Sulphuric Acid storage and dosing plant shall be located in the Bulk Chemical building and the chemical shall be pumped to the dosing point via four dosing pipelines (two per train). There shall be a spare dosing pipeline installed, changeover to the standby line shall be a manual operation.

The Sulphuric Acid Feed storage and dosing system shall include two Sulphuric Acid bulk storage tanks and a Sulphuric Acid pump skid which shall contain three feed pumps (two duty and a common standby). Each Tank TK-S210A and TK-S220, shall feed though their respective outlet flow valves its own stream going to the Sulphuric Acid pump skid common suction line. Only one storage tank outlet valve shall be open during normal operation. Each tank shall have a duty/standby level transmitter / indicators for monitoring purposes, which shall generate status signals and alarms at tank full, high high level, low level and 'refill' level. The high level alarm shall also generate an audible and visual warning to warn of overfilling of the tank.

Sulphuric Acid shall be delivered to the site by either rail car or road tanker, the rail car delivery point shall be located on the north side of the building and the road tanker delivery point shall be located on the south side of the building. The delivery operation shall be controlled by the operator at a local control panel located at each delivery point.

Sulphuric Acid shall be delivered to the two raw water train dosing points by variable speed, dosing pumps (1 duty per stream plus a common standby). The control of the injection of the Sulphuric Acid solution shall be flow proportional, based upon the totalized raw water flow for that train, as calculated by the summation from each of the 4 individual DAF tank inlet flow meters in that train. Dosing to either train shall be inhibited until the train is considered "in service", see Section 3.2 for details. Failure of a duty dosing pump shall automatically cause the appropriate valve on the standby dosing pump delivery line to open and start the standby pump.

If all the dosing pumps become unavailable, the plant shall begin a controlled shutdown.

Flow switches shall be provided on each dosing line at the point of application, and these switches along with flow meters at the pump discharge shall provide pump no flow protection and detect a possible burst pipe (i.e. flow at the pump but not at the point of injection) and shall automatically start the standby pump and raise an alarm.

Level switches shall be provided in the leak containment sumps; these shall be used to monitor pump pressure relief valve operation or spills and pipe leaks.

3.26.4 Automatic Control Philosophy

3.26.4.1 Sulphuric Acid Storage Tank Operation

The operation of both tanks is identical

Duty/standby Level and pressure transmitters shall be used to monitor the level in each storage tank and display the level on the SCADA/HMI. The operator shall select which transmitter in each tank is the duty instrument, in the event of a failure of the duty instrument the standby shall automatically become duty. If the standby transmitter fails or reads different than the duty transmitter, it shall be inhibited from operating and an alarm shall be raised on the SCADA/HMI

When the level in any tank reaches the "tank full" level during a filling operation then the tank inlet valve and the fill valve (SV-S200A or SV-S204A) shall be closed. If the level in any tank reaches a 'high high' level then an alarm shall be raised at the SCADA/HMI. A high high level alarm shall also generate an audible and visual warning at the respective local Filling Control Panel.

The tanks shall operate so that only one tank is supplying sulphuric acid to the pumps at any given time. To ensure that the chemicals are stored and used in a sequential manner tanks shall be operated as a duty/standby system. So initially when both tanks are filled at the same time tank TK-S210A shall be the duty tank and tank TK-S220A shall be standby. The standby tank shall become the duty tank when the duty tank level falls to the "re-fill" level. The status of both tanks shall be displayed on the SCADA/HMI. The operator shall have the ability to select a tank as duty or standby.

If the level in the tank in operation drops to below a 'Re-Fill' level, the standby tank level shall be checked and if the level is above the 'tank full' level, the level in the tank containment is not 'High' and the outlet valve is available, then the corresponding tank outlet valve shall be required to open. Once the standby tank outlet valve is opened, the previous operating tank outlet valve shall be allowed to close.

All tank levels shall also be monitored for rate of emptying, so that if the level in the tank is falling at an excessive rate an alarm shall be raised on the SCADA/HMI.

In addition, if the level in any tank continues to and goes below a 'Low' level then an alarm shall be raised at SCADA/HMI.

3.26.4.2 Sulphuric Acid Tank Local Fill Panel

Each sulphuric acid tank can be filled either by Rail Car or by Truck through separate paths. Dedicated local control panels are used when a tank is being filled from a Rail Car of from a Truck. Both local control panels operate in the same way and have the same commands, feedbacks and indications. The panel functions shall all be controlled by the PLC. All fill panel alarm lamp and sounder operation shall be hardwired through relays to provide fail-safe operation.

Each Fill Panel consists of:

- Tank Level Readout
  0-94m^3 Digital Display.
- Beacon/ Sounder alarm
  The Beacon/Sounder alarm shall operate if any the High Level alarm for any Tank is activated
- Tank Alarm Accept (mute) push button
  A button press shall silence the audible alarm and beacon and signal to the PLC that the alarm has been accepted. The appropriate alarm lamp shall continue to operate until the alarm is cleared.
- High Level Alarm Lamp for each Tank
  Lamp shall be lit while the tank high level alarm condition is active.

- Command Open lamp for each Tank inlet valve
  Lamp shall be lit while the command to open certain Tank inlet valve is active.
- Tank Selector push button for each Tank
  The operator shall be able to select through push buttons, which Tank is to be filled. Each Tank shall have its own push button.
- Start Fill push button
  The operator shall be able to start filling the selected Tank, by pressing the Start Fill push button.
- System Emergency Stop push button
  A button press shall close all valves and stop the filling of the tanks.
- Start Steam System (Rail Car LCP Only)
  Steam is injected in the rail car to prevent Sulphuric Acid from freezing. The operator can start the Steam System pressing a push button on the Rail Car Local Control Panel.

There shall be one emergency shower/eyewash station for operators at each delivery point. A flow switch in each station shall indicate when the emergency showers are operating.

3.26.4.3 Sulphuric Acid Tank Delivery Three Way Fill Valves SOL-S200A, SOL-S204A

The sulphuric acid tank delivery fill valves shall be located on each of the separate paths going to the tanks. Fill Valve SOL-S200A shall be opened to fill from a Rail Car, while fill valve SOL-S204A shall be opened to fill from a truck.

The operator selects via push buttons on the respective local control panel, which tank is to be filled. Once selected, the fill sequence is initiated by pressing the Start Fill push button located also on the local control panel.

The fill sequence shall open the respective fill valve to allow compressed air flow into the Rail Car or Truck. At the same time, the inlet flow valve to the selected tank shall open. Once the tank is full, the respective fill valve and the inlet flow valve to the selected tank shall close.

Any spillage in either of the chemical delivery areas is drained to its respective containment area. In the north containment area the normally closed valve FV-S207A can be opened by the operator through the SCADA/HMI system to drain the containment area to the north sump.

The south containment area shall have a manhole with a high level switch and a valve that shall remain closed while the tanks are being filled by road tanker. The level in the manhole shall remain below the high level switch to allow the valve to open to the LDS area.

3.26.4.4 Inlet Works Sulphuric Acid Dosing Pump Operation

There shall be a variable speed duty sulphuric acid dosing pump for each stream with a common standby pump serving both streams. Each pump shall also have standby dosing lines available in case of bursts or blockages. The protection systems on the dosing lines shall be described later.

Stream 1 Sulphuric Acid Dosing Pump	P-S230A
Stream 2 Sulphuric Acid Dosing Pump	P-S250A
Common Standby Pump	P-S240A

The duty pump shall be required to operate if the appropriate stream is in service. If the duty pump becomes unavailable then the standby pump shall be started. The discharge from the pump shall be directed to the correct dosing lines by opening a valve in the discharge line.

Stream 1	FV-S240A
Stream 2	FV-S240B

3.26.4.5 Sulphuric Acid Dosing Pump Speed Control

The speed of the pump shall be proportional to the flow in the in service stream and shall be calculated by the PLC.

The required pump speed shall be calculated based on a “Zero” speed at “Zero” flow and “Maximum” speed with “Maximum” flow.

The operator shall be able to adjust the speed of the pump manually through the SCADA/HMI system.

3.26.4.6 Pump and Dosing Line Protection

The south containment sump shall receive Sulphuric Acid in the event of any dosing pump pressure relief valve operation. The north containment sump shall receive Sulphuric Acid in the event of any storage tanks overflow. The sumps shall be monitored by level switches wired to local I/O as shown below. If a high level is detected, an alarm shall be raised, the appropriate duty pump shall stop and the standby shall start.

North Sump	LS-S260B
South Sump	LS-S260A

Each pump and its associated dosing line shall also be fitted with one flow meter and one flow switch, the first fitted in the discharge of the pump and the second fitted in the dosing line as near to the point of dose as possible. If flow is detected by the flow meter at the pump discharge, but not by the respective flow switch at the dosing point, the SCADA/HMI system shall interpret it as a no flow protection condition, and shall automatically raise an alarm, and inhibit the respective pump operation.

The pump discharge flow, the dosing line flow switch signal and the containment sump level shall be wired to local I/O. The flow signal inputs shall be overridden on pump start up for a preset time until flow is established. After initial start up, activation of the discharge flow protection devices, operation of the dosing line flow or containment sump level device shall inhibit the pump, shall cause the standby pump to start if available and an alarm shall be raised on SCADA/HMI.

3.26.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
	Failure of all sulphuric acid dosing pumps	Interlock	Shutdown works
	Failure of a stream 1 duty P-S230A pump and standby pump P-S240A	Interlock	Limit raw water flow to works
	Failure of a stream 2 duty P-S250A pump and standby pump P-S240A	Interlock	Limit raw water flow to works
LT-S210A PT-S210A LT-S220A PT-S220A	High Level	Alarm	Alarm on SCADA and at local fill panel
	Refill Level	Event	Alarm on SCADA. Tank in operation switches to the standby tank.
	Low Level	Alarm	Alarm on SCADA
	Instrument failure	Alarm	Alarm on SCADA If operating as duty transmitter, switch to standby transmitter. If operating as standby transmitter, inhibit transmitter from operating. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks. If both duty and standby instruments fail on the duty tank, and standby tank is available then change over to standby tank. If standby tank not available then the outlet valves shall open, ensuring dosing continues. The pumps have additional protection. If both duty and standby instruments fail on the standby tank, switchover shall be inhibited.

3.26.6

3.26.7 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Sulphuric Acid Storage Tanks High Level	0-xxx%
Sulphuric Acid Storage Tanks Re-fill Level	0-xxx%
Sulphuric Acid Storage Tanks Low Level	0-xxx%
Sulphuric Acid Dosing Pumps Required Speed	0-100.0 %

SCADA/HMI Operator adjustable set points

Description	Range
T-S210A Sulphuric Acid Storage Tank No.1 in Operation	Toggle
T-S220A Sulphuric Acid Storage Tank No.2 in Operation	Toggle

SCADA/HMI Status Signals

Description	Range
T-S210A Sulphuric Acid Storage Tank No.1 in Operation	
T-S220A Sulphuric Acid Storage Tank No.2 in Operation	
Sulphuric Acid Dosing Pumps Actual Speed	

SCADA/HMI Alarm Signals

Description	Range
T-S210A Sulphuric Acid Storage Tank No.1 Refill Required	
T-S220A Sulphuric Acid Storage Tank No.2 Refill Required	
All Sulphuric Acid Dosing Pumps Failed	
Stream 1 Sulphuric Acid Dosing Pump and Standby Failed	
Stream 2 Sulphuric Acid Dosing Pump and Standby Failed	

3.27 Sodium Hydroxide Storage and Dosing Plant

3.27.1 Documentation

WS-P0008	**P&ID Sodium Hydroxide Offloading and Storage**
WS-P0009	**P&ID Sodium Hydroxide Feed System 1 of 3**
WS-P0010	**P&ID Sodium Hydroxide Feed System 2 of 3**
WS-P0011	**P&ID Sodium Hydroxide Feed System 3 of 3**

3.27.2 Plant and Instruments

Tag	Description	
LCP-S301A	Local Control Panel for Bulk Sodium Hydroxide Rail Car Fill Side	
SOL-S300A	Fill Valve for Bulk Sodium Hydroxide Rail Car Fill Side	
LCP-S307A	Local Control Panel for Bulk Sodium Hydroxide Truck Fill Side	
SOL-S307A	Fill Valve for Bulk Sodium Hydroxide Truck Fill Side	
LS-S309A	Sodium Hydroxide Containment Manhole Level Switch	
FV-S309A	Sodium Hydroxide Containment Manhole Outlet Flow Valve	
P-S350A	Sodium Hydroxide Feed Duty Pump	
P-S360A	Sodium Hydroxide Feed Standby Pump	
P-S370A	Sodium Hydroxide Feed Duty Pump	
FV-S350A	Sodium Hydroxide Feed Pump P-S350A Outlet Control Valve	
FV-S360A	Standby Sodium Hydroxide Feed Pump P-S360A Outlet Control Valve	
FV-S370B	Sodium Hydroxide Feed Pump P-S370A Outlet Control Valve	
FT-S350A	Sodium Hydroxide Feed Pump P-S350A Flow Meter	
FT-S370A	Sodium Hydroxide Feed Pump P-S370A Flow Meter	
LA-S371C	Sodium Hydroxide Containment Visual Level High Alarm Lamp	
LA-S371D	Sodium Hydroxide Containment Visual Level High Alarm Lamp	
LS-S371A	Sodium Hydroxide Spill Containment Level Switch South Sump	
LS-S371B	Sodium Hydroxide Spill Containment Level Switch North Sump	
FS-S751A	Emergency Shower/Eyewash Station Rail Car Side	
FS-S758A	Emergency Shower/Eyewash Station Truck Side	
FS-S754A	Emergency Shower/Eyewash Station EEWS-S754A	
Sodium Hydroxide Bulk Storage Tank 1 TK-S310A		
HTR-S310A	Sodium Hydroxide Tank Heater	
HTR-S310B	Sodium Hydroxide Tank Heater	
HTR-S310C	Sodium Hydroxide Tank Heater	
TT-S310A	Sodium Hydroxide Tank Temperature	
LT-S310A	Sodium Hydroxide Tank Level Transmitter	

Tag	Description	
PT-S310A	Sodium Hydroxide Tank Pressure Transmitter	
FV-S310A	Sodium Hydroxide Storage Tank Inlet Flow Valve	
FV-S310C	Sodium Hydroxide Storage Tank Outlet Flow Valve	
Sodium Hydroxide Bulk Storage Tank 2 TK-S320A		
HTR-S320A	Sodium Hydroxide Tank Heater	
HTR-S320B	Sodium Hydroxide Tank Heater	
HTR-S320C	Sodium Hydroxide Tank Heater	
TT-S320A	Sodium Hydroxide Tank Temperature	
LT-S320A	Sodium Hydroxide Tank Level Transmitter	
PT-S320A	Sodium Hydroxide Tank Pressure Transmitter	
FV-S320A	Sodium Hydroxide Storage Tank Inlet Flow Valve	
FV-S320C	Sodium Hydroxide Storage Tank Outlet Flow Valve	
Sodium Hydroxide Bulk Storage Tank 3 TK-S330A		
HTR-S330A	Sodium Hydroxide Tank Heater	
HTR-S330B	Sodium Hydroxide Tank Heater	
HTR-S330C	Sodium Hydroxide Tank Heater	
TT-S330A	Sodium Hydroxide Tank Temperature	
LT-S330A	Sodium Hydroxide Tank Level Transmitter	
PT-S330A	Sodium Hydroxide Tank Pressure Transmitter	
FV-S330A	Sodium Hydroxide Storage Tank Inlet Flow Valve	
FV-S330C	Sodium Hydroxide Storage Tank Outlet Flow Valve	
Sodium hydroxide Bulk Storage Tank 4 TK-S340A		
HTR-S330A	Sodium Hydroxide Tank Heater	
HTR-S330B	Sodium Hydroxide Tank Heater	
HTR-S330C	Sodium Hydroxide Tank Heater	
TT-S330A	Sodium Hydroxide Tank Temperature	
LT-S340A	Sodium hydroxide Tank Level Transmitter	
PT-S340A	Sodium hydroxide Tank Pressure Transmitter	
FV-S340A	Sodium hydroxide Storage Tank Inlet Flow Valve	
FV-S340C	Sodium hydroxide Storage Tank Outlet Flow Valve	

3.27.3 General Operation

Water shall flow by gravity from the chlorine contact tanks to the clearwell. Sodium hydroxide shall be dosed through Duty/Standby flash mix injectors located on the channel, downstream of the chlorine contact tank and upstream of the clearwell. The control of injection of sodium hydroxide shall normally be based on de pH measurement in the clearwell and the acid dosing shall be used to adjust the pH level to between 7.4 and 7.8.

Sodium hydroxide shall be delivered to the throat of the nozzle, so that the turbulence generated by the nozzle shall flash mix the chemicals across the diameter of the channel.

The sodium hydroxide storage and dosing plant shall be located in the Bulk Chemical building and the chemical shall be pumped to the injection point via one of the two dosing pipelines operating as duty and standby. Changeover to the standby line shall be a manual operation.

The sodium hydroxide storage and dosing system shall include four sodium hydroxide bulk storage tanks and a sodium hydroxide pump skid which shall contain three feed pumps (two duty and a common standby). Tanks TK-S310A, TK-S320A, shall feed though their respective outlet flow valves to a common header going to the sodium hydroxide pump skid common suction line. Tanks TK-S330A and TK-S340A shall feed though their respective outlet flow valves to a second header going to the sodium hydroxide pump skid common suction line. Only one storage tank outlet valve shall be open during normal operation. Each tank shall have duty standby level transmitter/indicators for monitoring purposes, which shall generate status signals and alarms at tank full, high high level, low level and 'refill' level. The high level alarm shall also generate an audible and visual alarm to warn of overfilling of the tank.

Each tank shall also have three tank heaters and one temperature transmitter. When the temperature in any tank drops below its operational limit, the SCADA/HMI system shall raise an alarm and send a command to turn on the heaters in the respective tank.

Sodium hydroxide shall be delivered to the site by either rail car or road tanker. The rail car delivery point shall be located on the north side of the building and the road tanker delivery point shall be located on the south side of the building. The delivery operation shall be controlled by the operator at a local control panel located at each delivery point.

Sodium hydroxide shall be delivered to the sodium hydroxide mixer dosing point by variable speed, dosing pumps (2 duty plus a common standby). A compound loop process controller with feed forward (based on filtered flow rate calculated by the summation of the eight individual BAC filter outlet flow meters) and feedback (based on the treated water pH measured at the clearwell) shall provide speed control of the duty metering pump. It is required that the BAC filter Outlet Flow Valve to the filtered water chamber is opened in order for its flow meter measurement to be considered for the total filtered water flow calculation. The PLC shall calculate the total filtered water flow going to the filtered water chamber. Dosing to the water stream shall be inhibited until there's flow detected in the filtered water chamber, see section 3.9 for details. Failure of a duty dosing pump shall automatically cause the appropriate valve on the standby dosing pump delivery line to open and start the standby pump.

If all the dosing pumps become unavailable, the plant shall begin a controlled shutdown.

Flow switches shall be provided on each dosing line at the point of application to ensure that sodium hydroxide is being dosed at the correct injection point. These switches along with flow meters at the pump discharge shall provide pump no flow protection and detect a possible burst pipe (i.e. Flow at the flow meter but not at the flow switch).

Level switches shall be provided in the leak containment sumps; these shall be used to monitor pump pressure relief valve operation or spills and pipe leaks.

3.27.4 Automatic Control Philosophy

3.27.4.1 Sodium hydroxide Storage Tank Operation

The operation of all four tanks is identical.

Duty/standby Level and pressure transmitters shall be used to monitor the level in each storage tank and display the level on the SCADA/HMI. The operator shall select which transmitter in each tank is the duty instrument, in the event of a failure of the duty instrument the standby shall automatically become duty.

When the level in any tank reaches the “tank full” level during a filling operation then the tank inlet valve and the tank fill valve (SOL-S300A) shall be closed. If the level in any tank reaches a ‘high high’ level then an alarm shall be raised at the SCADA/HMI. A high high level alarm shall also generate an audible and visual warning at the respective local Filling Control Panel.

The tanks shall operate so that only one tank is supplying sodium hydroxide to the pumps at any given time. To ensure that the chemicals are stored and used in a sequential manner a queuing system shall be employed. So initially when the tanks are all filled at the same time tank TK-S310A shall be the duty tank and the other three tanks shall be standby in sequential order. A tank shall be placed in the queue when it is at the “tank full” level and it shall become the duty tank when the tank level in front of it in the queue falls to the “re-fill” level. The status of all the tanks and the queue positions shall be displayed on the SCADA/HMI. The operator shall have the ability to override the queue sequence and select a tank for duty.

If the level in the tank in operation drops to below a ‘Re-Fill’ level, the next available tank level shall be checked and if the level is above the ‘tank full’ level, the level in the tank containment is not ‘High’ and the outlet valve is available, then the corresponding tank outlet valve shall be required to open, if not, the next following tank shall be checked. Once the new operating tank outlet valve is opened, the previous operating tank outlet valve shall be allowed to close.

All tank levels shall also be monitored for rate of emptying, so that if the level in the tank is falling at an excessive rate an alarm shall be raised on the SCADA/HMI.

In addition, if the level in any tank continues to and goes below a ’Low’ level then an alarm shall be raised at SCADA/HMI.

To prevent sodium hydroxide from freezing in the tanks, the SCADA/HMI system shall also monitor the temperature in each of the tanks. If the temperature in any of the tanks shall drop below the operational limit, an alarm shall be raised in the SCADA/HMI system. The corresponding tank heater shall be turned on automatically when the low temperature alarm is active and the sodium hydroxide level in the tank is above the low level limit.

There shall be one emergency shower/eyewash station for operators. A flow switch shall indicate when the emergency shower is operating.

3.27.4.2 Sodium Hydroxide Tank Local Fill Panel

Dedicated local control panels are used when a tank is being filled either from a rail car or from a road tanker. Both local control panels operate in the same way and have the same commands, feedbacks and indications. The panel functions shall all be controlled by the PLC. All fill panel alarm lamp and sounder operation shall be hardwired through relays to provide fail-safe operation.

Each Fill Panel consists of:

- Tank Level Readout
  0-94m^3 Digital Display.
- Beacon/ Sounder alarm
  The Beacon/Sounder alarm shall operate if any the High Level alarm for any Tank is activated
- Tank Alarm Accept (mute) push button
  A button press shall silence the audible alarm and beacon and signal to the PLC that the alarm has been accepted. The appropriate alarm lamp shall continue to operate until the alarm is cleared.
- High Level Alarm Lamp for each Tank
  Lamp shall be lit while the tank high level alarm condition is active.
- Command Open lamp for each Tank inlet valve
  Lamp shall be lit while the command to open certain Tank inlet valve is active.
- Tank Selector push button for each Tank
  The operator shall be able to select through push buttons, which Tank is to be filled. Each Tank shall have its own push button.
- Start Fill push button
  The operator shall be able to start filling the selected Tank, by pressing the Start Fill push button.
- System Emergency Stop push button
  A button press shall close all valves and stop the filling of the tanks.
- Start Steam System (Rail Car LCP Only)
  Steam is injected in the rail car to prevent Sodium Hydroxide from freezing. The operator can start the Steam System pressing a push button on the Rail Car Local Control Panel

There shall be one emergency shower/eyewash station for operators at each delivery point. A flow switch in each station shall indicate when the emergency showers are operating.

3.27.4.3 Sodium Hydroxide Tank Delivery Three Way Fill Valves SOL-S300A, SOL-S307E

The sodium hydroxide tank delivery fill valves shall be located on each of the separate delivery points. Fill Valve SOL-S300A shall be opened to fill from a rail car, while fill valve SOL-S307E shall be opened to fill from a road tanker.

The operator selects via push buttons on the respective local control panel, which tank is to be filled. Once selected, the fill sequence is initiated by pressing the Start Fill push button located also on the local control panel.

The fill sequence shall open the respective fill valve to allow compressed air flow into the Rail Car or Truck. At the same time, the inlet flow valve to the selected tank shall open. Once the tank is full, the respective fill valve and the inlet flow valve to the selected tank shall close.

To prevent Sodium Hydroxide from freezing in the rail car, steam from boilers can be injected into the rail car by pressing the Start Steam System on the Local Control Panel.

3.27.4.4 Sodium Hydroxide Pump Operation

Sodium hydroxide shall flow from the operating sodium hydroxide storage tank to the sodium hydroxide pump skid where the flow shall be split into three streams. There shall be one variable speed sodium hydroxide dosing pump per stream. Two dosing pumps shall operate as duty, and one as a common standby pump serving both streams. Sodium hydroxide shall be dosed into the jet flash mixer through one of the two sodium hydroxide streams operating as duty/standby streams, located at the sodium hydroxide pump skid outlet. The operator shall operate the respective valves to decide which stream shall operate as duty and which stream shall remain as standby. Stream changeover shall be done manually. The protection systems on the dosing lines shall be described later.

Stream 1 Sodium hydroxide Dosing Pump	P-S350A
Stream 2 Sodium hydroxide Dosing Pump	P-S370A
Common Standby Pump	P-S360A

The duty pump corresponding to the dosing stream in operation shall be required to operate once flow to the filtered water chamber is detected. When the flow demand exceeds the pump capacity, the second duty pump shall be started. If either of the operating duty pumps become unavailable then the standby pump shall be started, discharge from the pump being directed to the correct dosing lines by opening the standby pump outlet valve FV-S360A and the valve to the corresponding discharge line, depending on the stream that is in operation.

Stream 1	FV-S350A
Stream 2	FV-S370A

If two pumps become unavailable, flow from the works shall be limited, and a plant controlled shut down shall be initiated.

3.27.4.5 Sodium Hydroxide Dosing Pump Speed Control

The speed of the pump shall be proportional to the flow in the filtered water chamber and shall be calculated by the PLC.

The required pump speed shall be calculated based on the following table:

Conditions	Duty Pump P-S350A	Duty Pump P-S370A
Stream 1 in operation, “zero” flow into the filtered water chamber	“Zero” speed	“Zero” speed
Stream 1 in operation, 25% flow into the filtered water chamber	50% speed	“Zero” speed
Stream 1 in operation, 50% flow into the filtered water chamber	“Maximum” speed	“Zero” speed
Stream 1 in operation, 75% flow into the filtered water chamber	“Maximum” speed	50% speed
Stream 2 in operation, 100% flow into the filtered water chamber	“Maximum” speed	“Maximum” speed
Stream 2 in operation, “zero” flow into the filtered water chamber	“Zero” speed	“Zero” speed
Stream 2 in operation, 25% flow into the filtered water chamber	“Zero” speed	50% speed
Stream 2 in operation, 50% flow into the filtered water chamber	“Zero” speed	“Maximum” speed
Stream 2 in operation, 75% flow into the filtered water chamber	50% speed	“Maximum” speed
Stream 2 in operation, 100% flow into the filtered water chamber	“Maximum” speed	“Maximum” speed

In case that one of the operating duty pumps becomes unavailable, the standby pump shall run at the same speed that the unavailable pump was running.

The operator shall be able to adjust the speed of the pump manually through the SCADA/HMI system in case the dosing

3.27.4.6 Pump and Dosing Line Protection

The south containment sump shall receive sodium hydroxide in the event of any dosing pump pressure relief valve operation. The north containment sump shall receive sodium hydroxide in the event of any storage tanks overflow. The sumps shall be monitored by level switches wired to local I/O as shown below. If a high level is detected, an alarm shall be raised, the appropriate duty pump shall stop and the standby shall start.

North Sump LS-S371B
South Sump LS-S371A

Each duty pump and its associated dosing line shall also be fitted with one flow meter and one flow switch, the first fitted in the discharge of the pump and the second fitted in the dosing line as near to the point of dose as possible. If flow is detected by the flow meter at the pump discharge, but not by the respective flow switch at the dosing point, the SCADA/HMI system shall raise a no flow protection alarm and take the proper action according depending on the following situations.

Stream in Operation	Pumps in Operation	Action
Stream 1	Duty Pump P-S350A	Stop Duty Pump P-S350A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S370A
Stream 1	Standby Pump P-S360A	Stop Standby Pump P-S360A Close outlet control valves FV-S360A and FV-S350A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S370A
Stream 1	Duty Pump P-S350A Duty Pump P-S370A	Stop Duty Pumps Confirm manual change over to standby dosing pipe. Start Duty Pumps
Stream 1	Duty Pump P-S350A Standby Pump P-S360A	Stop Pumps Open outlet control valve FV-S370A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S350A and Standby Pump P-S360A
Stream 2	Duty Pump P-S370A	Stop Duty Pump P-S370A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S350A
Stream 2	Standby Pump P-S360A	Stop Standby Pump P-S360A Close outlet control valves FV-S360A and FV-S350A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S350A
Stream 2	Duty Pump P-S350A Duty Pump P-S370A	Stop Duty Pumps Confirm manual change over to standby dosing pipe. Start Duty Pumps
Stream 2	Duty Pump P-S370A Standby Pump P-S360A	Stop Pumps Open outlet control valve FV-S350A Confirm manual change over to standby dosing pipe. Start Duty Pump P-S350A and Standby Pump P-S360A

In the case that only one duty pump is running, and there's no flow detected by the corresponding flow meter, the duty pump shall be stopped, the corresponding outlet control valves shall open and the standby pump P-S360A shall be started.

The pump discharge flow, the dosing line flow switch signal and the containment sump level shall be wired to local I/O. The flow signal inputs shall be overridden on pump start up for a preset time until flow is established. After initial start up, activation of the discharge flow protection devices, operation of the dosing line flow or containment sump level device shall inhibit the pump, and shall cause the standby pump to start if available and an alarm shall be raised on SCADA/HMI.

3.27.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
	Failure of all sodium hydroxide dosing pumps	Interlock	Start Plant Controlled Shutdown
	Failure of a stream 1 duty P-S350A pump and standby pump P-S360A	Interlock	Limit raw water flow to works
	Failure of a stream 2 duty P-S370A pump and standby pump P-S360A	Interlock	Limit raw water flow to works
LT-S310A LT-S320A LT-S330A LT-S340A	High Level	Alarm	Alarm on SCADA and at local fill panel
	Refill Level	Event	Alarm on SCADA, tank in operation switches to the next available.
	Low Level	Alarm	Alarm on SCADA
	Instrument failure	Alarm	Alarm on SCADA, switchover to standby transmitter. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks
PT-S310A PT-S320A PT-S330A PT-S340A	High Level	Alarm	Alarm on SCADA and at local fill panel
	Refill Level	Event	Alarm on SCADA, tank in operation switches to the next available.
	Low Level	Alarm	Alarm on SCADA
	Instrument failure	Alarm	Alarm on SCADA. If operating as standby transmitter, switchover must be inhibited. If operating as duty transmitter and standby transmitter is ok, switchover to standby transmitter. If both transmitters fail, and tank is in operation and the next one is available then they shall changeover. The instrument shall be configured to fail high, and the PLC value shall go high to prevent accidental overfilling of tanks. If both instruments fail then the outlet valves shall open, ensuring dosing continues. The pumps have additional protection.

3.27.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Sodium Hydroxide Storage Tanks High Level	0-xxx%
Sodium Hydroxide Storage Tanks Re-fill Level	0-xxx%
Sodium Hydroxide Storage Tanks Low Level	0-xxx%
Sodium Hydroxide Storage Tanks Low Temperature	0-xxx%
Sodium Hydroxide Dosing Pumps Required Speed	0-100.0 %

SCADA/HMI Operator Adjustable Set Points

Description	Range
T-S110A Sodium Hydroxide Storage Tank no.1 in Operation	Toggle
T-S120A Sodium Hydroxide Storage Tank no.2 in Operation	Toggle
T-S130A Sodium Hydroxide Storage Tank no.3 in Operation	Toggle
T-S140A Sodium Hydroxide Storage Tank no.4 in Operation	Toggle

SCADA/HMI Status Signals

Description	Range
T-S110A Sodium Hydroxide Storage Tank no.1 in Operation	
T-S120A Sodium Hydroxide Storage Tank no.2 in Operation	
T-S130A Sodium Hydroxide Storage Tank no.3 in Operation	
T-S140A Sodium Hydroxide Storage Tank no.4 in Operation	
Sodium Hydroxide Dosing Pumps Actual Speed	
Dosing stream 1 or 2 in Operation	

SCADA/HMI Alarm Signals

Description	Range
T-S110A Sodium Hydroxide Storage Tank no.1 Refill Required	
T-S120A Sodium Hydroxide Storage Tank no.2 Refill Required	
T-S130A Sodium Hydroxide Storage Tank no.3 Refill Required	
T-S140A Sodium Hydroxide Storage Tank no.4 Refill Required	
All Sodium Hydroxide Dosing Pumps Failed	
Stream 1 Sodium Hydroxide Dosing Pump and Standby Failed	
Stream 2 Sodium Hydroxide Dosing Pump and Standby Failed	

3.28 Chemical Storage Building Air Compressors

3.28.1 Documentation

WS-H0521 P&ID Compressed Air System

3.28.2 Plant and Instruments

Tag	Description	
CMP-S815A	Air Compressor	
CMP-S816A	Air Compressor	
PV-S826A	Compressed Air Receiver	
PT-S826B	Air Receiver Pressure Transmitter	

3.28.3 General Operation

The duty compressor shall operate to maintain air receiver pressure within a set point band measured at the discharge of the compressor. In the event of a failure of the duty compressor, the standby by compressor shall be started by the PLC. The selection of the duty and standby status shall be made manually by the Operator at the SCADA. A pressure transmitter located on a common line between the air receivers, shall be used to initiate the switch from the duty to the standby compressor, in the event of a low pressure or a failure signal from the duty machine.

3.28.4 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

None

3.29 Hydrogen Peroxide Storage and Dosing Plant

WC-P0001 P&ID Hydrogen Peroxide Storage

WC-P0002 P&ID Hydrogen Peroxide and Chemical Feed Systems

3.29.1 Plant and Instruments

Tag	Description	
LS-C800A	Hydrogen Peroxide Spill Containment High Level	
LCP-C-800	Hydrogen Peroxide Local Control Panel	
Hydrogen Peroxide Storage Tank TNK-C810A		
LI-C800A	Hydrogen Peroxide Storage Tank Sight Glass	
FV-C810B	Hydrogen Peroxide Storage Tank Inlet Valve	
LIT-C810A	Hydrogen Peroxide Storage Tank Level	
TIT-C810A	Hydrogen Peroxide Storage Tank Temperature	
HV-C830A	Hydrogen Peroxide Storage Tank Outlet Valve to Metering Pumps	
Hydrogen Peroxide Storage Tank TNK-C820A		
LI-C820A	Hydrogen Peroxide Storage Tank Sight Glass	
FV-C820B	Hydrogen Peroxide Storage Tank Inlet Valve	
LIT-C820A	Hydrogen Peroxide Storage Tank Level	
TIT-C820A	Hydrogen Peroxide Storage Tank Temperature	
HV-C830C	Hydrogen Peroxide Storage Tank Outlet Valve to Metering Pumps	
Hydrogen Peroxide Duty Metering Pump P-C840A		
FI-C840A	Service Water to Metering Pump P-C840A Flow Indicator	
FS-C840A	Service Water to Metering Pump P-C840A Low Flow	
FT-C840A	Hydrogen Peroxide Metering Pump P-C840A Outlet Flow Rate	
FV-C840A	Service Water to Metering Pump P-C840A Discharge Flow Control Valve	
PI-C840A	Hydrogen Peroxide Metering Pump P-C840A Outlet Pressure	
Hydrogen Peroxide Duty Metering Pump P-C850A		
FI-C850A	Service Water to Metering Pump P-C850A Flow Indicator	
FS-C850A	Service Water to Metering Pump P-C850A Low Flow	
FT-C850A	Hydrogen Peroxide Metering Pump P-C850A Outlet Flow Rate	
FV-C850A	Service Water to Metering Pump P-C850A Discharge Flow Control Valve	
PI-C850A	Hydrogen Peroxide Metering Pump P-C850A Outlet Pressure	
Hydrogen Peroxide Standby Metering Pump P-C860A		
FI-C860A	Service Water to Metering Pump P-C860A Flow Indicator	
FS-C860A	Service Water to Metering Pump P-C860A Low Flow	

Tag	Description	
FT-C860A	Hydrogen Peroxide Metering Pump P-C860A Outlet Flow Rate	
FV-C860A	Service Water to Metering Pump P-C860A Discharge Flow Control Valve	
FV-C860B	Hydrogen Peroxide to Ozone Contactor #1	
FV-C860C	Hydrogen Peroxide to Ozone Contactor #2	
PI-C860A	Hydrogen Peroxide Metering Pump P-C860A Outlet Pressure	

3.29.2 General Operation

A PLC shall monitor each aspect of the system operation, report on operating parameters, system status and alarm conditions.

There shall be ultrasonic level detectors in each of the two hydrogen peroxide tanks. Once the tank level reaches the reorder level set point, the system shall automatically send an alarm to prompt the operator to order more hydrogen peroxide.

The hydrogen peroxide dosing system shall have two main dosing streams; one to ozone contactor no. 1 and the other to ozone contactor no. 2. The hydrogen peroxide dosing system shall feed chemical at two possible application points within each contactor which shall be manually selected by the operator. Hydrogen peroxide shall be fed within the first ozone dissolution cell for advanced oxidation or the cell 6 for ozone quenching. It shall not be fed to both locations simultaneously.

Ozone contactor no. 1 and no. 2 shall each have a dedicated duty pump for hydrogen peroxide with a standby pump common to both trains.

For advanced oxidation, the amount of hydrogen peroxide added shall vary stoichiometrically with the applied ozone dose. For ozone quenching, the hydrogen peroxide dose shall vary with the ozone residual measured in cell 6 of the ozone contactor.

Properties of Hydrogen Peroxide Table

Parameter	Unit	Value
Chemical	-	Hydrogen Peroxide
Primary Use	-	Advanced oxidation
Secondary Use		Ozone residual quenching
Application Location	-	Ozone Contactors: Cell No. 2 for advanced oxidation and Cell No. 6 for quenching.
Number of Application Points	#	2 (plus 2 additional points within last cell - shall not be used simultaneously)
Active Agent	-	H_2O_2
Specific Gravity	-	1.13
Bulk Density	kg/m^3	1,130
Solution Strength	%	35
Active Density	kg/m^3	395

3.29.3 Automatic Control Philosophy

3.29.3.1 Hydrogen Peroxide Unloading Local Control Panel LCP-C-800A

A dedicated local control panel shall be used when a tank is being filled from a road tanker. The panel functions shall be hardwired to the level instrument controls. All fill panel alarm lamp and sounder operation shall be hardwired through relays to provide fail-safe operation.

Each Fill Panel consists of:

- <u>Tank Level</u>
  Display each of the hydrogen peroxide tank levels.
- <u>Sounder alarm</u>
  The Sounder alarm shall operate if the high level alarm for any tank is activated.
- <u>Acknowledgement Push Button</u>
  A button press shall silence the audible alarm and signal to the PLC that the alarm has been accepted. The appropriate alarm lamp shall continue to operate until the alarm is cleared.
- <u>High/ High High Level Alarm Lamp for each Tank</u>
  Lamp shall be lit while the tank high level alarm condition is active.
- <u>Open/Close Switch Command for each Tank</u>
  Manual switch for the operator to open/close the tank inlet valves.
- <u>Command Open lamp for each Tank inlet valve</u>
  Lamp shall be lit while the command to open certain tank inlet valve is active.
- <u>Command Closed lamp for each Tank inlet valve</u>
  Lamp shall be lit while the command to open certain tank inlet valve is active.

3.29.3.2 Hydrogen Peroxide Tank Operation TNK-C810A and TNK-C820A

The operation of both tanks is identical.

There shall be two hydrogen peroxide storage tanks TNK-C810A and TNK-C820A. Each Hydrogen Peroxide storage tank shall have a diameter of 1.625 m, have a height of 4.6 m and have a capacity of 9,000 L.

The control system shall monitor the hydrogen peroxide level in both tanks. In the event of a hydrogen peroxide refill, the inlet valve of the tanks shall be open and closed when the refill is completed.

There shall also be a sight glass connected to each of the tanks. The current tank levels shall also be shown through the sight glass.

3.29.3.3 Hydrogen Peroxide Tank Level Transmitter LIT-C810A and LIT-C820A

The hydrogen peroxide level in the hydrogen peroxide tanks shall be measured by the ultrasonic sensors. Remote display of storage tank level shall be shown at the hydrogen peroxide filling station (LI-C810B and LI-C820B) as well. The operator shall send a signal to the PLC to open the storage tank inlet flow valves at the initiation of storage tank filling operations (HS-C810A for tank TNK-C810A and HS-C820A for Tank TNK-C820A).

When the hydrogen peroxide in the storage tank drops to the reorder set point an alarm is generated and sent to SCADA to prompt the operator to place an order for hydrogen peroxide via a road tanker. The hydrogen peroxide refill shall be controlled by operator opening the valve via unloading local control panel.

In the event of the level in the hydrogen peroxide tanks dropping below 5%, the metering pumps shall be able inhibit in the automatic mode.

In the event where the level of the storage tanks reaches the low level set point and the metering pumps are running, the metering pumps shall stop upon reaching the low level set point. An alarm shall be generated and sent to the PLC.

An alarm shall be sent to the PLC when the tank reaches 90% capacity and the high level lamp shall be activated on the unloading local control panel. When tank capacity reaches 95%, the storage tank inlet flow valves shall be closed.

Remaining tank volume value shall be displayed on SCADA.

3.29.3.4 Hydrogen Peroxide Tank Temperature Transmitter TIT-C810A and TIT-C820A

There shall be temperature indicators located within each of the storage tanks which shall provide the current storage tank temperatures.

3.29.3.5 Hydrogen Peroxide Containment Sump Operation LS-C800A

There shall be a level switch located in the sump pit of the hydrogen peroxide storage containment area. In the event of a spill, an alarm signal shall be sent to the PLC.

3.29.3.6 Hydrogen Peroxide Metering Pumps Operation

There shall be two duty hydrogen peroxide metering pumps; one metering pump for the dosing stream to ozone contactor no. 1 and the other metering pump for the dosing stream to ozone contactor no. 2.

There shall be a standby metering pump available for both of the dosing streams.

If one of the operating duty pumps becomes unavailable then the standby pump shall be started, the duty pump outlet valve shall be closed, and the standby pump outlet valve shall be opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA/HMI system if required.

If both duty/standby pumps fail, plant shut down shall be initiated.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages.

The hydrogen peroxide dosing system shall feed chemical at two possible application points within each contactor. Hydrogen peroxide shall be fed within the second ozone dissolution cell for advanced oxidation or ozone cell 6 for ozone quenching by the operator manually operating the valves. It shall not be fed to both locations simultaneously.

Advanced Oxidation – Hydrogen Peroxide to Ozone Dissolution Cell 2 Manual Valve Operation

Dosing Stream	Valves Open	Valves Closed	
Ozone Contactor No. 1 (Duty)	HV-C840W HV-C840L	HV-C840V HV-C840N	HV-C840Q HV-C840P
Ozone Contactor No. 1 (Standby)	HV-C840V HV-C840N	HV-C840V HV-C840N	HV-C840Q HV-C840P
Ozone Contactor No. 2 (Duty)	HV-C850W HV-C850L	HV-C850V HV-C850N	HV-C850Q HV-C850P
Ozone Contactor No. 2 (Standby)	HV-C850V HV-C850N	HV-C850W HV-C850L	HV-C850Q HV-C850P

Ozone Quenching – Hydrogen Peroxide to Ozone Dissolution Cell 6 Manual Valve Operation

Dosing Stream	Valves Open	Valves Closed	
Ozone Contactor No. 1 (Duty)	HV-C840Q	HV-C840P HV-C840W HV-C840L	 HV-C840V HV-C840N
Ozone Contactor No. 1 (Standby)	HV-C840P	HV-C840Q HV-C840W HV-C840L	 HV-C840V HV-C840N
Ozone Contactor No. 2 (Duty)	HV-C850Q	HV-C850P HV-C850W HV-C850L	 HV-C850V HV-C850N
Ozone Contactor No. 2 (Standby)	HV-C850P	HV-C850Q HV-C850W HV-C850L	 HV-C850V HV-C850N

The dose delivered to cell 2 of ozone contactor no. 1 (TNK-O210A) and no. 2 (TNK-O230A) for advanced oxidation is flow-paced and set according to the applied ozone dose. Flow pacing shall be achieved through the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters.

Hydrogen peroxide metering pump no. 1 (P-C840A) shall be flow paced by Qtotal of DAF all the DAF units in service divided by the number of Ozone Contactors in service.

Hydrogen peroxide metering pump no. 2 (P-C860A) shall be flow paced by Qtotal of all the DAF units in service divided by the number of Ozone Contactors in service.

The hydrogen peroxide dose is set by the applied ozone dose and calculated to be 0.5 to 0.8 mg hydrogen peroxide per mg of applied ozone. The target default dosage is 0.8 mg/L of hydrogen peroxide per mg of applied ozone, and can be adjusted by the operator.

The dose delivered to cell 6 of ozone contactor no. 1 and no. 2 for ozone quenching is flow-paced and adjusted based on the ozone residual measured in cell 6 of the ozone contactor (AT-O221A and AT-O241A). The dose is calculated to be 0.5 to 0.8 mg hydrogen peroxide per mg of residual ozone. The target default dosage is 0.8 mg/L of hydrogen peroxide per mg of applied ozone, and can be adjusted by the operator.

Hydrogen Peroxide Dosing Table

Condition	Flow (ML/d)	Applied Ozone Dose (mg/L)	Hydrogen Peroxide Dose (mg/L)	Peroxide Mass Dose (kg/d)	Peroxide Hourly Dose (L/h)	Peroxide Daily Dose (L/d)
Minimum Hydrogen Peroxide Dose[1]	102	0.5	0.4	40.8	4.3	103
Average Hydrogen Peroxide Dose	258	1.5	1.2	310	32.6	783
Maximum Hydrogen Peroxide Dose	407	2.25	1.8	733	77.2	1,852

Note: [1] Assumes one contactor online and therefore one pump operating

Remote start/stop capabilities shall be available; duty pump selection can be made locally. A totalizer shall monitor chemical use and pump runtime.

In remote manual mode, chemical system parameters are selected by the operator via control logic within the PLC. The operator inputs the pump speed at the PLC, thus overriding the flow-paced control. The operator determines the speed required using the pump output curve.

In manual mode, the operator sets the pump speed directly at the pump. The operator determines the speed required using the pump output curve.

Hydrogen Peroxide Metering Pumps Table

Parameter	Value	Unit
Number of Active Metering Pumps	2	#
Number of Standby Metering Pumps	1	#
Minimum Metering Pump Rate, Each	2.15	L/h
Average Metering Pump Rate, Each	16.3	L/h
Maximum Metering Pump Rate, Each	38.6	L/h
Metering Pump Turndown Ratio	73	-
Number of Active Metering Pumps	2	#

3.29.3.7 Hydrogen Peroxide Flow Meter FIT-C840A, FIT-C850A, and FIT-C860A

The PLC shall monitor the outlet flow from the metering pumps to the ozone contact no. 1 and ozone contact no. 2 and shall also display the instantaneous value on the SCADA.

The accumulated flow shall be displayed on the SCADA.

3.29.4 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LS-C800A	Containment sump level high	Alarm & Interlock	Shutdown system and generate alarm.
LIT-C800X	Low level in hydrogen peroxide tanks	Alarm & Interlock	An alarm shall be sent to the PLC/SCADA and inhibit metering pumps.
	Reorder level in hydrogen peroxide tanks.	Alarm	An alarm shall be sent to PLC/SCADA to prompt operator to reorder more hydrogen peroxide
	High level (90%) in hydrogen peroxide tanks.	Alarm & Interlock	High level lamp on unloading local control panel shall be activated. An alarm shall be sent to the PLC/SCADA
	High high level (95%) in hydrogen peroxide tanks	Alarm & Interlock	Raise alarm to PLC/SCADA and close tank inlet valve.
FT-C840A	Hydrogen peroxide metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
FT-C850A	Hydrogen peroxide metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
FT-C860A	Standby hydrogen peroxide metering pump is running and no flow detected	Alarm & Interlock	Generate alarm on SCADA and initiate plant shutdown.
P-C840A / P-C860A	Duty and standby pumps fail	Alarm & Interlock	Plant shutdown and generate alarm on SCADA.
P-C850A / P-C860A	Duty and standby pumps fail	Alarm & Interlock	Plant shutdown and generate alarm on SCADA.

3.29.5 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Hydrogen Peroxide Tank TNK-C810A Reorder Level	
Hydrogen Peroxide Tank TNK-C820A Reorder Level	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Hydrogen Peroxide Tank TNK-C810A in Service	
Hydrogen Peroxide Tank TNK-C820A in Service	
Hydrogen Peroxide Dosing for Advanced Oxidation Selection	
Hydrogen Peroxide Dosing for Quenching Selection	

SCADA/HMI Status Signals

Description	Range
Hydrogen Peroxide Tank TNK-C810A in Service	
Hydrogen Peroxide Tank TNK-C820A in Service	
Hydrogen Peroxide Metering Pump P-C840A in Service	
Hydrogen Peroxide Metering Pump P-C850A in Service	
Hydrogen Peroxide Metering Pump P-C860A in Service	

SCADA/HMI Alarm Signals

Description	Range
All Hydrogen Peroxide Metering Pumps Failed	
Stream 1 Hydrogen Peroxide Metering Pump and Standby Failed	
Stream 2 Hydrogen Peroxide Metering Pump and Standby Failed	

3.30 Sodium Bisulphite Storage and Dosing Plant

3.30.1 Documentation

WC-P0003 P&ID Sodium Bisulphite Offloading and Storage

WC-P0004 P&ID Sodium Bisulphite Chemical Feed Systems

WO-P0022 P&ID Dissolved Ozone Sampling System No. 1

WO-P0023 P&ID Dissolved Ozone Sampling System No. 2

3.30.2 Plant and Instruments

Tag	Description	
LS-C980A	Sodium Bisulphite Spill Containment High Level	
Sodium Bisulphite Storage Tank TNK-C940		
FV-C940J	Sodium Bisulphite Storage Tank Inlet Valve	
LIT-C940B	Sodium Bisulphite Storage Tank Level	
HV-C940D	Sodium Bisulphite Storage Tank Outlet Valve to Metering Pumps	
Sodium Bisulphite Duty Metering Pump P-C950A		
FI-C950A	Service to Metering Pump Flow Indicator	
FS-C950A	Service Water to Metering Pump Low Flow	
FT-C950A	Sodium Bisulphite Metering Pump Outlet Flow Rate	
FV-C950A	Service Water to Metering Pump Discharge Flow Control Valve	
PI-C950A	Sodium Bisulphite Metering Pump Outlet Pressure	
Sodium Bisulphite Duty Metering Pump P-C960A		
FI-C960A	Service to Metering Pump Flow Indicator	
FS-C960A	Service Water to Metering Pump Low Flow	
FT-C960A	Sodium Bisulphite Metering Pump Outlet Flow Rate	
FV-C960A	Service Water to Metering Pump Discharge Flow Control Valve	
PI-C960A	Sodium Bisulphite Metering Pump Outlet Pressure	
Sodium Bisulphite Standby Metering Pump P-C970A		
FI-C970A	Service to Metering Pump Flow Indicator	
FS-C970A	Service Water to Metering Pump Low Flow	
FT-C970A	Sodium Bisulphite Metering Pump Outlet Flow Rate	
FV-C970A	Service Water to Metering Pump Discharge Flow Control Valve	
FV-C970C	Sodium Bisulphite to Ozone Contactor # 1	
FV-C970D	Sodium Bisulphite to Ozone Contactor # 2	
PI-C970A	Sodium Bisulphite Metering Pump Outlet Pressure	

3.30.3 General Operation

The master plant PLC shall control this system with the operators using information from the ozone vendor PLC to set dose points based on dissolved ozone analyzers in the dissolved ozone sampling systems.

There shall be an ultrasonic level detector in the sodium bisulphite tank. Once the tank level reaches the reorder level set point, the system shall automatically send an alarm to SCADA for a sodium bisulphite refill.

The sodium bisulphite dosing system shall have two main dosing streams; one to ozone contactor no. 1 and the other to ozone contactor no. 2. The 38% strength sodium bisulphite solution shall be dosed at cell 6 of each ozone contactor for quenching. Sodium bisulphite is oxidized to bisulphate when it reacts with strong oxidants, such as ozone. Stoichiometrically, 2 mg of sodium bisulphite react with 1 mg of ozone. This conversion shall eliminate the remaining ozone residual from the water.

Ozone contactor no. 1 and no. 2 shall each have a dedicated duty pump for sodium bisulphite dosing with a standby pump common to both trains. The amount of sodium bisulphite added shall vary depending on the concentration of dissolved ozone measured at the beginning of cell 6 of the ozone contactor. An ozone residual control loop shall be used for sodium bisulphite pacing. Dissolved ozone shall be monitored continuously within the contactor. The ozone residual, together with the water flow rate, shall be used to control the sodium bisulphite feed rate.

A sample element located in both cell 6 of ozone contactors no. 1 and no. 2 shall be provided to measure dissolved ozone (AT-0226A and AT-0246A). The minimum ozone residual of 0.05 mg/L corresponds to the practical detection limits of online aqueous ozone analyzers.

Properties of Sodium Bisulphite Table

Parameter	Value	Unit
Chemical	Sodium Bisulphite	-
Primary Use	Ozone residual quenching	-
Active Agent	$NaHSO_3$	-
Specific Gravity	1.33	-
Bulk Density	1,330	kg/m^3
Solution Strength	38	%
Active Density	505	kg/m^3

3.30.4 Automatic Control Philosophy

3.30.4.1 Sodium Bisulphite Tank Operation TNK-C940

There shall be one sodium bisulphite storage tank TNK-C940. Each sodium bisulphite storage tank shall have a diameter of 1.625 m, have a height of 2.0 m and have a capacity of 3,000 L.

The control system shall monitor the sodium bisulphite level in the tank. In the event of a sodium bisulphite refill, the inlet valve of the tank shall be open and then closed when the refill is completed.

3.30.4.2 Sodium Bisulphite Tank Level Transmitter LIT-C940B

The sodium bisulphite level in the sodium bisulphite tank shall be measured by the ultrasonic sensor.

When sodium bisulphite in the storage tank drops to the reorder set point an alarm is generated and sent to SCADA to prompt the system to refill sodium bisulphite via sodium bisulphate totes.

In the event of the level in the sodium bisulphite tank dropping below 5%, the metering pumps shall be able inhibit in the automatic mode.

In the event where the level of the storage tank reaches the low level set point and the metering pumps are running, the metering pumps shall stop upon reaching the low level set point. An alarm shall be generated and sent to the PLC.

When tank capacity reaches the high level, the storage tank inlet flow valves shall automatically close.

Remaining tank volume value shall be displayed on SCADA.

3.30.4.3 Sodium Bisulphite Containment Sump Operation LS-C980A

There shall be a level switch located in the sump pit of the sodium bisulphite storage containment area. In the event of a spill, an alarm signal shall be sent to the PLC.

3.30.4.4 Sodium Bisulphite Metering Pumps Operation

There shall be two duty sodium bisulphite metering pumps; one metering pump for the dosing stream to ozone contactor no. 1 and the other metering pump for the dosing stream to ozone contactor no. 2.

There shall be a standby metering pump available for both of the dosing streams.

If one of the operating duty pumps becomes unavailable then the standby pump shall be started, the duty pump outlet valve shall be closed, and the standby pump outlet valve shall be opened.

Whenever the duty pump fails, the standby pump shall run at the same speed that the unavailable pump was running. The operator shall be able to adjust the speed of the pump manually thought the SCADA/HMI system if required.

If both duty/standby pumps fail, plant shut down shall be initiated.

Each dosing stream shall also have standby manual changeover dosing line available in case of bursts or blockages.

Chemical dose is automatically calculated and controlled via control logic within the PLC. The dose delivered to cell 6 of ozone contactor no. 1 (TNK-O210A) and no. 2 (TNK-O230A) for ozone quenching is flow paced and adjusted to a dosage set point to achieve adequate ozone quenching in the ozone contactor cell as measured with the contactor’s cell 6 dissolved ozone analyzers.

Flow pacing shall be achieved through the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters.

Sodium bisulphite pump No. 1 (P-C950L) shall be flow paced by the Qtotal of all the DAF units in service divided by the number of Ozone Contactors in service.

Sodium bisulphite pump No. 2 (P-C970H) shall be flow paced by the Qtotal of all the DAF units in service divided by the number of Ozone Contactors in service.

The sodium bisulphite dose is calculated by multiplying the bisulphite dosage ratio by the measured dissolved ozone analyzers. The default dosage ratio is 2.2 mg/L of sodium bisulphite per mg of residual ozone, and can be adjusted by the operator.

Sodium Bisulphite Dosing Table

Scenario	Flow (ML/d)	Ozone Residual (mg/L)	$NaHSO_3$ Dose Required (mg/L)	$NaHSO_3$ Use		
				(kg/d)	(L/hr)	(L/d)
Maximum Flow, Average Residual	407	0.2	0.44	179	14.8	354
Maximum Flow, Maximum Residual	407	1	2.2	895	73.8	1,772
Average Flow, Average Residual	258	0.2	0.44	114	9.38	225
Minimum Flow, Minimum Residual[1]	102	0.05	0.11	11	0.9	22

Note: [1] *Assumes one contactor online.*

An alarm shall be sent to the PLC if the pump VSD is less than 10% or in excess of 95%. Remote start/stop capabilities shall be available; duty pump selection can be made locally. A totalizer shall monitor chemical use and pump runtime.

In PLC manual mode, chemical system parameters are selected by the operator via control logic within the PLC. The operator inputs the pump speed at the PLC, thus overriding the flow-paced control. The operator determines the speed required using the pump output curve.

In manual mode, the operator sets the pump speed directly at the pump. The operator determines the speed required using the pump output curve.

Sodium Bisulphite Metering Pumps Table

Parameter	Unit	Value
Number of Active Metering Pumps	#	2
Number of Standby Metering Pumps	#	1
Minimum Metering Pump Rate, Each	L/h	0.5
Average Metering Pump Rate (Avg. Flow, Avg. Dose), Each	L/h	4.7
Maximum Metering Pump Rate, Each	L/h	36.9
Metering Pump Turndown Ratio	-	73.8
Max. Turndown Potential Ratio		1000:1

3.30.4.5 Sodium Bisulphite Flow Meter FIT-C950A, FIT-C960A, and FIT-C970A

The PLC shall monitor the outlet flow from the metering pumps to the ozone contact no. 1 and ozone contact no. 2 and shall also display the instantaneous value on the SCADA.

The accumulated flow shall be displayed on the SCADA.

3.30.5 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LS-C980A	Containment sump level high	Alarm & Interlock	Shutdown system and generate alarm.
LIT-C940B	Low level in sodium bisulphite tank	Alarm & Interlock	An alarm shall be sent to the PLC/SCADA and inhibit metering pumps.
	Reorder level in sodium bisulphite tank	Alarm	An alarm shall be sent to PLC/SCADA to prompt operator to reorder more sodium bisulphite
	High level in sodium bisulphite tank	Alarm & Interlock	Raise alarm to PLC/SCADA and close tank inlet valve.
FT-C950A	Sodium bisulphite metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
FT-C960A	Sodium bisulphite metering pump is running and no flow detected	Alarm	Stop pump and take pump out of service. Generate alarm on SCADA.
	Instrument fault	Alarm	Hold last value and generate alarm on SCADA.
FT-C970A	Standby sodium bisulphite metering pump is running and no flow detected	Alarm & Interlock	Generate alarm on SCADA and initiate plant shutdown.
P-C950A / P-C970A	Duty and standby pumps fail	Alarm & Interlock	Plant shutdown and generate alarm on SCADA.
P-C960A / P-C970A	Duty and standby pumps fail	Alarm & Interlock	Plant shutdown and generate alarm on SCADA.

3.30.6 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
Sodium Bisulphite Tank TNK-C940 Reorder Level	

SCADA/HMI Operator Adjustable Set Points

Description	Range
Sodium Bisulphite Tank TNK-C940 in Service	

SCADA/HMI Status Signals

Description	Range
Sodium Bisulphite Tank TNK-C940 in Service	

SCADA/HMI Alarm Signals

Description	Range
All Sodium Bisulphite Metering Pumps Failed	
Stream 1 Sodium Bisulphite Metering Pump and Standby Failed	
Stream 2 Sodium Bisulphite Metering Pump and Standby Failed	

3.31 Overflows and Drainage

3.31.1 Documentation

WP-P0020 **P&ID DAF Area Process Sump Pumps**
WF-P0012 **P&ID Backwash Area Process Sump Pumps**
WH-P0001 **P&ID Sanitary Sump – Fire Pump Room**
WH-P0002 **P&ID Sanitary Sump – Backwash Pump Gallery**
WH-P0003 **P&ID Sanitary Sump – Elevator Pit**
WH-P0004 **P&ID Sanitary Sump – Administration Area**
WH-P0007 **P&ID Fire Pump Room Process Sump**

3.31.2 Plant and Instruments

Tag	Description	
DAF Area Process Sump Pumps		
AE-P981A	Sump Pump P-P981A Temperature Moisture Relay	
AE-P982A	Sump Pump P-P982A Temperature Moisture Relay	
AE-P983A	Sump Pump P-P983A Temperature Moisture Relay	
LCP-P981A	Sump Pumps P-P981A & P-P982A Local Starter/Control Panel	
LCP-P983A	Sump Pump P-P983A Local Starter/Control Panel	
LIT-P980A	Process Sump Level Duty Transmitter	
LIT-P980B	Process Sump Level Standby Transmitter	
P-P981A	DAF Gallery Process Sump Pump #1 (Jockey Pump)	
P-P982A	DAF Gallery Process Sump Pump #2 (Lead Pump)	
P-P983A	DAF Gallery Process Sump Pump #3 (Lag Pump)	
Backwash Area Process Sump Pumps		
AE-F981A	Sump Pump P-F981A Temperature Moisture Relay	
AE-F982A	Sump Pump P-F982A Temperature Moisture Relay	
AE-F982A	Sump Pump P-F982A Temperature Moisture Relay	
AE-F983A	Sump Pump P-F983A Temperature Moisture Relay	

Tag	Description	
LCP-F981A	Sump Pumps P-F981A & P-F982A Local Starter/Control Panel	
LCP-F983A	Sump Pump P-F983A Local Starter/Control Panel	
LCP-F984A	Sump Pump P-F984A Local Starter/Control Panel	
LIT-F980A	Process Sump Level Duty Transmitter	
LIT-F980B	Process Sump Level Standby Transmitter	
LS-F984A	Sump Low Level	
LS-F984B	Sump High Level	
P-F981A	Backwash Process Sump Pump #1	
P-F982A	Backwash Process Sump Pump #2	
P-F983A	Backwash Process Sump Pump #3	
P-F984A	Backwash Process Sump Pump #4	
Fire Pump Room Process Sump Pumps		
AE-H410A	Sump Pump P-H410A Temperature Moisture Relay	
AE-H420A	Sump Pump P-H420A Temperature Moisture Relay	
LCP-H410A	Sump Pump P-H410A Local Starter/Control Panel	
LCP-H420A	Sump Pump P-H420A Local Starter/Control Panel	
LIT-H400A	Process Sump Level Duty Transmitter	
LIT-H400B	Process Sump Level Standby Transmitter	
P-H410A	Backwash Process Sump Pump #1	
P-H420A	Backwash Process Sump Pump #2	
Sanitary Sump in Fire Pump Room		
AY-H501A	Sump Pump P-H501A Temperature Moisture Relay	
AY-H502A	Sump Pump P-H502A Temperature Moisture Relay	
HS-H500A	Pump Selector	
LS-H500A	Sump Low Low Level	
LS-H500B	Sump Low Level	
LS-H500C	Sump High Level	
LS-H500D	Sump High High Level	
P-H501A	Sump Pump #1	
P-H502A	Sump Pump #2	
Sanitary Sump in Backwash Pump Gallery		
AY-H511A	Sump Pump P-H511A Temperature Moisture Relay	
AY-H512A	Sump Pump P-H512A Temperature Moisture Relay	
HS-H510A	Pump Selector	

Tag	Description	
LS-H510A	Sump Low Low Level	
LS-H510B	Sump Low Level	
LS-H510C	Sump High Level	
LS-H510D	Sump High High Level	
P-H511A	Sump Pump #1	
P-H512A	Sump Pump #2	
Sanitary Sump in Elevator Pit		
HS-H520A	Pump Start	
LS-H520A	Sump Low Level	
LS-H520B	Sump High Level	
P-H521A	Sump Pump #1	
Sanitary Sump in Administration Area		
AY-H531A	Sump Pump P-H531A Temperature Moisture Relay	
AY-H532A	Sump Pump P-H532A Temperature Moisture Relay	
HS-H530A	Pump Selector	
LS-H530A	Sump Low Low Level	
LS-H530B	Sump Low Level	
LS-H530C	Sump High Level	
LS-H530D	Sump High High Level	
P-H531A	Sump Pump #1	
P-H532A	Sump Pump #2	

DAF Area Process Sump Pumps

3.31.3 General Operation

A dedicated process sump has been provided to deal with major leaks in the DAF Influent Gallery and the DAF Pump Gallery. The process sump is located at the floor of the DAF Influent Gallery. The process sump shall be equipped with grating and the edge of the process sump shall be approximately 25 mm above the floor level to ensure that washwater or other minor spills are directed to the floor drain system and removed via the sanitary sump pumps. In the event the water level on the floor rises above the 25 mm ledge, water shall be collected in the process sump.

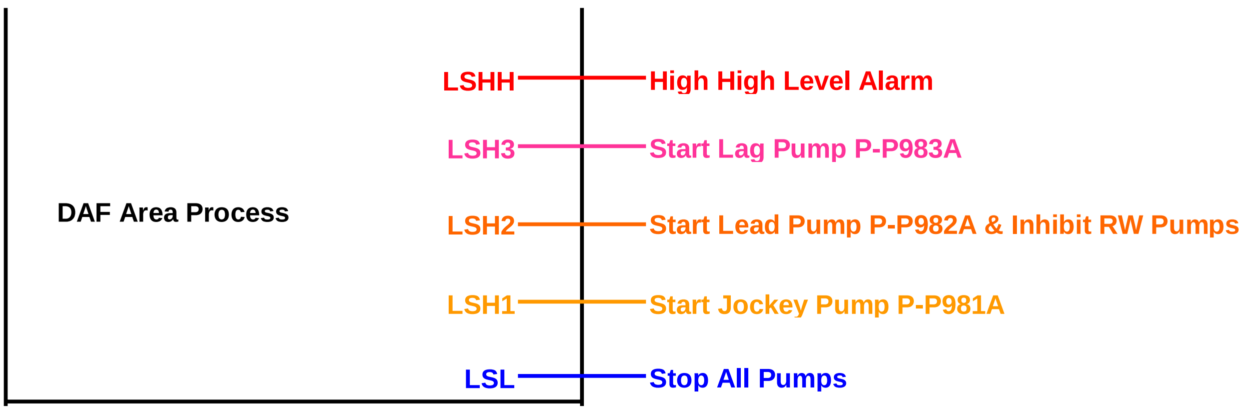
Three submersible process sump pumps shall be provided, one small jockey pump and two larger pumps operating in a lead-lag mode controlled by the sump level transmitter. The jockey pump has been designed to deal with a smaller leak, the equivalent of a 100 mm pipe leak at approximately 40 L/s. The two larger pumps have been sized to deal with the worst case scenario that of a coupling leak on the 1350 mm water main. It is estimated that a leak around a valve would be equivalent to approximately 340 L/s.

3.31.4 Automatic Control Philosophy

3.31.4.1 DAF Area Process Sump Level Transmitters LIT-P980A, LIT-P980B

The liquid level in the DAF area process sump shall be measured by duty/standby ultrasonic level transmitters. Duty/standby transmitter operation shall be selected at SCADA. In the event of the duty transmitter becomes unavailable, level control shall be automatically transferred to the standby transmitter.

There shall be five set points:



Level Set Points	Action(s)
Level High High	In the event where the level reaches this point, a high high alarm shall be generated to SCADA indicating the sump pumps are not keeping up with the flow.
Level High 3	In the event where the level reaches this point, a high 3 level alarm shall be generated to SCADA and the lag process pump P-P983A shall start.
Level High 2	In the event where the level reaches this point, a high 2 level alarm shall be generated to SCADA and the lead process pump P-P982A shall start. The jockey sump pump P-P981A shall stop after a 10 second time delay after the lead process pump has started. The raw water pumps shall also be inhibited at this time.
Level High 1	In the event where the level reaches this point, a high 1 level alarm shall be generated to SCADA and the jockey pump P-P981A shall start.
Level Low	In the event where the level reaches this point, all pumps shall be stopped.

3.31.4.2 DAF Area Process Sump Pumps Operation P-P981A, P-P982A, P-P983A

There shall be three process sump pumps – jockey, lead, and lag pumps. The operation of the pumps shall be controlled by the measured level from the sump level transmitters as stated above.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

Backwash Area Process Sump Pumps

3.31.5 General Operation

The backwash process sump is located north of the BWS pumps, in the backwash pump gallery. It is equipped with three process sump pumps, as well as one small transfer pump to the sanitary sump. The three process sump pumps shall operate in a lead-lag-lag mode and be controlled by duty/standby transmitters. The small transfer pump shall be controlled by two level switches. The pump sizes and capacities, as well as sump dimensions, are indicated in the table below.

Item	Values	Units
Backwash Process Sump – Physical Dimensions		
Length	3.5	m
Width	1	m
Depth	1.5	m
Capacity	5.25	m3
Process Sump Pumps (P-F981A/982A)		
Maximum Flow Rate	2.5	ML/d
Maximum Total Dynamic Head (TDH)	10.4	m
Pump Type	Submersible	-
Power (per unit)	7.5	kW
Process Sump Pumps (P-F983A)		
Maximum Flow Rate	14.1	ML/d
Maximum Total Dynamic Head (TDH)	10.4	m
Pump Type	Submersible	-
Power (per unit)	35	kW
Process Sump Pumps (P-F984A)		
Maximum Flow Rate	0.17	ML/d
Maximum Total Dynamic Head (TDH)	1.7	m
Pump Type	Submersible	-
Power (per unit)	0.37	kW

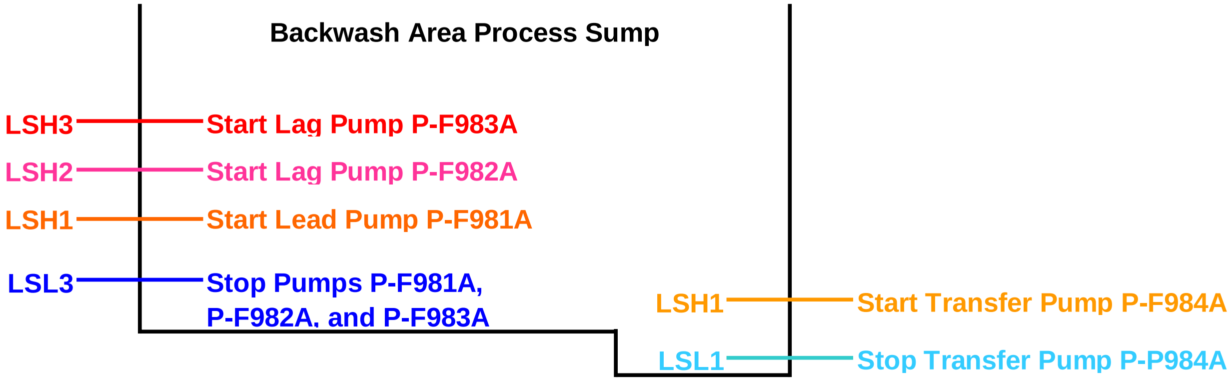
3.31.6 Automatic Control Philosophy

3.31.6.1 Backwash Area Process Sump Level Transmitters LIT-F980A, LIT-F980B and Level Switches LS-F984A, LS-F984B

The liquid level in the backwash area process sump shall be measured by duty/standby ultrasonic level transmitters. Duty/standby transmitter operation shall be selected at SCADA. In the event of the duty transmitter becomes unavailable, level control shall be automatically transferred to the standby transmitter.

High and low level set points for pumps P-F981A, P-F982A, and P-F983A shall be controlled by the level transmitters. High and low level set points for pumps P-F984A shall be controlled by two level switches LS-F984A and LS-F984B.

There shall be a total of six set points:



Level Set Points	Action(s)
Level High 4 (FT-F980A/B)	In the event where the level reaches this point, a high 4 level alarm shall be generated to SCADA and pump P-F983A shall start.
Level High 3 (FT-F980A/B)	In the event where the level reaches this point, a high 3 level alarm shall be generated to SCADA and pump P-F982A shall start.
Level High 2 (FT-F980A/B)	In the event where the level reaches this point, a high 2 level alarm shall be generated to SCADA and pump P-F981A shall start.
Level High 1 (LS-F984A)	In the event where the level reaches this point, a high 1 level alarm shall be generated to SCADA and pump P-P984A shall be inhibited.
Level Low 1 (LS-F984B)	In the event where the level reaches this point, a low 1 level alarm shall be generated to SCADA and pump P-P984A shall start.
Level Low 2 (FT-F980A/B)	In the event where the level reaches this point, a low 2 level alarm shall be generated to SCADA and pumps P-P981A, P-P982A, P-P983A shall stop.

3.31.6.2 Backwash Area Process Sump Pumps Operation P-F981A, P-F982A, P-F983A, P-F984A

There shall be three process sump pumps – lead, lag and lag pumps. The operation of the pumps shall be controlled by the measured level from the sump level transmitters as stated above. In the event where a leak occurs which is too large for the sanitary sump pump to handle, the water level in the process sump shall rise and pumps P-F981A, P-F982A, and P-F983A shall start their lead, lag, lag pump operation. Pumps P-F981A, P-F982A, and P-F983A shall pump the overflow to the floodway.

There shall also be a fourth pump in the sump which is a transfer pump to the sanitary sump. Once the leakage in the sump has decreased to level low 1, pump P-F984A shall begin to completely empty the process sump to the sanitary sump.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

Process Sump in Fire Pump Room

3.31.7 General Operation

There shall be two submersible process sump pumps provided in the process sump in the fire pump room. Leakages in the fire pump room floor are directed to the sump. The sump pumps shall transfer the fluid to the DAF overflow channel.

The process sump pumps shall operate in a lead-lag mode controlled by duty/standby ultra-sonic transmitters.

3.31.8 Automatic Control Philosophy

3.31.8.1 Fire Pump Room Process Sump Level Transmitters LIT-H400A, LIT-H400B

The liquid level in the fire pump room process sump shall be measured by duty/standby ultrasonic level transmitters. Duty/standby transmitter operation shall be selected at SCADA. In the event of the duty transmitter becomes unavailable, level control shall be automatically transferred to the standby transmitter.

There shall be a total of four set points:

Level Set Points	Action(s)
Level High High	In the event where the level reaches this point, a high high level alarm shall be generated to SCADA.
Level High	In the event where the level reaches this point, a high level alarm shall be generated to SCADA and pump P-H420A shall start.
Level Lead Pump Start	In the event where the level reaches this point, a pump start alarm shall be generated to SCADA and pump P-H410A shall start.
Level Low	In the event where the level reaches this point, a low low level alarm shall be generated to SCADA and all pumps shall stop.

3.31.8.2 Fire Pump Room Process Sump Pumps Operation P-H410A, P-H420A

There shall be two process sump pumps – lead and lag pumps. The operation of the pumps shall be controlled by the measured level from the sump level transmitters as stated above. In the event where the water level in the process sump shall rise, pumps P-H410A and P-H420A shall start their lead lag pump operation. Pumps P-H410A, P-H420A shall pump the overflow to the DAF overflow channel.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

Sanitary Sump in Fire Pump Room

3.31.9 General Operation

There shall be two submersible process sump pumps provided in the sanitary sump of the fire pump room. Leakages or pipe bursts in the fire pump room are directed to the floor drain and shall enter the sanitary sump. The sump pumps shall transfer the fluid to the sanitary sump in the administration area.

The process sump pumps shall operate in a lead-lag mode controlled by four level switches.

3.31.10 Automatic Control Philosophy

3.31.10.1 Sanitary Sump in Fire Pump Room Level Switches LS-H500A, LS-H500B, LS-H500C, LS-H500D

There shall be four level switches: low low, low, high, and high high. In the event of a low low level detection, all pumps shall be stopped. In the event of a lead pump start level detection, the lead pump shall start. In the event of a high level detection, the lag pump shall start. In the event of a high high level detection, both pumps shall continue to run and an alarm shall be generated to SCADA

3.31.10.2 Sanitary Sump in Fire Pump Room Sump Pumps Operation P-H501A, P-H502A

There shall be two process sump pumps – lead and lag pumps. The operation of the pumps shall be controlled by the level switches as described above. There shall be a hand switch for the operator to manually select which pump shall be lead pump.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

Sanitary Sump in Backwash Pump Gallery

3.31.11 General Operation

There shall be two submersible process sump pumps provided in the sanitary sump of the backwash pump gallery. Sanitary flow from the floor drains in the filter area and backwash process area shall be directed to the backwash pump gallery sanitary sump. The sump pumps shall transfer the fluid to the sanitary sump in the DAF pump gallery and sanitary sump in the administration area.

The process sump pumps shall operate in a lead-lag mode controlled by four level switches.

3.31.12 Automatic Control Philosophy

3.31.12.1 Sanitary Sump in Backwash Pump Gallery Level Switches LS-H510A, LS-H510B, LS-H510C, LS-H510D

There shall be four level switches: low low, low, high, and high high. In the event of a low low level detection, all pumps shall be stopped. In the event of a lead pump start level detection, the lead pump shall start. In the event of a high level detection, the lag pump shall start. In the event of a high high level detection, both pumps shall continue to run and an alarm shall be generated to SCADA.

3.31.12.2 Sanitary Sump in Backwash Pump Gallery Sump Pumps Operation P-H511A, P-H512A

There shall be two process sump pumps – lead and lag pumps. The operation of the pumps shall be controlled by the level switches as described above. There shall be a hand switch for the operator to manually select which pump shall be lead pump.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

Sanitary Sump in Elevator Pit

3.31.13 General Operation

There shall be one submersible process sump pump provided in the sanitary sump of in the elevator pit. Sanitary flow from the floor drain in elevator pit shall be directed to the elevator pit sump. The sump pump shall transfer the fluid to the sanitary sump in the DAF pump gallery and sanitary sump in the administration area.

The process sump pump shall be controlled by two level switches.

3.31.14 Automatic Control Philosophy

3.31.14.1 Sanitary Sump in Elevator Pit Level Switches LS-H520A, LS-H520B

There shall be two level switches: low and high. In the event of a low level detection, the pump shall be inhibited. In the event of a high level the pump shall start.

3.31.14.2 Sanitary Sump in Elevator Pit Pump Operation P-H521A

The operation of the pump shall be controlled by the level switches as described above. There shall be a hand switch for the operator to start the pump. The pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm on SCADA.

Sanitary Sump in Administration Area

3.31.15 General Operation

There shall be two submersible process sump pumps provided in the sanitary sump of the administration area. Sanitary flow from the floor drains in the sanitary sump in the fire pump room, backwash pump gallery, chemical system area, west administration area, second and third floor of administration area and including the gutter drains in RWPS area shall all be directed to administration sanitary sump. The sump pumps shall transfer the fluid to dewatering cell lift station.

The process sump pumps shall operate in a lead-lag mode controlled by four level switches.

3.31.16 Automatic Control Philosophy

3.31.16.1 Sanitary Sump in Administration Area Level Switches LS-H530A, LS-H530B, LS-H530C, LS-H530D

There shall be four level switches: low low, low, high, and high high. In the event of a low low level detection, all pumps shall be stopped. In the event of a lead pump start level detection, the lead pump shall start. In the event of a high level detection, the lag pump shall start. In the event of a high high level detection, both pumps shall continue to run and an alarm shall be generated to SCADA.

3.31.16.2 Sanitary Sump in Administration Area Sump Pumps Operation P-H531A, P-H532A

There shall be two process sump pumps – lead and lag pumps. The operation of the pumps shall be controlled by the level switches as described above. There shall be a hand switch for the operator to manually select which pump shall be lead pump.

Each pump shall have a temperature moisture relay. In the event of a broken pump seal, the moisture relay shall signal the control panel to stop the pump and generate an alarm to SCADA.

3.31.17 Failure and Interlock Conditions

The table below identifies how the control system responds to key failure and process interlock conditions in addition to the standard provisions of Appendix 1.

Tag	Event	Type	Control System Action
LIT-P980A/ LIT-P980B	Instrument Fault	Alarm	When duty transmitter fails, switch over the standby transmitter. Generate alarm to SCADA.
	DAF Process Sump High High Level	Alarm	Triggers an Alarm that indicates that the Sump pumps are not keeping up with the flow
	DAF Process Sump High 3 Level	Alarm and Interlock	Start the lag sump pump P-P983A and generate alarm to SCADA.
	DAF Process Sump High 2 Level	Alarm and Interlock	Start lead process sump pump P-P982A and stop the jockey sump pump P-P981A after a 10 second time delay. Inhibit the raw water pumps once the lead process sump pump has started. Raise alarm to SCADA.
	DAF Process Sump High 1 Level	Alarm and Interlock	Start jockey sump pump P-P981A and generate alarm to SCADA.
	DAF Process Sump Low Level	Interlock	Stop all sump pumps and generate alarm to SCADA.
LIT-F980A/ LIT-F980B	Instrument Fault	Alarm	When duty transmitter fails, switch over the standby transmitter. Generate alarm to SCADA.
	Backwash Process Sump High 4 Level	Alarm and Interlock	Start the lag sump pump P-F983A and generate alarm to SCADA.
	Backwash Process Sump High 3 Level	Alarm and Interlock	Start the lag sump pump P-F982A and generate alarm to SCADA.
	Backwash Process Sump High 2 Level	Alarm and Interlock	Start the lead sump pump P-F981A and generate alarm to SCADA.
	Backwash Process Sump Low 2 Level	Alarm and Interlock	Stop the sump pumps P-F981A, P-F982A, and P-F983A and generate alarm to SCADA.

Tag	Event	Type	Control System Action
LS-F984A	Backwash Process Sump Low 1 Level	Alarm and Interlock	Start the sump pump P-F984A and generate alarm to SCADA.
LS-F984B	Backwash Process Sump High 1 Level	Alarm and Interlock	Stop the sump pump P-F984A and generate alarm to SCADA.
LIT-H400A/ LIT-H400B	Instrument Fault	Alarm	When duty transmitter fails, switch over the standby transmitter. Generate alarm to SCADA.
	Process Sump in Fire Pump Room Low Low Level	Interlock	Stop all pumps and generate alarm to SCADA.
	Process Sump in Fire Pump Room Start Lead Pump Level	Interlock	Start lead sump pump.
	Process Sump in Fire Pump Room High Level	Interlock	Start lag sump pump.
	Process Sump in Fire Pump Room High High Level	Alarm	Generate alarm to SCADA.
LS-H500A	Sanitary Sump in Fire Pump Room Low Low Level	Interlock	Inhibit sump pumps P-H501A and P-H502A.
LS-H500B	Sanitary Sump in Fire Pump Room Start Lead Pump Level	Interlock	Start lead sump pump.
LS-H500C	Sanitary Sump in Fire Pump Room High High Level	Alarm	Generate alarm to SCADA.
LS-H500D	Sanitary Sump in Fire Pump Room High Level	Interlock	Start lag sump pump.
LS-H510A	Sanitary Sump in Backwash Pump Gallery Low Low Level	Interlock	Inhibit sump pumps P-H511A and P-H512A.
LS-H510B	Sanitary Sump in Backwash Pump Gallery Start Lead Pump Level	Interlock	Start lead sump pump.
LS-H510C	Sanitary Sump in Backwash Pump Gallery High High Level	Alarm	Generate alarm to SCADA.
LS-H510D	Sanitary Sump in Backwash Pump Gallery High Level	Interlock	Start lag sump pump.
LS-H520A	Sanitary Sump in Elevator Pit Low Level	Interlock	Start sump pump P-H521A.

Tag	Event	Type	Control System Action
LS-H520B	Sanitary Sump in Elevator Pit High Level	Interlock	Inhibit sump pump P-H521A.
LS-H530A	Sanitary Sump in Administration Area Low Low Level	Interlock	Inhibit sump pumps P-H531A and P-H532A.
LS-H530B	Sanitary Sump in Administration Area Start Lead Pump Level	Interlock	Start lead sump pump.
LS-H530C	Sanitary Sump in Administration Area High High Level	Alarm	Generate alarm to SCADA.
LS-H530D	Sanitary Sump in Administration Area High Level	Interlock	Start lag sump pump.

3.31.18 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

SCADA/HMI Engineer Adjustable Set Points

Description	Range
DAF Area Process Sump Pump P-P981A Start Level	xx%
DAF Area Process Sump Pump P-P982A Start Level	xx%
DAF Area Process Sump Pump P-P983A Start Level	xx%
DAF Area Process Sump Pumps P-P981A, P-P982A, P-P983A Stop Level	xx%
Backwash Area Process Sump Pump P-F981A Start Level	xx%
Backwash Area Process Sump Pump P-F982A Start Level	xx%
Backwash Area Process Sump Pump P-F983A Start Level	xx%
Backwash Area Process Sump Pumps P-F981A, P-F982A, P-F983A Stop Level	xx%
Backwash Area Process Sump Pump P-F984A Start Level	xx%
Backwash Area Process Sump Pump P-F984A Stop Level	xx%
Process Sump in Fire Pump Room Process Sump Pump P-H410A Start Level	xx%
Process Sump in Fire Pump Room Process Sump Pump P-H420A Start Level	xx%
Sanitary Sump in Fire Pump Room Process Sump Pump P-H501A Start Level	xx%
Sanitary Sump in Fire Pump Room Process Sump Pump	xx%

Description	Range
P-H501A Stop Level	
Sanitary Sump in Fire Pump Room Process Sump Pump P-H502A Start Level	xx%
Sanitary Sump in Fire Pump Room Process Sump Pump P-H502A Stop Level	xx%
Sanitary Sump in Backwash Pump Gallery Process Sump Pump P-H511A Start Level	xx%
Sanitary Sump in Backwash Pump Gallery Process Sump Pump P-H511A Stop Level	xx%
Sanitary Sump in Backwash Pump Gallery Process Sump Pump P-H512A Start Level	xx%
Sanitary Sump in Backwash Pump Gallery Process Sump Pump P-H512A Stop Level	xx%
Sanitary Sump in Elevator Pit Process Sump Pump P-H521A Start Level	xx%
Sanitary Sump in Elevator Pit Process Sump Pump P-H521A Stop Level	xx%
Sanitary Sump in Administration Area Process Sump Pump P-H531A Start Level	xx%
Sanitary Sump in Administration Area Process Sump Pump P-H531A Stop Level	xx%
Sanitary Sump in Administration Area Process Sump Pump P-H532A Start Level	xx%
Sanitary Sump in Administration Area Process Sump Pump P-H532A Stop Level	xx%

SCADA/HMI Operator Adjustable Set Points

Description	Range
DAF Area Process Sump Level Transmitter LIT-P980A Duty/Standby	
DAF Area Process Sump Level Transmitter LIT-P980B Duty/Standby	
Backwash Area Process Sump Level Transmitter LIT-F980A Duty/Standby	
Backwash Area Process Sump Level Transmitter LIT-F980B Duty/Standby	
Fire Pump Room Process Sump Level Transmitter LIT-H400A Duty/Standby	
Fire Pump Room Process Sump Level Transmitter LIT-H400B Duty/Standby	
Sanitary Sump in Fire Pump Room Process Sump Pump Selection	
Sanitary Sump in Backwash Pump Gallery Process Sump Pump Selection	
Sanitary Sump in Administration Area Process Sump Pump Selection	

SCADA/HMI Status Signals

Description	Range
DAF Area Process Sump Level Transmitter LIT-P980A Duty/Standby	
DAF Area Process Sump Level Transmitter LIT-P980B Duty/Standby	
Backwash Area Process Sump Level Transmitter LIT-F980A Duty/Standby	
Backwash Area Process Sump Level Transmitter LIT-F980B Duty/Standby	
Fire Pump Room Process Sump Level Transmitter LIT-H400A Duty/Standby	
Fire Pump Room Process Sump Level Transmitter LIT-H400B Duty/Standby	

SCADA/HMI Alarm Signals

None

3.32 Water Quality

3.32.1 Documentation

WP-P0001	**P&ID Flocculation and DAF**
WP-P0017	**P&ID DAF Effluent Channel**
WF-P0001	**P&ID Filter No. 1**
WF-P0002	**P&ID Filter No. 2**
WF-P0003	**P&ID Filter No. 3**
WF-P0004	**P&ID Filter No. 4**
WF-P0005	**P&ID Filter No. 5**
WF-P0006	**P&ID Filter No. 6**
WF-P0007	**P&ID Filter No. 7**
WF-P0008	**P&ID Filter No. 8**
WT-P001	**P&ID Clearwell Process and Instrumentation**
WD-P0006	**P&ID Branch 2 Process and Instrumentation**
WD-P0013	**P&ID Branch 2 Process and Instrumentation**
WR-P0006	**P&ID Washwater Recovery Tanks / Flocculation Chamber**
WR-P0008	**P&ID Gravity Thickeners**
WR-P0009	**P&ID Thickened Sludge Equalization Tanks**
WR-P0007	**P&ID Supernatant Pump Station**
CPG0465-I-01 Sheet 4 of 7	**P&ID On-Site Sodium Hypochlorite Generation System**
CPG0465-I-01 Sheet 5 of 7	**P&ID On-Site Sodium Hypochlorite Generation System**
CPG0465-I-01 Sheet 6 of 7	**P&ID On-Site Sodium Hypochlorite Generation System**
CPG0465-I-01 Sheet 7 of 7	**P&ID On-Site Sodium Hypochlorite Generation System**

3.32.2 Plant and Instruments

Tag	Description
Parallel Flash Mixers Trains 1 & 2	

Tag	Description	
AT-I024B	Train1 Raw Water pH	
AT-I025B	Train1 Post Flash Mixer Raw Water pH	
AT-I027B	Train2 Raw Water Turbidity	
AT-I026B	Train2 Post Flash Mixer Raw Water pH	
Common DAF Effluent Channel		
AE-P975A	Turbidity Analyzer	
AE-P976A	pH Analyzer	
Biological Activated Carbon Filters (BAC) 1 to 8		
AT-F110A	Filter TNK-F100A Outlet Turbidity	
AT-F110B	Filter TNK-F100A Outlet Particle Count	
AT-F210A	Filter TNK-F200A Outlet Turbidity	
AT-F210B	Filter TNK-F200A Outlet Particle Count	
AT-F310A	Filter TNK-F300A Outlet Turbidity	
AT-F310B	Filter TNK-F300A Outlet Particle Count	
AT-F410A	Filter TNK-F400A Outlet Turbidity	
AT-F410B	Filter TNK-F400A Outlet Particle Count	
AT-F510A	Filter TNK-F500A Outlet Turbidity	
AT-F510B	Filter TNK-F500A Outlet Particle Count	
AT-F610A	Filter TNK-F600A Outlet Turbidity	
AT-F610B	Filter TNK-F600A Outlet Particle Count	
AT-F710A	Filter TNK-F700A Outlet Turbidity	
AT-F710B	Filter TNK-F700A Outlet Particle Count	
AT-F810A	Filter TNK-F800A Outlet Turbidity	
AT-F810B	Filter TNK-F800A Outlet Particle Count	
Clearwell Water Quality Analyzer Systems		
AIT-T104A	Clearwell Total Chlorine, Total Ammonia, Free Ammonia and Monochloramine	
AIT-T105A	Clearwell Free Chlorine	
AIT-T106A	Clearwell pH	
AIT-T107A	Clearwell Turbidity	
AIT-T204A	Clearwell Total Chlorine, Total Ammonia, Free Ammonia and Monochloramine	
AIT-T205A	Clearwell Free Chlorine	
AIT-T206A	Clearwell pH	
AIT-T207A	Clearwell Turbidity	

Tag	Description	
Deacon Branch 1 & 2 Discharge		
AIT-D901A	DBPS Total Chlorine, Total Ammonia, Free Ammonia and Monochloramine	
AIT-D902A	DBPS Free Chlorine Analyzer	
AIT-D903A	DBPS pH Analyzer	
AIT-D911A	DBPS Total Chlorine, Total Ammonia, Free Ammonia and Monochloramine	
AIT-D912A	DBPS Free Chlorine Analyzer	
AIT-D913A	DBPS pH Analyzer	
Washwater Recovery Tanks - Flocculation Chamber FC-R001		
AIT-R001A	Washwater Recovery Tanks Solids to Flocculation Chamber Suspended Solids Monitor	
Gravity Thickeners No. 1 & 2		
AT-R500B	Gravity Thickener No.1 GT-R500A TSS	
AT-R500C	Gravity Thickener No.1 GT-R500A Turbidity	
AT-R600B	Gravity Thickener No.2 GT-R600A TSS	
AT-R600C	Gravity Thickener No.2 GT-R600A Turbidity	
Thickened Sludge Equalization Tank		
AIT-R730B	Thickened Sludge to Freeze Thaw Ponds TSS	
Supernatant Pumping Station		
AIT-R024A	Supernatant Pump Station Outlet Turbidity/TSS	
Hypochlorite Generation and Storage Plant		
AT-J001B	Hardness Monitor	

<u>Parallel Flash Mixers Trains 1 & 2</u>

3.32.3 Automatic Control Philosophy

3.32.3.1 Turbidity Monitoring

Both parallel flash mixer trains shall have sample lines installed which shall take a water sample to a turbidity analyzer. The analyzer output shall be monitored and displayed by the control system if the train is in service. The sample flow to each analyzer shall be monitored by a flow switch, if the train is in service and a low sample flow is detected an alarm shall be raised on SCADA/HMI.

3.32.3.2 pH Monitoring

Both parallel flash mixer trains shall have sample lines installed which shall take a water sample to a pH analyzer. The analyzer output shall be monitored and displayed by the control system if the train is in service. The sample flow to each analyzer shall be monitored by a flow switch, if the train is in service and a low sample flow is detected an alarm shall be raised on SCADA/HMI.

DAF Flocculation / Tanks 1 to 8

3.32.4 Automatic Control Philosophy

3.32.4.1 DAF Effluent Channel Turbidity Analyzer

The effluent from the channel shall be continuously analyzed by an inline instrument. Samples to the analyzer shall normally be taken from both sides of the channel and a flow switch shall monitor the sample line flow.

In the event of high turbidity being measured an alarm shall be raised on SCADA.

3.32.4.2 DAF Effluent Channel pH Analyzer

The effluent from the channel shall be continuously analyzed by an inline instrument. Samples to the analyzer shall normally be taken from both sides of the channel and a flow switch shall monitor the sample line flow.

In the event of high and low pH being measured an alarm shall be raised on SCADA.

Biological Activated Carbon Filters (BAC) 1 to 8

3.32.5 Automatic Control Philosophy

3.32.5.1 Filter Outlet Turbidity

If the turbidity analyzer in the outlet of a filter detects a high level for a preset time then an alarm shall be raised on SCADA and the operator can initiate a backwash if required.

If the turbidity analyzer in the outlet of a filter detects a high high level for a preset time then the filter shall be placed in the backwash queue.

During filter ripening when the filter is in FTR mode, the turbidity of the filter effluent shall be monitored and if it remains above a pre-set limit after the FTR time period has expired, the filter shall continue in FTR mode and an alarm shall be raised on SCADA.

3.32.5.2 Filter Outlet Particle Count

If the particle count analyzer in the outlet of a filter detects a high level for a preset time then an alarm shall be raised on SCADA and the operator can initiate a backwash if required.

During filter ripening when the filter is in FTR mode, the particle count of the filter effluent shall be monitored and if it remains above a pre-set limit after the FTR time period has expired, the filter shall continue in FTR mode and an alarm shall be raised on SCADA.

Clearwell

3.32.6 Automatic Control Philosophy

3.32.6.1 Water Quality Analyzer Systems

Two complete systems of water quality analytical instruments shall continuously monitor the water as it enters the Clearwell. The sample water shall be provided by a pump for each system.

- SP-T103A
- SP-T203A

Both pumps shall start as soon as the level in the Clearwell rises above the low level set point for a pre-set time. Once the pumps have started, the sample flow to the analyzers shall be monitored by flow switches installed on the rotameter of each instrument.

The analyzer systems shall work as a duty standby arrangement, so that if any individual duty analyzer fails and the standby analyzer is available, then the operator shall switch to the standby instrument. Both the duty and standby analyzer outputs shall be continuously displayed on the SCADA/HMI, the duty and standby designation shall be displayed to indicate the current status of each signal. A list of parameters measured is shown below.

- Turbidity
- pH
- Free Chlorine
- Total Chlorine
- Free Ammonia
- Monochloramine

The water quality signals shall be used to control the dosing of various chemicals as well as monitoring water quality. Refer to Sections 3.25 and 3.26 of this document for details on dosing control.

In the event where the measured level of pH, free chlorine, total chlorine, free ammonia, or monochloramine is out of range for a time period, an alarm shall be raised on SCADA. Raw water pumps shall be stopped, deacon pumps shall be stopped and the Clearwell outlet sluice gates (SLG-T102A and SLG-T202A).

Deacon Booster Pumps

3.32.7 Automatic Control Philosophy

3.32.7.1 Water Quality Analyzer Systems

Two complete systems of water quality analytical instruments shall continuously monitor the water as it leaves DBPS.

The analyzer systems shall work as a duty standby arrangement, so that if any individual duty analyzer fails and the standby analyzer is available, then the operator shall switch to the standby instrument. Both the duty and standby analyzer outputs shall be continuously displayed on the SCADA/HMI, the duty and standby designation shall be displayed to indicate the current status of each signal. A list of parameters measured is shown below.

- Free Chlorine
- Total Chlorine
- Free Ammonia
- Monochloramine
- pH

Washwater Recovery Tanks 1 to 4

3.32.8 Automatic Control Philosophy

3.32.8.1 Supernatant Quality

The supernatant quality from the WRT shall be monitored by a turbidity/TSS analyzer. The analyzer shall be supplied by a sample pump SP-R010A. The pump operation shall be interlocked with the decant valves in the WRTs so that it shall not run unless a decant valve is open. Whenever there are no decant valves open the reading from the analyzer shall be ignored by the control system.

3.32.8.2 Washwater Recovery Tank Turbidity/TSS Level

A TSS/Turbidity monitor with adjustable sensor level shall be provided to record the supernatant and solids characteristics. The TSS/turbidity monitor shall have capabilities to switch between either TSS or turbidity reading. Depending upon the zone of detection i.e. solids or supernatant, the operator can switch the unit into appropriate mode and lower (for solids) or raise (for supernatant) the sensor position in the tank by adjusting the sensor holder from the top of the tank. The intent is that the WRT TSS/turbidity equipment readings shall be utilized for solid settling time or solids concentration trend observation and manual input into the SCADA and not for an online day to day control.

3.32.8.3 Turbidity/TSS Monitor AIT-R001A

For TSS monitoring, a TSS/turbidity monitor shall be installed upstream of the solids flow meter, the output of which shall be used for trending and monitoring. If the flow meter detects a flow, TSS/Turbidity shall be recorded and displayed.

Gravity Thickeners No. 1 & 2

3.32.9 Automatic Control Philosophy

3.32.9.1 Turbidity Monitors AT-R500C, AT-R600C

For supernatant quality monitoring, an adjustable Turbidity monitor shall be installed near the supernatant decant trough. In the event of high supernatant turbidity, an alarm shall be generated on SCADA.

3.32.9.2 TSS Monitors AT-R500B, AT-R600B

The analyzer sensor can be used to measure the solids zone depth, and then be used to control the thickened sludge decant time. In the event of a high TSS value, the thickened sludge decant valve shall be opened until the TSS value falls below a pre-determined level when it shall be closed again.

Thickened Sludge Equalization Tanks

3.32.10 Automatic Control Philosophy

3.32.10.1 Thickened Sludge TSS Outlet Monitor

For TSS monitoring, an adjustable TSS and Turbidity monitor shall be installed and shall be used for trending.

Supernatant Pumping Station

3.32.11 Automatic Control Philosophy

3.32.11.1 Turbidity/TSS Monitor

A turbidity/TSS monitor shall be provided to record the effluent characteristics.

Hypochlorite Generation and Storage Plant

3.32.12 Automatic Control Philosophy

3.32.12.1 Hardness Monitor

The hardness monitor shall continuously monitor the sample softened water inlet flow to the brine tanks. Equipment readings shall be an input into the SCADA and, an alarm shall be raised when the total hardness exceeds the set point after two "hard" readings. When the capacity of the water softener is exhausted, regeneration shall automatically start. The alarm is automatically cancelled after one "soft" reading from the hardness monitor.

3.32.13 Failure and Interlock Conditions

Tag	Event	Type	Control System Action
Common DAF Effluent Channel			
AIT-P975A	High turbidity	Alarm	Alarm on SCADA
AIT-P976A	High pH	Alarm	Alarm on SCADA
Filter No. 1-8 The following list of actions applies to all filters.			
AT-F110A	Turbidity analyzer fault/ out of limits	Fault	Instrument output shall go high, filter shall be taken out of service.
	Outlet turbidity high	Alarm	Alarm only, operator can manually Instigate filter backwash
	Outlet turbidity high high	Alarm	Automatically stop filter run, put in backwash queue

Tag	Event	Type	Control System Action
AT-F110B	Particle Counter fault/ out of limits	Fault	Instrument output shall go high, filter shall be taken out of service.
	Outlet particle count high	Alarm	Alarm only, operator can manually Instigate filter backwash
Clearwell			
AIT-T*04A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*05A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*06A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-T*07A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
Deacon Branch 1 & 2 Discharge			
AIT-D9*1A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-D9*2A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
AIT-D9*3A	Instrument Fault	Fault	Instrument configured to generate alarm on SCADA and operator shall manually switch to standby instrument.
Gravity Thickeners 1 & 2			
AT-R500B AT-R600B	High TSS	Interlock	Initiate thickened sludge decant valve opening.
Hypochlorite Generation and Storage Plant			
AT-J1001B	High hardness level	Alarm	After two "hard" readings, generate alarm to SCADA.

3.32.14 System Set Points, Status and Alarms

The following requirements are specific requirements that are in addition to the standard control and functionality provisions of Appendix 1.

<u>SCADA/HMI Engineer Adjustable Set Points</u>

None

SCADA/HMI Operator Adjustable Set Points

None

SCADA/HMI Status Signals

None

SCADA/HMI Alarm Signals

Description	Range
Filter No.1 High Turbidity	0-3 NTU
Filter No.1 High High Turbidity	0-3 NTU
Filter No.1 High Particle Count	
Filter No.2 High Turbidity	0-3 NTU
Filter No.2 High High Turbidity	0-3 NTU
Filter No.2 High Particle Count	
Filter No.3 High Turbidity	0-3 NTU
Filter No.3 High High Turbidity	0-3 NTU
Filter No.3 High Particle Count	
Filter No.4 High Turbidity	0-3 NTU
Filter No.4 High High Turbidity	0-3 NTU
Filter No.4 High Particle Count	
Filter No.5 High Turbidity	0-3 NTU
Filter No.5 High High Turbidity	0-3 NTU
Filter No.5 High Particle Count	
Filter No.6 High Turbidity	0-3 NTU
Filter No.6 High High Turbidity	0-3 NTU
Filter No.6 High Particle Count	
Filter No.7 High Turbidity	0-3 NTU
Filter No.7 High High Turbidity	0-3 NTU
Filter No.7 High Particle Count	
Filter No.8 High Turbidity	0-3 NTU
Filter No.8 High High Turbidity	0-3 NTU
Filter No.8 High Particle Count	
High TSS Level in Gravity Thickener No. 1	
High TSS Level in Gravity Thickener No. 2	
High Turbidity Level in Gravity Thickener No. 1	
High Turbidity Level in Gravity Thickener No. 2	

3.33 Process Potable Water Booster Pumps

3.33.1 Documentation

WH-P0005 P&ID Process Potable Water

3.33.2 Plant and Instruments

Tag	Description	
Clearwell Area Process Potable Water Booster Pump		
P-H701A	Potable Water to Clearwell Area Booster Pump	
PT-H701A	Potable Water to Clearwell Area Pressure Transmitter	
Treatment Plant Potable Water Booster Pumps		
P-H702A	Potable Water to Treatment Plant Booster Pump	
P-H703A	Potable Water to Treatment Plant Booster Pump	
PT-H704A	Potable Water to Treatment Plant Pressure Transmitter	

3.33.3 General Operation

The process potable water booster pumps shall provide water around the site via direct mains.

The process potable water system installation shall comprise of three pumps, one fixed speed pump dedicated to the Clearwell area and the other two variable speed pumps (duty//standby) shall be used to pump water to the Main Treatment plant area. The pumps shall be used maintain the desired discharge pressure measured by the pressure instruments in each piping system.

3.33.4 Automatic Control Philosophy

Clearwell Potable Water Pump Operation

The PLC shall stop and start the pump in order to maintain the required pressure in the supply pipework. When the pressure in the pump discharge (as measured by PT-H701A) falls below the pump start set point the pump shall start and continue to run until the pressure rises above the stop pump set point.

Treatment Plant Potable Water

The Treatment Plant Potable Water pumps shall operate in a duty / standby regime.

The local PLC shall modulate the speed of the duty pump in order to maintain a desired pressure in the discharge pipework. The control of the pump speed shall be carried out using a PID loop.

Should the pressure in the line rise above a ‘Stop Pumps’ set-point then the pump shall stop operating. Adjustments to set points etc shall be made at the local HMI; no connection is available between the local PLC and the main plant control system

3.33.4.1 Service Water Pressure (PT-H701A, PT-H704A)

The PLC shall monitor the water pressure in both systems and display the instantaneous value on the SCADA. If the measured pressure exceeds a 'High Pressure' set-point for a period of time (10 minutes) then an alarm shall be raised on the SCADA.

Similarly, if the measure pressure drops below a 'Low Pressure' set-point for a period of time (10 minutes) then an alarm shall be raised on the SCADA

3.34 Standby Generators

Refer to Appendix 7

3.35 Building Services Control System Monitoring

The building services systems have an independent control which carries out all the associated control functions. The system operates independently from the PCS, access to the BMS will through the BMS dedicated workstations.

4. Start-up and Shutdown

4.1 Water Treatment Works Start-up and Shutdown

4.1.1 General Control Description

The works electrical power shall be provided by either the Manitoba Hydro Utility supply or the standby diesel generator system. The generators shall be capable of being synchronised to the mains so that when mains power is restored or during testing, there will be no further interruption of supply.

Works shutdown will be initiated either: -

Automatic Controlled Shutdown, due to extraordinary plant failure/emergency conditions – (with mains power available).

1. **Requested Controlled Shutdown** through SCADA by Operator Request. – (With mains power available).
2. **Short-term Mains Failure Shutdown** due to the standby generator starting delay upon loss of mains. Shutdown due to loss of power supply for shorter than 1 minute (adjustable).
3. **Sustained Mains Failure Shutdown** due to total failure of both mains and standby diesel generators –. Shutdown due to total loss of power supply for longer than 2 minutes (adjustable).

Works start-up will be initiated either:

1. **By the operator** if the works is shutdown due to the conditions as outlined in 1,2 ,3& 4 above.

During start-up after a mains failure, all drives shall be automatically reset by the PLC upon re-instatement of the mains supply.

The works start-up shall be fully controlled by the works PLC/SCADA system after operator initiation. Certain drives and equipment shall be enabled when their respective flows or levels rise above pre-set values.

The works SCADA shall monitor and display the status and condition of the plant during periods of shutdown and during the course of a start-up procedure.

4.1.2 Automatic Control Philosophy

4.1.2.1 Automatic Controlled Shutdown and Requested Controlled Shutdown

The WTW can be shutdown because of an operator request or automatically because of a particular process fault condition (listed below). The shutdown sequence is identical for both operator and automatically initiated controlled shutdowns.

	Plant Shutdown Parameters
1	High high level in DAF effluent channel
2	If final treated water residual chlorine level falls to below zero for a preset period. (*****secs). (see section 3.31).
3	If the final treated water residual chlorine level is outside preset range for preset time period (*****mins). (see section 3.31)
4	High high level in filter inlet channel (see section 3.9)
5	Insufficient functional plant units to provide required capacity, control system to check and confirm
9	High high level alarm in drainage sumps. (see section 3.30)

The shutdown sequence shall be as follows:

1. All Raw Water Pumps shall be stopped
2. DAF tanks in service will go out of service
3. Filters will go offline if the Filter Inlet Channel falls below the required level
4. When the flow to the plant is stopped plant processes such as chemical dosing should also stop under normal control

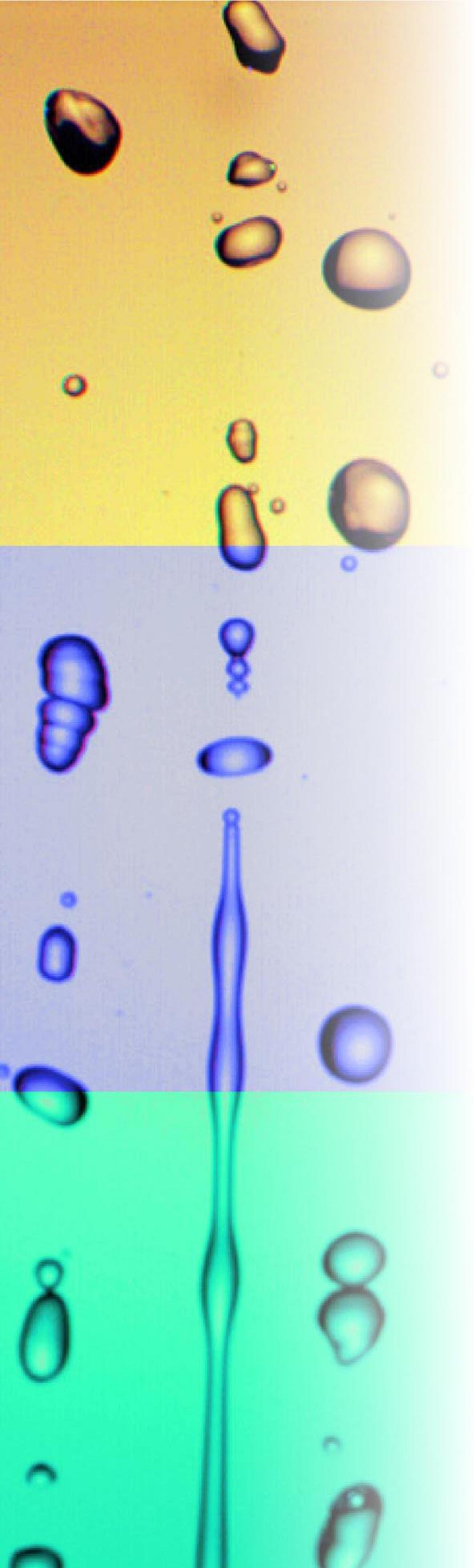
The following plant items shall continue to run under normal control

1. All chemical preparation systems
2. Potable Water Booster set
3. Residuals area systems

4.1.3 Start-up Sequence

Refer to the Operations manual for full details. The Operator must establish a flow path through the plant with enough treatment capacity for the flow required. This means putting DAF tanks into service, ozone contactors into service; this would then allow the Raw Water Pumps to start.

Appendix 1 – Standard Control Functionality



THE CITY OF WINNIPEG WATER TREATMENT PLANT

STANDARD CONTROL AND FUNCTIONALITY SPECIFICATION

Project No. 79538–02

March 2007

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ARCHITECTS

RECORD OF AMENDMENTS

Issue	Date	Author	Checked	Approved	Amendment Details
01	**11/04/07**	**N TOULSON**			**Document updated in line with comments from OC and City**

TABLE OF CONTENTS

1. AUTOMATIC CONTROL FUNCTIONALITY

.1 The purpose of this document is to specify the functionality required to be provided by the control system. The control system is made up of the PLC's and the various HMI located throughout the plant.

.2 The PLC's have the function of controlling the various plant and equipment throughout the Works to meet the process requirements.

.3 The following descriptions of control functionality shall be incorporated into the PLC programming.

  .1 Control & Monitor Fixed and Variable Speed Drives

  .2 Control &Monitor Electrical Switchgear and Protection Devices

  .3 Control & Monitor Actuated Valves

  .4 Control & Monitor Solenoid Valves

  .5 Condition Analogue Signals and set alarms

  .6 Condition Digital Signals and set alarms

  .7 Undertake Duty selection, rotation and auto changeover to standby.

  .8 Undertake PID Loop Control

  .9 Totalise Pulses for transfer to SCADA/HMI

  .10 Generate PLC Latched Faults

  .11 Monitor PLC/SCADA/HMI & PLC/PLC communications

  .12 Monitor Electrical Distribution System

.4 The fundamental design concept shall be that the plant/equipment reverts to a safe state (no danger to personnel) in the event of broken/loose wire connections of Real I/O and in the event of failure of any PLC.

.5 The following sections describe the detailed control functionality for the above.

.6 Any further required functionality such as extra alarms will be described in the User Requirement Specification (URS).

2. FIXED AND VARIABLE SPEED DRIVES

.1 All Fixed Speed and VSD drives shall be configured in accordance with the following.

2.1 Fixed Speed Drives

.1 The drive can be operated in the following modes

.1 **Automatic** - control is from the PLC control logic

.2 **Remote Manual -** the motor can be controlled manually from the HMI or SCADA

.3 **Local Manual -** the motor can only be controlled from the MCC using the control pushbuttons and switches on the starter door or mounted locally at the drive.

.2 Description of Hardwired Input Signals associated with Fixed Speed Drives

.1 Drive CPU

.1 This is a discrete signal indicating that the COH selector switch mounted at the drive or at the MCC is in CPU mode which will allow Automatic or Remote Manual operation of the drive.

.2 Drive Running/Stopped

.1 The drive is considered to be running if the motor has been “started” and the hardwired signal from the starter contactor is active. In some cases process instrumentation such as a flow meter shall provide positive confirmation that the drive is running, this will be described further in the user specification.

.3 Drive Fault

.1 This can be either a single input from the drive overload protection unit or a single input derived from multiple protection devices associated with the drive.

.1 Low pump suction level

.2 Low pump outlet flow

.3 High stator temperature

.2 These inputs shall be selected for use as appropriate to each drive application. A change in state of the input from healthy shall be used in the PLC logic to trip or inhibit the drive as required.

.3 During start-up of the drive it may be necessary to override certain process interlocks such as low pressure, an adjustable timer will available in the PLC logic for this purpose.

.3 Description of Hardwired Output Signals associated with Fixed Speed Drives

.1 Drive Start/Stop

.1 The drive can be started and stopped in either "Automatic" or "Remote Manual" using the hardwired output from the PLC to the drive starter. Whenever the drive is required to run the output must be maintained

.4 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

.1 None

.2 SCADA/HMI Operator adjustable set points

Description	Range
Drive to remote manual	
Drive to automatic	
Drive remote manual start	
Drive remote manual stop	
Reset hours run counter	

.3 SCADA/HMI status signals

Description	Range
Drive running	
Drive stopped	
Drive automatic	
Drive remote manual	
Drive local manual control indication	
Drive fault	
Drive hours run	

.4 SCADA/HMI alarm signals

Description	Range
Drive general fault	

2.2 Variable Frequency Drives (VFD)

.1 Variable Frequency Drive Features

.1 Each VFD motor starter contains an inverter, and an Operator interface panel. Some drives are connected to the control system with an Ethernet connection which can be used to provide added functionality which will be described below. Other drives are hardwired to the control system; this will also be described below.

.2 Local control is available by using the Operator interface panel to start/ stop the drive and raise/ lower the motor speed.

.3 The drive can be operated in the following modes

.1 **Automatic-** control is from the PLC control logic

.2 **Remote Manual-** the motor can be controlled manually from the HMI or SCADA

.3 **Local Manual-** the motor can only be controlled from the operator interface panel on the starter door.

.2 Drive connected with Hardwiring I/O Requirements

.1 Hard Wired Signals to/from VFD

Description	Type	Active State
Drive CPU	DI	0
Drive Running/Stopped	DI	1
Drive Fault	DI	0
Drive Start	DO	1
Drive Required Speed	AO	
Drive Speed	AI	

.3 Drive connected with Ethernet I/O Requirements

Description	Type	Active State
Running Speed		
Running Current		
Inverter Running	Bool	1
Drive Available	Bool	0

.4 Description of Hardwired Input Signals associated with VFD'S

.1 Drive CPU

.1 This is a discrete signal indicating that the Operator interface panel mounted at the drive or at the MCC is in CPU mode which will allow Automatic or Remote Manual operation of the drive.

.2 Drive Running/Stopped

.1 The drive is considered to be running if the motor has been "started" and the hardwired signal from the starter contactor is active. In some cases process instrumentation such as a flow meter shall provide positive confirmation that the drive is running, this will be described further in the user specification.

.3 Drive Fault

.1 This can be either a single input from the drive overload protection unit or a single input derived from multiple protection devices associated with the drive.

.1 Low pump suction level

.2 Low pump outlet flow

.3 High stator temperature

.2 These inputs shall be selected for use as appropriate to each drive application. A change in state of the input from healthy shall be used in the PLC logic to trip or inhibit the drive as required.

.4 Drive Speed

.1 Once the drive is started and confirmed as "running" and a required speed has been sent to the VFD, this 4-20ma signal will confirm that the drive is running at the correct speed.

.5 Description of Hardwired Output Signals associated with VFD'S

.1 Drive Start/Stop

.1 The drive can be started and stopped in either "Automatic" or "Remote Manual" using the hardwired output from the PLC to the drive starter. Whenever the drive is required to run the output must be maintained

.2 Drive Required Speed

.1 Once the drive is started and confirmed as "running" the required speed will be outputted by the control system in the form of a 4-20ma signal. The required speed will either be calculated by the PLC when in "automatic mode" or selected by the operator if the drive is in "remote manual" mode.

.6 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

Description	Range
Drive maximum speed	0-100%
Drive mininum speed	0-100%

.2 SCADA/HMI Operator adjustable set points

Description	Range
Set Speed	0-100%
Drive to remote manual	
Drive to automatic	
Drive remote manual start	
Drive remote manual stop	
Reset hours run counter	

.3 SCADA/HMI status signals

Description	Range
Drive running	
Drive stopped	
Drive automatic	
Drive remote manual	
Drive hours run	
Drive current	0-999% FLC
Drive Speed	0-100 %

.4 SCADA/HMI alarm signals

Description	Range
Drive general fault	
Drive overtemperature (where applicable)	
Drive set speed exceeded max/min	

2.3 Variable Speed Drives (VSD)

.1 Variable Speed Drive Features

.1 These drives generally have the same functionality as the VFD drives but the speed is not controlled by an inverter. Instead a variable magnetic coupling is used; the speed of the drive is controlled by varying the gap in the magnetic coupling. The gap distance is altered with an electric actuator. The same control functions apply.

3. ACTUATED VALVES AND PENSTOCKS

.1 All actuated valves and penstocks shall be connected to the PLC using hardwiring. The control and monitoring of each actuator shall be configured as follows.

3.1 Valve I/O Requirements

.1 Depending on valve type, open/ close or modulating the following I/O shall be available.

.2 Signals from Actuator to PLC

Description	Type	Active State
CPU Mode Selected	DI	1
Closed limit switch	DI	1
Open Limit Switch	DI	1
Position	AI	

.3 Signals from PLC to Actuator

Description	Type	Active State
Close	DO	1
Open	DO	1
Emergency shutdown	DO	1
Required Position	AO	

3.2 Description of Signals from Actuator to PLC

.1 CPU Mode Selected

.1 The actuator has a 3 position switch for selecting CPU, Local Stop or Hand Control. The switch passes from CPU to Local, or Local to CPU, through the Local Stop position. When the actuator local control switch is fully in the CPU position then this input is set to logic 1. This input is not present when the actuator control switch is in the Local Stop or Hand positions. The input is present as long as the switch is in the CPU position and it will clear only when the switch is returned to the Hand or Local Stop position.

.2 Close Limit Switch/ Open Limit Switch

.1 There are two limit switches relating to the actuator set positions for open and close positions. These limit positions may be set within the actual valve stroke. When the actuator reaches either the open or closed position the input will be set to logic 1.

.3 Valve Position

.1 A 4-20 mA analogue signal proportional to the valve position where 4 mA is closed and 20 mA is fully open.

.4 Description of Signals from PLC to Actuator

.1 Stop (Stay Put)

.1 A command issued to make the actuator stop moving if it has been requested to do so.

.2 Close/ Open

.1 Commands issued to move the valve open or closed between limits. Operation continues until the desired limit is reached or a new command is issued, to enable this to happen the signal has to be present until the position is reached and confirmed by the feedback.

.3 Emergency Shutdown

.1 An ESD command will override both the local control and any auxiliary remote commands and cause the valve go to a predetermined position.

.4 Required Position

.1 A 4-20 mA analogue signal proportional to the valve required position where 4 mA is closed and 20 mA is open.

.5 Description of Derived Signals associated with Actuators

.1 Actuator Fault

.1 If a valve is available for either automatic or remote manual operation and it is commanded to move in either direction, but fails to do so within the time set by the Engineer, then a valve fault alarm will be displayed on the SCADA/HMI.

3.3 System Setpoint, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

Description	Range
Valve Failed To Open/Close time (as required x seconds)	
Valve Control Deadband (typically 2%) – Modulating valve only	
Valve Failed To Move time (as required x seconds) – Modulating valve only	
Valve action on loss of signal	

.2 SCADA/HMI Operator adjustable set points

Description	Range
Valve automatic	
Valve remote manual	
Valve Open	
Valve Close	
Valve Required Position	

.3 SCADA/HMI status signals

Description	Range
Valve automatic	
Valve opened	
Valve closed	
Valve remote manual	
Valve Position	0-100%

.4 SCADA/HMI alarm signals

Description	Range
Failed to open	
Failed to close	
Valve position outside limits	

4. SOLENOID VALVES

4.1 Valve I/O Requirements

Description	Type	Active state
Open	DO	1

.1 No position feedback is available from solenoid valves and failure is not monitored. Status of the valve i.e. opened or closed is inferred from the PLC output. i.e.. (Opened = logic ‘1', Closed = logic ‘0’)

.2 Where available, flow and pressure switches may be used to check the status of the solenoid. For example, if the solenoid open output was set, but the flow switch had not detected a flow, an alarm may be generated.

4.2 Valve Control

.1 No facilities to operate a solenoid valve in remote manual mode from the SCADA/HMI/HMI has been provided.

4.3 Valve Monitoring

.1 No additional monitoring shall be performed by the PLC

4.4 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

.1 None

.2 SCADA/HMI Operator adjustable set points

.1 None

.3 SCADA/HMI status signals

.1 Open / Close Commands

.4 SCADA/HMI alarm signals

.1 None

5. ANALOGUE SIGNAL PROCESSING

.1 All Analogue signals shall be configured in accordance with the following.

5.1 I/O Requirements

Description	Type	Active state
Instrument Fault (If Installed)	DI	0
Instrument Signal	AI	0-20mA

.1 Instrument Fault

.1 This is a composite signal sourced from the instrument indicating any general fault present. e.g. loss of echo.

.2 Instrument Signal

.1 This is an analogue signal, sourced from associated transmitter and represents the process value as range 0 – 20mA.

5.2 Control Requirements

.1 As described in the User Requirement Specification for each instrument.

5.3 Signal Monitoring

.1 Signal Scaling

.1 All analogue signals inputted to the PLC shall be raw values. Scaling of the signal into engineering units shall not be performed in the PLC. Any scaling shall be carried out in the SCADA/HMI.

.2 Signal Validation

.1 All analogue input modules shall be configured to read 0 – 20 mA signals. Checks shall be performed by the PLC to ensure the signal is valid. If the signal falls outside a nominal range (<3.5mA, >20.5mA) for a configurable time, then a signal 'Out of Range' alarm shall be generated.

.2 When the alarm state has cleared (i.e. the signal has returned within range) for a pre set time, the PLC alarm shall clear. The alarm shall be set for the duration of the fault and shall not be latched.

.3 When an analogue signal is determined out of range, the 'conditioned' signal shall not be updated. Conditioned signals may be frozen at their current values, set to zero or set to 100 % depending on application.

.3 Instrument Failure

.1 Where applicable the instrument shall be monitored for failure. If the Failed signal is detected for a configurable time, then a signal ‘Failed’ alarm shall be generated.

.2 When the alarm state has cleared (i.e. the instrument has returned healthy) for a pre set time, the PLC alarm shall clear. The alarm shall be set for the duration of the fault and shall not be latched.

.3 When an instrument is deemed failed, the ‘conditioned' signal shall not be updated. Conditioned signals may be frozen at their current values, set to zero or set to 100 % depending on application.

.4 Process Alarms

.1 Alarm states shall be configured for High High, High, Low and Low Low conditions, where required. The set points for the alarm states shall be set through the HMI or SCADA/HMI.

.2 A reset deadband shall be a PLC configurable value and shall be applied to each alarm setpoint. The deadband value shall apply below High and High High alarm setpoints and above Low and Low Low alarm setpoints.

.3 Rate of change alarms shall also be configured for all analogue signals. The set points for the alarm states shall be set through the HMI or SCADA/HMI.

.4 Alarms shall automatically reset when the alarm condition subsides unless specifically detailed otherwise in the respective FDS sections.

5.4 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

Description	Range
Alarm deadband	0-10%
Instrument fault time	0-120 secs
Signal out of range time	0-120 secs
Rate of change time	0-120 secs

.2 SCADA/HMI Operator adjustable set points (Engineer Access)

Description	Range
High high setpoint	
High setpoint	
Low setpoint	
Low low setpoint	

.1 The above shall be configured as applicable

.3 SCADA/HMI status signals

Description	Range
Measured analogue value (units)	
Failed/ normal	
High High	
High	
Low	
Low Low	

.4 SCADA/HMI alarm signals

Description	Range
Instrument failure (where applicable)	
Signal out of range	
High high	
High	
Low	
Low low	
High rate of change	
Low rate of change	

6. DIGITAL PROCESS SIGNALS

.1 All digital process signals such as high/ low level, high low flow and high/ low pressure shall be configured in accordance with the following

6.1 I/O Requirements

Description	Type	Active state
Low Low	DI	0
Low	DI	0
High	DI	0
High High	DI	0

.1 Low Low, Low, High, High High

.1 This is a discrete signal from a device such as a level switch or flow switch. Generally only one signal level shall originate from each device. The device shall be wired to the PLC inputs or remote I/O or directly to an MCC starter when used as a drive process protection device. The device will be selected and configured to work in a fail safe manner, i.e. “open to alarm”

6.2 Control Requirements

.1 As described in the main Functional Design Specification for each instrument.

6.3 Signal Monitoring

.1 Signal Overrides

.1 In some instances such as low flow protection for a pump it will be necessary to override the signal during the initial process startup. This can be done in software as in the case of signals wired to protection devices units or the PLC, or alternatively using hardware timer relays.

.2 Instrument Failure

.1 It is not normally possible to monitor this type of device for failure.

.3 Process Alarms

.1 Alarm states shall be set against High High, High, Low and Low Low conditions, where required. The set points for the alarm states shall be defined by the installation or calibration of the device, ie. the length of conductivity probe or pressure trip setting on a pressure switch.

.2 Alarms shall automatically reset when the alarm condition subsides unless specifically detailed otherwise in the respective FDS sections.

6.4 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

Description	Range
Signal override time	0-30secs

.2 SCADA/HMI Operator adjustable set points (Engineer Access)

.1 None

.3 SCADA/HMI status signals

.1 None

.4 SCADA/HMI alarm signals

Description	Range
High high	
High	
Low	
Low low	

7. DUTY STANDBY SELECTION

7.1 Duty/Standby Operation

.1 The PLC, when required, shall run the drive selected as Duty. Should the Duty drive be unavailable then the PLC shall run the Standby drive and generate an alarm.

.2 Should the failed Duty drive become available the PLC shall stop the Standby (if running), run the Duty drive as required and cancel the alarm.

7.2 Duty/Assist Operation

.1 The PLC, when required, shall run the drive selected as Duty. Dependant upon process conditions the PLC shall start and stop the Assist drive.

.2 Staggered starting shall be applied to Duty and Assist drives in the event of process conditions requiring both drives

.3 The Assist drive shall act as a Standby drive, as above, in the event of Duty drive unavailability.

7.3 Duty/Assist/Standby Operation

.1 This shall be generally as above with the Standby able to replace either the Duty or Assist drive functionality.

7.4 Duty Selection / Auto Rotation

.1 A facility shall be provided to allow the duty allocation for equipment to re-assigned either manually or automatically.

.2 Each drive/unit shall be allocated individual ‘Duty cycle’ time periods (hours). These time periods can be allocated so as to optimise the operation the equipment.

.3 The PLC shall monitor the actual hours run for the respective duty drive and when this exceeds the allocated ‘Duty cycle’ time period automatic duty rotation shall occur. In certain applications it may be necessary to wait until ideal plant conditions exist before allowing rotation to be performed (e.g. both drives stopped).

.4 The facility to manually re-select a new duty drive shall be provided at the SCADA/HMI.

7.5 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

  .1 None

.2 SCADA/HMI Operator adjustable set points (Operator Access)

Description	Range
Drive A Duty Cycle Time	0-168 hrs
Drive B Duty Cycle Time	0-168 hrs
Drive C Duty Cycle Time	0-168 hrs
Drive A Manual Duty Selection	
Drive B Manual Duty Selection	
Drive C Manual Duty Selection – if applicable	

.3 SCADA/HMI status signals

Description	Range
Drive A Duty Status	
Drive B Duty Status	
Drive C Duty Status – if applicable	
Duty Drive Accumulated Run Time (Hours)	

.4 SCADA/HMI alarm signals

.1 None

8. PROPORTIONAL, INTEGRAL AND DERIVATIVE LOOP CONTROL

.1 Where specified in the User Requirement Specification (URS) the PLC shall perform closed loop PID control with all relevant parameters displayed and configurable at the associated HMI and SCADA/HMI.

.2 General

.1 PID loops shall have the following parameters and facilities within the PLC software

.2 Set Point value (Manual) (SPM): set by the operator at the HMI or SCADA/HMI.

.3 Set Point value (Remote) (SPR): set by the PLC software (e.g.. Sodium Hypochlorite control system has ‘n’ No. set points automatically input by the PLC).

.4 Set Point value (Working) (SP): the actual set point being used (i.e. either SPM or SPR or tracked value) by the PID controller at the current time.

.5 Process Variable (PV): is the signal from the process monitor (e.g. 4-20mA level, Chlorine Residual, flow signal)

.6 Error (ER): value between the PID's current set point (SP) and the Process Variable PV.

.7 Control Variable (CV): is the output from the PID controller (e.g.. 4-20mA blower speed command signal)

8.1 PID Control Modes

.1 The PID controller within the PLC software has an automatic and manual mode of operation as follows:-

.2 Manual Mode

.1 When in manual mode the PLC shall:-

.1 Write the manually adjusted loop output (e.g. manual speed) to the PID loop CV.

.2 Make the output to the drive/ device track the CV

.3 Make the set point SP track the PV.

.3 Automatic Mode

.1 When in Automatic mode the PID shall:-

.1 Set the set point mode to the pre-selected default i.e. (remote) or (manual).

.2 Set the set point (SP) to default mode (remote) or (manual) value, following any set point ramping requirements.

.3 Apply PID algorithm to the Error to calculate the required CV to achieve the SP.

.4 Make the output to the drive/ device track the CV.

.5 The PLC shall check the difference between the desired flow set-point and the PID loop set-point.

.6 If the difference is less than the ramp value (value required), then the PID loop set-point shall equal the desired set-point. However, if the difference is greater than the ramp then the PLC shall automatically adjust the PID loop set-point by the ramp value over a time period until the difference between the desired value and the PID set-point is less than the ramp value.

.4 Bump-less Man/Auto Transfer

.1 To prevent sudden surges in controller output, when changing from manual to automatic mode the PID shall,

.2 Instantaneously set the set point mode to the pre-selected default i.e. (remote) or (manual)

.3 Begin ramping (over a fixed rate of change set in the PLC) the working set point (SP) to the required set point value for the default mode. The rate of change shall be adjusted via the PLC programming tool to suit the PID control loop conditions during commissioning.

.4 Apply PID algorithm control to Error to calculate the CV.

.5 PID loss of PV signal

.1 If the PV signal to the PID controller goes Out Of Range, the PID controller shall be set to the Manual Mode and the loop output shall be frozen at the last value. When the Out Of Range state is cleared the PID controller shall be set to the automatic mode.

8.2 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

Description	Range
PID Loop Set Point,	
Manual/Auto Mode Selection,	
Proportional Gain	
Integral Time	
Derivative Time	
Loop Manual CV	
Deadband	

.2 SCADA/HMI Operator Adjustable Setpoints

.1 None

.3 SCADA/HMI Status

Description	Range
PID Loop Set Point,	
Manual /Auto Mode	
Proportional Gain	
Integral Time	
Derivative Time	
PID Loop CV	
PID Loop PV	

.4 SCADA/HMI Alarms

.1 None

9. TOTALISATION OF PULSES

.1 Where specified in the URS, the PLC shall totalise quantities from field devices such as kWh meters, flow meters etc. the PLC shall totalise pulses from the device.

.2 The cumulative value shall be stored in the PLC and transferred to the SCADA/HMI for display and reporting purposes.

.3 Totalised values shall be upto 7 digits i.e 9999999 units and shall auto reset to zero if exceeded. A facility shall be provided at SCADA/HMI to allow the cumulative total to be reset manually.

.4 Units shall be configured as engineering values.

9.1 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

- .1 None

.2 SCADA/HMI Control Signals (Engineer Access)

- .1 Manual reset

.3 SCADA/HMI Status

- .1 Total value

.4 SCADA/HMI Alarms

- .1 None

10. PLC LATCHED FAULTS

.1 The PLC shall monitor the condition of plant and equipment and shall set the fault status as appropriate. Some fault conditions shall automatically reset when the condition clears e.g. analogue signals returning within range. Other Faults shall be "latched" in the PLC e.g. drive failed to run and shall thus require to be reset.

.2 Reset functions shall be configured at the SCADA/HMI for each PLC.

.3 A reset shall be configured at each HMI to reset faults in the associated PLC. In the case where no HMI exists then a hardwired reset pushbutton shall be provided.

.4 Reset facilities shall simultaneously reset all associated PLC latched faults.

10.2 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

- .1 None

.2 SCADA/HMI Operator adjustable set points (Operator Access)

- .1 Manual reset

.3 SCADA/HMI status signals

- .1 Latched Alarm Present

.4 SCADA/HMI alarm signals

- .1 As appropriate

11. ELECTRICAL SYSTEM MONITORING

.1 All power meters shall be connected to Ethernet communications network and the following data will be available for display on the HMI.

11.1 System Setpoints, Status and Alarms

.1 SCADA/HMI Engineer adjustable set points

.1 None

.2 SCADA/HMI Operator Adjustable Setpoints

.1 None

.3 SCADA/HMI Status

Description	Range
Vln a	
Vln b	
Vln c	
Vln average	
Vll a	
Vll b	
Vll c	
Vll average	
I a	
I b	
I c	
kW Total	
kVAR Total	
kVA Total	
Freq	
pf signed	

.4 SCADA/HMI Alarms

.1 None

12. SYSTEM SYNCHRONIZATION AND FAILURES

12.1 Communications

.1 Entire Control System Network

.1 The SCADA/HMI and PLC network shall have a time reset and synchronization command, so that the Engineer can carry out a complete network reset.

.2 SCADA to PLC

.1 The SCADA/HMI system shall have a 'heartbeat' configured between itself and the Master PLC on the network. On loss of communications, the SCADA shall generate an alarm and the PLC shall generate an alarm to telemetry or other agreed systems.

.3 PLC to PLC

.1 Each PLC shall have a 'heartbeat' configured which shall be used to monitor the communications between itself and the other PLCs on the network which it communicates with. On detection of a communications failure, the PLC shall generate an alarm which shall be displayed on the associated HMI and at SCADA. A communication fault between PLC’s shall inhibit plant control in that area where necessary.

.4 PLC to HMI

.1 If a loss of communications is detected by the HMI diagnostic system, an alarm shall be displayed on the HMI

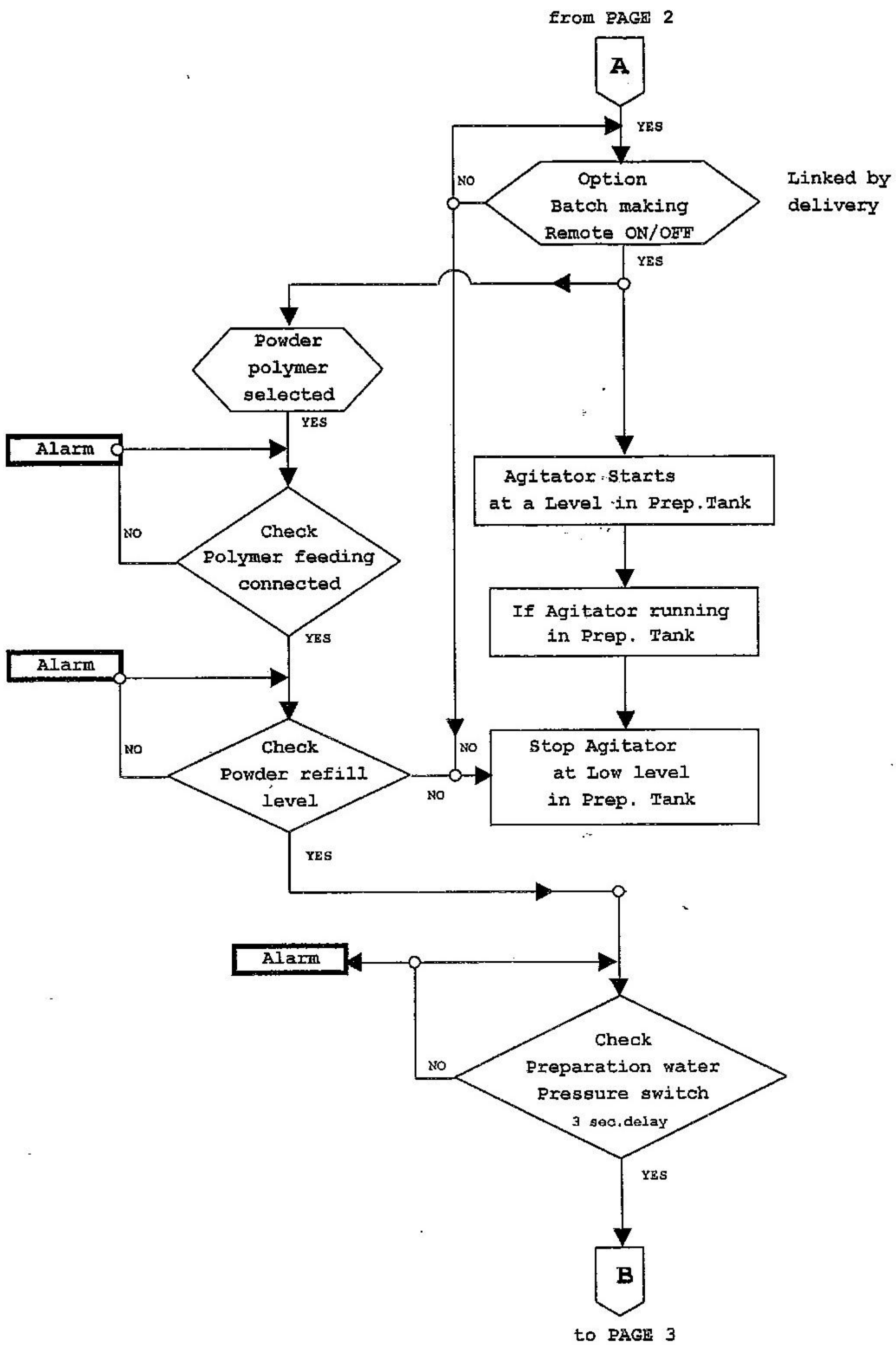
Appendix 2 – System Architecture Drawings

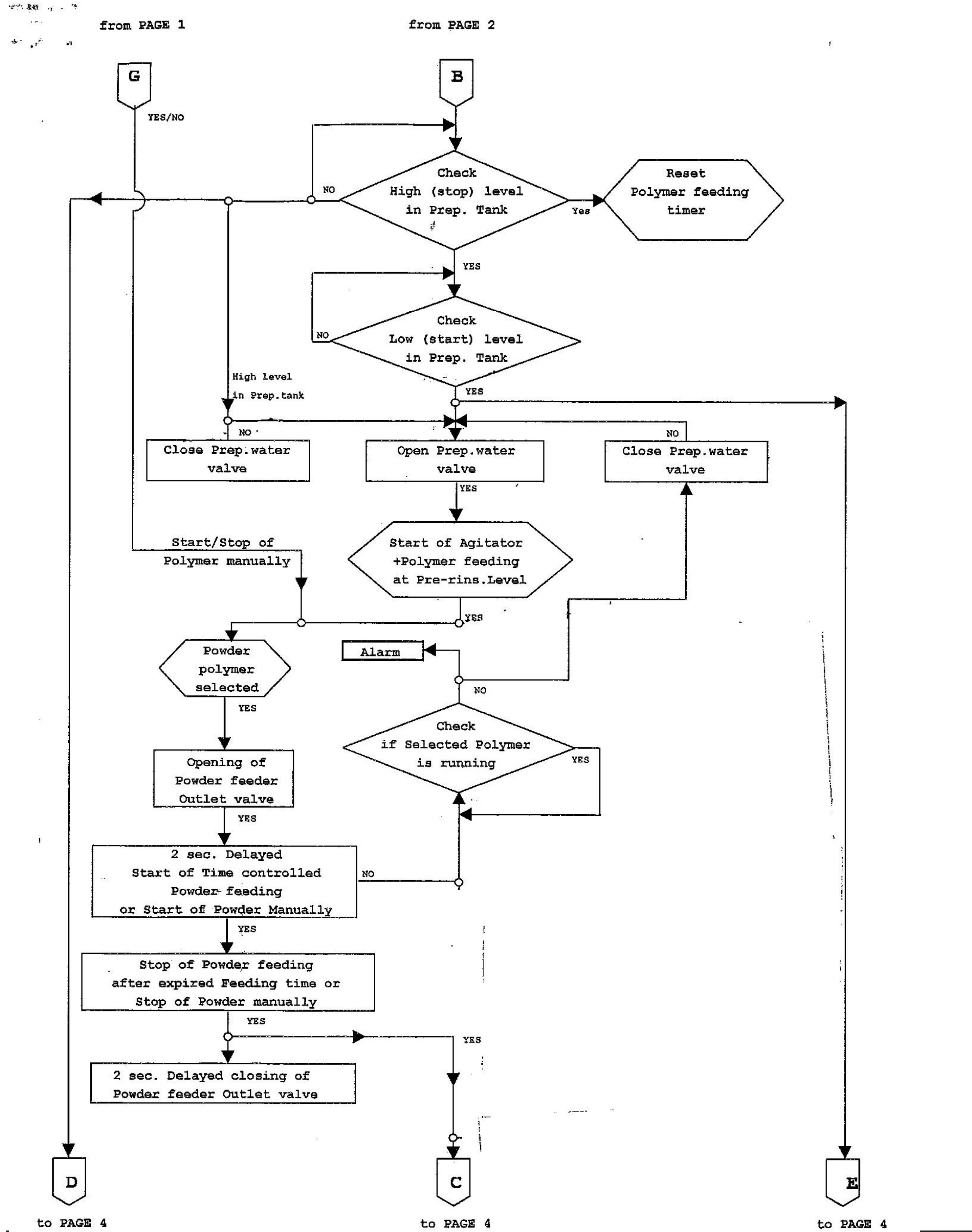
Please refer to the following drawings:

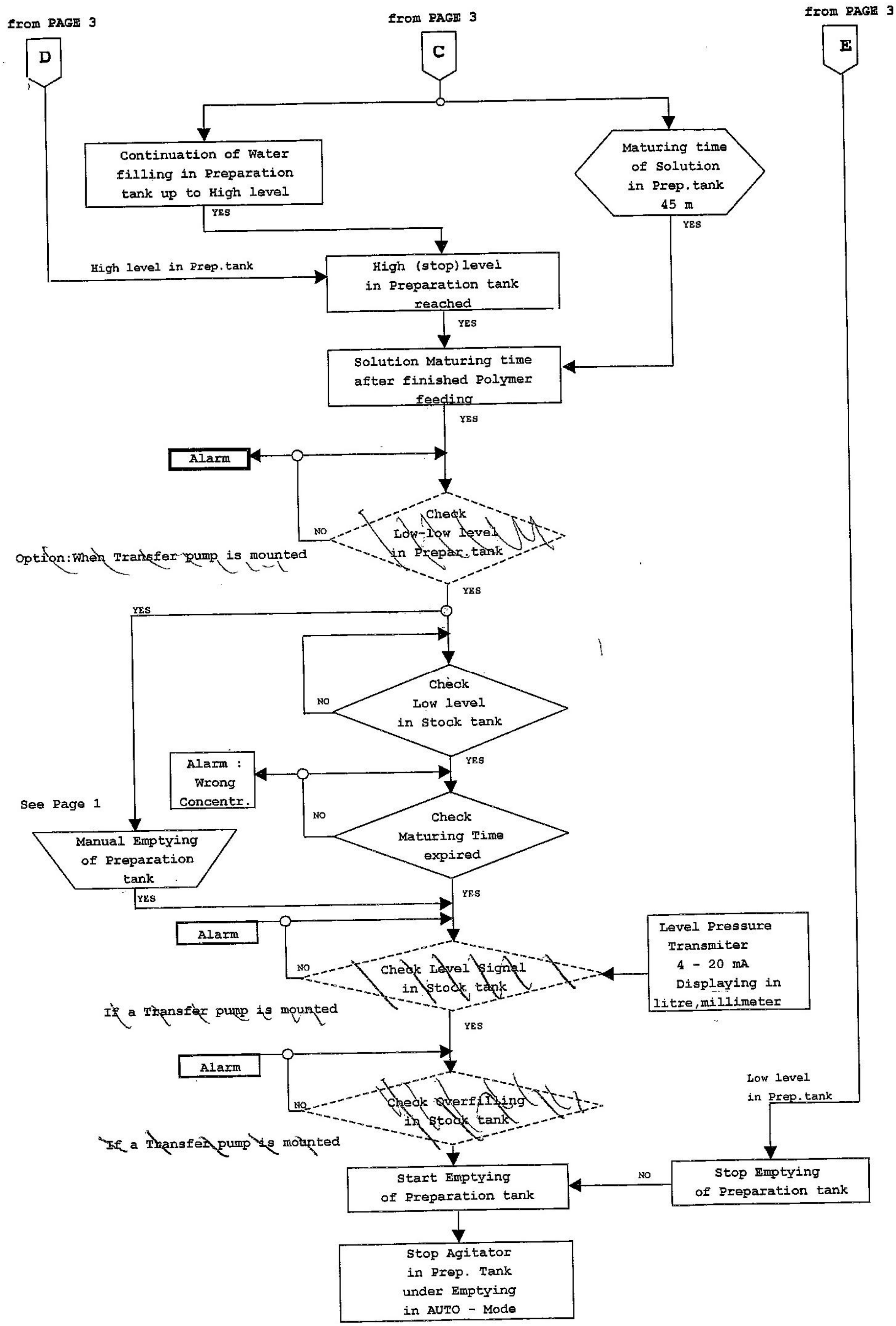
WH-A0100 P&ID Plant Communication Network Overall Block Cable Diagram
WH-A0102 P&ID Plant Communication Network Block Diagram
WH-A0103 P&ID Plant Communication Network Block Diagram
WH-A0104 P&ID Plant Communication Network Block Diagram
WH-A0105 P&ID Plant Communication Network Block Diagram
WH-A0106 P&ID Plant Communication Network Block Diagram
WB-A0001 P&ID Control System Network Architecture

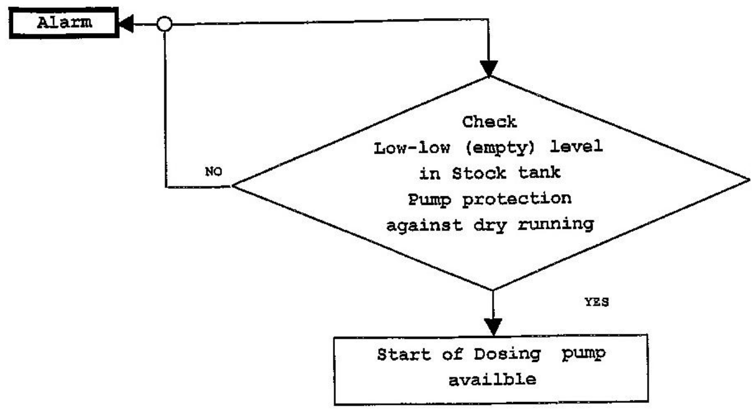
Appendix 3 – LOX Storage & Vaporisation (Refer to O&M Manuals)

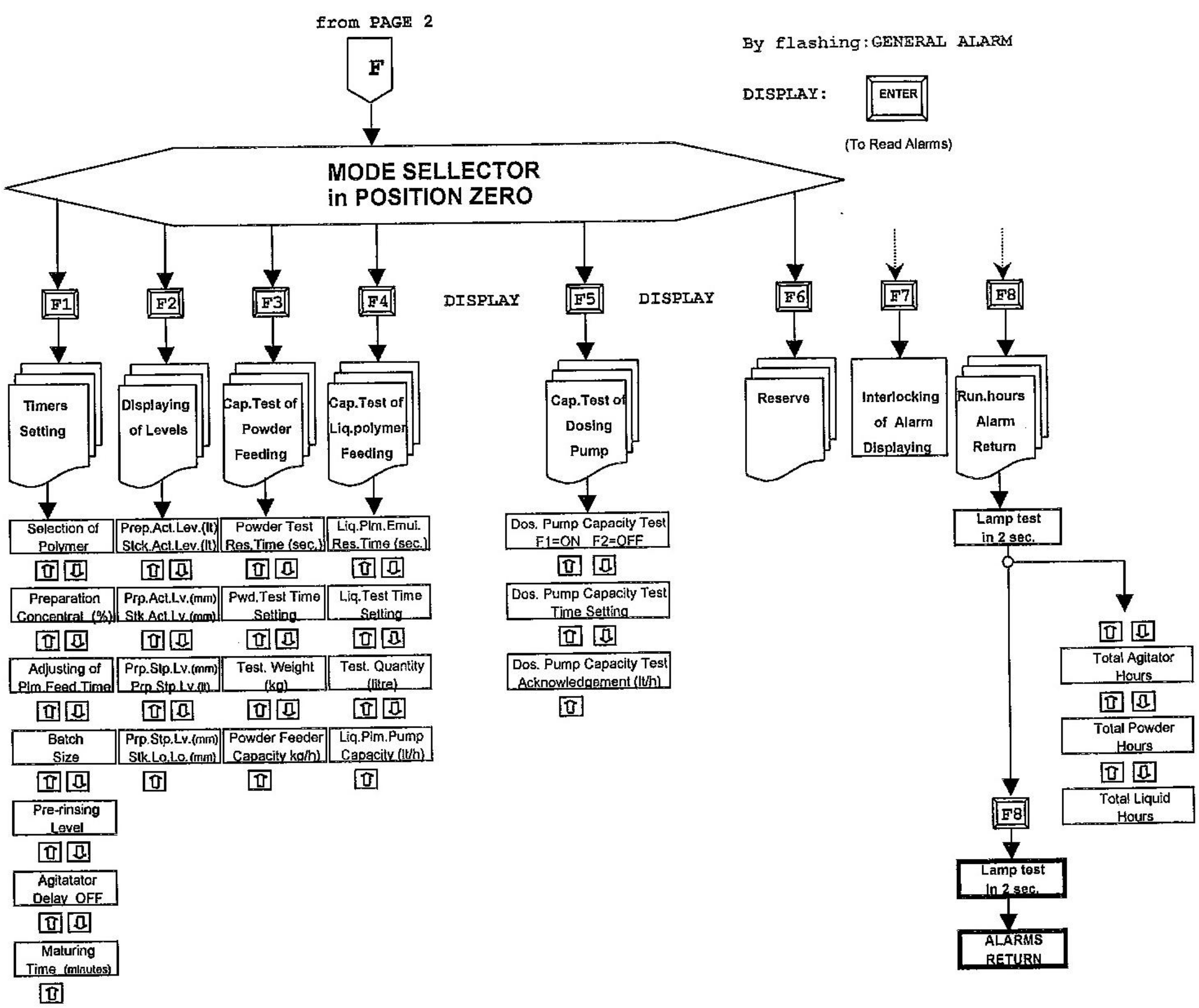
Appendix 4 – Sludge Polymer and Filtered Aid Polymer Process Diagrams


from PAGE 2
A
YES
NO
Option
Batch making
Remote ON/OFF
Linked by
delivery
YES
Powder
polymer
selected
YES
Alarm
NO
Check
Polymer feeding
connected
YES
Alarm
NO
Check
Powder refill
level
NO
NO
YES
Agitator Starts
at a Level in Prep.Tank
If Agitator running
in Prep. Tank
Stop Agitator
at Low level
in Prep. Tank
Alarm
NO
Check
Preparation water
Pressure switch
3 sec.delay
YES
B
to PAGE 3

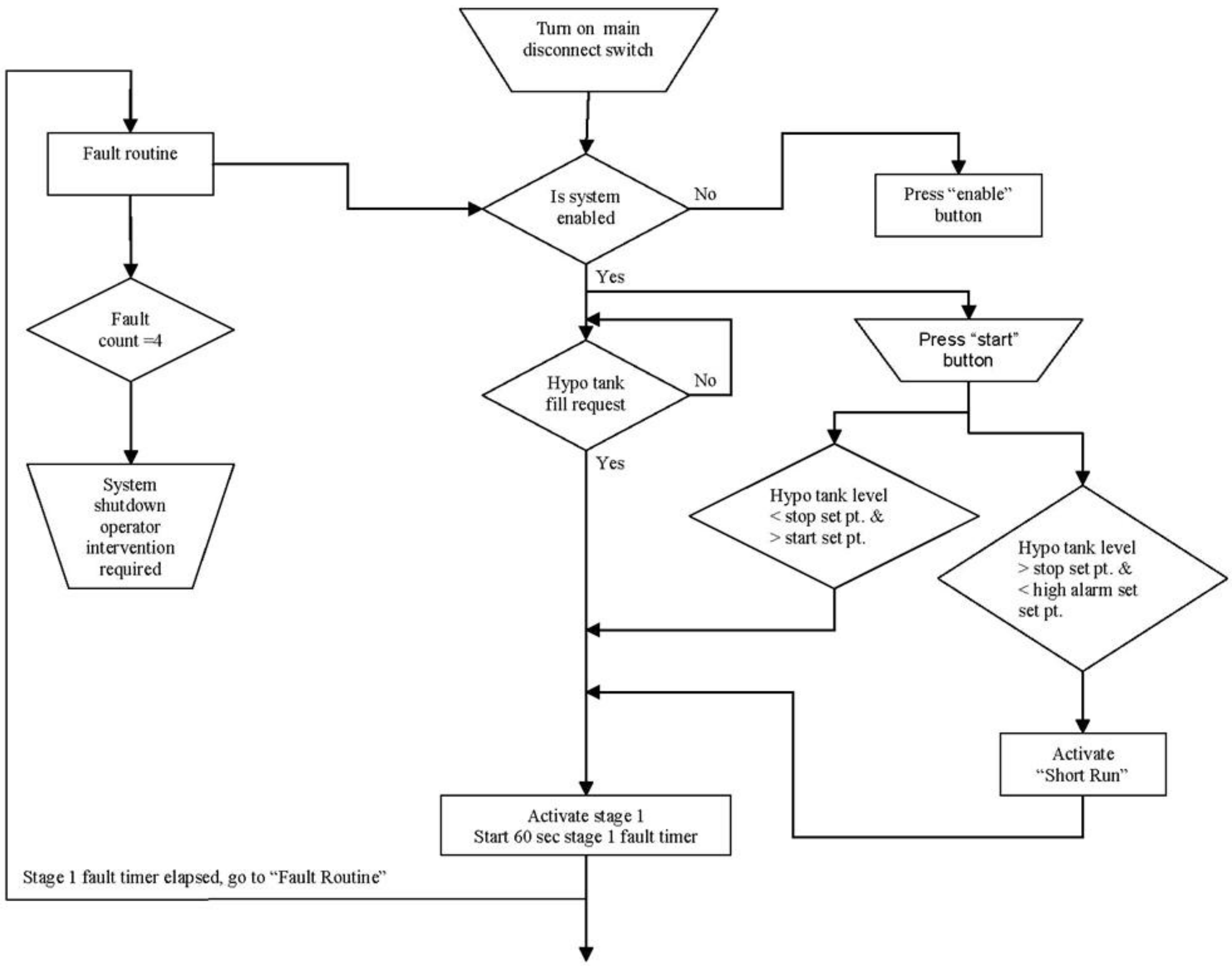

from PAGE 1
from PAGE 2
G
B
YES/NO
Check
High (stop) level
in Prep. Tank
NO
Yes
Reset
Polymer feeding
timer
YES
Check
Low (start) level
in Prep. Tank
NO
High level
in Prep.tank
YES
NO
Close Prep.water
valve
Open Prep.water
valve
NO
Close Prep.water
valve
YES
Start/Stop of
Polymer manually
Start of Agitator
+Polymer feeding
at Pre-rins.Level
YES
Powder
polymer
selected
Alarm
NO
YES
Check
if Selected Polymer
is running
YES
Opening of
Powder feeder
Outlet valve
YES
2 sec. Delayed
Start of Time controlled
Powder feeding
or Start of Powder Manually
NO
YES
Stop of Powder feeding
after expired Feeding time or
Stop of Powder manually
YES
YES
2 sec. Delayed closing of
Powder feeder Outlet valve
D
C
E
to PAGE 4
to PAGE 4
to PAGE 4

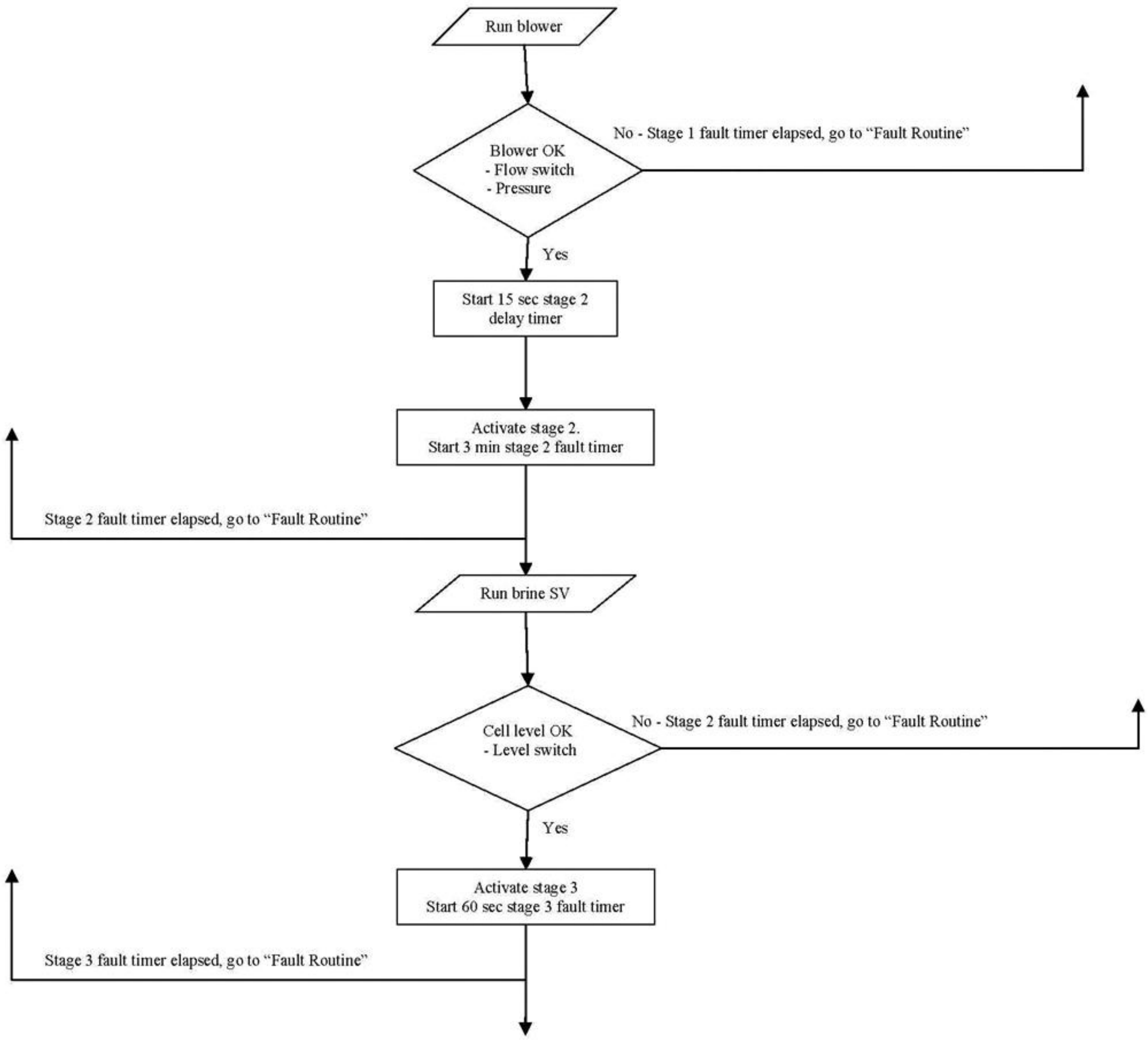

from PAGE 3
D
from PAGE 3
C
from PAGE 3
E
Continuation of Water filling in Preparation tank up to High level
YES
Maturing time of Solution in Prep.tank 45 m
YES
High level in Prep.tank
High (stop) level in Preparation tank reached
YES
Solution Maturing time after finished Polymer feeding
YES
Alarm
NO
Check Low-low level in Prepar.tank
Option:When Transfer pump is mounted
YES
YES
NO
Check Low level in Stock tank
YES
Alarm : Wrong Concentr.
NO
Check Maturing Time expired
See Page 1
Manual Emptying of Preparation tank
YES
YES
Alarm
NO
Check Level Signal in Stock tank
Level Pressure Transmiter 4 - 20 mA Displaying in litre,millimeter
If a Transfer pump is mounted
YES
Alarm
NO
Check Overfilling in Stock tank
If a Transfer pump is mounted
Low level in Prep.tank
Start Emptying of Preparation tank
NO
Stop Emptying of Preparation tank
Stop Agitator in Prep. Tank under Emptying in AUTO - Mode

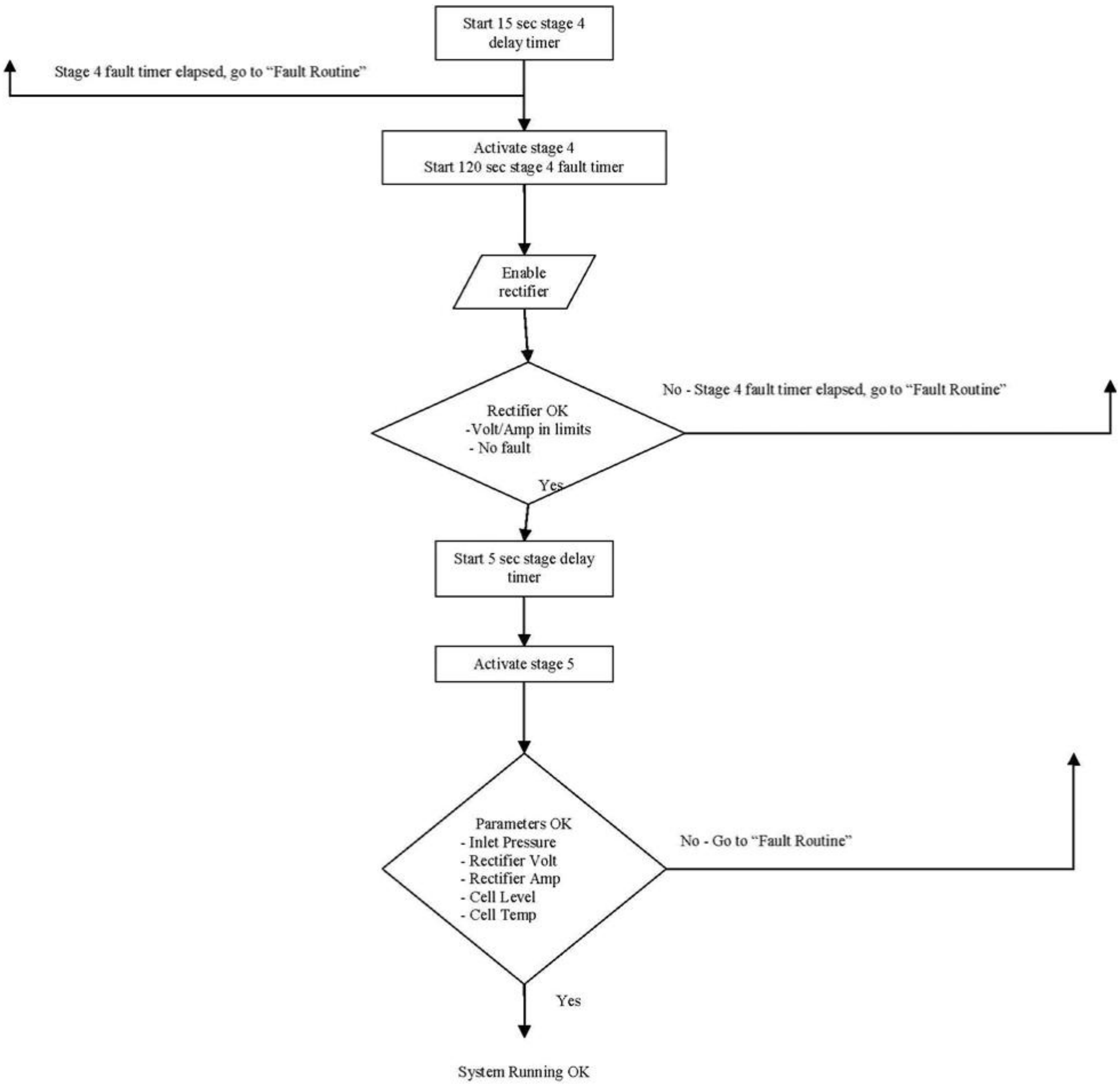

Alarm
Check
Low-low (empty) level
in Stock tank
Pump protection
against dry running
NO
YES
Start of Dosing pump
availble


from PAGE 2
F
By flashing:GENERAL ALARM
DISPLAY:
ENTER
(To Read Alarms)
MODE SELLECTOR
in POSITION ZERO
F1
F2
F3
F4
DISPLAY
F5
DISPLAY
F6
F7
F8
Timers
Setting
Displaying
of Levels
Cap.Test of
Powder
Feeding
Cap.Test of
Liq.polymer
Feeding
Cap.Test of
Dosing
Pump
Reserve
Interlocking
of Alarm
Displaying
Run.hours
Alarm
Return
Selection of
Polymer
Preparation
Concentral (%)
Adjusting of
Plm.Feed.Time
Batch
Size
Pre-rinsing
Level
Agitatator
Delay OFF
Maturing
Time (minutes)
Prep.Act.Lev.(lt)
Stck.Act.Lev.(lt)
Prp.Act.Lv.(mm)
Stk.Act.Lv.(mm)
Prp.Stp.Lv.(mm)
Prp.Stp.Lv.(lt)
Prp.Stp.Lv.(mm)
Stk.Lo.Lo.(mm)
Powder Test
Res.Time (sec.)
Pwd.Test Time
Setting
Test. Weight
(kg)
Powder Feeder
Capacity kg/h)
Liq.Plm.Emul.
Res.Time (sec.)
Liq.Test Time
Setting
Test. Quantity
(litre)
Liq.Plm.Pump
Capacity (lt/h)
Dos. Pump Capacity Test
F1=ON F2=OFF
Dos. Pump Capacity Test
Time Setting
Dos. Pump Capacity Test
Acknowledgement (lt/h)
Lamp test
in 2 sec.
Total Agitator
Hours
Total Powder
Hours
Total Liquid
Hours
F8
Lamp test
in 2 sec.
ALARMS
RETURN

Appendix 5 – Sodium Hypochlorite Generation System Process Diagrams


Turn on main disconnect switch
Fault routine
Is system enabled
No
Press "enable" button
Yes
Fault count =4
Hypo tank fill request
No
Press "start" button
Yes
System shutdown operator intervention required
Hypo tank level < stop set pt. & > start set pt.
Hypo tank level > stop set pt. & < high alarm set set pt.
Activate "Short Run"
Activate stage 1
Start 60 sec stage 1 fault timer
Stage 1 fault timer elapsed, go to "Fault Routine"


Run blower
Blower OK
- Flow switch
- Pressure
No - Stage 1 fault timer elapsed, go to "Fault Routine"
Yes
Start 15 sec stage 2
delay timer
Activate stage 2.
Start 3 min stage 2 fault timer
Stage 2 fault timer elapsed, go to "Fault Routine"
Run brine SV
Cell level OK
- Level switch
No - Stage 2 fault timer elapsed, go to "Fault Routine"
Yes
Activate stage 3
Start 60 sec stage 3 fault timer
Stage 3 fault timer elapsed, go to "Fault Routine"



Start 15 sec stage 4 delay timer
Stage 4 fault timer elapsed, go to "Fault Routine"
Activate stage 4
Start 120 sec stage 4 fault timer
Enable rectifier
Rectifier OK
-Volt/Amp in limits
- No fault
No - Stage 4 fault timer elapsed, go to "Fault Routine"
Yes
Start 5 sec stage delay timer
Activate stage 5
Parameters OK
- Inlet Pressure
- Rectifier Volt
- Rectifier Amp
- Cell Level
- Cell Temp
No - Go to "Fault Routine"
Yes
System Running OK

Appendix 6 – Ozone Generation and Dosing

Fuji Electric Corp of America

City of Winnipeg

Process Control Narrative

Version 2

Version Number	Date of Revision	Description of Changes
1	2/1/2008	Initial draft issued for review
2	11/23/2009	Final revision, issued for O&M

Table of Contents

1. Introduction:

This process control narrative describes the operation and control strategy for the ozone generating system. The process control narrative for the ozone system covers the following components: Ozone Generator(s), Power Supply Unit(s) (PSU), Cooling Water System(s) (CWS), Ozone Destruct Unit(s) (ODU), Supplemental Air (Nitrogen Boost System), and Master Control Panel (MCP).

a. Process Descriptions:

Liquid Oxygen (LOX) is drawn from one of two LOX tanks. The operator selects the tank and LOX is passed through one of the vaporizer(s) and heated (if required by the installed trim heater) before reaching the Ozone Generators. The gas passing through the generator must have a dew point of -60 deg C or lower. A Dew point Analyzer located on the Gaseous Oxygen (GOX) line, downstream of the particulate filters, displays the dew point locally and at SCADA HMI. This Analyzer is interlocked with the ozone generator system and shuts it down if the dew point exceeds the PLC set-point.

Three Ozone Destruct Units (ODU's) are provided. Each unit is sized to serve a single ozone contactor, with one destruct unit serving as a backup, operating singularly or in parallel under normal operating conditions. If a destruct unit fails, the standby unit will automatically start. The Destruct Unit uses thermal catalytic action to destroy excess (unused) ozone accumulated in the headspace of the contactor to an acceptable level prior to discharging to atmosphere. The Destruct Blower in operation will draw the ozone richened gas into the destruct reactor and at the same time maintain a negative pressure at the contactor head space. Each destruct is equipped with a pre-heater and is automatically turned on to elevate the moisture ladened ozone off gas temperature; ensuring the moisture stays in gas phase. Raising the relative humidity of the gas will prevent moisture from entering the vessel and shortening the life of the catalyst. The pre-heater temperature of the destruct vessels is controlled by individual temperature controllers. The set point input is normally set at approximately 17 deg. C higher than the contactor off-gas temperature.

Three closed loop Cooling Water Skids are provided for the Ozone Generators to remove reaction heat generated. Inefficient heat removal will adversely affect the efficiency of the generator. Cooling Water from the cooling system is provided to each generator. Each cooling water skid has three cooling circuits. Heat that is removed from the closed loop cooling circuit is rejected to the open loop (plant water cooling) circuit via an on-skid heat exchanger. FUJI enhanced cooling MicroGap™ inner deionized (DI) closed loop provides additional cooling to the installed High Voltage dielectrics..

One Supplemental Air (Nitrogen Boost System) is provided. It consists of dual compressors, particulate filters, desiccant dryers, flow signal, a horizontal receiver tank and a local on/off control panel. The Supplemental Air (Nitrogen Boost System) is provided to enhance ozone generating efficiency. A small amount of nitrogen (approximately ½ % of total gas flow) will be injected into the GOX line. The nitrogen system is a self contained unit. To operate the unit in local mode, switch power on and push start at the local control panel. In remote mode, the Master Control Panel (MCP) has control over the solenoid valve that allows the nitrogen to be injected into the GOX line. The MCP PLC issues an open command to the solenoid whenever a PSU inverter is activated and energized. No variable regulation is required for the FUJI ozone system – a one time adjustment to the rotameter is sufficient for all ranges of operation.

2. Ozone System Equipment:

Each Ozone Generator consists of an ASME/TSSA coded generator pressure vessel with a typical operating range at 12-15 PSIG, with electric/manual valves and instruments mounted on off skid piping. Each Cooling Water Skid consists of two pumps and two heat exchangers) whereby the de-ionized water closed loop cools the high voltage dielectrics and the potable water closed loop cools the generator vessel. Heat from both the DI loop and the generator vessel closed loop is rejected to the open (plant cooling water) loop. Each closed loop is serviced by their respective pumps.

There are three Ozone Destruct Skids; each skid consists of a destruct vessel, pre-heater, blower, manual and motorized valves, instruments, destruct catalyst, silencer, vent gas monitor, and Local Control Panel.

There are three Power Supply Units (PSU's) each comprises of a Local Control PLC/HMI subpanel, an Auxiliary Power subpanel, a high voltage subpanel consisting of Reactor, Transformer, Pulse Width Modulator Converter, Inverter, and an Air Condition subpanel. The Local Control subpanel consists of Modicon Unity PLC, IO modules, local HMI Magelis screen with Vijeo software which provides local control for the ozone system. The Auxiliary Power subpanel consists of a motor starter, relays, power converter to provide 120 volt and 24 volts power to on skid instruments, and valves. The high voltage subpanel will convert the incoming input power and step it up to about 4000-5000 volts required for ozone generator. The Air Condition subpanel consists of a water-to-air heat exchanger and blower to provide forced-air cooling to the high voltage subpanel maintaining the subpanel temperature to within operation limits.

Table 1 – Ozone Generator Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
PT-O030A	Oxygen Filter #1 Differential Pressure	0 ~50" (0 ~ 1270 mm) W.C.
PT-O031A	Oxygen Filter #2 Differential Pressure	0 ~50" (0 ~ 1270 mm) W.C.
AIT-O110A	Ozone Ambient Monitor	0~10 PPM
AIT-O110B	Oxygen Ambient Monitor	0 ~ 25 % of Oxygen
AIT-O130A	Ozone Ambient Monitor	0~10 PPM
AIT-O130B	Oxygen Ambient Monitor	0 ~ 25 % of Oxygen
AIT-O150A	Ozone Ambient Monitor	0~10 PPM

Table 2 – Supplemental Air Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
AI-O032A	Dew point Monitor	-166 ~ 140° F (-110 ~ 60° C)
AI-O051A	Dew point Monitor	-166 ~ 140° F (-110 ~ 60° C)
FS-O051A	Flow Switch	N/A
FV-O051A	Nitrogen Solenoid Valve	N/A

Table 3 – Generator O110A Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O119A	Generator #1 Inlet Gas Valve	N/A
PT-O110A	Generator #1 Inlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O110A	Generator #1 Inlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)
PT-O112A	Generator #1 Outlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O112A	Generator #1 Outlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O112A	Generator #1 Outlet Gas Flow	14.1 ~ 141 scfm(0.372 ~ 3.72 Nm3/min)
FCV-O112A	Generator #1 Outlet Gas Modulating Valve	N/A
AIT-O112A	Generator #1 Outlet Gas Concentration	0 ~ 14 wt. % of Ozone
FV-O112B	Generator #1 Outlet Gas Valve	N/A
LS-O110A	Generator #1 Inlet Level Switch	N/A
LS-O110B	Generator #1 Outlet Level Switch	N/A
GEN-O110A	Generator #1	N/A

Table 4 – Generator O130A Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O139A	Generator #2 Inlet Gas Valve	N/A
PT-O130A	Generator #2 Inlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O130A	Generator #2 Inlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)
PT-O132A	Generator #2 Outlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O132A	Generator #2 Outlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O132A	Generator #2 Outlet Gas Flow	14.1 ~ 141 scfm(0.372 ~ 3.72 Nm3/min)
FCV-O132A	Generator #2 Outlet Gas Modulating Valve	N/A
AIT-O132A	Generator #2 Outlet Gas Concentration	0 ~ 14 wt. % of Ozone
FV-O132B	Generator #2 Outlet Gas Valve	N/A
LS-O130A	Generator #2 Inlet Level Switch	N/A
LS-O130B	Generator #2 Outlet Level Switch	N/A
GEN-O130A	Generator #2	N/A

Table-5 – Generator O150A Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O159A	Generator #3 Inlet Gas Valve	N/A
PT-O150A	Generator #3 Inlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O150A	Generator #3 Inlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)

PT-O152A	Generator #3 Outlet Gas Pressure	0 ~30 psig (0 ~ 206 kPa)
TT-O152A	Generator #3 Outlet Gas Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O152A	Generator #3 Outlet Gas Flow	14.1 ~ 141 scfm(0.372 ~ 3.72 Nm3/min)
FCV-O152A	Generator #3 Outlet Gas Modulating Valve	N/A
AIT-O152A	Generator #3 Outlet Gas Concentration	0 ~ 14 wt. % of Ozone
FV-O152B	Generator #3 Outlet Gas Valve	N/A
LS-O150A	Generator #3 Inlet Level Switch	N/A
LS-O150B	Generator #3 Outlet Level Switch	N/A
GEN-O150A	Generator #3	N/A

Table 6 – Generator Cooling Water System Skid #1 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O410A	Open Loop Cooling Water Flow to Heat Exchanger	N/A
TT-O410A	Open Loop Cooling Water Supply Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O410A	Open Loop Cooling Water Supply Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
TT-O410B	Open Loop Cooling Water Supply Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FV-O411A	Closed Loop Cooling Water Valve	N/A
FT-O411A	Closed Loop Cooling Water Inlet Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
PT-O411A	Closed Loop Cooling Water Inlet Pressure	0 ~ 60 psig (0 ~ 400 kPa)
P-O411A	Closed Loop Cooling Water Pump #1	N/A
TT-O411A	Closed Loop Cooling Water Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
CT-O411A	DI Water Conductivity	0 ~ 10.0 uS
TT-O411B	Closed Loop Cooling Water Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
SOL-O411A	DI Solenoid Valve	N/A

Table 7 – Generator Cooling Water System Skid #2 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O420A	Open Loop Cooling Water Flow to Heat Exchanger	N/A
TT-O420A	Open Loop Cooling Water Supply Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O420A	Open Loop Cooling Water Supply Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
TT-O420B	Open Loop Cooling Water Supply Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FV-O421A	Closed Loop Cooling Water Valve	N/A

FT-O421A	Closed Loop Cooling Water Inlet Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
PT-O421A	Closed Loop Cooling Water Inlet Pressure	0 ~ 60 psig (0 ~ 400 kPa)
P-O421A	Closed Loop Cooling Water Pump #2	N/A
TT-O421A	Closed Loop Cooling Water Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
CT-O421A	DI Water Conductivity	0 ~ 10.0 uS
TT-O421B	Closed Loop Cooling Water Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
SOL-O421A	DI Solenoid Valve	N/A

Table 8 – Generator Cooling Water System Skid #3 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O430A	Open Loop Cooling Water Flow to Heat Exchanger	N/A
TT-O430A	Open Loop Cooling Water Supply Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FT-O430A	Open Loop Cooling Water Supply Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
TT-O430B	Open Loop Cooling Water Supply Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
FV-O431A	Closed Loop Cooling Water Valve	N/A
FT-O431A	Closed Loop Cooling Water Inlet Flow	0 ~ 300 gpm (0 ~ 1136 L/min)
PT-O431A	Closed Loop Cooling Water Inlet Pressure	0 ~ 60 psig (0 ~ 400 kPa)
P-O431A	Closed Loop Cooling Water Pump #2	N/A
TT-O431A	Closed Loop Cooling Water Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
CT-O431A	DI Water Conductivity	0 ~ 10.0 uS
TT-O431B	Closed Loop Cooling Water Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
SOL-O431A	DI Solenoid Valve	N/A

Table 9– Ozone Flow Control System #1 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O201A	Contactor Crossover Valve #1	N/A
FT-O216A	Contactor #1 Ozone Gas Flow #1	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O216A	Contactor #1 Flow Control Valve #1	N/A
FT-O217A	Contactor #1 Ozone Gas Flow #2	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O217A	Contactor #1 Flow Control Valve #2	N/A

FT-O218A	Contactor #1 Ozone Gas Flow #3	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O218A	Contactor #1 Flow Control Valve #3	N/A

Table 10– Ozone Flow Control System #2 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O202A	Contactor Crossover Valve #2	N/A
FT-O226A	Contactor #1 Ozone Gas Flow #1	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O226A	Contactor #1 Flow Control Valve #1	N/A
FT-O227A	Contactor #1 Ozone Gas Flow #2	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O227A	Contactor #1 Flow Control Valve #2	N/A
FT-O228A	Contactor #1 Ozone Gas Flow #3	14.1 ~ 141 scfm (0.372 ~ 3.72 Nm3/min)
FCV-O228A	Contactor #1 Flow Control Valve #3	N/A

Table 11– Ozone Destruct System #1 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
PT-O501A	Contactor #1 Ozone Offgas Pressure	-30" ~ 30" (-750 mm ~750 mm)
PT-O501B	Contactor #1 Ozone Demister Differential Pressure	0 ~ 5" (0 ~ 125 mm)
AT-O501A	Contactor #1 Ozone Offgas Monitor	0 ~ 4 wt. % of Ozone
FV-O521A	Destruct Crossover Valve #1	N/A
FV-O510A	Destruct #1 Inlet Valve	N/A
TT-O510A	Destruct #1 Heater Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
TT-O510B	Destruct #1 Heater Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
PT-O510A	Destruct #1 Heater Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C
TT-O510C	Destruct #1 Vessel Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
MN-O510A	Destruct #1	N/A
VFD-O510A	Destruct #1 Blower VFD	N/A
PT-O510B	Destruct #1 Blower Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C.
AT-O510A	Destruct #1 Ventgas Monitor	0~1 PPM
CDU-O510A	Catalytic Destruct Unit #1 Control Panel	N/A

Table 12– Ozone Destruct System #2 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
FV-O520A	Destruct #2 Inlet Valve	N/A
TT-O520A	Destruct #2 Heater Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
TT-O520B	Destruct #2 Heater Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
PT-O520A	Destruct #2 Heater Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C.

TT-O520C	Destruct #2 Vessel Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
MN-O520A	Destruct #2	N/A
VFD-O520A	Destruct #2 Blower VFD	N/A
PT-O520B	Destruct #2 Blower Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C.
AT-O520A	Destruct #2 Ventgas Monitor	0~1 PPM
CDU-O520A	Catalytic Destruct Unit #2 Control Panel	N/A

Table 13– Ozone Destruct System #3 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
PT-O505A	Contactor #3 Ozone Offgas Pressure	-30" ~ 30" (-750 mm ~750 mm)
PT-O505B	Contactor #3 Ozone Demister Differential Pressure	0 ~ 5" (0 ~ 125 mm)
AT-O505A	Contactor #3 Ozone Offgas Monitor	0 ~ 4 wt. % of Ozone
FV-O523A	Destruct Crossover Valve #3	N/A
FV-O530A	Destruct #3 Inlet Valve	N/A
TT-O530A	Destruct #3 Heater Inlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
TT-O530B	Destruct #3 Heater Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
PT-O530A	Destruct #3 Heater Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C.
TT-O530C	Destruct #3 Vessel Outlet Temperature	-40 ~ 185° F (-40 ~ 85° C)
MN-O530A	Destruct #3	N/A
VFD-O530A	Destruct #3 Blower VFD	N/A
PT-O530B	Destruct #3 Blower Differential Pressure	0 ~ 20" (0 ~ 500 mm) W.C.
AT-O530A	Destruct #3 Ventgas Monitor	0~1 PPM
CDU-O530A	Catalytic Destruct Unit #3 Control Panel	N/A

Table 14– Sample Pumps #1 - #4 Component List

EQUIPMENT TAG IDENTIFIER	EQUIPMENT DESCRIPTION	EQUIPMENT CALIBRATED RANGE
MN-O220A	Sample Pump #1	N/A
AIT-O221A	Dissolved Ozone Analyzer	0~3 PPM
MN-O225A	Sample Pump #2	N/A
AIT-O226A	Dissolved Ozone Analyzer	0~3 PPM
MN-O240A	Sample Pump #3	N/A
AIT-O241A	Dissolved Ozone Analyzer	0~3 PPM
MN-O245A	Sample Pump #4	N/A
AIT-O246A	Dissolved Ozone Analyzer	0~3 PPM

3. Control Modes:

In general, Local will mean that all equipment, valves and instruments will be controlled and monitored at the Local Operator Station (LOS). Remote Manual will mean that the equipment/components can be operated from the HMI screen (e.g. valves opened-closed). In this mode the operator will be required to set all operating conditions inclusive of setting all valves in remote status. Remote Auto will mean that the operator will input certain information into the HMI screen and then the PLC will take over and run the ozone system. The following sections describe the control logic of: Local, Remote Manual and Remote Auto operations.

a. PSU/ICP #1 Control: (PSU-O310A)

Local Mode: Generator/PSU #1 "start and stop" commands are located on the "LOS" PSU-HMI operator display panel (front control panel). Select the Local/Remote mode selector to "LOCAL" Depress the "START" button to energize the generator/PSU. Depress "STOP" to de-energize. Enter KW power set-point (0-100%), PSU will ramp the power to the required set-point. Cooling water pumps can be operated directly from the "LOS" PSU-HMI screen. All instruments and valves shall be set to manual or hand control and be adjusted by the operator.

Remote Manual Mode: Generator/PSU #1 "start and stop" commands are located at the "LOS" PSU-HMI. Select the Local/Remote mode selector to "REMOTE". In this mode, Local PSU controls are not operative. Controls will be initiated from the Master Control Panel (MCP). At the MCP-HMI, all instruments, automatic valves, and equipment shall be set to Manual mode and set point values shall be adjusted by the operator. The operator further inputs the "Ozone Dosage" and "Ozone Concentration Set-point" data values at the MCP-HMI or plant scada. The MCP PLC shall determine when a contactor is online based on whether its respective gate is open. The Plant Water Flow will be read into the MCP PLC from plant SCADA. Upon initiation of a generator start command, and all safety permissive criteria are met, automatic sequencing of starting the generator will commence. Upon energizing the inverter, Power will automatically ramp up to meet the set-point ozone concentration.

Remote Auto Mode: Generator/PSU #1 "start and stop" commands are located at the "LOS" PSU-HMI. Select the Local/Remote mode selector to "REMOTE". In this mode, Local PSU controls are not operative. At the MCP-HMI, all automatic valves, instruments, and equipment shall be set to AUTO mode. No manual set point values are required to be set by the operator. The operator is required to input the "Ozone Dosage" and "Ozone Concentration Set-point" data values at the MCP-HMI. The MCP PLC shall determine when a contactor is online based on whether its respective gate is open. The Plant Water Flow will be read into the MCP PLC from plant SCADA. The MCP PLC will automatically calculate the ozone production and oxygen gas flow required. The ozone gas flow control valve will automatically be adjusted to the calculated oxygen gas flow set-point for the contactor(s). Upon initiation of a generator start command, and all safety permissive criteria are met, automatic sequencing of starting the generator will commence. Upon energizing the inverter, Power will automatically ramp up to meet the set-point ozone concentration.

b. PSU/ICP #2 Control: (PSU-O320A)

Functionally identical to PSU/ICP #1 Control: (PSU-O310A)

c. PSU/ICP #3 Control: (PSU-O330A)

Functionally identical to PSU/ICP #1 Control: (PSU-O310A)

d. Nitrogen Solenoid Valve Control: (FV-O051A)

Local Mode: None

Remote Manual Mode: None

Remote Auto Mode: The Nitrogen Solenoid Valve is used to inject nitrogen into the gas stream. Nitrogen is provided by the addition of dry atmospheric air. The MCP will energize the solenoid valve when any PSU Inverter is energized. The valve will be de-energized when no PSU's are running.

e. Generator #1 Gas Inlet Valve Control: (FV-O119A)

The motorized gas inlet valve is the flow path for oxygen gas (GOX) to pass into the generator. This valve has local/remote indication and open/close switches. See below for valve operation.

Local Mode: To open the valve, select hand at the actuator and the valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the Master Control Panel (MCP) HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select Remote at the actuator and Auto at the Master Control Panel (MCP) HMI screen, the oxygen gas inlet valve will open automatically. It will close automatically once the ozone system is stopped and ozone concentration inside the generator is below 0.06 %wt.

f. Generator #2 Gas Inlet Valve Control: (FV-O139A)

Functionally identical to Generator #1 Gas Inlet Valve Control: (FV-O119A)

g. Generator #3 Gas Inlet Valve Control: (FV-O159A)

Functionally identical to Generator #1 Gas Inlet Valve Control: (FV-O119A)

h. Generator #1 Gas Outlet Valve Control: (FV-O112B)

The motorized gas outlet valve is the flow path for ozone gas to pass from the generator. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select Remote at the actuator and Auto at the MCP HMI screen, the gas inlet valve will open automatically. It will close automatically once the ozone system is stopped and ozone concentration inside the generator is below 0.06 %wt.

i. Generator #2 Gas Outlet Valve Control: (FV-O132B)

Functionally identical to Generator #1 Gas Outlet Valve Control: (FV-O132B)

j. Generator #3 Gas Outlet Valve Control: (FV-O152B)

Functionally identical to Generator #1 Gas Outlet Valve Control: (FV-O132B)

k. Generator #1 Gas Outlet Modulating Valve Controls: (FCV-O112A)

A mass flow meter and a motorized flow control valve per generator regulate the volume of ozone gas to be fed to the selected contactor(s). This valve has visual indication, remote actuation, percent opened/closed indication, and open/closed position switches.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, input a desired data value for the command set point. To close the valve, input a data value of zero for the command set point.

Remote Auto Mode: Ozone gas flow is controlled at the outlet of the generator by the gas flow meter and control valve (FT-O112A, FCV-O112A). Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, select Auto on the valve, which contactor is on line, input the "Ozone Dosage" and "Ozone Concentration Set-point" data values. The flow set point will be calculated from the PLC and FCV-O112A will be automatically modulated to the desired ozone gas flow rate.
Ozone gas flow control will be calculated as follows:

- Ozone Kg Per Day required from Dosage set-point and Plant Water Flow. Ozone Production (Kg/day) = Dose (mg/L) * Plant Water Flow (ML/day)

- Ozone Gas set-point is calculated by the following equation, Oxygen Gas Flow (Nm3/min) = Ozone Production (Kg/day) / ozone wt % * 20.59 (conversion factor)

l. Generator # 2 Gas Outlet Modulating Valve Controls: (FCV-O132A)

Functionally identical to Generator #1 Gas Outlet Modulating Valve Controls: (FCV-O132A)

m. Generator #3 Gas Outlet Modulating Valve Controls: (FCV-O152A)

Functionally identical to Generator #1 Gas Outlet Modulating Valve Controls: (FCV-O132A)

n. Contactor Crossover Gas Valve #1 Controls: (FV-O201A)

The motorized gas crossover valve is one of the flow paths for ozone gas to pass from the generator to the selected contactor(s). This valve has local/remote indication and open/close switches. This valve is used in conjunction with FV-O202A to direct ozone gas from generator #1, generator #2, or generator #3 to contactor #2, or from generator #1, generator #2, or generator #3 to contactor #1. Under normal operating conditions, generator #1 will be assigned to contactor #1 and generator #2 will serve as a backup.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: None

o. Contactor Crossover Gas Valve# 2 Controls: (FV-O202A)

The motorized gas crossover valve is one of the flow paths for ozone gas to pass from the generator to the selected contactor(s). This valve has local/remote indication and open/close switches. This valve is used in conjunction with FV-O201A to direct ozone gas from generator #1, generator #2, or generator #3 to contactor #2, or from generator #1, generator #2, or generator #3 to contactor #1. Under normal operating conditions, generator #3 will be assigned to contactor #2 and generator #2 will serve as a backup.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: None

p. Contactor #1 Flow Control Valve # 1 Controls: (FCV-O216A)

Three flow meters and motorized flow control valves per contactor regulate the volume of ozone gas entering the contactor cells. These valves have visual indication, remote actuation and open/closed position switches.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, input a desired data value for the command set point. To close the valve, input a data value of zero for the command set point.

Remote Auto Mode: Ozone gas flow is controlled at the inlet of the contactor by the gas flow meter and control valve (FT-O216A, FCV-O216A). Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, select Auto on the valve. The number of diffuser rows online in the contactors will be determined based on the gas flow out of the generator and the normal operating gas flow range of the diffusers.

q. Contactor #1 Flow Control Valve # 2 Controls: (FCV-O217A)

Functionally identical to Contactor #1 Flow Control Valve # 1 Controls: (FCV-O216A)

r. Contactor #1 Flow Control Valve # 3 Controls: (FCV-O218A)

Functionally identical to Contactor #1 Flow Control Valve # 1 Controls: (FCV-O216A)

s. Contactor #2 Flow Control Valve #1 Controls: (FCV-O236A)

Three flow meters and motorized flow control valves per contactor regulate the volume of ozone gas entering the contactor cells. These valves have visual indication, remote actuation and open/closed position switches.

Local Mode: To open the valve, select hand at the actuator and valve can be manually opened or closed locally.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, input a desired data value for the command set point. To close the valve, input a data value of zero for the command set point.

Remote Auto Mode: Ozone gas flow is controlled at the inlet of the contactor by the gas flow meter and control valve (FT-O236A, FCV-O236A). Select the Hand-Off-Remote switch to Remote at the actuator control box. At the MCP HMI screen, select Auto on the valve. The number of diffuser rows online in the contactors will be determined based on the gas flow out of the generator and the normal operating gas flow range of the diffusers.

t. Contactor #2 Flow Control Valve #2 Controls: (FCV-O237A)

Functionally identical to Contactor #2 Flow Control Valve # 1 Controls: (FCV-O236A)

u. Contactor #2 Flow Control Valve #3 Controls: (FCV-O238A)

Functionally identical to Contactor #2 Flow Control Valve # 1 Controls: (FCV-O236A)

v. Destruct Crossover Valve #1 Controls: (FV-O521A)

This motorized valve is used to direct ozone off-gas from contactor #1 to ozone destruct #2 or to allow the flow of ozone gas from contactor #1 to ozone destruct #1. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select auto. The valve will operate automatically according to which Destruct system is online or as needed in the event of a failure.

w. Destruct Crossover Valve #2 Controls: (FV-O523A)

This motorized valve is used to direct ozone off-gas from contactor #2 to ozone destruct #2 or to allow the flow of ozone gas from contactor #2 to ozone destruct #3. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select auto. The valve will operate automatically according to which Destruct system is online or as needed in the event of a failure.

x. Destruct #1 Inlet Valve Controls: (FV-O510A)

This motorized valve is used to allow the flow of ozone off-gas from contactor #1 to ozone destruct #1. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Ozone gas flow from the contactor headspace into the destruct unit is controlled at the inlet of the destruct unit. Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen, select Auto on the valve. The valve will open automatically if the bypass valve has not been selected.

y. Destruct #2 Inlet Valve Controls: (FV-O520A)

This motorized valve is used to allow the bypass flow of excessive ozone off-gas from contactor #1 or contactor #2 to ozone destruct #2. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Ozone gas flow from the contactor headspace into the destruct unit is controlled at the inlet of the destruct unit. Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen, select Auto on the valve. The valve will open automatically if the bypass valve has been selected. .

z. Destruct #3 Inlet Valve Controls: (FV-O530A)

This motorized valve is used to allow the flow of excessive ozone off-gas from contactor #2 to ozone destruct #3. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Ozone gas flow from the contactor headspace into the destruct unit is controlled at the inlet of the destruct unit. Select the Hand-Off-Remote switch to Remote at the actuator control box. At MCP HMI screen, select Auto on the valve. The valve will open automatically if the bypass valve has not been selected.

aa. Generator #1 Open Loop Cooling Water Valve Controls: (FV-O410A)

The motorized water valve will control the flow of open loop (plant cooling water) to the Cooling Water Skid heat exchangers. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box and set PSU HMI screen to Remote. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select Remote at the actuator and set PSU HMI screen to Remote. At the Master Control Panel (MCP) HMI screen select Auto; the valve will operate automatically in accordance with PLC commands.

bb. Generator #2 Open Loop Cooling Water Valve Controls: (FV-O420A)

Functionally identical to Generator #1 Open Loop Cooling Water Valve Controls: (FV-O410A)

cc. Generator #3 Open Loop Cooling Water Valve Controls: (FV-O430A)

Functionally identical to Generator #1 Open Loop Cooling Water Valve Controls: (FV-O410A)

dd. Generator #1 Close Loop Cooling Water Valve Controls: (FV-O411A)

The motorized water valve will control the flow of closed loop cooling water from the Cooling Water Skid heat exchangers to the generator vessel. This valve has local/remote indication and open/close switches.

Local Mode: To open the valve, select hand at the actuator and valve will open. To close the valve, turn switch to off at the actuator and the valve will close.

Remote Manual Mode: Select the Hand-Off-Remote switch to Remote at the actuator control box and set PSU HMI screen to Remote. At MCP HMI screen select manual and click the open button. To close the valve, click the close button.

Remote Auto Mode: Select Remote at the actuator and set PSU HMI screen to Remote. At the Master Control Panel (MCP) HMI screen select Auto; the valve will operate automatically in accordance with PLC commands.

ee. Generator #2 Close Loop Cooling Water Valve Controls: (FV-O421A)

Functionally identical to Generator #1 Close Loop Cooling Water Valve Controls: (FV-O411A)

ff. Generator #3 Close Loop Cooling Water Valve Controls: (FV-O431A)

Functionally identical to Generator #1 Close Loop Cooling Water Valve Controls: (FV-O411A)

gg. Destruct System #1 Controls: (CDU-O510A)

Each destruct system is dedicated to a single contactor (contactor #1) with Destruct #2 serving as a standby. Destruct systems will operate singularly or in parallel under normal operating conditions.

Local Mode: Destruct unit “start/stop” commands are located at the destruct local control panel. Select switch to “LOCAL” and depress the “START” button. The blower will start first followed by the pre-heater. Depress the “STOP” button and this will stop both the blower and heater.

Remote Manual Mode: Select “REMOTE” at the destruct local control panel. Destruct unit “start/stop” commands are located at the MCP HMI. The blower will start first followed by the pre-heater. Depress the “STOP” button and this will stop both the blower and heater. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

Remote Auto Mode: Select “REMOTE” at the destruct local control panel. At the MCP HMI screen select auto and Destruct #1 Online. The destruct system will operate automatically if Destruct #1 is selected online or as needed in the event of a failure. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

hh. Destruct System #2 Controls: (CDU-O520A)

This destruct system is dedicated to serve as a backup to Destruct Systems #1 & #3. Destruct systems will operate singularly or in parallel under normal operating conditions.

Local Mode: Destruct unit "start/stop" commands are located at the destruct local control panel. Select switch to "LOCAL" and depress the "START" button. The blower will start first followed by the pre-heater. Depress the "STOP" button and this will stop both the blower and heater.

Remote Manual Mode: Select "REMOTE" at the destruct local control panel. Destruct unit "start/stop" commands are located at the MCP HMI. The blower will start first followed by the pre-heater. Depress the "STOP" button and this will stop both the blower and heater. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

Remote Auto Mode: Select "REMOTE" at the destruct local control panel. At the MCP HMI screen select auto and Destruct #2 Online. The destruct system will operate automatically if Destruct #2 is selected online or as needed in the event of a failure. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

ii. Destruct System #3 Controls: (CDU-O530A)

Each destruct system is dedicated to a single contactor (contactor #2) with Destruct #2 serving as a standby. Destruct systems will operate singularly or in parallel under normal operating conditions.

Local Mode: Destruct unit "start/stop" commands are located at the destruct local control panel. Select switch to "LOCAL" and depress the "START" button. The blower will start first followed by the pre-heater. Depress the "STOP" button and this will stop both the blower and heater.

Remote Manual Mode: Select "REMOTE" at the destruct local control panel. Destruct unit "start/stop" commands are located at the MCP HMI. The blower will start first followed by the pre-heater. Depress the "STOP" button and this will stop both the blower and heater. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

Remote Auto Mode: Select "REMOTE" at the destruct local control panel. At the MCP HMI screen select auto and Destruct #3 Online. The destruct system will operate automatically if Destruct #3 is selected online or as needed in the event of a failure. The blower motor speed will modulate according to a vacuum set point entered at the MCP HMI or Plant Control System.

jj. Generator #1 DI Water Pump Controls: (P-O411A)

The closed loop DI circuit Water Pump #1 (P-O411A) is assigned to generator #1. Local controls are located on Cooling Water Pump Local Control Panel #1.

Local Mode: Select Local and On at the Hand Switches on Local Panel.

Remote Manual Mode: Set PSU HMI screen to Remote. At the MCP HMI screen, select Manual and click the Start button. The pump is interlocked with valve FV-O410A.

Remote Auto Mode: Set PSU HMI screen to Remote. At the MCP HMI screen, select Auto. Pump will start and stop automatically.

kk. Generator #2 DI Water Pump Controls: (P-O412A)

Functionally identical to Generator #1 DI Water Pump Controls: (P-O411A)

ll. Generator #3 DI Water Pump Controls: (P-O413A)

Functionally identical to Generator #1 DI Water Pump Controls: (P-O411A)

mm. Generator DI Cooling Water Solenoid Controls: (FV-O411A, 0421A, 0431A)

These solenoid valves have only automatic control and are located on each cooling water skid. The valve will open when the respective DI water conductivity is 3.0 micro-siemens or above and close when is below 3.0 micro-siemens. The respective ozone generator will shut down if the conductivity level is 4.0 micro-siemens or above. Below 4 micro-siemens and above 3 micro-siemens, the cooling system will continue to operate. The polishing loop consisting of a resin bottle and filter will take a bleed stream from the DI loop which will gradually remove all ionizing components and bring the conductivity level back within acceptable limits.

nn. Sample Pumps #1 - #4: (SP-O220A, SP-O225A, SP-O240A, SP-O245A)

The sample pumps operate to collect residual ozone samples from the contactors. Sample pumps #1 & 2 sample contactor #1 and sample pumps #3 & 4 sample contactor #2. Local controls are located on the Sample Pump Local Control Panel.

Local Mode: Select Local and On at the Hand Switches on Local Panel.

Remote Manual Mode: Set sample pump control switch to Remote. At the MCP HMI screen, select Manual and click the Start or Stop buttons accordingly.

Remote Auto Mode: Set sample pump control switch to Remote. At the MCP HMI screen, select Auto. Pump will start and stop automatically according to a sampling schedule.

Table 15 – Modes of Operation

Equipment Tag Identifier	Equipment Description	Local Manual	Remote Manual	Remote Auto
PSU-O310A	Power Supply Unit #1	☒	☒	☒
PSU-O320A	Power Supply Unit #2	☒	☒	☒
PSU-O330A	Power Supply Unit #3	☒	☒	☒
FV-O051A	Nitrogen Solenoid Valve	☐	☐	☒
FV-O119A	Generator #1 Gas Inlet Valve	☒	☒	☒
FV-O139A	Generator #2 Gas Inlet Valve	☒	☒	☒
FV-O159A	Generator #3 Gas Inlet Valve	☒	☒	☒
FV-O112B	Generator #1 Gas Outlet Valve	☒	☒	☒
FV-O132B	Generator #2 Gas Outlet Valve	☒	☒	☒
FV-O152B	Generator #3 Gas Outlet Valve	☒	☒	☒
FCV-O112A	Generator #1 Gas Outlet Modulating Valve	☒	☒	☒
FCV-O132A	Generator #2 Gas Outlet Modulating Valve	☒	☒	☒
FCV-O152A	Generator #3 Gas Outlet Modulating Valve	☒	☒	☒
FV-O201A	Contactor Crossover Valve #1	☒	☒	☐
FV-O202A	Contactor Crossover Valve #2	☒	☒	☐
FV-O216A	Contactor #1 Flow Control Valve # 1	☒	☒	☒
FV-O217A	Contactor #1 Flow Control Valve #2	☒	☒	☒
FV-O218A	Contactor #1 Flow Control Valve #3	☒	☒	☒
FV-O226A	Contactor #2 Flow Control Valve # 1	☒	☒	☒
FV-O227A	Contactor #2 Flow Control Valve #2	☒	☒	☒
FV-O228A	Contactor #2 Flow Control Valve #3	☒	☒	☒

FV-0236A	Contactor #3 Flow Control Valve # 1	☒	☒	☒
FV-0237A	Contactor #3 Flow Control Valve #2	☒	☒	☒
FV-0238A	Contactor #3 Flow Control Valve #3	☒	☒	☒
FV-0521A	Destruct Crossover Valve #1	☒	☒	☒
FV-0523A	Destruct Crossover Valve #2	☒	☒	☒
FV-0510A	Destruct #1 Inlet Valve	☒	☒	☒
FV-0520A	Destruct #2 Inlet Valve	☒	☒	☒
FV-0530A	Destruct #3 Inlet Valve	☒	☒	☒
FV-0410A	Generator #1 Open Loop Cooling Water Valve	☒	☒	☒
FV-0420A	Generator #2 Open Loop Cooling Water Valve	☒	☒	☒
FV-0430A	Generator #3 Open Loop Cooling Water Valve	☒	☒	☒
FV-0411A	Generator #1 Close Loop Cooling Water Valve	☒	☒	☒
FV-0421A	Generator #2 Close Loop Cooling Water Valve	☒	☒	☒
FV-0431A	Generator #3 Close Loop Cooling Water Valve	☒	☒	☒
CDU-0510A	Destruct System #1	☒	☒	☒
CDU-0510A	Destruct System #1	☒	☒	☒
CDU-0510A	Destruct System #1	☒	☒	☒
P-0411A	Generator #1 DI Water Pump	☒	☒	☒
P-0412A	Generator #2 DI Water Pump	☒	☒	☒
P-0413A	Generator #3 DI Water Pump	☒	☒	☒
FV-0411A	Generator #1 DI Cooling Water Solenoid	☐	☐	☒
FV-0412A	Generator #2 DI Cooling Water Solenoid	☐	☐	☒
FV-0413A	Generator #3 DI Cooling Water Solenoid	☐	☐	☒
SP-0220A	Sample Pump #1, Residual Ozone	☒	☒	☒
SP-0225A	Sample Pump #2, Residual Ozone	☒	☒	☒
SP-0240A	Sample Pump #3, Residual Ozone	☒	☒	☒
SP-0245A	Sample Pump #4, Residual Ozone	☒	☒	☒

4. Process Information:

a. Normal Operating Conditions:

Before energizing the PSU/generator, all of the following must minimally be met:

- ✓ At least one (1) destruct unit(s) must be on.
- ✓ Flow must be established for gaseous oxygen, open loop water, cooling water, and DI water.
- ✓ Oxygen gas pressure is stabilized and above 6 PSIG / 41 kPa and oxygen dew point is less than -60 deg C, the minimum set point value.
- ✓ Ozone generator purged for at least 15 minutes
- ✓ All safety permissives cleared (ozone, oxygen, monitors, electrical and other alarms)
- ✓ Plant water flow established and/or Contactors must be full of water.

The operator generally needs to adhere to a 3-step process when operating the ozone generator and power supply unit. This process is described below:

- ✓ Step One: Switch on the PSU and power up the Local Control Section. “LOCAL or REMOTE” can be selected from the PSU HMI screen on the Local Control front panel.

- ✓ Step Two: Destruct unit must be started and fully operational. Open all appropriate valves manually or automatically to establish gas and water flow.
- ✓ Step Three: When both gas and water flow paths are established, system is ready to produce ozone. An Operator can "start/stop" the generator using the HMI touch screen.

When start is pressed, the control logic of PSU PLC local control will initiate the start-up sequence. The control logic will check for all alarms. (See alarms shutdown under Safety Interlock Section below). If all alarms are normal, the designated generator will start purging oxygen for 15 minutes. During the 15-minute purging cycle, the cooling water pump and the DI pump must be activated. After 15 minutes of purging with dry oxygen, the inverter will automatically turn on. Power will be applied to the ozone generator dielectrics to produce ozone. Ozone is channeled into the appropriate contactor. Ozone production can be observed at the generator viewport in the form of a Corona discharge.
Note: Alarms cannot be reset remotely; only at the PSU-HMI.

Automatic Gas Flow Control:
Ozone gas flow control will be calculated as follows:

- Ozone Kg Per Day required from Dosage set-point and Plant Water Flow. Ozone Production (Kg/day) = Dose (mg/L) * Plant Water Flow (ML/day)
- Ozone Gas set-point is calculated by the following equation, Oxygen Gas Flow (Nm3/min) = Ozone Production (Kg/day) / ozone wt % * 20.59 (conversion factor)

Ozone concentration and ozone dosage should first be set by the operator. In general, an incremental change in plant water flow will require an increase in ozone production to meet treatment objectives (and vice versa). At a fixed ozone concentration and dosage, increased oxygen/ozone gas flow will be required for increased ozone demand. The control system will adjust the flow control valve automatically until the measured gas flow (FIT/FE-25101, and/or FIT/FE-25201) and set-point ozone gas flow is achieved.

<u>Fault Conditions</u>
There are two types of shutdowns:

- Emergency shutdown:
  During emergency shutdown, all gas flow is halted, the PSU is de-energized and ozone production is inhibited.

- Normal control shutdown:
  During the normal control shutdown, the PSU is de-energized and ozone production is inhibited. Purge gas is directed to the generator outlet valve continuously until ozone concentration inside the generator vessel reaches 0.06 wt % of lower.

In event of a failure, the PLC program will respond as follows:

a) High-high ambient oxygen- discrete input (AA-O110B, AA-O130B, AA-O150B):

> The ambient oxygen monitor is set to sense high / high-high oxygen ambient from the environment. The alarm is set at greater than 22.5 %. When the monitor senses the high-high ambient oxygen of 24%, it will signal the control logic to shutdown the ozone generator. Ozone production will stop and gas purge will continue until ozone concentration is < 0.06 wt%. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

b) Low Oxygen Pressure –switch software generated (PIT-O110A#LL, PIT-O130A#LL, PIT-O150A#LL):

Generator oxygen inlet pressure transmitter is set to sense low pressure. The alarm is set at 41 kPa. When it senses the low pressure alarm, it will signal the control logic to shutdown the ozone generator with no oxygen gas purge. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

c) Outlet gas high-high pressure – switch software generated (PIT-O112A#HH, PIT-O132A#HH, PIT-O152A#HH):

The ozone generator outlet pressure transmitter is set to sense high-high pressure. The alarm is set at 124 kPa. When it senses the high-high pressure alarm, it will signal the control logic to stop ozone production with no oxygen gas purge. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

d) High-high ambient ozone concentrations- switch software generated (AIT-O110A#HH, AIT-O130A#HH, AIT-O150A#HH):

The ambient ozone monitor is set to sense high / high-high ozone ambient from the environment. The alarm is set at greater than 0.1 PPMV for high ozone ambient and 0.3 PPMV for high high ozone ambient. When the switch senses the high-high ambient ozone, it will signal the control logic to shutdown the ozone generator. Ozone production will stop with no oxygen gas purge. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

e) Ozone inlet gas Temperature – switch software generated (TIT-O110A#LL, TIT-O130A#LL, TIT-O150A#LL):

The ozone generator inlet temperature transmitter is set to sense low temperature. The low alarm is set at 4.4 deg C and the low-low alarm is set at 1.6 Deg C. When it senses the low-low temperature, it will signal the control logic to stop ozone production, oxygen gas purging will continue until ozone concentration is below 0.06 % wt. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

f) Ozone outlet gas Temperature – switch software generated (TIT-O112A#HH, TIT-O132A#HH, TIT-O152A#HH):

The ozone generator outlet temperature transmitter is set to sense high / high high temperature. The high alarm is set 50 deg C and the high high alarm at 60 Deg C. When it senses the high high temperature , it will signal the control logic to stop ozone production, oxygen gas purging will continue until ozone concentration is below 0.06 % wt. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

g) DI conductivity - switch software generated (CI-O411A#HH, CI-O421A#HH, CI-O431A#HH):

The generator closed loop DI circuit conductivity switch is set to sense high / high high conductivity. The high alarm is set at 3 micro-siemens and the high high alarm at 4 micro-siemens. When it senses high conductivity, it will open the DI solenoid in the cooling loop system to remove ionizing components. The solenoid will close when the conductivity is below 3 micro-siemens. When it senses a high high conductivity, it will signal the control logic to stop ozone production, gas purging will continue until ozone concentration is below 0.06 % wt. % Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

h) Open Loop cooling water Supply low-low flow – switch software generated (FIT-O410A#LL, FIT-O420A#LL, FIT-O430A#LL):

The generator Open loop cooling water flow transmitter is set to sense low-low flow. The alarm is set at 568 L/m. An alarm delay timer is set at 10 seconds. When the timer times out, the low-low gas flow alarm activates and ozone production will stop and oxygen gas purging will continue until ozone concentration is below 0.06 %wt. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

i) Closed Loop cooling water Return low-low flow – switch software generated (FIT-O411A#LL, FIT-O421A#LL, FIT-O431A#LL):

The generator Closed loop cooling water flow transmitter is set to sense low-low flow. The alarm is set at 450 L/m. An alarm delay timer is set at 10 seconds. When the timer times out, the low-low gas flow alarm activates and ozone production will stop and oxygen gas purging will continue until ozone concentration is below 0.06 %wt. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

j) High-high Oxygen Dewpoint – switch software generated (AIT-O051A#HH):

The oxygen dewpoint monitor is set to sense high / high-high oxygen dewpoint. The high alarm is set – 60 deg C and high high at - 40 deg C. When the switch senses the high-high oxygen dewpoint, it will signal control logics to shut down the ozone generator. Ozone production will stop and gas purge will continue until the dewpoint is below -60 deg C. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

k) Inverter will shutdown upon sensing one of the following alarm conditions. Ozone production will cease but oxygen gas purge will continue:

1. PWM failed.
2. Over Voltage.
3. Under Voltage.
4. Blown Fuse.
5. Charging circuit abnormal.
6. Ozone tubes over voltage.
7. Over current.
8. Overload.
9. Ozone tubes short circuit.
10. Inverter over heating.

Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

l) The Power Supply will shutdown upon sensing one of the following. Ozone Production will cease but oxygen gas purge will continue:

1. All/any PSU doors opened.
2. Transformer high temperature.
3. HV Reactor high temperature
4. PSU enclosure high temperature.
5. Emergency shut down in the case of fire or other emergency situations. Resetting the alarm is required to clear the fault. If alarm is not corrected, system cannot restart.

m) Emergency:

In event of fire, high ambient ozone or other emergency situations, or upon depressing the RED E-STOP button at the front of the PSU Local Control Panel, (or equivalent to stop the PSU LCP unit from SCADA), ozone production will cease.

b. System Safety Interlocks

Description	Hardware	Software
The high-high ambient oxygen will shutdown PSU and ozone production and continue purge.		☒
The generator ozone outlet gas low pressure will shutdown PSU and ozone production and no purging.		☒
The generator ozone gas low-low flow will shutdown PSU and ozone production and no purging.		☒
The generator ozone outlet gas high-high outlet pressure will shutdown PSU and ozone production and no purging.		☒
The high-high ambient ozone will shutdown PSU and ozone production and no purging.		☒
The generator inlet gas low-low temperature will shutdown PSU and ozone production and purging continues until ozone concentration below 0.06% is obtained		☒
The generator ozone outlet gas high-high temperature will shutdown PSU and ozone production and purging continues.		☒
The generator DI cooling water high-high conductivity will shutdown PSU and ozone production and purging continues.		☒
The generator open loop cooling water supply low-low flow will shutdown PSU and ozone production and purging continues.		☒
The generator closed loop cooling water return low-low flow will shutdown PSU and ozone production and purging continues.		☒
The high-high dewpoint will shutdown PSU and ozone production and purging continues.		☒
Inverter electrical fault signals will shutdown PSU and ozone production and purging continues.		☒
The PSU electrical fault signal will shut down the PSU and ozone production and purging continues.		☒
Emergency shutdown signal will shutdown PSU and ozone production.		☒

c. System Settings

i. Instrument Operation Ranges

Data Point	Units	Precision	Range		Adjustable
			Min	Max	
Generator ozone inlet temperature gas – TIT-O110A, TIT-O130A, TIT-O150A	Deg C	3	-40	85	No
Generator ozone outlet temperature gas – TIT-O112A, TIT-O132A, TIT-O152A	Deg C	3	-40	85	No
Generator outlet pressure gas – PIT-O112A, PIT-O132A, PIT-O152A	kPa	4	0	206	No
Generator GOX Inlet Pressure – PIT-O110A, PIT-O130A, PIT-O150A	kPa	4	0	206	No
Generator Ozone Gas Flow – FIT-O112A, FIT-O132A, FIT-O152A	Nm3/min	4	0.372	3.72	No
Generator Open Loop CW supply – FIT-O410A, FIT-O420A, FIT-O430A	l/min	4	0	1136	No
Generator Closed Loop CW return – FIT-O411A, FIT-O421A, FIT-O431A	l/min	4	0	1136	No
Ambient Oxygen - AIT-O110B, AIT-O130B	% wt	3	0	25	No
Oxygen Dewpoint - AIT-O032A, AIT-O051A	Deg C	3	-110	50	No
Ambient Ozone – AIT-O110A, AIT-O130A, AIT-O150A	PPM	3	0	10	No
GOX Filter DP - PDIT-O030A, PDIT-O031A	mm WC	4	0	1270	No
Demister DP - PDIT-O501B, PDIT-O505B	mm WC	3	0	635	No
Destruct Catalyst DP - PDT-O510A, PDT-O520A, PDT-O530A	mm WC	3	0	500	No
Destruct Blower DP - PDT-O510B, PDT-O520B, PDT-O530B	mm WC	3	0	500	No
Close Loop CW Temperature - TIT-O411A,B, TIT-O421A,B, TIT-O431A,B	Deg C	3	-40	85	No
DI Water Conductivity – CT-O411A, CT-O421A, CT-O431A	µS	3	0	10	No
Vent Gas Ozone - AIT-O510A, AIT-O520A, AIT-O530A	PPM	2	0	1	No
High Concentration Ozone - AIT-O112A, AIT-O132A, AIT-O152A	% wt	3	0	14	No
Off Gas Ozone - AIT-O501B, AIT-O505B	% wt	2	0	4	No

ii. Alarm Setpoints

Data Point	Low Low	Low	High	High High	Unit	Adjustable
Generator GOX Inlet Temperature low-low alarm– TIT-O110A, TIT-O130A, TIT-O150A	1.6	4.4			Deg C	No
Generator GOX Inlet Pressure alarm – PIT-O110A, PIT-O130A, PIT-O150A	24	41		124	kPa	No
Generator Ozone gas outlet temperature high-high alarm – TIT-O112A, TIT-O132A, TIT-O152A			50	60	Deg C	No
Generator Ozone gas outlet pressure alarm – PIT-O112A, PIT-O132A, PIT-O152A	24			124	kPa	No
Generator Ozone Gas Flow low-low flow alarm – FIT-O112A, FIT-O132A, FIT-O152A	15				Nm3/hr	No
Generator Open Loop CW supply low-low flow alarm – FIT-O410A, FIT-O420A, FIT-O430A	568				l/min	No
Generator Closed Loop CW return low-low flow alarm – FIT-O411A, FIT-O421A, FIT-O431A	450				l/min	No
Ambient Oxygen high-high alarm - AIT-O110B, AIT-O130B			22.5	24	% wt	No
Oxygen Dewpoint high-high alarm - AIT-O032A, AIT-O051A			-60	-40	Deg C	No
Ambient Ozone high-high alarm - AIT-O110A, AIT-O130A, AIT-O150A			0.1	0.3	PPM	No
Vent Gas Ozone high-high alarm - AIT-O510A, AIT-O520A, AIT-O530A			0.1	0.3	PPM	No

Appendix 7 – Standby Power Generator Systems

THE CITY OF WINNIPEG

Functional Design Specification

Deacon UV Disinfection System

March 20, 2006
Revision 0 (As-Built)

Prepared by:

Tartan Engineering Ltd.

Revision History

Version	Initials	Date	Description
A	PS	Nov 24, 2004	Preliminary
B	PS	Dec 15, 2004	Internally Reviewed – Issued for Client Approval
C	BCS	Feb 09, 2005	Re-Issued for Client Approval
0	BCS	Mar 20, 2006	As-Built

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1.0 GENERAL

The following Functional Design Specification (FDS) document is based on the Project Kick-off and Information Gathering meeting held in Winnipeg in November 2004 and the follow up meetings that occurred in Winnipeg in January 2005. It is also based on P&ID's, specifications, and operating philosophies provided by the client. It has been updated to reflect the changes in control that occurred as a result of commissioning and testing. This FDS details how the overall system functions and describes the operation of the various components. A description of how the System is configured, how it operates, and how system logic is implemented is included in this document.

The FDS is used as a technical guideline of how the system has been implemented and has been reviewed and approved by the client. This document is included as part of the project final documentation.

1.1 Reference Documents

The following documents in conjunction with this document will provide details on the control philosophy and programming requirements of the Deacon UV System PLC's.

- UV Disinfection System PLC Programming Requirements (By Earth Tech)
- Process Description Document (63672-C5-6(X), March, 2006)
- UVMDATA_rev0.xls (Tartan – PLC/RSView Database)
- D_SPLC_UV_Mar01.xls (SCADA Database)

1.2 Definitions

The following definitions will apply throughout this document:

- CPP — Control and Power Panel
- ESV — Emergency Solenoid Valve ("Valve fast close")
- FDS — Functional Design Specification
- HMI — Human Machine Interface
- IMMEDIATESD — Immediate Shut Down
- I/O — Input / Output
- NSV1(2) — Normal Solenoid Valve
- P&ID — Process and Instrumentation Drawing
- PID — Proportional, Integral, Derivative (Controller)
- PLC — Programmable Logic Controller
- P-PLC — Pump Programmable Logic Controller
- PV — Process Variable
- CV — Control Variable
- SP — Setpoint
- RSView — Rockwell Software (Human Machine Interface Software)
- S-PLC — Station Programmable Logic Controller
- SCADA — Supervisory and Data Acquisition
- UV — Ultra-Violet
- UVM-PLC — Ultra-Violet Master Programmable Logic Controller

1.3 System Description

The Deacon Booster Pump facility is the site of a new UV reactor system for disinfecting the City of Winnipeg's potable water. The new system has a PLC control system and interfaces with the existing PLC control system and the SCADA host at McPhillips through the existing Station PLC (S-PLC).

At this time the new UV system is not fully integrated with the current SCADA system and the host at McPhillips Control Center. A limited amount of imformation/control has been passed from the UVM-PLC through the S-PLC to SCADA. A separate RSView host (considered temporary until UV integration into the new SCADA system with the water treatment plant) has been configured on a separate leased line connection from McPhillips to Deacon. In addition, a local RSView system will be located at Deacon.

The six new reactors each have a Control and Power Panel (CPP) and Modicon PLC based unit control system. Each CPP also has a local touch-screen HMI. These CPP's are all networked together on a Modbus Plus network to the local HMI. A UV Master PLC, a redundant hot-standby Modicon PLC, is also connected to this Modbus Plus network.

Calgon Carbon Corporation, the UV Reactor supplier, programmed all the CPP PLC's and HMI's. The RSView local and remote HMI's were also configured by Calgon. The UV Master PLC was programmed by Tartan Engineering, as were the logic changes to the existing Pump and Station PLC's.

2.0 PUMP AND STATION PLC LOGIC

2.1 Booster Pump Logic

The station has three two-speed pumps. In low speed (392 RPM), the pump capacity is approx 135 ML/D and in the high speed (508 RPM), the pump capacity is approx 160 ML/D (actual flow rates are determined by the position of downstream valves). Each of the pump Local Control Panels is provided with an Off/COMPUTER/Local (OCL) switch and a HAND/MAINTENANCE (HM) switch that provides a control mode selection for the respective pump. A Low/High (LH) switch allows the selection of the desired pump operating speed, and a Stop/Start switch (SS) initiates the pump stop or start sequence. The HM, LH, and SS switches are only used when the OCL switch is in the Local position. Positions of all control switches are monitored by the pump PLC and are also displayed locally and on the SCADA Workstations. Each pump can be started in the HAND, COMPUTER, and MAINTENANCE modes.

HAND Mode - In this mode, the pump PLC controls the sequenced startup and shutdown of the pump and its respective discharge valve. With a pump's OCL switch in the "Local" position the HM switch in the "HAND" position, and the LH switch in the desired position, a low or high speed pump start sequence is manually initiated by selecting either low or high speed using the Low/High switch and then initiating the stop or start with the SS switch. The start initiates a sequence which starts to close the pump discharge valve and also sends a permissive request to the UV system to ensure adequate reactors are treating before allowing the pump to start. When the sequence is initiated the local pilot light for the speed that has been selected will flash while the reactors are starting and the discharge valve closes. When both permissives are met the pump will start in the requested speed and the corresponding pilot light will be on steady state. Once differential pressure is satisfied (a few seconds) the discharge valve will re-open and the pump will be in service.

COMPUTER Mode - COMPUTER mode provides a manual remote control mode for each pump. In this mode, the Station PLC provides remote master control of the pumps while the respective pump PLC's continue to provide pump specific interlocking and protection.

With the OCL switch in the "COMPUTER" position and the SCADA workstations in "COMPUTER" selection, a low or high speed pump start sequence is manually initiated (as selected by either low or high speed using the Low/High switch) by the pump start on SCADA. The start initiates a sequence which starts to close the pump discharge valve and also sends a permissive request to the UV system to ensure adequate reactors are treating before allowing the pump to start. When the sequence is initiated the local pilot light for the speed that has been selected will flash while the reactors are starting and the discharge valve closes. When both permissives are met the pump will start in the requested speed and the corresponding pilot light will be on steady state. Once differential pressure is satisfied (a few seconds) the discharge valve will re-open and the pump will be in service.

MAINTENANCE Mode - With the OCL switch in the local position and the HM switch in the maintenance position, a pump may be started/stopped in the MAINTENANCE mode. There is no sequence initiated and the pump start/stop and discharge valve open/close are initiated manually and independently from the switches on the local panel.

Pump status - Indications of pump and discharge valve status and alarms are connected to the pump PLC and displayed locally at the pump control panel and also at the SCADA Workstations. Each pump and motor is equipped with a temperature and vibration monitoring system. The system monitors temperatures and vibration at key locations on the pump and motor. A Modbus serial communication link continuously transmits temperature and vibration data to the station PLC. Additionally, three hard-wired alarm contacts (Point-in-alarm, system alarm & shutdown) are also connected to the station PLC as a backup.

Pump Shutdown conditions – Once a pump has been started in one of the previously mentioned operating modes, a pump stop sequence will be initiated at the pump PLC by any of the following conditions;

- When the pump is being operated in the HAND or maintenance modes, the operator may stop the pump manually using the stop switch on the local control panel or by selecting the off position with the OCL switch.
- When the pump is being operated in the COMPUTER mode, a manual stop command may be issued by an operator at one of the SCADA workstations.
- Loss of pump PLC power.
- A Lo Lo pump differential pressure alarm occurring during pump operation.

- Suction isolation valve not open.
- Discharge isolation valve not open.
- High temperature or vibration alarm at the pump or motor.
- Failure of the temperature and vibration monitoring system.
- Low or high speed electrical fault.
- Discharge valve fail to open.
- Reactor Hi flow alarm (if any UV Reactor experiences a hi flow condition)

The station PLC also monitors a number of conditions that will result in immediate shutdown of the pumps:

- Lo Lo suction pressure
- Station electrical supply fault
- Station Stage II Flood
- Branch 2 ESD

Following a pump stop command or shutdown, the pump will be prevented from restarting for 20 minutes. A logic reset button at the pump local control panel allows authorized operations and maintenance personnel to bypass the timer if required.

Pump Isolation Valves - Each pump has manually operated inlet and discharge isolation valves equipped with open and closed position switches. Valve positions are monitored by the pump PLC and displayed on the workstations. The isolation valves must be confirmed open before a pump start sequence can be initiated.

Pump Differential Pressure - Each pump is equipped with a differential pressure transmitter connected across the inlet and outlet. The differential signal is by the pump PLC and displayed on the workstations. Two set points are used to trigger the Low Pressure alarm and the Low-Low Pressure alarm/shut-down for each pump.

Pump Discharge Valve Control - The valve operation is controlled using one solenoid pilot valve and is powered by water pressure obtained from a separate constant water pressure source. Speed control valves in the hydraulic lines permit adjustment of normal opening and closing speeds. Closing time is set at approx 3-4 minutes and opening speed is set at approx 10 minutes. The slower opening speed is meant to reduce rapid flow increase through the reactors when starting pumps. The pilot indicating lights on the LCP indicate valve position, open, close and in transition both are on. Added functionality for the lights include flashing to indicate direction of travel ie: if valve is opening and in transition the open pilot light will flash and the close light will be steady state, when the valve reaches full open the close light will go off and the open light will be steady state on.

When the pump station is in GRAVITY flow mode, the pump PLC will de-energize the solenoid pilot valve causing the pump discharge control valve to open. In the event of station power failure during gravity flow, or in the event of power failure to the pump PLC panel, the solenoid valve will de-energize causing the discharge valve to remain open so that gravity flow to the aqueduct will continue uninterrupted. To prevent pressure surges in the aqueduct, pumps are always started and stopped with the respective discharge valve closed.

Normal start sequence for the pump;

- Energize the discharge solenoid valve and wait for limit switch confirmation that the valve has closed.
- Send request to reactors to ensure adequate UV availability and wait for confirmation of sufficient reactors online.
- Start the pump motor and wait for pump differential pressure to rise to the target set point.
- De-energize the normal solenoid pilot valve to initiate opening of the pump discharge valve.
- Monitor pump, motor, valve, differential pressure, and station discharge pressure, and initiate alarms for abnormal operation.
- As soon as the first pump is running and in service (valve fully open), the discharge valves for pumps not currently running will automatically start to close to prevent backspin.

Normal stop sequence for the pump;

- Energize the discharge solenoid valve and wait for limit switch confirmation that the valve has closed.
- Stop the pump motor.
- When the last pump running is stopped, its' discharge valve will remain open and the other two pump discharge valves will automatically re-open for return to GRAVITY mode.

Emergency stop sequence for the pump;

- For Emergency stop scenarios (Station Waterflood and Branch 2 ESD) which require immediate multiple pumps to stop simultaneously, all pump discharge valves will close simultaneously.

2.2 Station PLC Logic

The Station PLC (S-PLC) logic has been modified for the following:

1. The logic will determine if at least one pump discharge valve is fully open to provide a valid flow path for the branch 2 reactors. If this is not the case then an alarm will be generated back to the host.

2. The data mapping between the S-PLC's and the P-PLC's has been modified to support the UV Master PLC logic and I/O changes for the UV project.

3. In GRAVITY mode the discharge valves of the pumps will be fully open. The pump start sequence now includes the closing of the discharge valve. After starting the first pump its' discharge valve will fully open and the remaining discharge valves of the non running pumps will then begin to fully close to prevent backspin in the pumps not running. Starting of the 2nd pump will then be with the discharge valve already closed and upon starting will open to

allow flow with the 3rd pump discharge valve remaining closed. Initiating the stop of the third or second pump will first initiate closing the respective discharge valve, the pump stops only after the valve is fully closed. Initiating the stop of the last pump will stop the pump immediately and the respective valve will remain open for return to GRAVITY mode. On the condition of returning to gravity flow all discharge valves will open when no pumps are running. Exceptions to this are a station waterflood situation and an operator initiated Branch 2 Emergency Shutdown from the RSView workstations at either McPhillips or Deacon.

4. The logic to control DHV-1 (Branch 1) is also located in the S-PLC. The hardwiring for the valve control and statuses is through the UVM-PLC and as such is used as remote I/O for the S-PLC in this instance. The control for DHV-1 is displayed on the SCADA system and was modeled on the the existing valve VC-302. DHV-1 will close automatically on Station Flood and Branch 1 ESD.

5. The communications between the S-PLC and the UVM-PLC (both data writes' and reads') have been added to the S-PLC. Refer to the UVMDATA_rev0.xls database for details of the information that is transferred.

3.0 UV MASTER PLC LOGIC

3.1 S-PLC Interface

The UV Master PLC (UVM-PLC) interfaces to the S-PLC in the following manner:

1. When the operator requests either a Hi-start or Low-start of a pump, this start request will be passed from the Booster Pump PLC through the S-PLC to the UVM PLC. The UVM PLC will provide an inhibit command to prevent actual pump start until sufficient UV reactors are on line to handle the anticipated flow. The UVM PLC will start reactor(s) based on the anticipated additional flow from the pump being started. Flow rates for typical combinations of pumps and speeds (per operations practice) will be stored in a look-up table or similar means in the UVM PLC. The agreed upon valid PUMPING mode will be with two pumps running in slow. This requires 3 reactors online in Branch 2. The S-PLC will functionally allow or inhibit the Pumps from running in low and/or high speed depending on available reactor capacity. These inhibit status's will be available for the SCADA host to display to inform the operator of the pump availability status's.

2. Some diagnostic and various operational alarms/data are passed through the S-PLC from the UVM-PLC to the existing SCADA system. For details refer to the UVMDATA_rev0.xls and D_SPLC_UV_Mar01.xls spreadsheets.

3.2 UVM-PLC Logic

The UV Master PLC (UVM-PLC) performs the following logic:

1. The UVM-PLC is configured to read and write all data to and from all UV Reactor CPP's. It acts as a data concentrator and is the source of data (both read and write) from the local and remote RSView host HMI's. Refer to the UVMDATA_rev0.xls spreadsheet for details.

2. Logic exists to confirm that a valid flow path exists for each reactor prior to allowing the reactor to start. The open status of the appropriate valves will be used to determine this flow path. Reactors 1100 and 1200 will be utilized only for Branch 1 of the Aqueduct while Reactors 2100, 2200, 2300, and 2400 will be utilized for Branch 2 of the Aqueduct. It is possible for cross over to occur through header valve arrangements, such that Reactors are servicing the opposite Aqueduct Branch. Although this may not be used as a flow path under normal operation, this case will also be considered as a valid flow path and reactor operation will only be allowed in a HAND mode. Refer to the Reactor Availability Matrix and also P&ID drawing D-8398.

   An alarm will be generated by the UVM-PLC (one alarm per Aqueduct Branch) if there is not a valid flow path and corresponding reactors for that branch will not be permitted to treat.

3. The control interface between the UVM and individual reactor PLC's consists of the following combination of hardwire and 'soft' points:

   Hardwire statuses from the reactor PLC are as follows;

   - Shutdown – currently activates only when a full reactor shutdown has occurred.
   - Ready – this signal is active when the reactor shutdowns are clear, permissives are met and is available to run in any mode (Local/Remote/Auto/Manual).
   - Alarm – this signal is active whenever there are reactor alarms which have caused the shutdown of at least one lamp bank. Alarms are latched and only when a reset is initiated from either the reactor local control panel or remotely via the RSView workstations will they clear.
   - Treating – this signal is active when a start has been initiated and the lamps have warmed up sufficiently to begin treatment. This takes approximately 5 minutes upon start request. Further, once warm-up has been completed flow has to be established within approx 4 minutes or reactor will shutdown on low flow.
   - Hardwire Shutdown (formerly remote run/stop which has become a soft signal) – this signal is active when no Station Waterflood or Branch specific ESD condition exists. The main purpose of this is to allow an unconditional remote shutdown of the reactor which is not dependant on the integrity of the communication between the UVM and reactor PLC's.

   Soft statuses from the reactor PLC that are required for remote operation are as follows;

   - Local/Remote – this is status of the selection on the reactor control panels and if in Remote mode the reactor PLC will accept remote control requests from either the UVM or operator commands from the RSView workstations. In Local mode the reactor PLC will ignore all remote commands with the exception of the remote Emergency Shutdown hardwired signal. Refer to UVMDATA_rev0.xls spreadsheet for complete list of points.
   - Lamp Bank Auto/Manual(x3) – each reactor bank (3) has an independent Auto/Manual selection for its' control. All Banks will be required to be in auto for any station remote control.

- Low Dose Alarm – this alarm indicates that the desired treatment level is not being achieved by the reactor. The resultant action will be explained further in the station operating modes.
- Start/Stop – this request to remotely start/stop the reactor

4. The Flow Modulating Valves have a local control switch in order to select either Local, Off or Remote mode. In Off the valve will not move from its' current position. In Local the operator has the ability to manually change position of the valve and the valve will ignore the position command from the UVM PLC. In this mode the UVM-PLC tracks the position of the valve in order to provide bumpless transfer when the valve is switched back to Remote. Also, an alarm will activate on the RSView workstations in Local mode to indicate that the control system no longer has control of the valve and if the reactor is treating the corresponding branch will switch to HAND mode. In Remote the valve position will be set by the UVM PLC to required position to satisfy flow requirements. The remote closing rate of the FCV's for Branch 2 is set for approx 10 minutes when Branch 2 is in PUMPING mode and approx 75 sec when in GRAVITY mode or when ESD/Waterflood have been intiated. This is to help reduce the impact of large flow changes for the reactors. Normal operating mode will be Remote with the Branches in COMPUTER mode.

5. A HAND-COMPUTER mode for station Reactor control will be configured in the UVM-PLC to be selectable through the RSView local and remote HMI. The transition between HAND and COMPUTER modes will be bumpless and operator initiated (exceptions are noted under the COMPUTER description). A separate HAND-COMPUTER selection will be made available for each Branch to operate as follows:

- HAND: No automatic start sequence control commands from the UVM-PLC will be sent to the Reactor CPP-PLC's. The remote RSView host (remote operator) can issue reactor start/stop if the reactor is in Remote mode and if the Reactor is available (valid flow path and Ready). In addition, the reactor will be able to operate from the local control panel if the CPP Remote/Local switch is in Local. The flow modulating valves for both branches will stroke fully open or close based on individual operator initiated commands from the RSView workstations.

- COMPUTER: If the reactor Local/Remote switch on the CPP is in the 'Remote' position and the reactor is available for service (Remote, Ready and full auto) then the UVM-PLC will be able to issue start/stop sequence commands to the reactor CPP-PLC's to satisfy the treating capacity and flow rates based on the duty cycle setpoints and also for failovers. The following conditions will provide an automatic switch from COMPUTER to HAND.

  Branch 1:

  - If in COMPUTER and a reactor is treating and its' corresponding FCV is switched to local (not remote)

  - If in COMPUTER and a reactor is treating and communications fails between the UVM-PLC and the reactors' PLC.

- Station Waterflood
- Station Power Failure (if auto restart is selected for the power failure mode on the SCADA system then after restart timer has timed out the branch will return to COMPUTER mode automatically)
- Branch 1 Not Enough Reactors Available – this alarm will occur whenever the UV branch sequencer has called on more reactors than were available to treat automatically
- DD-050-ZB-2 Discharge header valve DD-050-DHV-2 is not closed (see P&ID drawing D-8398)
- Branch 1 ESD has been initiated (needs operator reset)

Branch 2:

- If in COMPUTER and a reactor is treating and its' corresponding FCV is switched to local (not remote)
- If in COMPUTER and a reactor is treating and communications fails between the UVM-PLC and the reactors' PLC.
- Station Waterflood
- Station Power Failure (if auto restart is selected for the power failure mode on the SCADA system then after restart timer has timed out the branch will return to COMPUTER mode automatically)
- Branch 2 Not Enough Reactors Available – this alarm will occur whenever the UV branch sequencer has called on more reactors than were available to treat automatically
- DD-050-ZB-2 Discharge header valve DD-050-DHV-2 is not closed (see P&ID drawing D-8398)
- Branch 2 ESD has been initiated (needs operator reset)

6. The UVM-PLC monitors the Reactor status points for Ready, Remote and full auto (all banks in Auto mode) status of each reactor and will lock out any reactor that is not ready. This is clearly indicated on the host display for the operator. Reactor duty selection is operator selectable from the host HMI (RSView). Each reactor is given a duty number to be used by the logic to determine which reactor is duty 1 (flow valve fully open or max flow) and which is next up. A group of two registers for Branch 1 and four registers for Branch 2 in the

UVM-PLC is used for this. The RSView will write all (two or four) registers simultaneously once completed by the operator so that the logic can detect a one-shot change in the duty table for each branch. Reactors 1100 and 1200 are assigned as Branch 1 reactors while reactors 2100, 2200, 2300, and 2400 are assigned as Branch 2 reactors.

Automatic duty rotation will not be incorporated into the logic at this time. This will strictly be a manual selection by the operator.

7. In GRAVITY mode (no pumps running) the UVM-PLC will automatically bring on and off reactors as required to accommodate the flow rate through the booster station in a responsive manner. It will be the operators' responsibility to adjust the flow rate through the station in a manner (SLOWLY) that allows the reactors to respond to the change in flow rate and also to ensure that there are sufficient reactors available before increasing flow. The UVM-PLC will sum the individual reactor flow rates to determine the overall Branch flow rate and start or stop the required numbers of reactors to satisfy treating capacity. In Pumped mode the Branch 2 flow rate will be predictable as previously described in sections 2.1 and 3.1 and the appropriate number of reactors will come online in anticipation of flow. Twenty minutes after pump starts are complete the UV sequencer will look at actual flow to determine if the reactors are all required to still be treating. There will be two operator selectable modes for this automatic (COMPUTER) control;

   PUMPING Mode

   The duty 1 reactor is always on-line and operating unless a shutdown causes it to be unavailable (flow control valve is fully open or max flow). When the anticipated station flow rate due to starting a pump exceeds the current treating capacity of the on-line reactor(s) the UVM-PLC will issue a start sequence to the next duty reactor. The reactor DUTY ON and DUTY OFF values in Table 2 will be used (initial values) to determine what flow rate will require an additional reactor to be on and what flow rate determines when to turn off an excess reactor.

   When the pump start request (from the pumps through the S-PLC) is received the UV sequencer will start the required number of reactors (3 for either one or two pumps in slow).

   The UVM-PLC will monitor the status of the reactor and once the status shows 'Treating' the control valve will be ramped fully open.

   Once treating status has been achieved and the reactors' associated FCV has started to open the UVM-PLC will send a permissive to the pump that is waiting to run.

   After twenty minutes and the branch 2 flow rate is at or drops to a level that requires less than the current number of reactors to run, then, once the 'DUTY OFF TIME DELAY' has been exceeded, the UVM-PLC will issue a ramp close to the modulating valve of the highest duty reactor. Once the valve is closed the reactor will be issued a remote stop.

   A maximum flow override (on a reactor basis) based on the Branch 2 Reactor Maximum Flow Setpoint from the RSView will start to choke the corresponding FCV if the branch is in COMPUTER mode. See Figure 1 for a diagram to explain this case.

   The UVM-PLC will use the branch 2 flow (sum through all reactors on a branch basis) to determine if another reactor should be brought on-line or off-line. The tables below represent the initial settings that will be programmed into the UVM-PLC. These settings are available for the operator to change from the RSView workstations and are applicable for either PUMPING or GRAVITY modes.

Table 1 - Branch 1

Flow Rate (Ml/d)	Duty On	Duty Off'	# Reactors
0-89			1
90-170	89	85	2

Table 2 - Branch 2

Flow Rate (Ml/d)	Duty On	Duty Off'	# Reactors
0-89			1
90-184	89	85	2
185-279	184	180	3
280-328	279	275	4

REACTOR FLOW SPLITTING CONTROL (Pumping)

STATION FLOW FOR THIS EXAMPLE APPROX 265 Ml/d

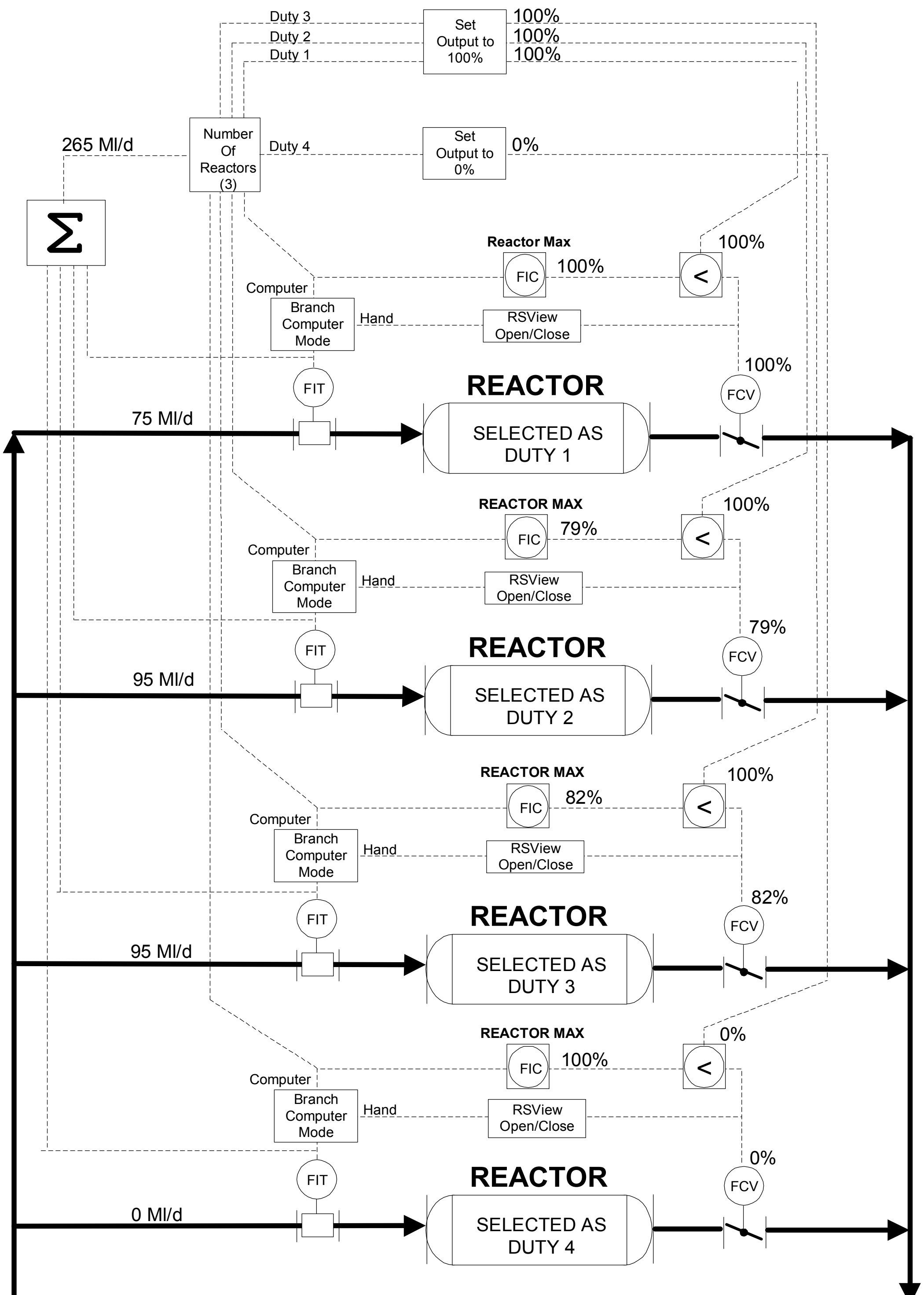

FIGURE 1

GRAVITY Control Mode

In this mode the sequencing on and off of the reactors is the same as above but the flow through the reactor bank is modulated. The duty 1 valve (or lowest duty reactor valve in the event of a failure) is always ramped fully open to maximum flow capability. If another reactor comes on-line then this valve is modulated to keep the previous reactor(s) flow rate to near 100% of the maximum flow rate. The flow rate through the modulated reactor must be kept greater than the minimum flow rate of the reactor.

Refer to Figure 2 below for a P&ID representation of the control strategy. The logic will determine which of the flow signals is from the highest duty reactor. This signal will be the process variable (PV) for a PID loop to maintain a minimum flow rate through that reactor. The other flow signals will pass through a 'low select' block to use the lowest flow rate of the lower duty reactors as the PV for another PID loop. This PID control loop will be used to modulate the lead reactor valve to maintain as close to 100% of reactor capacity of the lower duty (lowest of remaining) as possible. The output of the two min/modulating max PID loops will pass through a 'high select' to decide which signal will then be compared with the reactor max override (one loop for each reactor) in a 'low select' and then be fed to the valve control output. The other valve control outputs for the lower duty reactors will all be set to 100% open and then be compared with the reactor max override (one loop for each reactor) in a 'low select' and then be fed to the valve control output. This allows for hydraulic imbalance which is inherent with this installation. See figure 2.

When the branch flow rates drop to a level that requires less than the current number of reactors to run, then, on a branch basis once the 'DUTY OFF TIME DELAY' has been exceeded, the UVM-PLC will issue a ramp close to the modulating valve of the highest duty reactor. Once the valve is closed the reactor will be issued a remote stop. The new highest duty reactor then becomes the modulating reactor.

REACTOR FLOW SPLITTING CONTROL (Gravity)

STATION FLOW FOR THIS EXAMPLE APPROX 200 Ml/d

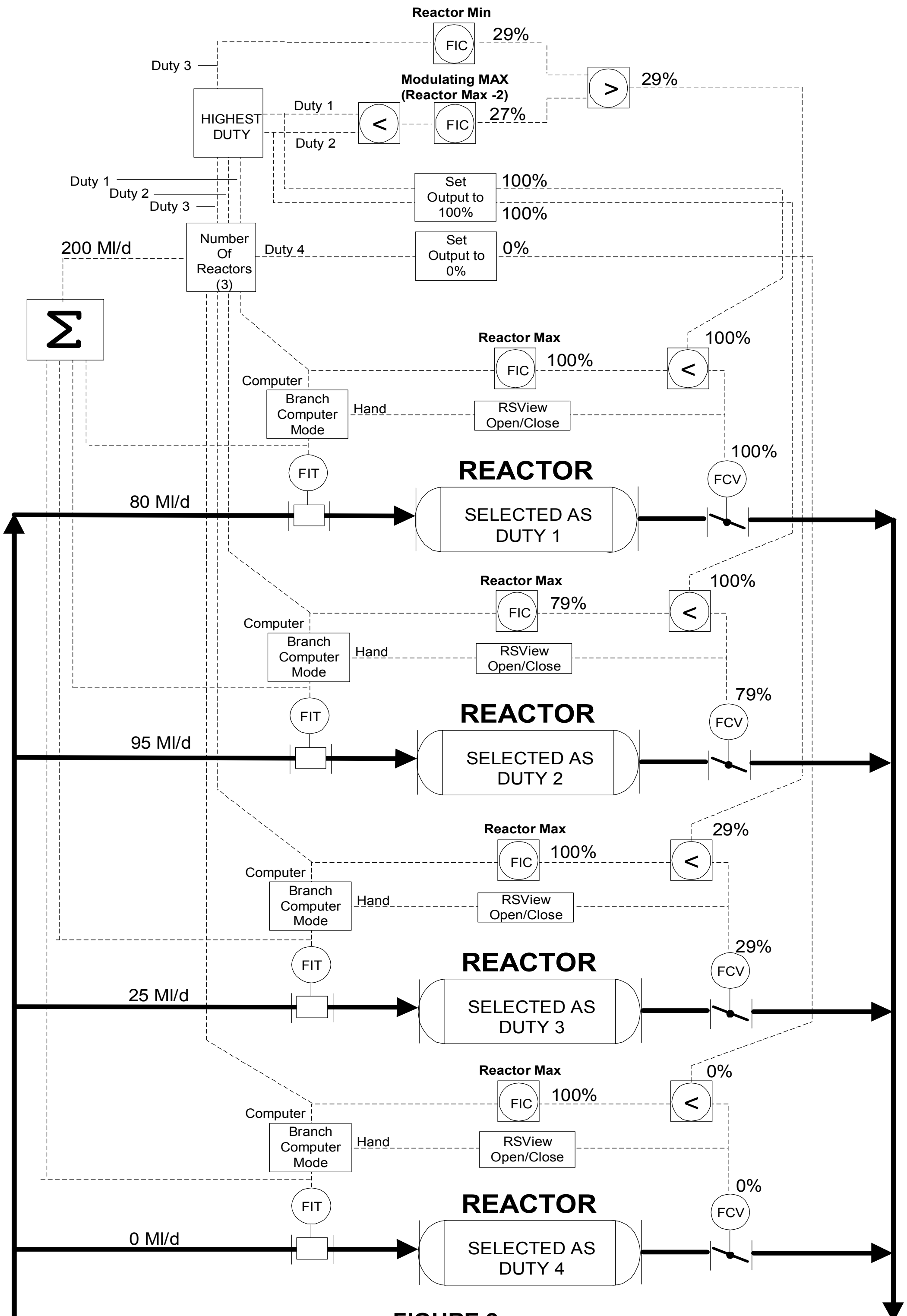

FIGURE 2

4.0 STATION FAIL/RECOVERY MODES

4.1 Failure/Recovery Modes

1. Power Failure – Station has experienced either momentary or sustained power failure. No automatic recovery will be attempted until power has returned and is stable for at least a minimum of 5 minutes (to allow for a complete cooldown cycle of the reactors that were running). Upon detection of power failure the following will occur simultaneously; alarm generated in existing SCADA system, the pumps will shut down, the pump discharge valves will open (if closed), the reactors will shutdown, the flow modulating valves will remain in their last state and the branch modes will switch to HAND. Upon resumption of stable power and if the power fail restart is enabled on SCADA and timed out, the reactors will be sent a reset request from the UVM PLC, the branches will be switched to COMPUTER (if in COMPUTER prior to power failure) and based on the duty cycle and station flow rate, the reactors will be requested to start in a sequential order with the next reactor waiting to start until the previous reactor has completed its' warm-up cycle. For Branch 2 the power failure recovery is in GRAVITY mode. If the desired flow requires pumps to run the starting will be based on an operator action. As part of the pump start sequence, the pumps will be given a permissive to start when the adequate treatment for the desired flow is available. If the operator determines that an auto restart for the reactors is not desirable he will switch off the power restart enable on SCADA and the branches will remain in HAND.

2. Station Waterflood – Station has experienced a flood condition based on the existing float detector. Upon detection of flood the following will occur simultaneously; alarm generated in existing SCADA system, the pumps will shut down, the pump discharge valves will close, valves DRV-308 and DRV-301 will close, the reactors will shutdown, the flow modulating valves will close, DHV-1 branch 1 discharge valve will close and the branch modes will switch to HAND with no automatic recovery being attempted. For the pumps to be able to restart the reset must be initiated from each pump LCP.

3. Moisture detected in Lamp Banks – At least one reactor has experienced a moisture condition which is indicative of a breach (leak or broken quartz). Upon detection of moisture, the affected reactor will shut down, an alarm initiated, and the respective valve will close after the next duty reactor has been brought on line. Refer to the ERP for more details relating to this event.

4. Emergency Shutdown Branch 1 – An operator has initiated the ESD Branch 1 push button on an RSView workstation. Upon detection of ESD Branch 1 the following will occur simultaneously; the Branch 1 reactors will shutdown, the flow modulating valves will close, DHV-1 branch 1 discharge valve will close and the branch will switch to HAND mode. In order to restart an operator ESD reset will be initiated from an RSView workstation. Then the operator will switch back to COMPUTER and based on both the duty cycle and desired flow setpoint, the reactors will be requested to start in a sequential order with the next reactor waiting to start until the previous reactor has completed its' warm-up cycle.

5. Emergency Shutdown Branch 2 – An operator has initiated the ESD Branch 2 push button on an RSView workstation. Upon detection of ESD Branch 2 the following will occur simultaneously; the pumps will shut down, the pump discharge valves will close, the Branch 2 reactors will shutdown, the flow modulating valves will close and the branch will switch to HAND mode. In order to restart an operator ESD reset will be initiated from an RSView workstation. The operator would then open the discharge valves of the pumps. Then the operator will switch back to COMPUTER and based on both the duty cycle and desired flow setpoint, the reactors will be requested to start in a sequential order with the next reactor waiting to start until the previous reactor has completed its' warm-up cycle. The operator would then initiate starting a pump if desired and the UV sequencer will request the reactor start and provide the necessary permissive for the pump to run.

6. Loss of Communication between the UVM-PLC and an active reactor PLC – loss of comm's will alarm to the RSView (and SCADA) workstations. Station flow control is based on the flow signals from the reactor PLC's being passed to the UVM PLC and automatic control cannot be accomplished. If the branch is in COMPUTER, the branch will switch to HAND mode. If branch 2 is in HAND mode already, only an alarm is generated.

7. Reactor Over Flow condition – a hardwired reactor high flow switch (from each flow transmitter on the reactors) is connected directly to the pump PLC's in order to provide protection from the flow being high enough to the point of causing physical damage to the reactor. If a high flow condition (130 Ml/day) exists than all pumps are disabled from running. For the pumps to restart the reset will be initiated from each pump LCP after the high flow condition has cleared.

8. Low Dose Alarm on a reactor in service – if branch is in HAND mode, no action taken. If branch is in COMPUTER mode (in either GRAVITY or PUMPING modes) and another reactor is available then start next available reactor based on duty selection. Upon completion of warm-up (treating status) then open modulating valve of available reactor. After the replacement reactors' valve is full open (or at max flow) then close the modulating valve of alarmed reactor. When modulating valve of alarmed reactor is closed then issue shutdown to alarmed reactor. When alarmed reactor condition is corrected and becomes available as per duty cycle selection it will start and reverse the sequence. If condition exists and no reactors are available the branch switches to hand and initiates an alarm on the RSView.

9. Reactor Shutdown on a reactor in service – if branch is in HAND mode reactor will shutdown with other no action taken. If branch is in COMPUTER mode (in either GRAVITY or PUMPING modes) and another reactor is available then start next available reactor based on duty selection. Upon completion of warm-up (treating status) then open modulating valve of available reactor. After the replacement reactors' valve is full open (or at max flow) then close the modulating valve of alarmed reactor. When modulating valve of alarmed reactor is closed then issue shutdown to alarmed reactor. When alarmed reactor condition is corrected and becomes available as per duty cycle selection it will start and reverse the sequence. If condition exists and no reactors are available then no action taken. If condition exists and no reactors are available the branch switches to hand and initiates an alarm on the RSView.

1. GENERAL

1.1 Work Included

.1 This section describes the operation of the UV light disinfection system installed within the Deacon Booster Pumping Station (DBPS).

.2 This document is intended to provide an overview of the functions and features of the UV Light Disinfection System. Refer to Standard Operating Procedures and component Operating and Maintenance manuals for specific and detailed procedures.

.3 The UV Light Disinfection System was purchased and installed using several contracts including the following:

- .1 Supply contract for six Calgon Sentinel UV light reactor systems with power panels, control panels, and operator interface RSView system.
- .2 Supply contract for five new hydraulically operated pump discharge control valves.
- .3 Supply contract for six new magnetic flow meters.
- .4 Supply contract for six new electrically operated control valves.
- .5 Supply and installation of and electric actuator on existing discharge header valve #1.
- .6 Supply, installation, and commissioning of new mechanical HVAC systems.

2. PRODUCTS

2.1 Process Equipment Numbering

.1 The process equipment has been numbered for identification as follows:

- .1 Existing pump suction isolation valves on the Branch 2 side are designated SV-1, SV-2, and SV–3. Future pump suction isolation valves for the Branch 1 side will be designated SV–4 and SV-5.
- .2 Existing pumps on the Branch 2 side are designated PP-1, PP-2, and PP–3. Future pumps for the Branch 1 side will be designated PP–4 and PP-5.
- .3 Pump discharge control valves on the Branch 2 side are designated PDV-1, PDV-2, and PDV–3. Future pump discharge control valves for the Branch 1 side will be designated PDV–4 and PDV-5.
- .4 Pump discharge isolation valves on the Branch 2 side are designated DV-1, DV-2, and DV–3. Future pump discharge isolation valves for the Branch 1 side will be designated DV–4 and DV-5.

.5 Isolation valves on the Intermediate Header are designated IHV-1, IHV-2, IHV–3, IHV–4, and IHV-5.

.6 UV reactor inlet isolation valves for Branch 1 are designated SIV-1, and SIV-2; and UV reactor inlet isolation valves for Branch 2 are designated SIV-3, SIV-4, SIV-5, and SIV-6.

.7 Magnetic flow meters for Branch 1 are designated FIT-1, and FIT-2; and magnetic flow meters for Branch 2 are designated FIT-3, FIT-4, FIT-5, and FIT-6.

.8 UV light reactors on Branch 1 are designated UVR-1100 and UVR-1200; and UV light reactors on Branch 2 are designated UVR-2100, UVR-2200, UVR-2300, and UVR-2400.

.9 UV reactor flow control/discharge isolation valves for Branch 1 are designated FCV-1, and FCV-2; and UV reactor flow control/discharge isolation valves for Branch 2 are designated FCV-3, FCV-4, FCV-5, and FCV-6.

.10 Isolation valves on the station discharge header are designated DHV-1, DHV-2, DHV–3, DHV–4, and DHV-5.

3. EXECUTION

3.1 General

.1 Two major operating scenarios exist. The first scenario is for unfiltered water, which will exist from the present time to approximately January 2008 when the new water treatment plant is expected to be operational. The second scenario is for filtered water, which will exist indefinitely once the new water treatment plant is operational.

.2 During the commissioning process, the UV reactors were Validated to establish the treatment capacity and control algorithms to be used for the unfiltered water scenario. At present, the UV reactors have been Validated to treat flows between 24 and 95 ML/d each. It should be noted that the UV reactors are capable of treating flows both above and below the Validated flow range but the treatment effectiveness outside of the Validated range is not certified and therefore should be avoided during normal operation.

.3 Following commissioning of the new water treatment plant, the UV reactors will need to be Validated once again to establish the treatment capacity and control algorithms to be used for the filtered water scenario. It is expected that the filtered water treatment capacity of each reactor will increase to approximately 125 ML/d.

.4 The DBPS currently operates as two independent systems; Branch 1 and Branch 2. For the existing unfiltered water scenario, Branch 1 operates in gravity mode only using available head from the Deacon raw water reservoir cells. Branch 2 can be operated in gravity mode by flowing through the de-energized pumps, or in pumping mode by operating the pumps.

.5 For the future filtered water scenario, the water treatment plant clearwell will operate at a lower water level than the existing reservoir cell levels and gravity flow mode will no longer be feasible. Pumps will be installed in the Branch 1 side, and all flow in both branches will be pumped from that point forward.

.6 Branch 1 delivers water primarily to the McPhillips reservoir and Branch 2 delivers water primarily to the Hurst reservoir. An interconnecting pipe joins the two branch aqueducts near the MacLean reservoir allowing MacLean to be fed from either branch aqueducts. The interconnection also allows cross feeding from one branch to the other to facilitate maintenance activities.

.7 Flow through the branch aqueducts is manually set by adjusting reservoir inlet valve positions at McPhillips, Hurst, and MacLean reservoirs. Valve DHV-1 at the DBPS is also manually adjusted in conjunction with the McPhillips inlet valve to maintain normal water levels in the Tache surge tower. The respective reservoir inlet flow rates are summed for each branch aqueduct and displayed on the SCADA workstation at Deacon for reference.

.8 The six UV reactors are each equipped with individual control and power panels, isolation valves, flow control valves, and magnetic flow meters. Each UV reactor operates independently and has an automatic dose-paced control system, fully capable of allowing lamps to maintain a target UV dose based on flow rate, lamp intensity, and water quality conditions. The dose-pacing control strategy resides in each of the individual reactor PLCs. Each reactor is guaranteed to be capable of providing a dose of 28 mJ/cm^2 under the following conditions:

- Flow rate of 95 ML/d at UVT of 75% for the unfiltered water scenario.
- Flow rate of at least 125 ML/d in Branch I and 102 ML/d in Branch II at UVT of 90% for the filtered water scenario.

.9 The UV system is monitored and controlled from a computer workstation with Human-Machine Interface (HMI) software called RSView. The RSView system provides full access to control and monitor the UV reactors remotely from the pump station control room and/or from the McPhillips control Center.

.10 The UV Master PLC communicates with the individual reactor PLC's, the RSView system, the Station Master PLC, the pump PLC's, and SCADA and then performs all interlocking and control function to operate the UV system. The main function of the UV Master PLC is to provide supervisory control of the UV system by deciding how many reactors need to be on line for each branch and to maintain flow split to each operating UV reactor within set operating limits. This PLC also coordinates UV system operation with other pump station operations and provides safety interlocking with the booster pumps, and station flood alarm shutdown.

.11 An important goal of the UV control system is to provide 100% treatment of the flow passing through the station. To facilitate this goal, the reactor flow control valves are normally closed whenever a reactor is offline. When a reactor is requested to start, the flow control valve remains closed until the UV lamps have warmed up and effective treatment is confirmed. Similarly, when a reactor is requested to stop, the flow control valve will first close, and then the reactor is turned off.

.12 The UV system control sequencer for each branch has duty start/stop flow setpoints and time delay settings to control the starting and stopping of reactors in response to the branch flow rate. When the reactors are on line, the flow split to each reactor is governed by the operating mode of the branch sequencer. Two operating modes are available, gravity mode and pumping mode. The gravity flow mode attempts to provide optimal reactor utilization by partially choking the flow in the last duty reactor to encourage full rated flow in the lead reactor(s). The pumped flow mode will only throttle the flow control valves as required to prevent flows in excess of the Validated capacity of the reactor, otherwise the flow control valves will remain 100% open.

3.2 Automatic Branch 1 Operating Scenario for Gravity Flow

.1 Automatic sequencer control for the branch requires that both reactors and their respective flow control valves are on remote control and full automatic dose control. One reactor may be taken out of service if required, but a combination of local and remote control is not allowed.

.2 If a reactor fails during remote automatic control, the sequencer will request startup of the next available duty reactor, when the replacement reactor is confirmed on line and treating the sequencer will take the failed reactor out of service. If a reactor fails when there is not a replacement available, the sequencer will switch to Hand control and initiate a “Not enough reactors” alarm. The operator will need to either; reduce flow, shut down the branch, or make another reactor available.

.3 At any time that the flow demand of the branch exceeds available UV treatment capacity, the the sequencer will switch to Hand control and initiate a “Not enough reactors” alarm. The operator will need to either; reduce flow, shut down the branch, or make another reactor available.

.4 For flows up to approximately 90 ML/d, a minimum of only one UV reactor will be on-line. Based on the flow rate through the operating reactor, the reactor PLC will determine the required number of lamps and power settings required based on the treatment dose set point.

.5 When the branch 1 flow rate reaches the duty #2 start setpoint, the UV Master PLC will request startup of the second duty reactor. The reactor lamps will warm up, treatment is established, and the flow control valve opens and is released to automatic control in the selected control mode.

.6 For flows between approximately 90 and 190 ML/d, two UV reactors will be on-line and the flow split to the two reactors will be governed by the selected operating mode, gravity or pumping.

.7 When the branch flow demand decreases to the duty #2 stop set point, the UV Master PLC will request shutdown of the second duty reactor. The reactor lamps will remain on while the flow control valve is closed after which the lamps will be turned off.

3.3 Branch II Operating Scenario for Gravity Flow

.1 Automatic sequencer control for the branch requires that all reactors and their respective flow control valves are on remote control and full automatic dose control. One reactor may be taken out of service if required, but a combination of local and remote control is not allowed.

.2 If a reactor fails during remote automatic control, the sequencer will request startup of the next available duty reactor, when the replacement reactor is confirmed on line and treating the sequencer will take the failed reactor out of service. If a reactor fails when there is not a replacement available, the sequencer will switch to Hand control and initiate a "Not enough reactors" alarm. The operator will need to either; reduce flow, shut down the branch, or make another reactor available.

.3 At any time that the flow demand of the branch exceeds available UV treatment capacity, the the sequencer will switch to Hand control and initiate a "Not enough reactors" alarm. The operator will need to either; reduce flow, shut down the branch, or make another reactor available.

.4 For flows up to approximately 90 ML/d, a minimum of only one UV reactor will be on-line. Based on the flow rate through the operating reactor, the reactor PLC will determine the required number of lamps and power settings required based on the treatment dose set point.

.5 When the branch 2 flow rate reaches the duty #2 start set point, the UV Master PLC will request startup of the second duty reactor. The reactor lamps will warm up, treatment is established, and the flow control valve opens and is released to automatic control in the selected control mode.

.6 For flows between approximately 90 and 180 ML/d, two UV reactors will be on-line and the flow split to the two reactors will be governed by the selected operating mode, gravity or pumping.

.7 When the branch 2 flow rate reaches the duty #3 start set point, the UV Master PLC will request startup of the third duty reactor. The reactor lamps will warm up, treatment is established, and the flow control valve opens and is released to automatic control in the selected control mode.

.8 For flows between approximately 180 and 270 ML/d, three UV reactors will be on-line and the flow split to the three reactors will be governed by the selected operating mode, gravity or pumping.

.9 When the branch 2 flow rate reaches the duty #4 start set point, the UV Master PLC will request startup of the fourth duty reactor. The reactor lamps will warm up, treatment is established, and the flow control valve opens and is released to automatic control in the selected control mode.

.10 For flows between approximately 270 and 380 ML/d, four UV reactors will be on-line and the flow split to the four reactors will be governed by the selected operating mode, gravity or pumping.

3.4 Branch 2 Operating Scenario For Pumping Mode

.1 The three booster pumps available for branch 2 are two speed pumps with hydraulically operated discharge control valves. The discharge control valves have been adjusted to provide very slow opening and closing speeds to prevent surges and pressure spikes. Speed and reverse spin monitors have been installed to augment the existing pump monitoring systems which include temperature and vibration monitoring.

.2 Operation of pumping mode should only be required on rare occasions where the branch 2 demand rises significantly above 160 ML/d for an extended period of time. When pumping does become necessary, normal practice dictates that two of the pumps must be started on low speed to boost system flow to approximately 275 ML/d.

.3 Operation of one pump alone will not boost aqueduct flows significantly and must be avoided due to the risk of cavitation damage to the pump. Single pump operation should only occur during the transition from gravity flow to pumped flow and from pumped flow back to gravity flow. Operation of pumps on high speed and/or operation of more than two pumps on slow speed is not required to meet projected demands and should not be attempted without prior approval.

.4 The transition from gravity mode to pump mode occurs when the first pump start request is made. The startup of the first pump will be inhibited until several conditions are met; the branch control mode must be switched to pumping mode, at least two reactors must be on line, and the pump discharge valve must close. If a pump start request is made before these conditions are met, the control system will automatically close the pump discharge valve, start the next duty reactor if required, and switch the branch control mode to pumping mode if required. Once the first pump has been successfully started, the control system will automatically initiate closing of the pump discharge valves of the pumps that are not running.

.5 The startup of the second pump will be inhibited until two conditions are met; at least three reactors must be on line and the pump discharge valve must be closed. If a pump start request is made before these conditions are met, the control system will automatically wait until the pump discharge valve is fully closed and then start the next duty reactor if required.

.6 The reactor control sequencing described for gravity flow operation is also true for pumped flow operation except that the sequencer control is forced into pumping mode. The reactor flow control valves will only throttle if required to prevent flow exceeding the reactor's treatment capacity.

3.5 Reactor Control

.1 Refer to the UV System Operations and Maintenance manuals for comprehensive instructions for UV system operations.

.2 Each UV reactor may be controlled locally or remotely based on a local/remote selection at the local control panels.

.3 When local control is selected, the reactor will not respond to supervisory signals from the UV Master PLC and automatic sequencer control of the respective branch is inhibited.

.4 When remote control is selected, the reactor will respond to control signals from the UV Master PLC.

.5 The reactors each have a fully automatic dose control mode and two forms of manual controls that are primarily for maintenance activities.

3.6 Power Failure

.1 Power failure at the pump station will result in immediate shut down of all pumps and UV reactors. The control system will remain active on UPS power and the emergency generator will start to provide power for life safety and essential services. Pumps and UV reactors are currently not supported by the emergency generator.

.2 All electrically operated valves will remain in their last positions and the pump discharge control valves will open if they were closed prior to the power failure. These actions effectively return the station to gravity flow mode and to allow any surging or reverse flows to stabilize.

.3 If the power failure duration is more than a few minutes or if the weather indicates that numerous power failures are likely, the operator should consider stopping the branch flows until the power has stabilized. This will minimize the quantity of untreated water being sent to the city reservoirs and reduce undue stress and cycling on the equipment.

.4 Upon restoration of power, the UV reactors may be restarted manually or automatically based on the "Auto Restart Reactors after Power Failure" selection in the SCADA system.

.5 If the auto restart function has been enabled, alarms related specifically to the power failure will automatically reset, the branch sequencer controls will switch back to automatic control, and reactors will be restarted in sequence following a time delay. The delay timer ensures that power is stable and that reactors have cooled down sufficiently to enable restart. It should be noted that in some instances, alarms such as "Loss of Phase" may occur requiring manual reset before the automatic restart of reactors will begin.

.6 If the auto restart function is turned off, both branch sequencer controls will switch to hand control and alarms will be initiated for "Reactor XXXX flowing without treatment". The operator will be required to take some immediate action, either restarting the reactors or shutting down the branch flows.

.7 Pump alarms specifically related to the power failure will be reset automatically but the pumps will not restart automatically.

3.7 Emergency Shut Down – "ESD"

.1 The RSView system is equipped with an Emergency Shut Down feature for each branch of the UV system. In the event of an emergency situation requiring immediate shut down of the branch aqueduct, the Emergency Shut Down feature initiates immediate shut down of the reactors, pumps, and flow control valves for the affected branch.

.2 It should be noted that use of the ESD function may result in air being introduced into the affected branch aqueduct. Follow up of such an event should include inspection of all related equipment and piping according to established protocols. Refilling of the branch aqueduct may also be necessary to displace any air that enters the system.

3.8 Station Flood Alarm Shut Down

.1 The booster pump station is equipped with a critical alarm called “Station Flood” which is initiated by a High-High water level in the south-east floor sump. Activation of this alarm will cause an immediate shut down of all UV reactors, booster pumps, and all remote controlled valves related to station isolation.

.2 It should be noted that occurrence of the station flood alarm may result in air being introduced into the branch aqueducts. Follow up of such an event should include inspection of all related equipment and piping according to established protocols. Refilling of the branch aqueducts may also be necessary to displace any air that enters the system.

END OF SECTION

Appendix 8 – Initial Settings

ANALOG SETTINGS

3/26/2010

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Raw Water Pump Station - Operator													
	Wet Well 1 Level 1	LT-I000A	75.0	80.0	99.0	100.0	3	2	0	10	0	4	Enabled
	Wet Well 2 Level 1	LT-I000B	75.0	80.0	99.0	100.0	3	2	0	10	0	4	Enabled
	Wet Well 1 Level 2	LT-I000C	75.0	80.0	99.0	100.0	3	2	0	10	0	4	Enabled
	Wet Well 2 Level 2	LT-I000D	75.0	80.0	99.0	100.0	3	2	0	10	0	4	Enabled
	Raw Water pH	AT-I024B	6.0	6.5	8.8	9.0	3	2	0	1	0	10	Enabled
	Raw Water Turbidity	AT-I027B	0.0	0.0	3.0	4.0	3	2	2	1	0	10	Enabled
	Header 1 Temperature	TT-I011A	0.0	0.2	20.0	22.0	3	2	0	1	0	10	Enabled
	Header 2 Temperature	TT-I012A	0.0	0.2	20.0	22.0	3	2	0	1	0	10	Enabled
	Header 1 Pressure	PT-I011B	0.0	0.0	103.0	105.0	2	0	0	0	0	0	Enabled
	Header 2 Pressure	PT-I012B	0.0	0.0	103.0	105.0	2	0	0	0	0	0	Enabled
	Header 1 pH	AT-I025B	5.0	5.3	8.3	8.5	10	2	0	1	0	10	Enabled
	Header 2 pH	AT-I026B	5.0	5.3	8.3	8.5	10	2	0	1	0	10	Enabled
	DAF 1 Flow	FT-P100A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 2 Flow	FT-P200A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 3 Flow	FT-P300A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 4 Flow	FT-P400A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 5 Flow	FT-P500A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 6 Flow	FT-P600A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 7 Flow	FT-P700A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 8 Flow	FT-P800A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
Raw Water Pump Station - Status Pump 1													
	Top Bearing Temperature	TT-I001A	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-I001H	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-I001B	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-I001C	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-I001D	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-I001E	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-I001F	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-I001G	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Magnadrive Temperature	TT-I001I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Magnadrive Bearing Temperature	TT-I001J	0.0	0.0	55.0	60.0	0	0	0	0	0	0	Enabled
	Vibration	VT-I001A	0.0	0.0	0.2	0.5	0	0	0	0	0	0	Enabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Raw Water Pump Station - Status Pump 2													
	Top Bearing Temperature	TT-I002A	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-I002H	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-I002B	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-I002C	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-I002D	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-I002E	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-I002F	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-I002G	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Magnadrive Temperature	TT-I002I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Magnadrive Bearing Temperature	TT-I002J	0.0	0.0	55.0	60.0	0	0	0	0	0	0	Enabled
	Vibration	VT-I002A	0.0	0.0	0.2	0.5	0	0	0	0	0	0	Enabled
Raw Water Pump Station - Status Pump 3													
	Top Bearing Temperature	TT-I003A	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-I003H	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-I003B	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-I003C	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-I003D	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-I003E	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-I003F	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-I003G	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Magnadrive Temperature	TT-I003I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Magnadrive Bearing Temperature	TT-I003J	0.0	0.0	55.0	60.0	0	0	0	0	0	0	Enabled
	Vibration	VT-I003A	0.0	0.0	0.2	0.5	0	0	0	0	0	0	Enabled
Raw Water Pump Station - Status Pump 4													
	Top Bearing Temperature	TT-I004A	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-I004H	0.0	0.0	85.0	90.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-I004B	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-I004C	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-I004D	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-I004E	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-I004F	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-I004G	0.0	0.0	120.0	140.0	0	0	0	0	0	0	Enabled
	Magnadrive Temperature	TT-I004I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Magnadrive Bearing Temperature	TT-I004J	0.0	0.0	55.0	60.0	0	0	0	0	0	0	Enabled
	Vibration	VT-I004A	0.0	0.0	0.2	0.5	0	0	0	0	0	0	Enabled

ANALOG SETTINGS

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Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
DAF													
	DAF 1 Flow	FT-P100A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 2 Flow	FT-P200A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 3 Flow	FT-P300A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 4 Flow	FT-P400A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 5 Flow	FT-P500A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 6 Flow	FT-P600A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 7 Flow	FT-P700A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 8 Flow	FT-P800A	100.0	250.0	750.0	800.0	5	5	1	0	0	0	Auto
	DAF 1 Level	LT-P100A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 2 Level	LT-P200A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 3 Level	LT-P300A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 4 Level	LT-P400A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 5 Level	LT-P500A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 6 Level	LT-P600A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 7 Level	LT-P700A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	DAF 8 Level	LT-P800A	350.0	375.0	550.0	575.0	10	0	1	10	0	10	Disabled
	Train 1 Effluent Channel Level	LT-P970A	5.0	10.0	83.0	95.0	2	2	1	0	0	0	Enabled
	Train 2 Effluent Channel Level	LT-P971A	5.0	10.0	83.0	95.0	2	2	1	0	0	0	Enabled
	DAF Effluent Turbidity	AT-P975A	0.0	0.0	0.8	1.0	90	2	1	30	0	10	Enabled
	DAF Effluent pH	AT-P976A	5.0	5.3	8.3	8.5	2	2	1	30	0	10	Enabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
DAF Saturators													
	Saturator 1 Flow	FT-P001A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 1 Level	LT-P001A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 1 Pressure	PT-P001A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 1 Temperature	TT-P001A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 2 Flow	FT-P002A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 2 Level	LT-P002A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 2 Pressure	PT-P002A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 2 Temperature	TT-P002A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 3 Flow	FT-P003A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 3 Level	LT-P003A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 3 Pressure	PT-P003A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 3 Temperature	TT-P003A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 4 Flow	FT-P004A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 4 Level	LT-P004A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 4 Pressure	PT-P004A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Saturator 4 Temperature	TT-P004A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Air Compressor Pressure	PT-P900A	580.0	620.0	930.0	950.0	0	0	0	0	0	0	Disabled
DAF Float Sumps													
	Float Sump 1 Level 1	LT-P930A	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 1 Level 2	LT-P930B	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 2 Level 1	LT-P940A	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 2 Level 2	LT-P940B	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 1 / 2 Flow	FT-P990A	4.0	5.0	16.0	18.0	60	0	2	0	0	0	Auto
	Float Sump 3 Level 1	LT-P950A	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 3 Level 2	LT-P950B	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 4 Level 1	LT-P960A	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 4 Level 2	LT-P960B	20.0	25.0	90.0	95.0	2	2	1	0	0	0	Enabled
	Float Sump 3 / 4 Flow	FT-P993A	4.0	5.0	16.0	18.0	60	0	2	0	0	0	Auto
	DAF Area Process Sump Level A	LT-P980A	0.0	5.0	50.0	90.0	2	2	1	0	0	0	Enabled
	DAF Area Process Sump Level B	LT-P980B	0.0	5.0	50.0	90.0	2	2	1	0	0	0	Enabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
O_3 Generator 1													
			Enabled Locally										
O_3 Generator 2													
			Enabled Locally										
O_3 Generator 3													
			Enabled Locally										
O_3 GOX & Cooling Water													
			Enabled Locally										
O_3 Contactors													
			Enabled Locally										
O_3 Destruct													
			Enabled Locally										
Filter 1													
	Filter 1 Level	LT-F100A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 1 Headloss	PT-F100A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 1 Turbidity	AT-F110A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 1 Particle Count 2-5	AT-F110B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 1 Particle Count 5-15	AT-F110C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 1 Particle Count 15-20	AT-F110D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 1 Particle Count >50	AT-F110E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 1 Flow	FT-F103A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter 2													
	Filter 2 Level	LT-F200A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 2 Headloss	PT-F200A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 2 Turbidity	AT-F210A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 2 Particle Count 2-5	AT-F210B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 2 Particle Count 5-15	AT-F210C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 2 Particle Count 15-20	AT-F210D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 2 Particle Count >50	AT-F210E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 2 Flow	FT-F203A	0.0	-	-	-	0	0	0	0	0	0	Auto

ANALOG SETTINGS

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Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Filter 3													
	Filter 3 Level	LT-F300A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 3 Headloss	PT-F300A	0.0	0.0	0.0	48.0	60	0	5	0	0	0	Enabled
	Filter 3 Turbidity	AT-F310A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 3 Particle Count 2-5	AT-F310B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 3 Particle Count 5-15	AT-F310C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 3 Particle Count 15-20	AT-F310D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 3 Particle Count >50	AT-F310E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 3 Flow	FT-F303A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter 4													
	Filter 4 Level	LT-F400A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 4 Headloss	PT-F400A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 4 Turbidity	AT-F410A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 4 Particle Count 2-5	AT-F410B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 4 Particle Count 5-15	AT-F410C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 4 Particle Count 15-20	AT-F410D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 4 Particle Count >50	AT-F410E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 4 Flow	FT-F403A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter 5													
	Filter 5 Level	LT-F500A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 5 Headloss	PT-F500A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 5 Turbidity	AT-F510A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 5 Particle Count 2-5	AT-F510B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 5 Particle Count 5-15	AT-F510C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 5 Particle Count 15-20	AT-F510D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 5 Particle Count >50	AT-F510E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 5 Flow	FT-F503A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter 6													
	Filter 6 Level	LT-F600A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 6 Headloss	PT-F600A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 6 Turbidity	AT-F610A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 6 Particle Count 2-5	AT-F610B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 6 Particle Count 5-15	AT-F610C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 6 Particle Count 15-20	AT-F610D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 6 Particle Count >50	AT-F610E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 6 Flow	FT-F603A	0.0	-	-	-	0	0	0	0	0	0	Auto

ANALOG SETTINGS

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Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Filter 7													
	Filter 7 Level	LT-F700A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 7 Headloss	PT-F700A	0.0	0.0	45.0	48.0	60	0	5	0	0	0	Enabled
	Filter 7 Turbidity	AT-F710A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 7 Particle Count 2-5	AT-F710B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 7 Particle Count 5-15	AT-F710C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 7 Particle Count 15-20	AT-F710D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 7 Particle Count >50	AT-F710E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 7 Flow	FT-F703A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter 8													
	Filter 8 Level	LT-F800A	0.0	0.0	45.0	50.0	0	0	0	0	0	0	Enabled
	Filter 8 Headloss	PT-F800A	0.0	0.0	40.0	43.0	60	0	5	0	0	0	Enabled
	Filter 8 Turbidity	AT-F810A	0.0	0.0	0.3	0.5	60	0	0	0	0	0	Enabled
	Filter 8 Particle Count 2-5	AT-F810B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 8 Particle Count 5-15	AT-F810C	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 8 Particle Count 15-20	AT-F810D	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 8 Particle Count >50	AT-F810E	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Filter 8 Flow	FT-F803A	0.0	-	-	-	0	0	0	0	0	0	Auto
Filter Backwash													
	Blower 1 Inlet Pressure	PT-F010A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Enabled
	Blower 1 Discharge Pressure	PT-F010B	0.0	0.0	95.0	105.0	2	0	0	0	0	0	Enabled
	Blower 2 Inlet Pressure	PT-F020A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Enabled
	Blower 2 Discharge Pressure	PT-F020B	0.0	0.0	95.0	105.0	2	0	0	0	0	0	Enabled
	Blower Discharge Temperature	TT-F030A	0.0	0.0	90.0	100.0	60	0	0	0	0	0	Enabled
	Blower Flow	FT-F030A	0.0	58.0	74.0	80.0	99	0	0	0	0	0	By Blower
	Backwash Water Tank 1 Level	LT-F910A	15.0	30.0	92.0	100.0	2	0	2	0	0	0	Enabled
	Backwash Water Tank 2 Level	LT-F920A	15.0	30.0	92.0	100.0	2	0	2	0	0	0	Enabled
	Backwash Pump 1 Disch Temp	TT-F911A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Backwash Pump 1 Disch Press	PT-F911A	0.0	0.0	105.0	110.0	10	0	0	0	0	0	Enabled
	Backwash Pump 1 Flow	FT-F911A	0.0	0.0	1100.0	1150.0	2	0	0	0	0	0	Enabled
	Backwash Pump 2 Disch Temp	TT-F921A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Backwash Pump 2 Disch Press	PT-F921A	0.0	0.0	105.0	110.0	10	0	0	0	0	0	Enabled
	Backwash Pump 2 Flow	FT-F921A	0.0	0.0	1100.0	1150.0	2	0	0	0	0	0	Enabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Backwash Pump 1 Status													
	Top Bearing Temperature	TT-F911I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-F911H	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-F911B	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-F911C	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-F911D	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-F911E	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-F911F	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-F911G	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Unused	TT-F911A											
Backwash Pump 2 Status													
	Top Bearing Temperature	TT-F921I	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-F921H	0.0	0.0	120.0	130.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-F921B	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-F921C	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-F921D	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-F921E	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-F921F	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-F921G	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Unused	TT-F921A											
Filtered Water Chamber, CCT & Backwash Sump Pumps													
	Filtered Water Chamber pH	AT-F050A	5.0	6.0	9.0	10.0	5	0	0	0	0	0	Disabled
	Filtered Water Chamber Level	LT-F050A	3.0	5.0	65.0	67.0	2	0	2	0	0	0	Enabled
	Chlorine Contact Chamber Free Residual	AT-F056A	0.5	0.7	1.5	2.0	30	2	0	1	0	10	Enabled
	Hypochlorite Mixing Pump 1 Flow	FT-J701A	5.0	7.0	12.0	15.0	15	0	0	0	0	0	Disabled
	Hypochlorite Mixing Pump 2 Flow	FT-J702A	5.0	7.0	12.0	15.0	15	0	0	0	0	0	Disabled
	Backwash Area Process Sump Level 1	LT-F980A	0.0	0.0	42.0	55.0	2	0	2	0	0	0	Enabled
	Backwash Area Process Sump Level 2	LT-F980B	0.0	0.0	42.0	55.0	2	0	2	0	0	0	Enabled
Clearwell													
	Clearwell 1 Level 1	LT-T101A	25.0	60.0	79.0	87.0	3	2	0	60	0	3	Auto
	Clearwell 1 Level 2	LT-T101B	25.0	60.0	79.0	87.0	3	2	0	60	0	3	Auto
	Clearwell 2 Level 1	LT-T201A	25.0	60.0	79.0	87.0	3	2	0	60	0	3	Auto
	Clearwell 2 Level 2	LT-T202A	25.0	60.0	79.0	87.0	3	2	0	60	0	3	Auto
	Clearwell 1 Free Chlorine Residual	AT-T105A	0.5	0.6	3.5	4.0	0	0	0	0	0	0	Enabled
	Clearwell 1 pH	AT-T106A	6.5	6.8	8.0	8.4	0	0	0	0	0	0	Enabled
	Clearwell 1 Turbidity	AT-T107A	0.0	0.0	0.3	0.5	15	0	2	0	0	0	Enabled
	Clearwell 2 Free Chlorine Residual	AT-T205A	0.5	0.6	3.5	4.0	0	0	0	0	0	0	Enabled
	Clearwell 2 pH	AT-T206A	6.5	6.8	8.0	8.4	0	0	0	0	0	0	Enabled
	Clearwell 2 Turbidity	AT-T207A	0.0	0.0	0.3	0.5	15	0	2	0	0	0	Enabled
Deacon Booster 1													
Deacon Booster 2													

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Wash Water Recovery													
	WRT 1 Level	LT-R100D	10.0	15.0	70.0	75.0	20	2	2	5	0	5	Enabled
	WRT 1 TSS	LT-R100E	0.0	0.0	19.5	20.0	0	0	0	0	0	0	Enabled
	WRT 2 Level	LT-R200D	10.0	15.0	70.0	75.0	20	2	2	5	0	5	Enabled
	WRT 3 Level	LT-R300D	10.0	15.0	70.0	75.0	20	2	2	5	0	5	Enabled
	WRT 4 Level	LT-R400D	10.0	15.0	70.0	75.0	20	2	2	5	0	5	Enabled
	WRT Solids Decant TSS	AT-R001A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	WRT Supernatant Turbidity	AT-R010A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	WRT Solids Decant Flow	FT-R001B	10.0	15.0	40.0	45.0	60	0	2	0	0	0	Auto
Gravity Thickener & Sludge Equalization Tank													
	Gravity Thickener 1 TSS	AT-R500B	0.0	0.0	10.0	10.0	0	0	0	0	0	0	Enabled
	TSET 1 Level	LT-R710D	14.0	16.0	80.0	82.0	2	0	1	60	0	15	Enabled
	TSET 2 Level	LT-R720D	14.0	15.0	80.0	82.0	2	0	1	60	0	15	Enabled
	Thickened Sludge Flow	FT-R730A	3.0	5.0	32.0	35.0	99	0	0	0	0	0	Auto
	Thickened Sludge TSS	AT-R730B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
Supernatant Pump Station													
	Supernatant Pump Station Level	LT-R020A	20.0	28.0	75.0	80.0	2	0	0	0	0	0	Enabled
	Supernatant Flow	FT-R024A	0.0	0.0	900.0	1000.0	0	0	0	0	0	0	Auto
	Supernatant Turbidity	AT-T024A	0.0	0.0	10.0	20.0	10	10	0	0	0	0	Enabled
Supernatant Pump 1 Status													
	Top Bearing Temperature	TT-R021A	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-R021H	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-R021B	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-R021C	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-R021D	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-R021E	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-R021F	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-R021G	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	VSD Temperature	TT-R021I	0.0	0.0	73.0	84.0	0	0	0	0	0	0	Enabled
	Vibration	VT-R021A	0.0	0.0	0.2	0.5	10	0	0	0	0	0	Enabled
Supernatant Pump 2 Status													
	Top Bearing Temperature	TT-R022A	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-R022H	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-R022B	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-R022C	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-R022D	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-R022E	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-R022F	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-R022G	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	VSD Temperature	TT-R022I	0.0	0.0	73.0	84.0	0	0	0	0	0	0	Enabled
	Vibration	VT-R022A	0.0	0.0	0.2	0.5	10	0	0	0	0	0	Enabled

ANALOG SETTINGS

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Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Supernatant Pump 3 Status													
	Top Bearing Temperature	TT-R023A	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Bottom Bearing Temperature	TT-R023H	0.0	0.0	90.0	100.0	0	0	0	0	0	0	Enabled
	Winding Temperature 1	TT-R023B	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 2	TT-R023C	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 3	TT-R023D	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 4	TT-R023E	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 5	TT-R023F	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Winding Temperature 6	TT-R023G	0.0	0.0	160.0	165.0	0	0	0	0	0	0	Enabled
	Vibration	VT-R023A	0.0	0.0	0.3	0.5	10	0	0	0	0	0	Enabled
HV Services													
	Potable Booster Pump Pressure	PT-H704A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Clearwell Booster Pump Pressure	PT-H701A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Fire Pump Room Sump Level 1	LT-H400A	0.0	0.0	99.0	100.0	2	0	0	0	0	0	Enabled
	Fire Pump Room Sump Level 2	LT-H400B	0.0	0.0	99.0	100.0	2	0	0	0	0	0	Enabled
Dewatering Pump Station													
	Pump Station Level	LT-L920A	0.3	0.6	1.8	1.9	0	0	0	0	0	0	Enabled
	Pump Station Flow	FT-L924A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Auto
	Pump Station Temperature	TT-L965A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Pump Station TSS	AT-L924A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Metering Chamber Ambient Temperature	TT-L924A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Enabled
Ferric Chloride													
	Ferric Tank 1 Upper Level	LT-S110B	6.0	10.0	90.0	95.0	2	2	1	5	0	5	Enabled
	Ferric Tank 1 Lower Level	LT-S110D	6.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ferric Tank 2 Upper Level	LT-S120B	6.0	10.0	90.0	95.0	2	2	1	5	0	5	Enabled
	Ferric Tank 2 Lower Level	LT-S120D	6.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ferric Tank 3 Upper Level	LT-S130B	6.0	10.0	90.0	95.0	2	2	1	5	0	5	Enabled
	Ferric Tank 3 Lower Level	LT-S130D	6.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ferric Tank 4 Upper Level	LT-S140B	6.0	10.0	90.0	95.0	2	2	1	5	0	5	Enabled
	Ferric Tank 4 Lower Level	LT-S140D	6.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ferric Train 1 Flow	FT-S165A	0.5	1.0	10.0	15.0	60	0	2	0	0	0	Auto
	Ferric Train 2 Flow	FT-S185A	0.5	1.0	10.0	15.0	60	0	2	0	0	0	Auto

ANALOG SETTINGS

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Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Sulphuric Acid													
	Sulphuric Acid Tank 1 Upper Level	LT-S210B	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Sulphuric Acid Tank 1 Lower Level	LT-S210D	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Sulphuric Acid Tank 2 Upper Level	LT-S220B	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Sulphuric Acid Tank 2 Lower Level	LT-S220D	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Sulphuric Acid Train 1 Flow	FT-S235A	0.1	0.2	4.0	5.0	60	0	2	0	0	0	Auto
	Sulphuric Acid Train 2 Flow	FT-S255A	0.1	0.4	4.0	5.0	60	0	2	0	0	0	Auto
Sodium Hydroxide													
	Hydroxide Tank 1 Upper Level	LT-S310B	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Hydroxide Tank 1 Lower Level	LT-S310D	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Hydroxide Tank 1 Temperature	TT-S310B	18.0	20.0	40.0	45.0	2	0	1	0	0	0	Enabled
	Hydroxide Tank 2 Upper Level	LT-S320B	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Hydroxide Tank 2 Lower Level	LT-S320D	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Hydroxide Tank 2 Temperature	TT-S320B	18.0	20.0	40.0	45.0	2	0	1	0	0	0	Enabled
	Hydroxide Tank 3 Upper Level	LT-S330B	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Hydroxide Tank 3 Lower Level	LT-S330D	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Hydroxide Tank 3 Temperature	TT-S330B	18.0	20.0	40.0	45.0	2	0	1	0	0	0	Enabled
	Hydroxide Tank 4 Upper Level	LT-S340B	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Hydroxide Tank 4 Lower Level	LT-S340D	5.0	7.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Hydroxide Tank 4 Temperature	TT-S340B	18.0	20.0	40.0	45.0	2	0	1	0	0	0	Enabled
	Hydroxide Train 1 Flow	FT-S350A	0.1	0.2	25.0	30.0	60	0	2	0	0	0	Auto
	Hydroxide Train 2 Flow	FT-S370A	0.1	0.2	25.0	30.0	60	0	2	0	0	0	Auto
Ammonia													
	Ammonia Tank 1 Upper Level	LT-S410A	0.0	0.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Ammonia Tank 1 Lower Level	LT-S410B	0.0	0.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ammonia Tank 2 Upper Level	LT-S420A	0.0	0.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Ammonia Tank 2 Lower Level	LT-S420B	0.0	0.0	90.0	95.0	2	2	1	1	0	5	Disabled
	Ambient Ammonia Analyzer	GT-S450B	0.0	0.0	85.0	90.0	2	2	0	0	0	0	Enabled
	Ammonia Train 1 Flow	FT-S430A	0.1	0.2	1.8	2.0	60	0	2	0	0	0	Auto
	Ammonia Train 2 Flow	FT-S440A	0.1	0.2	1.8	2.0	60	0	2	0	0	0	Auto
Steam Boiler													
	Hardness	AT-S701A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Amine Feed Drum Weight	WT-S702A	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Chemical Unloading Air Compressors													
	Air Receiver Pressure	PT-S826B	30.0	35.0	120.0	130.0	2	2	1	0	0	0	Enabled
Hydrogen Peroxide													
	Tank 1 Level	LT-C810A	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Tank 1 Temperature	TT-C810A	1.0	2.0	35.0	40.0	2	0	1	0	0	0	Enabled
	Tank 2 Level	LT-C820A	5.0	10.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Tank 2 Temperature	TT-C820A	1.0	2.0	35.0	40.0	2	0	1	0	0	0	Enabled
	Pump 1 Flow	FT-C840A	1.0	2.0	37.0	38.0	60	0	1	0	0	0	Auto
	Pump 2 Flow	FT-C850A	1.0	2.0	37.0	38.0	60	0	1	0	0	0	Auto
	Pump 3 Flow	FT-C860A	1.0	2.0	37.0	38.0	60	0	1	0	0	0	Auto
Sodium Bisulphite													
	Tank Level	LT-C940B	10.0	15.0	90.0	95.0	2	2	1	1	0	5	Enabled
	Pump 1 Flow	FT-C950A	1.0	2.0	35.0	36.0	60	0	2	0	0	0	Auto
	Pump 2 Flow	FT-C960A	1.0	2.0	35.0	36.0	60	0	2	0	0	0	Auto
	Pump 3 Flow	FT-C970A	1.0	2.0	35.0	36.0	60	0	2	0	0	0	Auto
Filter Aid Polymer													
	Bulk Bag Weight	WT-C020A	50.0	100.0	1100.0	1200.0	30	0	2	10	0	30	Enabled
	Feed Tank Level	LT-C022A	10.7	14.3	100.0	106.8	2	0	1	0	0	101	Enabled
	Pump 1 Flow	FT-C061A	1.0	2.0	81.0	82.0	60	0	2	0	0	0	Auto
	Pump 2 Flow	FT-C062A	1.0	2.0	81.0	82.0	60	0	2	0	0	0	Auto
	Pump 3 Flow	FT-C063A	1.0	2.0	81.0	82.0	60	0	2	0	0	0	Auto
Residuals Polymer													
	Bulk Bag Weight	WT-C030A	50.0	100.0	1100.0	1200.0	30	0	2	10	0	30	Enabled
	Feed Tank Level	LT-C032A	17.9	21.0	47.3	99.5	2	0	1	0	0	1	Enabled
	Pump 1 Flow	FT-C071A	1.0	2.0	45.0	50.0	60	0	2	0	0	0	Auto
	Pump 2 Flow	FT-C072A	1.0	2.0	40.0	50.0	60	0	2	0	0	0	Auto
	Polymer Tote Weight	WT-C001B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
	Liquid Polymer Flow	FT-C001B	0.0	0.0	0.0	0.0	0	0	0	0	0	0	Disabled
Brine Tanks													
	Tempered Water Hardness	AT-J100B	0.0	0.0	10.0	10.0	0	0	0	0	0	101	Enabled
	Tempered Water Flow	FT-J001A	40.0	45.0	200.0	225.0	60	0	0	0	0	101	Enabled
	Tempered Water Temperature	TT-J003A	2.0	5.0	29.0	30.0	0	0	2	1	0	10	Enabled
	Tank 1 Brine Level	LT-J100A	75.0	80.0	98.0	99.0	1	0	2	1	0	2	Enabled
	Tank 1 Salt Level	LT-J100B	15.0	20.0	60.0	70.0	2	0	2	1	0	2	Enabled
	Tank 1 Temperature	TT-J100A	5.0	10.0	50.0	55.0	2	0	2	1	0	10	Enabled
	Tank 2 Brine Level	LT-J200A	75.0	80.0	98.0	99.0	1	0	2	1	0	2	Enabled
	Tank 2 Salt Level	LT-J200B	20.0	25.0	60.0	70.0	2	0	2	1	0	2	Enabled
	Tank 2 Temperature	TT-J200A	5.0	10.0	50.0	55.0	2	0	2	1	0	10	Enabled

ANALOG SETTINGS

Screen	Description	Tag	Lo Lo	Lo	Hi	Hi Hi	Flt Tm sec	OOR Tm sec	DB %	ROC Tm sec	LROC %	HROC %	Status
Hypochlorite Generators													
	Ambient Hydrogen Detector 1	GT-J450A	0.0	0.0	50.0	55.0	2	0	25	1	0	10	Enabled
	Ambient Hydrogen Detector 2	GT-J450B	0.0	0.0	50.0	55.0	2	0	25	1	0	10	Enabled
	Generator 1 Upper Flow	FT-J400A	20	21	30	31	15	0	2	0	0	101	Auto
	Generator 1 Lower Flow	FT-J400B	20	21	30	31	15	0	2	0	0	101	Auto
	Generator 1 Voltage	ET-J400A	0	85	105	110	10	0	2	0	0	101	Auto
	Generator 1 Current	IT-J400A	0	1100	1350	1400	10	0	2	0	0	101	Auto
	Generator 2 Upper Flow	FT-J420A	20	21	30	35	15	0	2	0	0	101	Auto
	Generator 2 Lower Flow	FT-J420B	20	21	30	35	15	0	2	0	0	101	Auto
	Generator 2 Voltage	ET-J420A	0	85	105	110	10	0	2	0	0	101	Auto
	Generator 2 Current	IT-J420A	0	1100	1350	1400	10	0	2	0	0	101	Auto
	Generator 3 Upper Flow	FT-J440A	20	21	30	31	15	0	2	0	0	101	Auto
	Generator 3 Lower Flow	FT-J440B	20	21	30	31	15	0	2	0	0	101	Auto
	Generator 3 Voltage	ET-J440A	0	85	105	110	10	0	2	0	0	101	Auto
	Generator 3 Current	IT-J440A	0	1100	1350	1400	10	0	2	0	0	101	Auto
Solution Tanks													
	Ambient Hydrogen Detector 3	GT-J550A	0.0	0.0	50.0	55.0	2	0	25	1	0	10	Enabled
	Ambient Hydrogen Detector 4	GT-J550B	0.0	0.0	50.0	55.0	2	0	25	1	0	10	Enabled
	Tank 1 Level	LT-J500A	35	40	90	95	10	0	2	1	0	10	Auto
	Tank 2 Level	LT-J520A	35	40	90	95	10	0	2	1	0	10	Auto
	Tank 3 Level	LT-J540A	35	40	90	95	10	0	2	1	0	10	Auto
	Tank 4 Level	LT-J560A	35	40	90	95	10	0	2	1	0	10	Auto
Hypochlorite Pumping													
	Pump 1 Speed	ST-J610A	0	0	90	95	0	0	0	0	0	101	Auto
	Pump 2 Speed	ST-J620A	0	0	90	95	0	0	0	0	0	101	Auto
	Pump 3 Speed	ST-J630A	0	0	90	95	0	0	0	0	0	101	Auto
	Pump 4 Speed	ST-J640A	0	0	90	95	0	0	0	0	0	101	Auto
	Contact Chamber Hypo Flow	FT-J610A	0	0	180	200	0	0	0	0	0	101	Auto
	Filtered Water Channel Hypo Flow	FT-J640A	0	0	180	200	0	0	0	0	0	101	Auto

CONTROLLER SETTINGS

Screen	Description	Tag	P	I	D	Dev Band %	Dev Time sec
Raw Water Pump Station							
	Raw Water Total Flow	FIC-I000A	0.060	0.021	0.004	5	180
	Raw Water 1 Pump Speed	FIC-I001A	0.110	0.008	0.000	10	180
	Raw Water 2 Pump Speed	FIC-I002A	0.110	0.008	0.000	10	180
	Raw Water 3 Pump Speed	FIC-I003A	0.110	0.008	0.000	10	180
	Raw Water 4 Pump Speed	FIC-I004A	0.110	0.008	0.000	10	180
	DAF 1 Flow	FIC-P100A	0.091	0.067	0.000	5	60
	DAF 2 Flow	FIC-P200A	0.091	0.067	0.000	5	60
	DAF 3 Flow	FIC-P300A	0.091	0.067	0.000	5	60
	DAF 4 Flow	FIC-P400A	0.091	0.067	0.000	5	60
	DAF 5 Flow	FIC-P500A	0.091	0.067	0.000	3	60
	DAF 6 Flow	FIC-P600A	0.091	0.067	0.000	3	60
	DAF 7 Flow	FIC-P700A	0.091	0.067	0.000	3	60
	DAF 8 Flow	FIC-P800A	0.091	0.067	0.000	5	60
Filters							
	Filter 1 Flow	FIC-F103A	0.005	0.001	0.000	30	300
	Filter 2 Flow	FIC-F203A	0.005	0.001	0.000	30	300
	Filter 3 Flow	FIC-F303A	0.005	0.001	0.000	30	300
	Filter 4 Flow	FIC-F403A	0.005	0.001	0.000	30	300
	Filter 5 Flow	FIC-F503A	0.005	0.001	0.000	30	300
	Filter 6 Flow	FIC-F603A	0.005	0.001	0.000	30	300
	Filter 7 Flow	FIC-F703A	0.005	0.001	0.000	30	300
	Filter 8 Flow	FIC-F803A	0.005	0.001	0.000	30	300
Backwash							
	Backwash Pump 1 Speed	FIC-F911A	0.001	0.001	0.000	100	180
	Backwash Pump 2 Speed	FIC-F921A	0.001	0.001	0.000	100	180
Ferric Chloride							
	Pump 1 Speed	FIC-S160A	0.400	0.250	0.000	2	60
	Pump 2 Speed	FIC-S180A	0.400	0.250	0.000	2	60
Sulphuric Acid							
	Pump 1 Speed	FIC-S240A	0.400	0.400	0.000	2	30
	Pump 2 Speed	FIC-S250A	0.400	0.400	0.000	2	30
Sodium Hydroxide							
	Pump 1 Speed	FIC-S350A	0.030	0.002	0.002	0.2	60
	Pump 2 Speed	FIC-S370A	0.023	0.002	0.002	0.2	60
Ammonia							
	Pump Speed	FIC -S430A	1.000	3.000	0.000	2	30
Hydrogen Peroxide							
	Pump 1 Speed	FIC-840A	0.500	0.200	0.000	5	120
	Pump 2 Speed	FIC-850A	0.500	0.200	0.000	5	120
	Pump 3 Speed	FIC-860A	0.500	0.200	0.000	5	120
Sodium Bisulphite							
	Pump 1 Speed	FIC-950A	0.500	0.200	0.000	5	120
	Pump 2 Speed	FIC-960A	0.500	0.200	0.000	5	120
	Pump 3 Speed	FIC-970A	0.500	0.200	0.000	5	120
Sodium Hypochlorite Pumps							
	Free Chlorine	AIC-F056A	0.050	0.020	0.000	0.5	250
	Pump 1/2	FIC-J610A	0.100	0.020	0.000	5	60
	Total Chlorine	AIC-F056B	0.200	0.090	0.000	0.5	60
	Pump 3/4	FIC-J640A	0.100	0.020	0.000	5	60

ALARM SWITCH SETTINGS

Screen	Description	Tag	Delay	Enabled	Hi/Lo
Raw Water Pump Station					
	Raw Water pH Flow	FS-I024B	2	Yes	Low
	Raw Water Turbidity Flow	FS-I027B	2	Yes	Low
	Header 1 Sulphuric Acid Flow	FS-I022E	60	Yes	Low
	Header 1 Ferric Chloride Flow	FS-I017D	100	No	Low
	Header 1 pH Flow	FS-I025B	2	Yes	Low
	Header 2 Sulphuric Acid Flow	FS-I023E	60	Yes	Low
	Header 2 Ferric Chloride Flow	FS-I018D	60	No	Low
	Header 2 pH Flow	FS-I026B	2	Yes	Low
DAF					
	DAF 1 Overtorque	VS-P001A	0	Yes	High
	DAF 2 Overtorque	VS-P002A	0	Yes	High
	DAF 3 Overtorque	VS-P003A	0	Yes	High
	DAF 4 Overtorque	VS-P004A	0	Yes	High
	DAF 5 Overtorque	VS-P005A	0	Yes	High
	DAF 6 Overtorque	VS-P006A	0	Yes	High
	DAF 7 Overtorque	VS-P007A	0	Yes	High
	DAF 8 Overtorque	VS-P008A	0	Yes	High
	DAF Effluent Channel 1 Level	LS-P970A	5	Yes	Low
	DAF Effluent Channel 2 Level	LS-P971A	5	Yes	Low
	DAF Effluent Turbidity Flow	FS-P975A	2	Yes	Low
Saturation Tanks					
	Saturator 1 Level	LS-P001A	2	Yes	Low
	Saturator 1 Pressure	PS-P001A	2	Yes	Low
	Saturator 2 Level	LS-P002A	2	Yes	Low
	Saturator 2 Pressure	PS-P002A	2	Yes	Low
	Saturator 3 Level	LS-P003A	2	Yes	Low
	Saturator 3 Pressure	PS-P003A	2	Yes	Low
	Saturator 4 Level	LS-P004A	2	Yes	Low
	Saturator 4 Pressure	PS-P004A	2	Yes	Low
GOX Prep & Cooling Water					
	Nitrogen Boost Low Pressure	PS-O050A			
		FS-O051A?			
	PSU Cooling Water Low Flow	FS-O404A	10	No	Low
	PSU 1 High Temperature	TS-O310A			
	PSU 1 High ?	DS-O310A			
	PSU 2 High Temperature	TS-O320A			
	PSU 2 High ?	DS-O320A			
	PSU 3 High Temperature	TS-O330A			
	PSU 3 High ?	DS-O330A			
Ozone Generators					
		AA-O110A			
		AA-O110B			
		AA-O130A			
		AA-O130B			
		AA-O150A			
		AA-O152A			
Ozone Contactors					
	Contactor 1 Ozone Analyzer Flow 1	FS-O221A	Hardwired to pumps		
	Contactor 1 Ozone Analyzer Flow 2	FS-O226A	Hardwired to pumps		
	Contactor 2 Ozone Analyzer Flow 1	FS-O241A	Hardwired to pumps		
	Contactor 2 Ozone Analyzer Flow 2	FS-O246A	Hardwired to pumps		

ALARM SWITCH SETTINGS

Screen	Description	Tag	Delay	Enabled	Hi/Lo
Filters					
	Filter 1 Turbidity Flow	FS-F110A	3	Yes	Low
	Filter 1 Particle Count Flow	FS-F110B	3	Yes	Low
	Filter 2 Turbidity Flow	FS-F210A	3	Yes	Low
	Filter 2 Particle Count Flow	FS-F210B	3	Yes	Low
	Filter 3 Turbidity Flow	FS-F310A	3	Yes	Low
	Filter 3 Particle Count Flow	FS-F310B	3	Yes	Low
	Filter 4 Turbidity Flow	FS-F410A	3	Yes	Low
	Filter 4 Particle Count Flow	FS-F410B	3	Yes	Low
	Filter 5 Turbidity Flow	FS-F510A	3	Yes	Low
	Filter 5 Particle Count Flow	FS-F510B	3	Yes	Low
	Filter 6 Turbidity Flow	FS-F610A	3	Yes	Low
	Filter 6 Particle Count Flow	FS-F610B	3	Yes	Low
	Filter 7 Turbidity Flow	FS-F710A	3	Yes	Low
	Filter 7 Particle Count Flow	FS-F710B	3	Yes	Low
	Filter 8 Turbidity Flow	FS-F810A	3	Yes	Low
	Filter 8 Particle Count Flow	FS-F810B	3	Yes	Low
Clearwell					
	Clearwell 1 Total Chlorine Residual Flow	FS-T104A	0	No	Low
	Clearwell 1 Free Chlorine Residual/pH Flow	FS-T105A	0	Yes	Low
	Clearwell 1 Turbidity Residual Flow	FS-T107A	0	Yes	Low
	Clearwell 2 Total Chlorine Residual Flow	FS-T204A	0	No	Low
	Clearwell 2 Free Chlorine Residual/pH Flow	FS-T205A	0	Yes	Low
	Clearwell 2 Turbidity Residual Flow	FS-T207A	0	Yes	Low
	Valve Chamber Flood	LS-T301A	1	No	Low
	Valve Chamber Flood	LS-T302A	2	No	Low
Filtered Water Channel, CCT & BW Sump Pumps					
	CCT Outlet Free Chlorine Flow	FS-F056A	0	Yes	Low
	NaOH Dilution Water Flow	FS-C110A	0	No	High
	NaOH Dilution Water Flow	FS-C110B	1	No	High
	Backwash Process Sump Pump Start	LS-F984A	2	Yes	Low
	Backwash Process Sump Pump Stop	LS-F984B	15	Yes	Low
Washwater Recovery Tanks					
	WRT Inlet Channel High Level 1	LS-R010A	60	No	Low
	WRT Inlet Channel High Level 2	LS-R010B	60	Yes	Low
	WRT 1 Low Level	LS-R100A	2	Yes	Low
	WRT 1 High Level	LS-R100B	5	Yes	Low
	WRT 2 Low Level	LS-R200A	2	Yes	Low
	WRT 2 High Level	LS-R200B	5	Yes	Low
	WRT 3 Low Level	LS-R300A	2	Yes	Low
	WRT 3 High Level	LS-R300B	5	Yes	Low
	WRT 4 Low Level	LS-R400A	2	Yes	Low
	WRT 4 High Level	LS-R400B	5	Yes	Low
	Flocculation Tank Low Level	LS-R001A	99	Yes	Low
	Flocculation Tank High Level	LS-R001B	99	Yes	Low
	Flocculation Tank High High Level	LS-R001C	20	Yes	Low
	WRT Supernatant Turbidity Flow	FS-R010A	20	Yes	Low
Gravity Thickeners					
	Gravity Thickener 1 High Level	LS-R500A	2	Yes	Low
	Gravity Thickener 1 High Torque	VS-R500A	0	Yes	High
	Gravity Thickener 2 High Level	LS-R600A	2	Yes	Low
	Gravity Thickener 2 High Torque	VS-R600A	0	Yes	High
	Sludge Equalization Tank Low Level 1	LS-R710A	2	No	Low
	Sludge Equalization Tank High Level 1	LS-R710B	2	Yes	Low
	Sludge Equalization Tank Low Level 2	LS-R720A	2	No	Low
	Sludge Equalization Tank High Level 2	LS-R720B	2	Yes	Low

ALARM SWITCH SETTINGS

Screen	Description	Tag	Delay	Enabled	Hi/Lo
Supernatant Pump Station					
	Supernatant Pump Station Low Level	LS-R020A	15	Yes	Low
	Supernatant Pump Station High Level	LS-R020B	2	Yes	Low
	Overflow Channel High Level	LS-R020C	2	Yes	Low
	Overflow Channel High High Level	LS-R020D	2	Yes	Low
Dewatering Pump Station					
	Dewatering Pump Station High Level	LS-L920A	5	Yes	High
	Dewatering Pump Station Low Level	LS-L920B	5	Yes	High
	Metering Chamber High Level	LS-L924A	0	Yes	Low
Bulk Ckemical Building					
	West Truck Containment High	LS-S206A	2	Yes	Low
	Ferric Chloride South Sump High	LS-S190A	2	Yes	High
	Ferric Chloride North Sump High	LS-S190B	3	Yes	Low
	Ferric Chloride Room Eyewash/Shower	FS-S757A	2	Yes	High
	Sulphuric Acid South Sump High	LS-S260A	2	Yes	Low
	Sulphuric Acid North Sump High	LS-S260B	2	Yes	Low
	Sulphuric Acid Room Eyewash/Shower	FS-S755A	2	Yes	High
	East Truck Unloading Eyewash/Shower	FS-S759A	3	Yes	Low
	East Rail Unloading Eyewash/Shower	FS-S750A	2	Yes	High
	East Truck Containment High	LS-S309A	2	Yes	Low
	Sodium Hydroxide South Sump High	LS-S371A	15	Yes	Low
	Sodium Hydroxide North Sump High	LS-S371B	15	Yes	Low
	Sodium Hydroxide Room Eyewash/Shower	FS-S754A	2	Yes	High
	Sodium Hydroxide Dosing Line 1 Heating Fault	UF-S350A	2	Yes	Low
	Sodium Hydroxide Dosing Line 2 Heating Fault	UF-S370A	2	Yes	Low
	Ammonia Room Sump High	FS-S450A	2	Yes	Low
	Ammonia Room Eyewash/Shower	FS-S752A	2	Yes	High
	Ammonia Tank 1 Water Column Level Low	LS-S405A	2	No	High
	Ammonia 1 Tank Pressure High	PS-S410A	2	Yes	Low
	Ammonia Tank 2 Water Column Level Low	LS-S405B	2	No	High
	Ammonia 2 Tank Pressure High	PS-S420A	2	Yes	Low
	West Rail Unloading Eyewash/Shower	FS-S758A	2	Yes	High
	West Truck Unloading Eyewash/Shower	FS-S751A	2	Yes	High
Filter Aid Polymer Prep					
	Makeup Water Temperature Low	TS-C020A	0	Yes	Low
	Makeup Water Pressure Low	PS-C021A	3	Yes	Low
	Polymer Bulk Feeder Hopper Low	LS-C020A	0	Yes	High
	Polymer Bulk Feeder Screw Feeder Blocked	LS-C020B	5	Yes	High
	Polymer Preparation Unit High Level	LS-C021A	3	Yes	High
	Polymer Preparation Unit Low Level	LS-C021B	0	Yes	High
	Filter Aid Polymer Dosing Pump 1 Flow	FS-C061A	40	Auto	Low
	Filter Aid Polymer Dosing Pump 2 Flow	FS-C062A	10	Auto	Low
	Filter Aid Polymer Dosing Pump 3 Flow	FS-C063A	40	Auto	Low
Residuals Polymer Prep					
	Makeup Water Pressure Low	PS-C031A	3	Yes	Low
	Polymer Bulk Feeder Hopper Low	LS-C030A	0	Yes	High
	Polymer Bulk Feeder Screw Feeder Blocked	LS-C030B	0	Yes	High
	Polymer Preparation Unit High Level	LS-C031A	10	Yes	High
	Polymer Preparation Unit Low Level	LS-C031B	0	Yes	High
	Filter Aid Polymer Dosing Pump 1 Flow	FS-C071A	10	Auto	Low
	Filter Aid Polymer Dosing Pump 2 Flow	FS-C072A	10	Auto	Low
Hydrogen Peroxide					
	Hydrogen Peroxide Sump	LS-C800A	2	Yes	Low
	Hydrogen Peroxide Dosing Pump 1 Flow	FS-C840A	15	Auto	Low
	Hydrogen Peroxide Dosing Pump 2 Flow	FS-C850A	15	Auto	Low
	Hydrogen Peroxide Dosing Pump 3 Flow	FS-C860A	15	Auto	Low

ALARM SWITCH SETTINGS

Screen	Description	Tag	Delay	Enabled	Hi/Lo
Sodium Bisulphite					
	Sodium Bisulphite Sump	LS-C980A	2	Yes	Low
	Sodium Bisulphite Dosing Pump 1 Flow	FS-C950A	15	Auto	Low
	Sodium Bisulphite Dosing Pump 2 Flow	FS-C960A	15	Auto	Low
	Sodium Bisulphite Dosing Pump 3 Flow	FS-C970A	15	Auto	Low
Brine					
	Containment Level	LS-J666A	2	Yes	Low
Hypochlorite Generators					
	Generator 1 Output Valve	ZS-J400B	0	Auto	Low
	Generator 1 Vent Valve	ZS-J400A	0	Auto	Low
	Generator 1 Rupture Disc	PS-J400B	0	Auto	Low
	Generator 1 Upper Cell Level	LS-J400B	10	Auto	Low
	Generator 1 Upper Cell Temperature	TS-J400B	0	Auto	Low
	Generator 1 Lower Cell Level	LS-J400A	10	Auto	Low
	Generator 1 Lower Cell Temperature	TS-J400A	0	Auto	Low
	Generator 1 Cell Pressure High	PS-J400A	0	Auto	Low
	Generator 1 Cell Pressure Relief Valve	FS-J400C	5	Auto	Low
	Generator 2 Output Valve	ZS-J420B	0	Auto	Low
	Generator 2 Vent Valve	ZS-J420A	0	Auto	Low
	Generator 2 Rupture Disc	PS-J420B	0	Auto	Low
	Generator 2 Upper Cell Level	LS-J420B	7	Auto	Low
	Generator 2 Upper Cell Temperature	TS-J420B	0	Auto	Low
	Generator 2 Lower Cell Level	LS-J420A	7	Auto	Low
	Generator 2 Lower Cell Temperature	TS-J420A	0	Auto	Low
	Generator 2 Cell Pressure High	PS-J420A	0	Auto	Low
	Generator 2 Cell Pressure Relief Valve	FS-J420C	5	Auto	Low
	Generator 3 Output Valve	ZS-J430B	0	Auto	Low
	Generator 3 Vent Valve	ZS-J430A	0	Auto	Low
	Generator 3 Rupture Disc	PS-J430B	0	Auto	Low
	Generator 3 Upper Cell Level	LS-J430B	7	Auto	Low
	Generator 3 Upper Cell Temperature	TS-J430B	0	Auto	Low
	Generator 3 Lower Cell Level	LS-J430A	7	Auto	Low
	Generator 3 Lower Cell Temperature	TS-J430A	0	Auto	Low
	Generator 3 Cell Pressure High	PS-J430A	0	Auto	Low
	Generator 3 Cell Pressure Relief Valve	FS-J430C	5	Auto	Low
Sodium Hypochlorite Storage					
	Containment Level	LS-J550A	5	Yes	Low
	Standpipe Flow Switch	FS-J450A	3	Auto	Low
	Standpipe Pressure Switch	PS-J450A	3	Auto	Low
	Tank 1 Flow Switch	FS-J500A	3	Auto	Low
	Tank 1 Pressure Switch	PS-J500A	3	Auto	Low
	Tank 2 Flow Switch	FS-J520A	3	Auto	Low
	Tank 2 Pressure Switch	PS-J520A	3	Auto	Low
	Tank 3 Flow Switch	FS-J540A	3	Auto	Low
	Tank 3 Pressure Switch	PS-J540A	3	Auto	Low
	Tank 4 Flow Switch	FS-J560A	3	Auto	Low
	Tank 4 Pressure Switch	PS-J560A	4	Auto	Low
Hypochlorite Metering Pumps					
	Pump 1 Burst Hose	LS-J610A	0	Yes	Low
	Pump 2 Burst Hose	LS-J620A	0	Yes	Low
	Pump 3 Burst Hose	LS-J640A	0	Yes	Low
	Pump 4 Burst Hose	LS-J660A	0	Yes	Low

PUMP, BLOWER, MIXER CONTROL SETTINGS

Raw Water Pump Station

	Move Tm	Min Spd	Max Spd
Raw Water Pump 1	20	45	95
Raw Water Pump 2	20	45	95
Raw Water Pump 3	20	45	95
Raw Water Pump 4	20	45	95

DAF

	Set Spd	Max Spd	Min Spd
DAF 1 Mixer 1	45	100	0
DAF 1 Mixer 2	45	100	0
DAF 1 Mixer 3	25	100	0
DAF 1 Mixer 4	25	100	0
DAF 1 Mixer 5	25	100	0
DAF 1 Mixer 6	25	100	0
DAF 2 Mixer 1	45	100	0
DAF 2 Mixer 2	45	100	0
DAF 2 Mixer 3	25	100	0
DAF 2 Mixer 4	25	100	0
DAF 2 Mixer 5	25	100	0
DAF 2 Mixer 6	25	100	0
DAF 3 Mixer 1	45	100	0
DAF 3 Mixer 2	45	100	0
DAF 3 Mixer 3	25	100	0
DAF 3 Mixer 4	25	100	0
DAF 3 Mixer 5	25	100	0
DAF 3 Mixer 6	25	100	0
DAF 4 Mixer 1	45	100	0
DAF 4 Mixer 2	45	100	0
DAF 4 Mixer 3	25	100	0
DAF 4 Mixer 4	25	100	0
DAF 4 Mixer 5	25	100	0
DAF 4 Mixer 6	25	100	0
DAF 5 Mixer 1	45	100	0
DAF 5 Mixer 2	45	100	0
DAF 5 Mixer 3	25	100	0
DAF 5 Mixer 4	25	100	0
DAF 5 Mixer 5	25	100	0
DAF 5 Mixer 6	25	100	0
DAF 6 Mixer 1	45	100	0
DAF 6 Mixer 2	45	100	0
DAF 6 Mixer 3	25	100	0
DAF 6 Mixer 4	25	100	0
DAF 6 Mixer 5	25	100	0
DAF 6 Mixer 6	25	100	0
DAF 7 Mixer 1	45	100	0
DAF 7 Mixer 2	45	100	0
DAF 7 Mixer 3	25	100	0
DAF 7 Mixer 4	25	100	0
DAF 7 Mixer 5	25	100	0
DAF 7 Mixer 6	25	100	0
DAF 8 Mixer 1	45	100	0
DAF 8 Mixer 2	45	100	0
DAF 8 Mixer 3	25	100	0
DAF 8 Mixer 4	25	100	0
DAF 8 Mixer 5	25	100	0
DAF 8 Mixer 6	25	100	0

PUMP, BLOWER, MIXER CONTROL SETTINGS

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	Set Spd	Max Spd	Min Spd
DAF 1 Scraper	50	100	0
DAF 2 Scraper	50	100	0
DAF 3 Scraper	50	100	0
DAF 4 Scraper	50	100	0
DAF 5 Scraper	50	100	0
DAF 6 Scraper	50	100	0
DAF 7 Scraper	50	100	0
DAF 8 Scraper	50	100	0

Ozone Catalytic Destruct Units	Set Spd	Max Spd	Min Spd
Blower 1			
Blower 2			
Blower 3			

Filter Air Scour and Backwash	Set Spd	Max Spd	Min Spd
Backwash Pump 1	Auto	100	0
Backwash Pump 2	Auto	100	0

Residual - Washwater Recovery Tank	Set Spd	Max Spd	Min Spd
Solids Decant Pump 1	95	95	0
Solids Decant Pump 2	95	95	0
Solids Decant Pump 3	95	95	0
Solids Decant Pump 4	95	95	0
Flocculation Chamber Mixer	75	100	0

Residual Gr Th and Sludge Eq	Set Spd	Max Spd	Min Spd
TSET Pump 1	55	100	45
TSET Pump 2	55	100	45
TSET Mixer 1	50	100	0
TSET Mixer 2	50	100	0

Residual Supernatant Pump Station	Move Tm	Min Spd	Max Spd
Supernatant Pump 1	20	45	100
Supernatant Pump 2	20	0	100
Supernatant Pump 3	N/A	N/A	N/A

PUMP, BLOWER, MIXER CONTROL SETTINGS

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Ferric Chloride	Set Spd	Max Spd	Min Spd
Ferric Chloride Feed Pump 1	Auto	100	10
Ferric Chloride Feed Pump 2	Auto	100	10
Ferric Chloride Feed Pump 3	Auto	100	10

Sulphuric Acid	Set Spd	Max Spd	Min Spd
Sulphuric Acid Feed Pump 1	Auto	100	5
Sulphuric Acid Feed Pump 2	Auto	100	5
Sulphuric Acid Feed Pump 3	Auto	100	5

Sodium Hydroxide	Set Spd	Max Spd	Min Spd
Sodium Hydroxide Feed Pump 1	Auto	100	5
Sodium Hydroxide Feed Pump 2	Auto	100	5
Sodium Hydroxide Feed Pump 3	Auto	100	5

Ammonia	Set Spd	Max Spd	Min Spd
Ammonia Feed Pump 1	Auto	100	5
Ammonia Feed Pump 2	Auto	100	5

Hydrogen Peroxide	Set Spd	Max Spd	Min Spd
Hydrogen Peroxide Feed Pump 1	Auto	95	15
Hydrogen Peroxide Feed Pump 2	Auto	95	15
Hydrogen Peroxide Feed Pump 3	Auto	95	15

Sodium Bisulphite	Set Spd	Max Spd	Min Spd
Sodium Bisulphite Feed Pump 1	Auto	100	15
Sodium Bisulphite Feed Pump 2	Auto	100	15
Sodium Bisulphite Feed Pump 3	Auto	100	15

Polymer makeup Filter Aid	Set Spd	Max Spd	Min Spd
Filter Polymer Feed Pumps Feed Pump 1	Auto	100	10
Filter Polymer Feed Pumps Feed Pump 2	Auto	100	10
Filter Polymer Feed Pumps Feed Pump 3	Auto	100	10

Polymer Makeup Residual	Set Spd	Max Spd	Min Spd
Residual Polymer Feed Pumps Feed Pump 1	Auto	100	10
Residual Polymer Feed Pumps Feed Pump 2	Auto	100	10

Hypochlorite Chemical Pumping	Set Spd	Max Spd	Min Spd
Hypochlorite Pump 1	Auto	100	5
Hypochlorite Pump 2	Auto	100	5
Hypochlorite Pump 3	Auto	100	5
Hypochlorite Pump 4	Auto	100	5

CONTROL VALVE SETTINGS

Raw Water Pump Station

	Open Tm	Close Tm
FV-I000A	160	160
FV-I000B	160	160

DAF

	Move Tm	Control DB	Fail Action
FCV-P100A	60	2	100
FCV-P200A	60	5	100
FCV-P300A	60	5	100
FCV-P400A	60	5	100
FCV-P500A	60	5	100
FCV-P600A	60	5	100
FCV-P700A	60	5	100
FCV-P800A	60	5	100

	Move Tm	Control DB	Fail Action
SLG-P140A	120	5	0
SLG-P240A	120	5	0
SLG-P340A	120	5	0
SLG-P440A	120	5	0
SLG-P540A	120	5	0
SLG-P640A	120	5	0
SLG-P740A	120	5	0
SLG-P840A	120	5	0

Ozone Contactors

		Open Tm	Close Tm
Valves	FV-O201A		
	FV-O202A		
	FV-O216A		
	FV-O217A		
	FV-O218A		
	FV-O236A		
	FV-O237A		
	FV-O238A		
Gates	SLG-O210A	200	200
	SLG-O210B	200	200
	SLG-O210C	200	200
	SLG-O230A	200	200
	SLG-O230B	200	200
	SLG-O230B	200	200

CONTROL VALVE SETTINGS

Filter 1

	Open Tm	Close Tm
FV-F101A	60	60
FV-F102A	60	60
FV-F104A	60	60
FV-F105A	60	60
FV-F106A	60	60
FV-F107A	60	60

	Move Tm	Control DB	Fail Action
FCV-F103A	180	3	0

Filter 2

	Open Tm	Close Tm
FV-F201A	60	60
FV-F202A	60	60
FV-F204A	60	60
FV-F205A	60	60
FV-F206A	60	60
FV-F207A	60	60

	Move Tm	Control DB	Fail Action
FCV-F203A	180	3	0

Filter 3

	Open Tm	Close Tm
FV-F301A	60	60
FV-F302A	60	60
FV-F304A	60	60
FV-F305A	60	60
FV-F306A	60	60
FV-F307A	60	60

	Move Tm	Control DB	Fail Action
FCV-F303A	180	3	0

Filter 4

	Open Tm	Close Tm
FV-F401A	60	60
FV-F402A	60	60
FV-F404A	60	60
FV-F405A	60	60
FV-F406A	60	60
FV-F407A	60	60

	Move Tm	Control DB	Fail Action
FCV-F403A	180	3	0

Filter 5

	Open Tm	Close Tm
FV-F501A	60	60
FV-F502A	60	60
FV-F504A	60	60
FV-F505A	60	60
FV-F506A	60	60
FV-F507A	60	60

	Move Tm	Control DB	Fail Action
FCV-F503A	180	3	0

CONTROL VALVE SETTINGS

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Filter 6

	Open Tm	Close Tm
FV-F601A	60	60
FV-F602A	60	60
FV-F604A	60	60
FV-F605A	60	60
FV-F606A	60	60
FV-F607A	60	60

	Move Tm	Control DB	Fail Action
FCV-F603A	180	3	0

Filter 7

	Open Tm	Close Tm
FV-F701A	60	60
FV-F702A	60	60
FV-F704A	60	60
FV-F705A	60	60
FV-F706A	60	60
FV-F707A	60	60

	Move Tm	Control DB	Fail Action
FCV-F703A	180	3	0

Filter 8

	Open Tm	Close Tm
FV-F801A	60	60
FV-F802A	60	60
FV-F804A	60	60
FV-F805A	60	60
FV-F806A	60	60
FV-F807A	60	60

	Move Tm	Control DB	Fail Action
FCV-F803A	180	3	0

Filter Air Scour & Backwash

	Open Tm	Close Tm
FV-F010A	60	60
FV-F020A	60	60
FV-F910A	60	60
FV-F920A	60	60
FV-F911A	100	100
FV-F921A	100	100
FV-F931A	100	100
FV-F932A	99	60
FV-F933A	120	120

	Move Tm	Control DB	Fail Action
FCV-F911A	60	2	0
FCV-F921A	60	2	0

Clearwell

	Open Tm	Close Tm
FV-T301A	180	180
FV-T302A	180	180

CONTROL VALVE SETTINGS

Residual - Washwater Recovery Tank

	Open Tm	Close Tm
SLG-R100A	240	240
SLG-R200A	240	240
SLG-R300A	240	240
SLG-R400A	240	240
FV-R100A	250	250
FV-R200a	250	250
FV-R300A	250	250
FV-R400A	250	250

Residual Gr Th and Sludge Eq

	Open Tm	Close Tm
FV-R710A	120	120
FV-R720A	120	120

Ferric Chloride

	Open Tm	Close Tm
FV-S107A	30	30
FV-S206A	50	75
FV-S110A	22	22
FV-S110B	18	18
FV-S110C	22	22
FV-S120A	22	22
FV-S120B	18	18
FV-S120C	22	22
FV-S130A	22	22
FV-S130B	18	18
FV-S130C	22	22
FV-S140A	22	22
FV-S140B	18	18
FV-S140C	22	22
FV-S170A	22	22
FV-S170B	22	22

Sulphuric Acid

	Open Tm	Close Tm
FV-S207A	50	75
FV-S206A	50	75
FV-S210A	22	30
FV-S210B	18	18
FV-S210C	22	22
FV-S220A	22	22
FV-S220B	18	18
FV-S220C	22	22
FV-S240A	30	30
FV-S240B	30	30

CONTROL VALVE SETTINGS

3/26/2010

Sodium Hydroxide

	Open Tm	Close Tm
FV-S309A	70	70
FV-S310A	22	22
FV-S310B	18	18
FV-S310C	22	22
FV-S320A	22	22
FV-S320B	18	18
FV-S320C	22	22
FV-S330A	22	22
FV-S330B	18	18
FV-S330C	22	22
FV-S340A	22	22
FV-S340B	18	18
FV-S340C	22	22
FV-S350A	22	22
FV-S360B	22	22
FV-S370B	22	22

Ammonia

	Open Tm	Close Tm
FV-S410A	22	22
FV-S410B	22	22
FV-S410C	22	22
FV-S420A	22	22
FV-S420B	22	22
FV-S420C	22	22
FV-S440A	22	22

Hydrogen Peroxide

	Open Tm	Close Tm
FV-C860C	20	20
FV-C860D	20	20

Sodium Bisulphite

	Open Tm	Close Tm
FV-C490J	10	10
FV-C490C	20	20
FV-C490D	20	20

Polymer Makeup Filter Aid

	Open Tm	Close Tm
FV-C064B	20	20
FV-C065B	20	20

Polymer Makeup Residual

	Open Tm	Close Tm
FV-C073A	20	20

CONTROL VALVE SETTINGS

3/26/2010

Brine Tanks

	Open Tm	Close Tm
FV-J666A	70	70

Solution Tanks

	Open Tm	Close Tm
FV-J500C	30	30
FV-J500D	30	30
FV-J520C	30	30
FV-J520D	30	30
FV-J540C	30	30
FV-J540D	30	30
FV-J560C	30	30
FV-J560D	30	30

Hypochlorite Pumping

	Open Tm	Close Tm
FV-J610B	20	20
FV-J620B	20	20
FV-J630B	20	20
FV-J640B	20	20
FV-J665A	10	10

Raw Water Pump Station

Daily Required Treatment Flow	Input
Raw Water Flow (Instantaneous)	Displayed
Raw Water Flow (Totalized)	Displayed
Train 1 In Service	Select
Train 2 In Service	Select
Crossover Operating	Select
Section 1 In Service	Select
Section 2 In Service	Select
Duty Level Transmitter Section 1	Toggle
Duty Level Transmitter Section 2	Toggle
Raw Water Pumps	
Recommended Number	Displayed
Pump 1 In Service	Select
Pump 2 In Service	Select
Pump 3 In Service	Select
Pump 4 In Service	Select
Pump 1 Order	Select
Pump 2 Order	Select
Pump 3 Order	Select
Pump 4 Order	Select
Pump Group Status	Displayed
Auto	Toggle
Manual	Toggle
Auto/Manual Status	Displayed
Start	Toggle
Stop	Toggle
Pump Group Status	Displayed
Initial Pump Speed	Input
Duty Standby Rotation:	
Timer Hours	Input
Timer Minutes	Input
Duty Run Time Hours	Displayed
Duty Run Time Minutes	Displayed

DAF Tanks	
Recommended Number	Displayed
Number In Service	Displayed
Tank 1 In Service	Select
Tank 2 In Service	Select
Tank 3 In Service	Select
Tank 4 In Service	Select
Tank 5 In Service	Select
Tank 6 In Service	Select
Tank 7 In Service	Select
Tank 8 In Service	Select
Tank 1 Available	Displayed
Tank 2 Available	Displayed
Tank 3 Available	Displayed
Tank 4 Available	Displayed
Tank 5 Available	Displayed
Tank 6 Available	Displayed
Tank 7 Available	Displayed
Tank 8 Available	Displayed
Filters	
Maximum Standby Filters	Input #
Number in Filtration	Display
Filter 1 Return to Filter Mode	Toggle
Filter 2 Return to Filter Mode	Toggle
Filter 3 Return to Filter Mode	Toggle
Filter 4 Return to Filter Mode	Toggle
Filter 5 Return to Filter Mode	Toggle
Filter 6 Return to Filter Mode	Toggle
Filter 7 Return to Filter Mode	Toggle
Filter 8 Return to Filter Mode	Toggle
Filter 1 Status	Display
Filter 2 Status	Display
Filter 3 Status	Display
Filter 4 Status	Display
Filter 5 Status	Display
Filter 6 Status	Display
Filter 7 Status	Display
Filter 8 Status	Display

DAF Train 1

Train In Service	Select
Tank 1 in Service	Select
Tank 2 in Service	Select
Tank 3 in Service	Select
Tank 4 in Service	Select
Tank 1 Skimmer Number of Passes	Input
Tank 1 Skimmer Off Time	Input
Tank 1 Skimmer Forward Delay Time	Input
Tank 1 Skimmer Reverse Delay Time	Input
Tank 1 Trough Spray Down Time	Input
Tank 1 Trough Spray Wash-down Time	Input
Tank 1 Trough Spray Valve Malfunction Time	Input
Tank 1 Sidewall Spray Down Time	Input
Tank 1 Sidewall Spray Wash-down Time	Input
Tank 1 Sidewall Spray Valve Malfunction Time	Input
Tank 2 Skimmer Number of Passes	Input
Tank 2 Skimmer Off Time	Input
Tank 2 Skimmer Forward Delay Time	Input
Tank 2 Skimmer Reverse Delay Time	Input
Tank 2 Trough Spray Down Time	Input
Tank 2 Trough Spray Wash-down Time	Input
Tank 2 Trough Spray Valve Malfunction Time	Input
Tank 2 Sidewall Spray Down Time	Input
Tank 2 Sidewall Spray Wash-down Time	Input
Tank 2 Sidewall Spray Valve Malfunction Time	Input
Tank 3 Skimmer Number of Passes	Input
Tank 3 Skimmer Off Time	Input
Tank 3 Skimmer Forward Delay Time	Input
Tank 3 Skimmer Reverse Delay Time	Input
Tank 3 Trough Spray Down Time	Input
Tank 3 Trough Spray Wash-down Time	Input
Tank 3 Trough Spray Valve Malfunction Time	Input
Tank 3 Sidewall Spray Down Time	Input
Tank 3 Sidewall Spray Wash-down Time	Input
Tank 3 Sidewall Spray Valve Malfunction Time	Input

DAF Train 2

Train In Service	Select
Tank 5 in Service	Select
Tank 6 in Service	Select
Tank 7 in Service	Select
Tank 8 in Service	Select
Tank 5 Skimmer Number of Passes	Input
Tank 5 Skimmer Off Time	Input
Tank 5 Skimmer Forward Delay Time	Input
Tank 5 Skimmer Reverse Delay Time	Input
Tank 5 Trough Spray Down Time	Input
Tank 5 Trough Spray Wash-down Time	Input
Tank 5 Trough Spray Valve Malfunction Time	Input
Tank 5 Sidewall Spray Down Time	Input
Tank 5 Sidewall Spray Wash-down Time	Input
Tank 5 Sidewall Spray Valve Malfunction Time	Input
Tank 6 Skimmer Number of Passes	Input
Tank 6 Skimmer Off Time	Input
Tank 6 Skimmer Forward Delay Time	Input
Tank 6 Skimmer Reverse Delay Time	Input
Tank 6 Trough Spray Down Time	Input
Tank 6 Trough Spray Wash-down Time	Input
Tank 6 Trough Spray Valve Malfunction Time	Input
Tank 6 Sidewall Spray Down Time	Input
Tank 6 Sidewall Spray Wash-down Time	Input
Tank 6 Sidewall Spray Valve Malfunction Time	Input
Tank 7 Skimmer Number of Passes	Input
Tank 7 Skimmer Off Time	Input
Tank 7 Skimmer Forward Delay Time	Input
Tank 7 Skimmer Reverse Delay Time	Input
Tank 7 Trough Spray Down Time	Input
Tank 7 Trough Spray Wash-down Time	Input
Tank 7 Trough Spray Valve Malfunction Time	Input
Tank 7 Sidewall Spray Down Time	Input
Tank 7 Sidewall Spray Wash-down Time	Input
Tank 7 Sidewall Spray Valve Malfunction Time	Input

Tank 4 Skimmer Number of Passes	Input	Tank 8 Skimmer Number of Passes	Input
Tank 4 Skimmer Off Time	Input	Tank 8 Skimmer Off Time	Input
Tank 4 Skimmer Forward Delay Time	Input	Tank 8 Skimmer Forward Delay Time	Input
Tank 4 Skimmer Reverse Delay Time	Input	Tank 8 Skimmer Reverse Delay Time	Input
Tank 4 Trough Spray Down Time	Input	Tank 8 Trough Spray Down Time	Input
Tank 4 Trough Spray Wash-down Time	Input	Tank 8 Trough Spray Wash-down Time	Input
Tank 4 Trough Spray Valve Malfunction Time	Input	Tank 8 Trough Spray Valve Malfunction Time	Input
Tank 4 Sidewall Spray Down Time	Input	Tank 8 Sidewall Spray Down Time	Input
Tank 4 Sidewall Spray Wash-down Time	Input	Tank 8 Sidewall Spray Wash-down Time	Input
Tank 4 Sidewall Spray Valve Malfunction Time	Input	Tank 8 Sidewall Spray Valve Malfunction Time	Input

DAF Tank Washdown Popup

Float Trough Spray Timer DAF 1	Displayed	Sidewall Spray Timer DAF 1	Displayed
Float Trough Spray Timer DAF 2	Displayed	Sidewall Spray Timer DAF 2	Displayed
Float Trough Spray Timer DAF 3	Displayed	Sidewall Spray Timer DAF 3	Displayed
Float Trough Spray Timer DAF 4	Displayed	Sidewall Spray Timer DAF 4	Displayed
Float Trough Spray Timer DAF 5	Displayed	Sidewall Spray Timer DAF 5	Displayed
Float Trough Spray Timer DAF 6	Displayed	Sidewall Spray Timer DAF 6	Displayed
Float Trough Spray Timer DAF 7	Displayed	Sidewall Spray Timer DAF 7	Displayed
Float Trough Spray Timer DAF 8	Displayed	Sidewall Spray Timer DAF 8	Displayed

Float Sumps Duty Select Pop-ups

P-P931A / P-P932A	Toggle	P-P941A / P-P942A	Toggle
Duty Run Time	Displayed	Duty Run Time	Displayed
Rotation Timer	Input	Rotation Timer	Input
P-P951A / P-P952A	Toggle	P-P961A / P-P962A	Toggle
Duty Run Time	Displayed	Duty Run Time	Displayed
Rotation Timer	Input	Rotation Timer	Input

Pre-Filter Mixing Chambers	Select
One Per Train	Select
Duty/Standby	Select
Average	Select

Filter 1

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 2

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 3

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 4

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 5

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 6

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 7

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Filter 8

Backwash Triggers Selection:	
Filter Over Running Time	Select
High Turbidity	Select
High Differential Pressure	Select
Filtration Running Time	Select
Filter to Recycle Configuration:	
Monitoring Turbidity	Select
Monitoring Particle Counts	Select
Monitoring Elapsed Time	Select
Goes to Production Mode After FTR	Select
Backwash Watchdog Selection:	
Backwash Stage 2 Watchdog	Select
Backwash Stage 3 Watchdog	Select
Backwash Stage 4 Watchdog	Select
Backwash Stage 5 Watchdog	Select
Backwash Stage 6 Watchdog	Select
Backwash Stage 7 Watchdog	Select
Backwash Stage 8 Watchdog	Select

Clearwell

Clearwell 1 In Service	Select
Clearwell 2 In Service	Select
LT-T101A/B	Toggle
LT-T201A/B	Toggle
AT-T105A/B	Toggle
AT-T106A/B	Toggle
AT-T107A/B	Toggle

Washwater Recovery Tanks

Decant Stop Level	Input
Decant Start Level	Input
Flow Dampening Level	Input
Operator Alarm Reset	Toggle

WRT 1 Status

In Service	Select
Volume	Displayed
Stage Selection:	
In Flow	Display/Select
Settling	Display/Select
Decanting	Display/Select
Solids Decanting	Display/Select
Idle	Display/Select

WRT 2 Status

In Service	Select
Volume	Displayed
Stage Selection:	
In Flow	Display/Select
Settling	Display/Select
Decanting	Display/Select
Solids Decanting	Display/Select
Idle	Display/Select

WRT 3 Status

In Service	Select
Volume	Displayed
Stage Selection:	
In Flow	Display/Select
Settling	Display/Select
Decanting	Display/Select
Solids Decanting	Display/Select
Idle	Display/Select

WRT 4 Status

In Service	Select
Volume	Displayed
Stage Selection:	
In Flow	Display/Select
Settling	Display/Select
Decanting	Display/Select
Solids Decanting	Display/Select
Idle	Display/Select

Supernatant Pump Station

Duty Pump Rotation	Toggle
Timer	Input
Duty Pump Run Time	Displayed
Duty Pump Manual Selection	Input
Pump 1 In Service	Select
Pump 2 In Service	Select
Pump 3 In Service	Select
Duty Pump	Displayed
Pump 1 Speed Set Point	Input
Pump 2 Speed Set Point	Input
Operator Alarm Reset	Toggle

Gravity Thickeners

Gravity Thickener 1 In Service	Select
Gravity Thickener 2 In Service	Select
Thickener 1 Decant Mode	Select
Thickener 2 Decant Mode	Select
Timer Mode;	
Decant Duration	Input
Decant Period	Input
TSS Mode:	
Valve Open TSS	Input
Valve Close TSS	Input
Operator Alarm Reset	Toggle

Thickened Sludge Equalization tank

Tank 1 In Service	Select
Tank 2 In Service	Select
LT-R710D / 720D	Toggle
LS-R710A / 720A	Toggle
LS-R710B / 720B	Toggle
TSET Pump Settings:	
Pump Start Level	Input
Pump Stop Level	Input
Pump Speed Ramp Up Level	Input
Pump Speed Ramp Down Level	Input
Pump High Speed Set Point	Input
Pump Low Speed Set Point	Input
Operator Alarm Reset	Toggle

Dewatering Pump Station Duty Select

P-L921A / P-L922A	Toggle
Duty Run Time	Displayed
Rotation Timer	Input

Raw Water Pump Station

Raw Water Tank High Level	90	%
Raw Water Tank Low Level	80	%
Raw Water Tank HiHi Level	100	%
Raw Water Tank LoLo Level	75	%

DAF Tank 1 to 8

Operating Level	475	mm
High Level	550	mm
Low Level	1	mm
Skimmer Rev Speed	100	%

DAF Saturation Tank 1 to 4

Operating Level	300	mm
HiHi Level	550	mm
High Level	500	mm
Low Level	100	mm
LoLo Level	50	mm
Hi Pressure	1000	kPa
Low Pressure	300	kPa
High Temperature	0	C
Low Temperature	0	C

DAF Area Process Sump Pump

P-P981A Start Level	30	%
P-P921A Start Level	60	%
P-P983A Start Level	75	%
Stop Level	25	%

DAF Float Transfer Pump

Start Level	60	%
Stop Level	35	%
Complete Run Timer	5	m

Filter 1 to 8

Inlet Valve Full Closure Time	46	sec
Inlet Valve Close Delay Time	12	min
Inlet Valve Closure Unit Time	3	sec
Refill (Partial Open) Time	8	sec

Filter Outlet Flow Control Ramp Rate	33	L/s/min		
Filter Outlet Max Flow	60	MLD		
Filter Outlet Hi Flow	57	MLD		
Filter Outlet Lo Flow	20	MLD		
Filter Air Scour Time	3	min		
Combined Air Scour/Low Rate Backwash	2	min	0 min	Filts. 3, 4, 5
Low Rate Backwash	3	min		
High Rate Backwash	9	min		
Low Rate Backwash	5	min		
High Rate Backwash Total Flow	0	MLD		
Drain Down Level	5	%		
Normal Water Level	30	%		
HiHI Loss of Head	48	kPa		
High Loss of Head	45	kPa		
FTR Required Flow Rate	30	MLD		
FTR Turbidity	0.3	NTU		
FTR Partical Counts	200	part/ml		
FTR Time	35	min		
Standby to FTR Time	0	min		
Filtration Overrunning Time	30	hr		
Filtration Running Time	30	hr		
Stage 2 Watchdog	10	min		
Stage 3 Watchdog	10	min		
Stage 4 Watchdog	15	min		
Stage 5 Watchdog	20	min		
Stage 6 Watchdog	30	min		
Stage 7 Watchdog	40	min		
Stage 8 Watchdog	15	min		

Filter Air Scour and Backwash Configuration

BWS Normal Working Level	95	%	
BWS Insufficient Volume Level	30	%	
Low Rate Backwash Desired Flow	330	L/s	
Low Rate Backwash Water Flow High	360	L/s	
Low Rate Backwash Established Time	2	sec	
High Rate Backwash Desired Flow	***	L/s	***operator overide
High Rate Backwash Calculated Flow	calc.	L/s	
High Rate Backwash Flow High	1100	L/s	
High Rate Backwash Established Time	2	sec	
Air Scour Flow Rate High Range	74	Nm3/min	

Air Scour Flow Rate Low Range	58	Nm3/min

Clearwell

	Cell 1	Cell 2	
Upper Level Operating Band	0	0	%
Lower Level Operating Band	0	0	%
ROC Setpoint	3	3	%
ROC Timer	1	1	min

Washwater Recovery Tanks

Solids Pump Stop Level	20	%
Solids Pump Start Level	39	%
WRT Full Level	65	%
WRT Settling Time	150	min

Thickened Sludge Equalization Tank

TNK-R710 ROC	15	%/min
TNK-R720 ROC	15	%/min

Supernatant Pump Station

Duty Start Level	49	%
Assist Start Level	73	%
Assist Assist Start Level	76.5	%
All Pump Stop Level	39	%
Reduce Speed Setpoint	43	%

Dewatering Pump Station

Duty Pump Start Level	1.6	m
Duty Pump Stop Level	0.7	m

Ferric Chloride Pumps

High level	90	%
HiHi Level	95	%
Low Level	10	%
LoLo Level	6	%
Re-fill Level	15.9	%
Dosing Rate for 100 MLD	4	L/100MLD
Concentration	40	%
Sp. Gr.	1.42	kg/l
Dosing Rate	30	mg/l

Sulphuric Acid Pumps

High level	90	%
HiHi Level	95	%
Low Level	10	%
LoLo Level	6	%
Re-fill Level	15	%
Dosing Rate for 100 MLD	0.89	L/100MLD
Concentration	93	%
Sp. Gr.	1.83	kg/l
Dosing Rate	25	mg/l

Sodium Hydroxide

High level	90	%
HiHi Level	95	%
Low Level	8.9	%
LoLo Level	5	%
Re-fill Level	25	%
Heater Low	22	C
Heater High	25	C
Duty Pump 1 Start	50	MLD
Duty Pump 2 Start	300	MLD
AllStop	30	MLD
Dosing Rate for 100 MLD	3.3	L/100MLD
Concentration	50	%
Sp. Gr.	1.54	kg/l
Dosing Rate	20	mg/l

Ammonia

High level	90	%
HiHi Level	95	%
Low Level	0	%
LoLo Level	0	%
Re-fill Level	20	%
Dosing Rate for 100 MLD	1	L/100MLD

Hydrogen Peroxide

TNK-C810A Reorder Level	15	%
TNK-C820A Reorder Level	15	%
Hydrogen Peroxide Density	395	g/L

Sodium Bisulphite

TNK-C940A Reorder Level	15	%
Sodium Bisulphite Density	505	g/L

Polymer Makeup Filter Aid

Unloading & Conv. Unit Level	10	%
Preparation Tank Level	11	%
Feed Tank Level	12	%
Water Temperature	13	C
Dosing Concentration	16	mg/m3

Polymer Makeup Residual

Unloading & Conv. Unit Level	1	%
Preparation Tank Level	2	%
Feed Tank Level	3	%
Water Temperature	4	C
Dosing Concentration	150	mg/m3

Sodium Hypochlorite Generators

Current Ramp Rate		
EL-J400A	25	A/sec
EL-J420A	25	A/sec
EL-J440A	25	A/sec
Restart Delay		
EL-J400A	60	sec
EL-J420A	60	sec
EL-J440A	60	sec
Alarm Delay		
EL-J400A	50	sec
EL-J420A	50	sec
EL-J440A	50	sec

Sodium Hypochlorite Pumps

AIC_F056A CCT Max Hypo Adjustment	1.5	%
AIC_F056B Filt. Water Max Hypo Adjustment	0	%
AIC_F056A Hypo Dosing Factor	26.5	%
AIC_F056B Hypo Dosing Factor	0	%
Process Lag for Clearwell Chloramination	13	%