Electrical & Instrumentation Operation & Maintenance Manual

for the

Iqaluit Water Treatment Plant

Iqaluit, Nunavut

Year of Completion: 2004

Original Scope: Expand existing water treatment facility to meet city's requirements and Canadian Drinking Water Quality Guidelines.

This manual has been updated to include:

Date	Description of Change

Iqaluit Water Treatment Plant

Project History

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for the

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Iqaluit, Nunavut

Chapter 1

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INDEX OF DRAWINGS

(LOCATED AT THE END OF CHAPTER 4)

Chapter 3

BACKGROUND AND DESIGN DATA

3.1 General

The discussion in this document includes the background and design data for the electrical and instrumentation systems provided in the Iqaluit Water Treatment Plant.

3.2 Background

Electrical power to the facility is provided from the community's NTPC grid. The electrical supply and distribution equipment is configured to provide a continuous power source for entire facility.

3.3 Power Source

A 400A, 347/600 Volt overhead service is provided to the facility from utility pole mounted transformer. The facility's utility metering is located on the interior wall at the south corner of the building. From this point power is routed through the customer's meter cabinet before reaching the main distribution panel.

3.4 Facility Power Distribution

3.4.1 Main Distribution Panel

A single 400 A, main distribution panel feds all facility panels. The major panels fed from the main distribution panel include distribution panel 2A, distribution panel 2B, distribution panel 6A and the motor control center. In addition, the main distribution panel feds a 200A splitter which in turn feeds two UV control panels. Lower level electrical loads are fed from distribution panel 2A. Upper level loads are fed from distribution panels 2B and 6B.

3.4.2 Distribution Panel 2A

A 120/208 V, 60 circuit distribution panel feeds the lower level loads. The lower level loads include lower level receptacles, unit heaters, sodium hypochlorite pumps,

motorized valves, lower floor PLC panels, Clearwell level loads, battery packs and tunnel lighting.

3.4.3 Distribution Panel 2B

A 120/208 V, 60 circuit distribution panel feeds the majority of the upper level loads. The upper level loads include upper level receptacles, unit heaters, exhaust fans, motorized valves, upper floor PLC panels, chlorinators, zinc orthophosphate dosing pumps, fluorosilicic pumps, fire alarm panel, exit lighting and battery packs.

3.4.4 Distribution Panel 6A

A 347/600 V, 24 circuit distribution panel feeds the 347/600 V loads. The 347/600 V loads include exterior and interior lighting and air handling unit AHU-2.

3.4.5 Motor Control Center

The motor control center is configured to operate various process and mechanical equipment.

Refer to Chapter 6 of this Manual for the water treatment process operating procedures.

3.5 Water Treatment Process Controls and Alarms

The overall water treatment process is controlled utilizing PLC control with multiple HMI interfaces. The facility main control panels are the upper PLC cabinet, the lower PLC cabinet and the motor control center. Each PLC cabinet will control and operate the water treatment process instrumentation devices located on the same level as the PLC cabinet. The lower PLC module rack is interfaced with the upper PLC via a bus extension cable the PLC operates using a single Processor module located in the Upper PLC cabinet. HMI interface terminals located in the upper and lower PLC cabinets are identical in the make and model and both allow complete access to all elements of the plant control system.

Refer to Chapter 6 of this Manual for the water treatment process operating procedures

3.5.1 Water Treatment Process Control

The water treatment process control consists of UV disinfection, filtration, chlorination, fluoridation, pH adjustment and orthophosphate addition.

The water treatment plant will be capable of operating on a continuous basis and in an automatic mode. Overall, the water treatment plant will be started and stopped via the level within the off site reservoir. When the plant is called to start and equipment is in automatic mode, the PLC will control and operate the plant.

Refer to Drawings I-1 through I-7 at the end of Chapter 4 of this Manual for the overall water treatment process instrumentation schematic.

Refer to Appendix for water treatment process control philosophy.

3.5.2 Water Treatment Process Alarms

The PLC continuously monitor the water treatment plant's process, mechanical and electrical operating systems. System or equipment failure alarms are indicated on the Versaview HMI screen. Various conditions of alarms will be detected and reported to the PLC, some will shut the plant down and others will turn on back up equipment.

Refer to Chapter 6 of this Manual for the water treatment process alarms.

3.6 Chlorine Detection & Monitoring

The Chlorination Room is continuously monitored for chlorine leak.

Refer to Chapter 6 of this Manual for the chlorine detection alarms.

3.7 Telecommunications/Alarm Dialer

The water treatment plant has a dedicated phone line for the facility alarm dialer. When the facility is unoccupied alarms requiring operator intervention will be annunciated on both the PLC and to the operator via an auto dialer.

Refer to Chapter 6 of this manual lists of major alarms and their associated annunciations.

3.8 Fire Alarm

The water treatment plant fire alarm system consists of smoke detectors, thermal detectors and alarm pull stations. All devices are wired back to the facility control panel mounted to the right of the main entrance door.

3.9 Electrical Wiring

The plant electrical and controls system wiring is provided by Teck cabling or wiring contained in conduit.

END OF CHAPTER 3

Chapter 4

SCHEMATICS AND FUNCTIONAL DATA

4.1 Power Distribution Schematic (Refer to Drawings E-1 and E-2 and E-3 at the end of this section)

Power Distribution Schematic

No.	Component	Location	Function Performed	Remarks
1	Utility Transformer	South exterior power pole	Provide power to facility	
2	Weatherhead	South upper floor adjacent to new office	Overhead utility service entrance.	
3	Utility Meter Cabinet	South exterior wall	Utility billing is based on this meter.	
4	Customer Meter Cabinet	Interior wall, adjacent to new office	Customer check for utility billing.	
5	400A Main Distribution	Main Distribution Panel, adjacent to new office	Provides service to facility.	
6	Distribution Panel 6B	Upper Level	Provides distribution and overcurrent protection for exterior and upper floor lighting.	
7	75 kVA Transformer to Panel 2A	Lower Level	Provide power to panel 2A.	
8	Distribution Panel 2A	Lower Level	Provides distribution and overcurrent protection for lower level loads.	
9	40 kVA Transformer to Panel 2B	Upper Level	Provide power to panel 2B.	
10	Distribution Panel 2B	Upper Level	Provides distribution and overcurrent protection for upper level loads.	
11	Motor Control Center	Mechanical Mezzanine 201	Starts and controls facility motors.	

Power Distribution Schematic

No.	Component	Location	Function Performed	Remarks
12	37.5 kVA Transformer to 200A Splitter	Upper Level	Provides power to UV control panels.	
13	200A Splitter	Upper Level	Provides service to UV control panels.	
14	100A Fused Disconnect	Upper Level, UV Control Panel	Disconnects UV Control Panel from utility power.	
15	UV Control Panel	Upper Level	Operates UV Package: SV-1201 & SV-1211 UV Reactors #1 & #2 X-120 & X-121 FCV-1009 & FCV-1012	
16	Ground Grid	Facility Exterior	Grounding of facility electrical system.	

4.2 PLC Control Schematic
(Refer to Drawings I-1 to I-7 & E-4 to E-6 at the end of this section)

PLC Control Schematic

No.	Component	Location	Function Performed	Remarks
1	Raw Water Turbidity (Inlet) AIT-1001	Pre-Treatment Process	Measure raw water turbidity into water treatment plant.	Recorded once every minute.
2	Raw Water PH (Inlet) AIT-1002	Pre-Treatment Process	Measure raw water pH into water treatment plant.	Recorded once every 15 minutes.
3	Raw Water Flow (Inlet) FIT-1001	Pre-Treatment Process	Measure raw water flow into water treatment plant.	
4	Raw Water Valve (Inlet) FCV-1001	Pre-Treatment Process	Control flow of raw water into water treatment plant.	Valve is driven closed by a dedicated UPS in the event of a utility power failure.

PLC Control Schematic

No.	Component	Location	Function Performed	Remarks
5	UV System CPP #1 & #2	Pre-Treatment Process	Control and monitoring of disinfection reactors X-120 & X-121.	UV control panels can be controlled manually or by the PLC. Even wear on lamp assemblies facilitated by reactor rotation. Rotation shall not exceed 4 per day.
6	Filter Inlet Valve FCV-2101 FCV-2111 FCV-2121 FCV-2131	Filtration Process	Control flow of pre-treated water into rapid gravity filters.	P&ID shows one of four filter assemblies.
7	Filter Water Level LIT-2101 LIT-2111 LIT-2121 LIT-2131	Filtration Process	Measure filtered water level in the rapid gravity filters.	P&ID shows one of four filter assemblies.
8	Pressure Drop Across Filter PIT-2101 PIT-2111 PIT-2121 PIT-2131	Filtration Process	Measures the pressure drop across the filter media.	P&ID shows one of four filter assemblies.
9	Filtered Water Turbidity AIT-2102 AIT-2112 AIT-2122 AIT-2132	Filtration Process	Measure filtered water turbidity.	P&ID shows one of four filter assemblies.
10	Air Scour Inlet Valve FCV-2107 FCV-2117 FCV-2127 FCV-2137	Filtration Process	Controls flow of air into rapid gravity filter.	P&ID shows one of four filter assemblies.
11	Filter to Waste Valve LCV-2103 LCV-2113 LCV-2123 LCV-2133	Filtration Process	After backwash sequence valve modulates to maintain level in rapid gravity filter.	P&ID shows one of four filter assemblies.

PLC Control Schematic

No.	Component	Location	Function Performed	Remarks
12	Filtered Water Valve LCV-2104 LCV-2114 LCV-2124 LCV-2134	Filtration Process	After filter to waste sequence valve modulates to maintain level in Clearwell.	P&ID shows one of four filter assemblies.
13	Backwash Supply Valve FCV-2105 FCV-2115 FCV-2125 FCV-2135	Filtration Process	Controls the backwash supply to the rapid gravity filter.	P&ID shows one of four filter assemblies.
14	Backwash Waste Valve FCV-2106 FCV-2116 FCV-2126 FCV-2136	Filtration Process	Allows backwash waste to leave the rapid gravity filter.	P&ID shows one of four filter assemblies.
15	Air Scour Blowers C-200 & C-201	Filtration Process	Used in backwash sequence to clear rapid gravity filters.	Pump duty switched every month by PLC.
16	Backwash Pumps P-205 & P-206	Clearwell & Backwash Supply Process	In backwash sequence pumps filtered water back through the rapid gravity filter.	Pump duty switched every month by PLC.
17	Backwash Pumping Chamber Level LIT-2501	Clearwell & Backwash Supply Process	Measurement of water level within backwash pumping chamber.	
18	Treated Water to Storage FCV-2501	Clearwell & Backwash Supply Process	Controls the flow of treated water to the storage reservoir.	
19	Treated Water Analysis AIT-2501	Clearwell & Backwash Supply Process	Measure treated water turbidity and pH.	
20	Chlorine Gas Monitor AIT-1001	Chlorination Room	Monitor chlorination room for chlorine gas leak.	
21	Facility Horn	Exterior of Chlorination Room	Warn facility of chlorine leak.	
22	Facility Beacon	Exterior of Chlorination Room	Warn facility of chlorine leak.	
23	Gas Chlorinators X-340 & X-341	Chlorine Supply Process	Chlorination of water.	Chlorination system comes complete with controls.

PLC Control Schematic

No.	Component	Location	Function Performed	Remarks
24	Zinc Orthophosphate Dosing Pumps P-303 & p-304	Flouride & Orthophosphate & Fluorosilicic Acid Supply Process	Treat water.	Pump duty switched every month by PLC.
25	Hydro Fluorosilicic Dosing Pumps P-305 & P-306	Flouride & Orthophosphate & Fluorosilicic Acid Supply Process	Treat water.	Pump duty switched every month by PLC.
26	Backwash to Sewer Tank Level LIT-4001	Fluoride & Orthophosphate Supply Process	Measure level in backwash storage tank.	Level indicated in meters.
27	Backwash to Sewer Flow FIT-4001	Fluoride & Orthophosphate Supply Process	Measure flow from backwash storage tank to sewer.	
28	Backwash to Sewer Valve FCV-4001	Fluoride & Orthophosphate Supply Process	Control flow of backwash water to sewer.	
29	Filter to Waste Tank Level LIT-4011	Fluoride & Orthophosphate Supply Process	Measure level in filter to waste storage tank.	Level indicated in meters.
30	Filter to Waste Flow FIT-4011	Fluoride & Orthophosphate Supply Process	Measure filtered water to waste storage tank flow.	
31	Filter to Waste Valve FCV-4011	Fluoride & Orthophosphate Supply Process	Control flow of filtered water to waste storage tank.	
32	Service Pumps P-410 & P-411	Service Water Pumps Process	Pump raw water.	Pump duty switched every month by PLC.
33	Service Water Pumps Switch PSL-4112	Service Water Pumps Process	Indicate low pressure in chlorination supply.	

4.3 Lower PLC Cabinet (Refer to Drawing E-7 at the end of this section)

Lower PLC Cabinet

No.	Component	Location	Function Performed	Remarks
1	Power Supply (Rack Mount)	Lower PLC Cabinet (Interior)	Provide power to rack mounted modules.	
2	PLC Rack (13 Slot)	Lower PLC Cabinet (Interior)	Provide location for module installation.	
3	Digital Input Module	Lower PLC Cabinet (Interior)	Provide connection for PLC discrete inputs.	
4	Digital Output Module	Lower PLC Cabinet (Interior)	Provide connection for PLC discrete outputs.	
5	Analog Input Module	Lower PLC Cabinet (Interior)	Provide connection for PLC analog inputs.	
6	Analog Output Module	Lower PLC Cabinet (Interior)	Provide connection for PLC analog outputs.	
7	Remote I/O Scanner	Lower PLC Cabinet (Interior)		
8	Power Supply (24VDC)	Lower PLC Cabinet (Interior)		
9	HMI	Lower PLC Cabinet (Exterior)	Interface between operator and PLC.	
10	Light Switch	Lower PLC Cabinet (Interior)	Turn on PLC enclosure light.	
11	Fluorescent Luminaire	Lower PLC Cabinet (Interior)	Illuminate PLC enclosure.	
12	120VAC Receptacle	Lower PLC Cabinet (Interior)	Provide receptacle power for operator at panel location.	
13	End Bracket	Lower PLC Cabinet (Interior)	Provide end point for din rail mounted devices.	
14	Fuse Holder (AC)	Lower PLC Cabinet (Interior)	Provide location for AC fuse.	
15	Fuse Holder (DC)	Lower PLC Cabinet (Interior)	Provide location for DC fuse.	

Lower PLC Cabinet

No.	Component	Location	Function Performed	Remarks
16	Ground Terminal	Lower PLC Cabinet (Interior)	Provide ground to rail mounted devices.	
17	Terminal Block	Lower PLC Cabinet (Interior)	Provide connection point to electrician.	
18	Wireway	Lower PLC Cabinet (Interior)	Provide space to store all PLC enclosure wiring.	
19	Vapor Corrosion Inhibiter	Lower PLC Cabinet (Interior)		
20	120VAC Interposing Relay	Lower PLC Cabinet (Interior)		
21	Relay Base	Lower PLC Cabinet (Interior)	Provide connection point for relay.	

4.4 Upper PLC Cabinet (Refer to Drawing E-8 at the end of this section)

Upper PLC Cabinet

No.	Component	Location	Function Performed	Remarks
1	Power Supply	Upper PLC Cabinet (Interior)	Provide power to rack mounted modules.	
2	PLC Rack (13 Slot)	Upper PLC Cabinet (Interior)	Provide location for module installation.	
3	SLC 5/05	Upper PLC Cabinet (Interior)		
4	Digital Input Module	Upper PLC Cabinet (Interior)	Provide connection for PLC discrete inputs.	
5	Digital Output Module	Upper PLC Cabinet (Interior)	Provide connection for PLC discrete outputs.	
6	Analog Input Module	Upper PLC Cabinet (Interior)	Provide connection for PLC analog inputs.	
7	Isolated Output Relay	Upper PLC Cabinet (Interior)		

Upper PLC Cabinet

No.	Component	Location	Function Performed	Remarks
8	Analog Output Module	Upper PLC Cabinet (Interior)	Provide connection for PLC analog outputs.	
9	Remote I/O Scanner	Upper PLC Cabinet (Interior)		
10	Power Supply (24VDC)	Upper PLC Cabinet (Interior)		
11	HMI	Upper PLC Cabinet (Exterior)	Interface between operator and PLC.	
12	8 Port EtherNET Switch	Upper PLC Cabinet (Interior)		
13	Modular Slot Filler	Upper PLC Cabinet (Interior)		
14	Fuse Holder (AC)	Upper PLC Cabinet (Interior)	Provide location for AC fuse.	
15	Fuse Holder (DC)	Upper PLC Cabinet (Interior)	Provide location for DC fuse.	
16	Ground Terminal	Upper PLC Cabinet (Interior)	Provide ground to rail mounted devices.	
17	Terminal Block	Upper PLC Cabinet (Interior)	Provide connection point to electrician.	
18	Wireway	Upper PLC Cabinet (Interior)	Provide space to store all PLC enclosure wiring.	
19	UPS	Upper PLC Cabinet (Interior)	Provide uninterruptible power supply.	
20	Light Switch	Upper PLC Cabinet (Interior)	Turn on PLC enclosure light.	
21	Fluorescent Luminaire	Upper PLC Cabinet (Interior)	Illuminate PLC enclosure.	
22	120VAC Receptacle	Upper PLC Cabinet (Interior)	Provide receptacle power for operator at panel location.	
23	End Bracket	Upper PLC Cabinet (Interior)	Provide end point for din rail mounted devices.	

Upper PLC Cabinet

No.	Component	Location	Function Performed	Remarks
24	Vapor Corrosion Inhibitor	Upper PLC Cabinet (Interior)		
25	Voice Dialer	Upper PLC Cabinet (Interior)	Dials preset number	
26	120VAC Interposing Relay	Upper PLC Cabinet (Interior)		
27	Relay Base	Upper PLC Cabinet (Interior)	Provide connection point for relay.	
28	EEPROM Memory Module	Upper PLC Cabinet (Interior)		

4.5 Motor Control Centre
(Refer to Drawing E-9 at the end of this section)

Motor Control Centre

No.	Component	Location	Function Performed	Remarks
1	Incoming Lugs	MCC Cabinet	Connection to field devices.	
2	Spare	MCC Cabinet	Allows for future expansion.	
3	Air Handling Unit AHU-1	MCC Cabinet	Refer to Mechanical O&M Manual.	
4	Space for Future Expansion	MCC Cabinet	Allows for future expansion.	
5	Exhaust Fan EF-3	MCC Cabinet	Refer to Mechanical O&M Manual.	
6	Potable Water Pump P-1 & P-2	MCC Cabinet	Refer to Process O&M Manual.	
7	Glycol Heating Pump P-3 & P-4	MCC Cabinet	Refer to Mechanical O&M Manual.	
8	Air Scourer AS-1 & AS-2	MCC Cabinet	Refer to Process O&M Manual.	

Motor Control Centre

No.	Component	Location	Function Performed	Remarks
9	Backwash Pump BP-1 & BP-2	MCC Cabinet	Refer to Process O&M Manual.	
10	Existing Boiler B-1 & B-2	MCC Cabinet	Refer to Mechanical O&M Manual.	
11	Terminal Control Section	MCC Cabinet	Connection to PLC and field devices.	

END OF CHAPTER 4

Chapter 5

COMPONENT DETAILS

5.1 Power Distribution Schematic (Refer to Drawings E-1 and E-2 and E-3 at the end of Chapter 4)

Power Distribution Schematic

No.	Component	Details	Setting	Remarks
1	Utility Transformer			
2	Weatherhead			
3	Utility Meter Cabinet			
4	Customer Meter Cabinet			
5	400A Main Distribution Panel	Cuttler Hammer PRL3000		1200A Main Bus Rating 347/600 Volts
6	Distribution Panel 6B	Cuttler Hammer PL3a		24 Circuits 250 Amperes 347/600 Volts
7	75 kVA Transformer to Panel 2A	Hammond MK075PBC		NEMA-3R Enclosure
8	Distribution Panel 2A	Cuttler Hammer PL3a		42 Circuits 225 Amperes 120/208 Volts
9	40 kVA Transformer to Panel 2B			
10	Distribution Panel 2B	Cuttler Hammer PL3a		42 Circuits 225 Amperes 120/208 Volts
11	Motor Control Center	Cuttler Hammer		
12	37.5 kVA Transformer to 200A Splitter	Hammond MF037PEC		NEMA-3R Enclosure
13	200A Splitter			
14	100A Fused Disconnect			

Power Distribution Schematic

No.	Component	Details	Setting	Remarks
15	UV Control Panel			
16	Ground Grid			

5.2 PLC Control Schematic (Refer to Drawings I-1 to I-7 & E-4 to E-6 at the end of Chapter 4)

PLC Control Schematic

No.	Component	Details	Setting	Remarks
1	Raw Water Turbidity (Inlet) AIT-1001	c/w AE-1001 Hach 1720D Turbidimeter Cat# 52001-00	Scaled 0-100.0 NTU	w/ Aqua Trend Interface with SOM and 1720D Turbidimeter Power Supply
2	Raw Water PH (Inlet) AIT-1002	AIT-1002 Endress & Hauser Liquisys-M CPM253 CPM253-PS3105 AE-1002 Endress & Hauser Orbipac-W CPF81 CPF81-LH11C2	Scaled 0-14 pH	
3	Raw Water Flow (Inlet) FIT-1001	c/w FE 1001 Endress & Hauser PROMAG 50W DN 200/8”	Scaled 0-120 L/sec	
4	Raw Water Valve (Inlet) FCV-1001			
5	UV System CPP #1 & #2	Refer to Process O&M Manual		
6	Filter Inlet Valve FCV-2101 FCV-2111 FCV-2121 FCV-2131	14” Bray Series 30-111 c/w Bray S70-0501 electric actuator, 120VAC power supply	Valve operating time is 30 seconds	

PLC Control Schematic

No.	Component	Details	Setting	Remarks
7	Filter Water Level LIT-2101 LIT-2111 LIT-2121 LIT-2131	c/w LE-2101, LE-2111, LE-2121, LE-2131 Milltronics Level System XPS-10 Series		
8	Pressure Drop Across Filter PIT-2101 PIT-2111 PIT-2121 PIT-2131	Endress & Hauser Deltabar S PMD235 PMD235-2U4F9EH1B	Scaled 0-4.00 meters water	
9	Filtered Water Turbidity AIT-2102 AIT-2112 AIT-2122 AIT-2132	c/w AE-2101, AE-2111, AE-2121, AE-2131 Hach 1720D Turbiditimeters Cat# 52000-00	Scaled 0-2.00 NTU	w/ Aqua Trend Interface with SOM and 1720D Turbidimeter Power Supply
10	Air Scour Inlet Valve FCV-2107 FCV-2117 FCV-2127 FCV-2137	4” Bray Series 30-109 c/w Bray S70-0031 electric actuator, 120VAC power supply	Valve operating time 30 seconds	
11	Filter to Waste Valve LCV-2103 LCV-2113 LCV-2123 LCV-2133	8” Bray Series 30-109 c/w Bray S70-0121 electric actuator, 120 VAC power supply & 4-20mA input		
12	Filtered Water Valve LCV-2104 LCV-2114 LCV-2124 LCV-2134	8” Bray Series 30-109 c/w Bray S70-0121 electric actuator, 120 VAC power supply & 4-20mA input		
13	Backwash Supply Valve FCV-2105 FCV-2115 FCV-2125 FCV-2135	12” Bray Series 30-111 c/w Bray S70-0301 electric actuator, 120VAC power supply	Valve operating time is 30 seconds	

PLC Control Schematic

No.	Component	Details	Setting	Remarks
14	Backwash Waste Valve FCV-2106 FCV-2116 FCV-2126 FCV-2136	16" Bray Series 30-111 c/w Bray S70-0501 electric actuator, 120VAC power supply	Valve operating time is 30 seconds	
15	Air Scour Blowers C-200 & C-201	Refer to Process O&M Manual		
16	Backwash Pumps P-205 & P-206	Refer to Process O&M Manual		
17	Backwash Pumping Chamber Level LIT-2501	c/w LE-2501 Milltronics Level System XPS-10 Series		
18	Treated Water to Storage FCV-2501	12" Bray Series 30-111 c/w Bray S70-0301 electric actuator, 120VAC power supply	Valve operating time is 30 seconds	
19	Treated Water Analysis AIT-2501	c/w AE-2501 (Chlorine Cell) & AE-2502 (pH Sensor) Depolox 3 Plus	Free Chlorine Residual Scaled 0-5.0 mg/L pH Scaled 4.0-10	
20	Chlorine Gas Monitor AIT-1001	c/w AE-3401 Acutec 35	Scaled 0-10 ppm	
21	Facility Horn	Edwards		
22	Facility Beacon	Edwards		
23	Gas Chlorinators X-340 & X-341	Refer to Process O&M Manual		
24	Zinc Orthophosphate Dosing Pumps P-303 & p-304	Refer to Process O&M Manual		
25	Hydro Fluorosilicic Dosing Pumps P-305 & P-306	Refer to Process O&M Manual		

PLC Control Schematic

No.	Component	Details	Setting	Remarks
26	Backwash to Sewer Tank Level LIT-4001	c/w LE-4001 Milltronics Level System XPS-10 Series		
27	Backwash to Sewer Flow FIT-4001	c/w FE-4001 Endress & Hauser Promag 50W DN 100/4” 50W1H-UL0A1RC1B4AA	Scaled 0-12 L/sec	
28	Backwash to Sewer Valve FCV-4001	4” Bray Series 30-109 c/w Bray S70-0031 electric actuator, 120VAC power supply, 4-20 mA input		
29	Filter to Waste Tank Level LIT-4011	LIT-4011 Endress & Hauser Process Transmitter RMA 421 RMA421-A11A4A LE-4011 Endress & Hauser Waterpilot FMX167 FMX167-F2AMC1C1	Scaled 0-4.00 meters	
30	Filter to Waste Flow FIT-4011	c/w FE-4011 Endress & Hauser Promag 50W DN 100/4” 50W1H-UL0A1RC1B4AA	Scaled 0-5 L/sec	
31	Filter to Waste Valve FCV-4011	4” Bray Series 30-109 c/w Bray S70-0031 electric actuator, 120VAC power supply, 4-20 mA input		
32	Service Pumps P-410 & P-411	Refer to Process O&M Manual		
33	Service Water Pumps Switch PSL-4112	Asco S-Series	SP = 206.85 kPa (30psi)	Contacts open on decreasing pressure

5.3 Lower PLC Cabinet (Refer to Drawing E-7 at the end of Chapter 4)

Lower PLC Cabinet

No.	Component	Details	Setting	Remarks
1	Power Supply (Rack Mount)	Allen Bradley 1746-P2		
2	PLC Rack (13 Slot)	Allen Bradley 1746-A13		
3	Digital Input Module	Allen Bradley 1746-IA16		
4	Digital Output Module	Allen Bradley 1746-OA16		
5	Analog Input Module	Allen Bradley 1746-NI8		
6	Analog Output Module	Allen Bradley 1746SC-NO8I		
7	Remote I/O Scanner	Allen Bradley 1747-ASB		
8	Power Supply (24VDC)	Weidmuller 9925340024		
9	HMI	Allen Bradley 6182H-15BEH4B		15” RAC6186 w/ Versaview
10	Light Switch	800T-J2		
11	Fluorescent Luminaire	Hammond FLK48 & FLK48MM		
12	120VAC Receptacle			
13	End Bracket	Weidmuller WEW 35/2		
14	Fuse Holder (AC)	Weidmuller 101440		c/w Indicator
15	Fuse Holder (DC)	Weidmuller 101470		c/w Indicator

Lower PLC Cabinet

No.	Component	Details	Setting	Remarks
16	Ground Terminal	Weidmuller		
17	Terminal Block	Weidmuller		
18	Wireway	Panduit G3x4WH6 & C3WH6 G2x4WH6 & C2WH6		c/w Cover
19	Vapor Corrosion Inhibiter	Hammond XC110		
20	120VAC Interposing Relay	Allen Bradley 700-HK32A1		
21	Relay Base	Allen Bradley 722-HN122		

5.4 Upper PLC Cabinet (Refer to Drawing E-8 at the end of Chapter 4)

Upper PLC Cabinet

No.	Component	Details	Setting	Remarks
1	Power Supply	Allen Bradley 1746-P2		
2	PLC Rack (13 Slot)	Allen Bradley 1746-A13		
3	SLC 5/05	Allen Bradley 1747-L552		
4	Digital Input Module	Allen Bradley 1746-IA16		
5	Digital Output Module	Allen Bradley 1746-OA16		
6	Analog Input Module	Allen Bradley 1746-NI8		
7	Isolated Output Relay	Allen Bradley 1746-OX8		

Upper PLC Cabinet

No.	Component	Details	Setting	Remarks
8	Analog Output Module	Allen Bradley 1746SC-NO8I		
9	Remote I/O Scanner	Allen Bradley 1747-SN		
10	Power Supply (24VDC)	Weidmuller 9925340024		
11	HMI	Allen Bradley 6182H-15BEH4B		c/w Versaview 6181P 15” Integrated Display
12	8 Port EtherNET Switch	Allen Bradley ENET Switch		
13	Modular Slot Filler	Allen Bradley 1746-N2		
14	Fuse Holder (AC)	Weidmuller 101440		c/w Indicator
15	Fuse Holder (DC)	Weidmuller 101470		c/w Indicator
16	Ground Terminal	Weidmuller		
17	Terminal Block	Weidmuller		
18	Wireway	Panduit G3x4WH6 & C3WH6 G2x4WH6 & C2WH6		c/w Cover
19	UPS	Always On GES-202L	1400W 2000VA	
20	Light Switch			
21	Fluorescent Luminaire	Hammond FUK48MM		2 x 48”
22	120VAC Receptacle			

Upper PLC Cabinet

No.	Component	Details	Setting	Remarks
23	End Bracket	Weidmuller WEW 35/2		
24	Vapor Corrosion Inhibitor	Hammond XC110		
25	Voice Dialer	Barnett B1290		
26	120VAC Interposing Relay	Allen Bradley 700-HK32A1		
27	Relay Base	Allen Bradley 722-HN122		
28	EEPROM Memory Module	Allen Bradley 1747-M13		

5.5 Motor Control Centre (Refer to Drawing E-9 at the end of Chapter 4)

Motor Control Centre

No.	Component	Details	Setting	Remarks
1	Incoming Lugs			
2	Spare	Cuttler Hammer E1A20612		
3	Air Handling Unit AHU-1	Cuttler Hammer E1A20612	2 HP 2.7 FLA	
4	Space for Future Expansion			
5	Exhaust Fan EF-3	Cuttler Hammer E1A20612	2 HP 2.7 FLA	
6	Potable Water Pump P-1 & P-2	Cuttler Hammer E1A20612	5 HP 6.1 FLA	
7	Glycol Heating Pump P-3 & P-4	Cuttler Hammer E1A20612	3 HP 3.9 FLA	

Motor Control Centre

No.	Component	Details	Setting	Remarks
8	Air Scourer AS-1 & AS-2	Cuttler Hammer E2A20612	20 HP 22 FLA	
9	Backwash Pump BP-1 & BP-2	Cuttler Hammer E2A20612	25 HP 27 FLA	
10	Existing Boiler B-1 & B-2	Cuttler Hammer BFAHFD12		30A Trip
11	Terminal Control Section			

END OF CHAPTER 5

Chapter 6

OPERATING PROCEDURES

6.1 General

The operations portion of this manual should be read in conjunction with Chapter 6 of the Process and Mechanical Operations and Maintenance Manuals. The operating procedures described in this section will relate to the electrical and water treatment process controls systems.

6.2 Facility Power and Standby Power System

The building power is supplied by a 400 Amp, 347/600 Volts utility service. This electrical power services all the water treatment process controls and alarm systems, auxiliary electrical systems, lighting and mechanical systems.

Utility power availability is continuously monitored by the PLC. In the event of a utility power failure, the raw water intake control valve (FCV-1001) and the plant treated water outlet valve (FVC 2501) will be driven closed by a dedicated uninterruptible power supply shutting down the water treatment operation. All other facility valves will fail to their last position.

Upon resumption of utility power and with no alarms, the water treatment plant and process will automatically restart.

6.3 Water Treatment Controls Systems

The water treatment plant will be capable of operating on a continuous basis and in an automatic mode. The automated control of the plant is based on the need to treat water as determined by the level in the off site reservoir.

6.3.1 Pre-Treatment

(Refer to Drawing I-1 at the end of Chapter 4)

Raw water entering the water treatment plant is measured for level of turbidity and pH. AE-1001 is a continuous on-line turbidity meter. The continuous measurements are transmitted to the PLC via AIT-1001, recorded once per minute and stored for archive purposes. AI-1001 will display the raw water turbidity on the PLC. The raw water sample line leading to AE-1001 will be equipped with an electric solenoid valve SV-1001. During plant operation SV-1001 will be energized open, during plant shut down SV-1001 will de-energize and the valve will close. AE-1002 provides continuous on-line pH monitoring of the raw water. The continuous measurements are transmitted to the PLC via AIT-1002, recorded once per 15 minutes and stored for archive purposes. AI-1002 will display the raw water pH on the PLC. The raw water sample line leading to AE-1002 will be equipped with an electric solenoid valve SV-1002. During plant operation SV-1002 will be energized open, during plant shut down SV-1002 will de-energize and the valve will close.

Raw water flow entering the water treatment plant is measured by FE-1001. FIT-1001 transmits the flow to the PLC. FIT-1001 has a calibrated range of 0-60 L/s corresponding to a 4-20 mA output signal. FI-1001 will display the raw water flow on the PLC. FAL-1001 is a low flow alarm for the raw water inlet. If the plant is called into operation and no raw water flow is detected FAL-1001 will alarm on the PLC.

The flow of raw water into the water treatment plant is controlled by FCV-1001. This valve is equipped with both REMOTE-OFF-LOCAL (ROL) and OPEN-STOP-CLOSE (OSC) hand switches labelled HS-1001A and HS-1001B respectively. When HS-1001A is in the LOCAL position, HS-1001B is used to open and close the valve as required. When HS-1001A is in the OFF position FCV-1001 will not operate. The position of FCV-1001 when HS-1001A is the in the REMOTE position will be controlled based on the flow detected by FE-1001 and a desired plant production rate chosen by the plant operator. FCV-1001 is equipped with a position indicator ZI-1001 that detects the position of the valve. ZI-1001 is expressed on the PLC as a percentage open from 0-100% based on the 4-20 mA signal.

Upon loss of utility power FCV-1001 is driven closed by a dedicated uninterruptible power supply, therefore shutting down the water treatment process. FCV-1001 is the only valve in the facility to be powered in this manner. All other valves fail to their last position upon a loss of utility power.

The UV disinfection reactors X-120 and X-121 disinfect the raw water. The plant PLC is connected to each reactors dedicated control panel via Ethernet. Each of the reactors is controlled manually (at the UV control panel) or remotely at the PLC. Under normal conditions (remote PLC control), the WTP is called to produce water by the level sensor in the reservoir. The plant PLC will call for the duty UV reactor to start. From this point onwards the reactor controller determines control of start-up, normal operation and shutdown of the UV reactor. In the event of duty reactor failure the PLC manages the switchover to the standby reactor.

Both X-120 and X-121 are associated with an influent valve, effluent valve and drain valve. Influent valves (V-1007 and V-1008) are manually operated to isolate the UV reactors. V-1007 and V-1008 remain fully open unless a UV reactor is out of service. Effluent control valves (FCV-1009 and FCV-1012) will be controlled (on/off) and monitored (open/closed) by the UV control panels based on the requirements established by Trojan Technologies. Drain valves (SV-1201 and SV-1211) provide cooling water to the UV reactors during start-up and shut down sequences. SV-1201 and SV-1211 are controlled by the UV control panels. Cooling water is monitored by FE-1001.

120 and X-121 are continuously monitored by the dedicated control panels supplied with the equipment. The control panels will monitor various parameters with minor, major and critical common alarms being communicated to the plant PLC via Ethernet.

To facilitate even wear on the lamp assemblies a “reactor rotation” timer shall be provided in the PLC. Designation of the current standby reactor shall rotate between the reactors. The PLC shall designate of the reactor positions that shall be regularly rotated into and out of service. The rotation timer shall be set at an initial setting of 168 hours (one week). This timer shall be fully adjustable to suit operator preferences, but shall not

exceed 4 rotations per day. It shall be possible for the operator to manually reset the timer.

6.3.2 Filtration

(Refer to Drawing I-2 at the end of Chapter 4)

The filters will operate in several different modes, filtration mode, backwash mode and filter to waste mode. A description of each operation is included here as references to these modes are used throughout this section.

6.3.2.1 Filtration Mode

This mode is the normal operating regime of each of the filters. The operator will select which filters will be in operation via the PLC based on the desired plant production rate. During filtration:

- Filter inlet valve (FCV-2101) will be fully open
- Backwash waste valve (FCV-2106) will be closed
- Air scour inlet valve (FCV-2107) will be closed
- Backwash supply valve (FCV-2105) will be closed
- Filter to waste valves (LCV-2103) will be closed
- The filtered water valve (LCV-2104) will modulate to maintain a constant level within the filter based on the level in the rapid gravity filter (LE-2101).

Filtration will continue until one of the following conditions occurs at which time the backwash mode will be started:

- Filtered water turbidity > 0.3 NTU
- Filtered water valve is fully open
- Filter media differential pressure
- Operator enables the backwash sequence on the PLC
- Elapsed time (variable set in the PLC)

6.3.2.2 Backwash Mode

This mode will begin based on the above conditions, these conditions indicate that the filter is dirty and needs to be cleaned. Prior to the initiation of the backwash sequence the PLC will confirm that the following conditions are met. If the reservoir level is calling for the plant to run the PLC confirms that the filter inlet valve, and the filter to clear well valve for at least one of the three other filters are proven as open. This ensures that a backwash cannot be initiated if the reservoir requires water. At least one filter must be available for normal use. Once a backwash has been triggered the following events will happen sequentially:

- Filter inlet control valve will close and prove as such, allowing the water level in the filter to decrease.
- The filtered water valve will close when the water level reaches 150 mm above the filter media as measured by LE-2101 and prove as such.
- The air scour valve will prove open, followed by the starting of one of the air scour blowers. Air will be delivered to the filter for approximately 5 minutes followed by the blower shutting down, then the air scour valve closing and proving as such.
- The backwash pump will be started with PRV-2501 fully open. (pilot solenoid de-energized).
- The backwash waste valve and backwash supply valves will now be opened.
- After a delay of 3 minutes the PRV-2501 pilot solenoid will be energized allowing this valve to close slowly, thereby closing the pump bypass allowing backwash water to be introduced into the filter.
- The backwash pump will deliver water to the filter 10 minutes.
- PRV-2501 pilot solenoid will be de-energized allowing PRV-2501 to return to bypass mode.
- Backwash supply and backwash waste valves will be closed.
- The backwash pump will be shut down following 2 minutes after PRV-2501 is fully open and valve status is confirmed for all backwash related vales, the filter is ready to enter to waste mode at which time the filter will be ripened.

6.3.2.3 Filter to Waste Mode

This mode allows the filter to ripen following the backwash sequence and pass filtered water with excess turbidity to storage. This will be accomplished by the following:

- Filter influent valve will open.
- Filter to waste valve will be modulated to maintain the filter water level. This will require that the valve be closed for some time so the filter has time to fill up.
- Filter to waste will continue for a pre-set time (~ 10-15 minutes) or until the turbidity of the filtered water is < 0.3 NTU.
- The filtered water valve will open and the filter to waste valve will close, thereby placing the filter into filtration mode.

Filtered water turbidity from the rapid gravity filter F-210 is measured by AE-2102. The continuous measurements are transmitted to the PLC via AIT-2102, recorded once per minute and stored for archive purposes. Alarm AE-2102 will display F-210 filtered water turbidity on the PLC. AAH-2102 will be used to notify the operations staff that the filtered water turbidity is high and a backwash is required. The filtered water sample line leading to AE-2102 will be equipped with an electric solenoid valve (SV-2102). During filtration SV-2102 will be energized open, when F-210 is in a backwash sequence or the plant is not in operation SV-2102 will de-energize and the valve will close.

Pressure drop across the filter media is monitored by PIT-2101. The reference leg of the transmitter is located above the filter media, and represents a constant pressure value. The measuring leg of the transmitter is located at the under drain piping outlet, and will see lower pressure as the filter media becomes occluded. The differential pressure required to initiate a backwash will be set during commissioning.

The filter inlet valve on F-210, FCV-2101, is equipped with a HAND-OFF-AUTO (HOA) switch HS-2101A and an OPEN-CLOSE (OC) switch HS-2101B. FCV-2101 will be equipped with position switches ZSO-2101 and ZSC-2101 to detect the valve open and closed position respectively. When HS-2101A is in the OFF position the valve will not operate. When HS-2101A is the in HAND position the valve position can be

opened and closed using HS-2101B. When HS-2101A is the in AUTO position, the PLC controls FCV-2101.

When the filter is in filtration mode FCV-2101 is signalled to open. When the filter is in backwash mode or is out of service (as determined by the operator on the PLC) FCV-2101 is signalled closed. ZSO-2101 and ZSC-2101 display the open/closed status of the filter inlet valve on the PLC. In the event that FCV-2101 is signalled to open and ZSO-2101 fails, a failure to open alarm annunciates. In the event that FCV-2101 is signalled to close and ZSC-2101 is not activated, the backwash sequence will be disabled for F-210, LCV-2103 and LCV-2104 will be closed and a failure to close alarm annunciates.

Water level within F-210 is continuously measured by LE-2101. LIT-2101 provides local level indication and transmits the level within F-210 to the PLC. LI-2101 displays the level within F-210 on the PLC. LIT-2101 monitors the filter level and alarms on a high level (300mm above operating level). The occurrence of a high level alarm indicates a downstream blockage or valve closure and results in the closure of FCV-2101.

The filter to waste valve (LCV-2103) is equipped with position indicator ZT-2103. Following the backwash sequence, LCV-2103 will open and modulate to maintain the water level within F-210 as detected by LE-2101. The filter to waste valve will continue to modulate until the turbidity (measured by AE-2102) is below 0.3 NTU. ZI-2103 provides display of the position status of the filter to waste valve on the PLC. The filter is disabled in the event that LCV-2103 is signalled to close and the valve fails to close or when LCV-2103 is signalled to open and the valve fails to open, FCV-2101 is closed and valve close/open failure alarm annunciates.

LCV-2103 will be equipped with a ROL switch HS-2103A and an OC switch HS-2103B. When HS-2103A is in the OFF position the valve will not operate. When HS-2103A is the in LOCAL position the valve position can be opened and closed using HS-2103B. When HS-2103A is the in REMOTE position, the PLC will control LCV-2103.

The filtered water valve (LCV-2104) is equipped with position indicator ZT-2104. Following the filer to waste sequence, the filter to waste valve will be closed and the

filtered water valve will open. The filtered water valve will continue to modulate allowing filtered water to enter the clearwell. Once a condition is met that requires backwashing (see filtration mode description), the filtered water valve will close. ZI-2104 provides display of the position of the filtered water valve on the PLC. The filter is disabled in the event that LCV-2104 is signalled to close and the valve fails to close or when LCV-2104 is signalled to open the valve fails to open, FCV-2101 is closed and a valve close/open failure alarm annunciates. If ZI-2004 indicates that the valve is fully open in order to maintain the water level in the filter, a backwash is required.

LCV-2104 will be equipped with a ROL switch HS-2104A and an OC switch HS-2104B. When HS-2104A is in the OFF position the valve will not operate. When HS-2104A is the in LOCAL position the valve can be opened and closed using HS-2104B. When HS-2104A is the in REMOTE position, the PLC will control LCV-2104.

The backwash water supply to F-210 is controlled by FCV-2105. The valve is equipped with position switches ZSO-2105 and ZSC-2105 to detect the valve open and closed position respectively. During the backwash sequence, FCV-2105 will open and allow the backwash water to enter the filter following air scour. ZSO-2105 and ZSC-2105 provide display of the open/closed status of the filter to waste valve on the PLC. In the event that FCV-2105 is signalled to open and ZSO-2105 fails, a failure to open alarm annunciates. This results in a failure of the backwash sequence, that disables F-210 from coming back online. In the event that FCV-2105 is signalled to close and ZSC-2105 is not activated, the filter will be disabled, a failure to close annunciates.

FCV-2105 will be equipped with a HOA switch HS-2105A and an OC switch HS-2105B. When HS-2105A is in the OFF position the valve will not operate. When HS-2105A is the in HAND position the valve position can be opened and closed using HS-2105B. When HS-2105A is the in AUTO position, the PLC will control FCV-2105.

The backwash waste valve on F-210 is controlled by FCV-2106. The valve is equipped with position switches ZSO-2106 and ZSC-2106 to detect the valve open and closed position respectively. During the backwash sequence, FCV-2106 will open and allow the backwash waste to leave the filter. ZSO-2106 and ZSC-2106 provide display of the

open/closed status of the filter to waste valve on the PLC. In the event that FCV-2106 is signalled to open and ZSO-2106 fails, a failure to open alarm annunciates. This results in a failure of the backwash sequence, that disables F-210 from coming back online. If ZOA-2006 is active the backwash pumps, P-205/206 will be disabled. In the event that FCV-2106 is signalled to close and ZSC-2106 is not activated, the filter will be disabled, a failure to close alarm annunciates.

FCV-2106 will be equipped with a HOA switch HS-2106A and an OC switch HS-2106B. When HS-2106A is in the OFF position the valve will not operate. When HS-2106A is the in HAND position the valve position can be opened and closed using HS-2106B. When HS-2106A is the in AUTO position, the PLC will control FCV-2106.

The air scour valve on F-210 is controlled by FCV-2107. The valve is equipped with position switches ZSO-2107 and ZSC-2107 to detect the valve open and closed position respectively. During the backwash sequence, FCV-2107 will open and prove as such, enabling the air scour blower start, which will allow the air to enter the filter. Upon completion of the air scour the operational sequence will shut down the blower prior to sending the FCV-2107 close signal. ZSO-2107 and ZSC-2107 provide display of the open/closed status of the air scour valve on the PLC. In the event that FCV-2107 is signalled to open and ZSO-2107 fails, a failure to open alarm annunciates. This results in a failure of the backwash sequence, that disables F-210 from coming back online. If ZOA-2007 is active the air scour blowers, C-200/C-201 will be disabled. In the event that FCV-2107 is signalled to close and ZSC-2107 is not activated, the filter will be disabled, a failure to close alarm annunciates.

FCV-2107 will be equipped with a HOA switch HS-2107A and an OC switch HS-2107B. When HS-2107A is in the OFF position the valve will not operate. When HS-2107A is the in HAND position the valve position can be opened and closed using HS-2107B. When HS-2107A is the in AUTO position, the PLC will control FCV-2107.

HS-2001 and HS-2001 are HOA manual switches associated with air scour blowers C-200 and C-201 respectively. HS-2001 and HS-2001 are located in the MCC. When HS-2001 is in HAND position, blower C-200 starts and continues to run disregarding any

other condition. In the OFF position, the blower is off disregarding any other condition. In the AUTO position the blower starts and stops as called for by the PLC. Running status of the blowers will be displayed on the PLC along with fault status and automatic operation. Running lights for each blower will be located on the plant MCC. C-200 and C-201 will be alternated automatically by the PLC once per month or in the case of fault with the duty blower. All controls are similar for both C-200 and C-201.

6.3.3 Clearwell and Backwash Supply

(Refer to Drawing I-3 at the end of Chapter 4)

HS-2051 and HS-2061 are HOA switches associated with backwash pumps P-205 and P-206 respectively. HS-2051 and HS-2061 are located locally at P-205 and P-206. When HS-2051 is in HAND position, pump P-205 starts and continues to run disregarding other condition. In the OFF position, the pump will not operate. In the AUTO position the pump starts and stops as called for by the PLC. Running status, fault status and automatic operation of the pumps is displayed on the PLC. Running lights for each pump are located on the plant MCC. P-205 and P-206 will be alternated automatically by the PLC once per month or in the case a duty pump fault. P-205 and P-206 operate when required by the backwash mode. All controls are similar for both P-205 and P-206.

Water level within the backwash pumping chamber is continuously monitored by LE-2501. LIT-2501 provides local level indication and transmits the level within the pumping chamber to the PLC. LI-2501 displays the level within the clearwell on the PLC. LAL-2501 provides a low level alarm, which disables the backwash pumps. LAL-2501 will also indicate that the water treatment plant needs to start or there is problem with water getting to the off-site reservoir. LAH-250 will indicate a failure of the level control within the reservoir or a valve closure between the water treatment plant and the offsite reservoir.

The treated water supply to the storage reservoir is controlled by FCV-2501. FCV-2501 ensures that treated water exiting the plant meets the quality criteria dictated by AIT-2501. An alarm generated by AIT-2501 will result in a plant stop condition closing FCV-1001 and FCV-2501. Once the plant conditions that initiated the AIT-2501 alarm are

addressed the PLC allows the plant to restart and FCV-2501 to re-open. At this point AIT-2501 alarms are bypassed for 10 minutes to allow a treated water sample to reach the analyzer. The valve will be equipped with position switches ZSO-2501 and ZSC-2501 to detect the valve open and closed position respectively. During normal plant operations, FCV-2501 is open and allows the treated water to enter the storage reservoir. ZSO-2501 and ZSC-2501 provide display of the open/closed status of the plant outlet valve on the PLC. In the event that FCV-2501 is signalled to open and ZSO-2501 is not activated, a failure to close alarm annunciates. This results in a failure of the plant to produce water and a plant major alarm dial out occurs. In the event that FCV-2501 is signalled to close and ZSC-2501 is not activated, a failure to close alarm annunciates and a plant major alarm dial out occurs.

FCV-2501 will be equipped with a HOA switch HS-2501A and an OC switch HS-2501B. When HS-2501A is in the OFF position the valve will not operate. When HS-2501A is the in HAND position the valve position can be opened and closed using HS-2501B. When HS-2501A is the in AUTO position, the PLC will control FCV-2501.

6.3.4 Chlorination

(Refer to Drawing I-4 at the end of Chapter 4)

The ambient chlorine gas detection sensor, AE-3401, alarms on the detection of chlorine gas within the chlorination room. AAH-3401 is the chlorine alarm that is annunciated on the PLC. Alarm horn, HN-3401 and alarm beacon, BA-3401 mounted outside of the chlorine room external to the water treatment plant will both be activated if AAH-3401 alarms.

The chlorination system is supplied by US Filter and comes complete with controls, refer to US Filter documentation. The plant PLC will feed gas chlorinators X-340 and X-341 with the raw water flow measured by FE-1001.

6.3.5 Fluoride, Orthophosphate and Hypochlorite

(Refer to Drawing I-5 at the end of Chapter 4)

Each chemical dosing system will be set up with two dosing pumps, P-303 and 304 for orthophosphate, P-305 and 306 for fluoride and P-362 and 363 for the temporary hypochlorite and ultimate caustic soda. Each pump will operate in the same manner and therefore only one set of pumps is described herein.

HS-3031 and HS-3041 are HOA switches located on the MCC control panel, associated with raw water pumps P-303 and P-304 respectively. When HS-3031 is in HAND position, pump P-303 starts and continues to run disregarding any other condition. In the OFF position, the pump will not operate. In the AUTO position the pump starts and stops as called for by the PLC. The PLC provides a flow signal (raw water flow FE-1001) for flow pacing of each pump. P-303 is monitored for Auto status, operational status and fault signals. The pump duty will be alternated automatically from the PLC every month. Similarly for HS-3041 and P-304.

6.3.6 Waste Tankage

(Refer to Drawing I-6 at the end of Chapter 4)

Water level in the backwash storage tank is measured by LE-4001. LIT-4001 is the local level indicating transmitter. LI-4001 will indicate the level in the tank on the PLC in meters (0-3.5m). LAH-4001 will be a high level alarm indicating a high backwash level that will disable any further backwashing of filters.

The flow of backwash water to the sewer is controlled my FCV-4001. This valve will be equipped with both ROL and OSC switches, HS-4001A and HS-4001B respectively. When HS-4001A is in the LOCAL position, HS-4001B can be used to open and close the valve as required. When HS-4001A is in the OFF position the valve will not operate. When HS-4001A is in the REMOTE position the PLC controls the position of FCV-4001. The plant PLC indicates the position of HS-4001A.

The position of FCV-4001 when HS-4001A is the in the REMOTE position will be controlled based on the flow detected via FE-4001 and an operator input flow set point.

FCV-4001 is equipped with a position indicator ZI-4001, to detect the position of the valve and therefore to detect fully open and fully closed positions. During operation of the WTP, the operator will input the desired outlet of backwash water rate via the PLC. ZI-4001 will be expressed on the PLC as a percentage open from 0-100% based on the 4-20 mA signal.

Water level in the filter to waste storage tank is measured by LE-4011. LIT-4011 is the local level indicating transmitter. LI-4011 indicates the level in the tank on the PLC in meters (0-3.5m). LAH-4011 will be a high level alarm indicating a high filter to waste level that will disable any filter to waste functions at the filters.

The flow of backwash water to the sewer is controlled by FCV-4011. This valve will be equipped with both ROL and OSC switches, HS-4011A and HS-4011B respectively. When HS-4011A is in the LOCAL position, HS-4011B can be used to open and close the valve as required. When HS-4011A is in the OFF position the valve will not operate. When HS-4011A is in the REMOTE position the PLC controls the position of FCV-4011. The plant PLC will indicate the position of HS-4011A.

The position of FCV-4011 when HS-4011A is the in the REMOTE position is controlled based on the flow detected via FE-4011 and an operator input flow set point. FCV-4011 is equipped with a position indicator ZI-4011, to detect the position of the valve and therefore to detect fully open and fully closed positions. During operation of the water treatment plant, the operator will input the desired outlet of backwash water rate via the PLC. ZI-4011 will be expressed on the PLC as a percentage open from 0-100% based on the 4-20 mA signal.

6.3.7 Service Water Pumps

(Refer to Drawing I-7 at the end of Chapter 4)

HS-4101 and HS-4111 are HOA switches located on the MCC control panel, associated with raw water pumps P-410 and P-411 respectively. When HS-4101 is in HAND position, pump P-410 starts and continues to run disregarding other condition. In the OFF position, the pump will not operate. In the AUTO position the pump starts and stops

as called for by the PLC, either P-410 or P-411 will be in operation at all times. P-410 will be monitored for its Auto status, operational status and fault signals. The pump duty will be alternated automatically by the PLC every month. Similarly for HS-4111 and P-411.

PSL-4112 is a pressure switch mounted in the service water header. This switch indicates low pressure in the supply, which will feed water to the chlorination system and the duty of the pumps.

6.4 Troubleshooting

6.4.1 Alarms

The PLC continuously monitor the water treatment plant's process, mechanical and electrical operating systems. System or equipment failure alarms are indicated on the HMI screen. Various process and facility alarm conditions are detected by the PLC, some will shut the plant down and others will turn on back up equipment.

The following tables list the alarm tag #'s, the alarm function descriptions and the form of annunciation. All alarms will be stored in memory and will be downloaded as a single file to HMI PC hard drive in the plant office once a week. The alarm log file will use a file name that includes the date upon which the file is written to disk. Information saved will be date, time, alarm descriptor No., Tripped by, and Acknowledgement date and time. Alarms are also printed on a dot matrix printer in the plant office to provide a continuous record of all PLC system alarms in chronological order.

Unless otherwise noted in the tables below, water treatment process alarms will be held out when equipment is selected as out of service or the plant is off line due to a full level in the storage reservoir.

6.4.1.1 Pre-Treatment Alarms

Pre-Treatment Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	FAL-1001	Low flow in raw water supply header *Alarm held out or 5minutes on plant start sequence*	2 L/s	Plant Shut Down & Plant Dial Out
2	X-120 Minor Alarm	X-120 UV System #1 Control Panel	Various Conditions	None
3	X-120 Major Alarm	X-120 UV System #1 Control Panel	Various Conditions	Duty/Standby reactor change over
4	X-120 Critical Alarm	X-120 UV System #1 Control Panel	Various Conditions	Duty/Standby reactor change over & Plant Dial Out
5	X-121 Minor Alarm	X-120 UV System #2 Control Panel	Various Conditions	None
6	X-121 Major Alarm	X-120 UV System #2 Control Panel	Various Conditions	Duty/Standby reactor change over
7	X-121 Critical Alarm	X-120 UV System #2 Control Panel	Various Conditions	Duty/Standby reactor change over & Plant Dial Out
8	LAL-5001	Low level in the existing reservoir	3.5 m	WTP Start
9	LAH-5001	High level in the existing reservoir	4.46 m	WTP Stop
10	LAL-2501	Low level in the backwash pumping chamber	m	WTP Start
11	LAH-2501	High level in the backwash pumping chamber	m	WTP Stop

6.4.1.2 Filtration Alarms

Filtration Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	AAH-2101	Filtration Mode – High filtered water turbidity Filter to Waste Mode – High filtered water turbidity	>0.3 NTU <0.3 NTU	Backwash sequence initiated Change to filtration mode
2	ZOA-2101	Failure of filter influent valve to open		Filter will not enter filtration or filter to waste mode
3	ZCA-2101	Failure of filter influent valve to close		Filter will not enter backwash mode
4	ZOA-2103	Filter to waste valve is fully open		Filter shutdown. Backwash was not effective.
5	ZCA-2103	Filter to waste valve has failed to open		Filter shutdown. Filter to waste cannot occur
6	ZOA-2104	Filtered water valve is fully open		Backwash required.
7	ZCA-2104	Filtered water valve has failed to open		Filtration cannot proceed
8	ZOA-2105	Failure of backwash water supply valve to open		Backwash pumps (P-205/206) cannot start, backwash cannot proceed
9	ZCA-2105	Failure of backwash water supply valve to close		Filter to waste cannot proceed
10	ZOA-2106	Failure of backwash waste valve to open		Backwash pumps (P-205/206) cannot start, backwash cannot proceed
11	ZCA-2106	Failure of backwash waste valve to close		Filter to waste cannot proceed, filter influent valve remains closed
12	ZOA-2107	Failure of air scour valve to open		Air scour blowers (C-200/201) cannot start, backwash cannot proceed
13	ZCA-2107	Failure of air scour valve to close		Backwash cannot proceed.

Filtration Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
14	UA-2001*	Fault in Air Scour Blower C-200		If duty blower, set C-201 as duty pump. If UA-201 active, plant shut down & Plant Dial Out
15	UA-2011*	Fault in Air Scour Blower C-201		If duty blower, set C-200 as duty pump. If UA-200 active, plant shut down & Plant Dial Out
16	LAH 2101	High level in filter	300mm above normal operating level	FCV 2101 filter inlet valve closed

6.4.1.3 Clearwell & Backwash Supply Alarms

Clearwell & Backwash Supply Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	UA-2051	Fault with Backwash Pump P-205		If duty pump, set P-206 as duty pump. If UA-2061 active, plant shut down & Plant Dial Out
2	UA-2061	Fault with Backwash Pump P-206		If duty pump, set P-205 as duty pump. If UA-2051 active, plant shut down & Plant Dial Out
3	LAL-2501	Low level in backwash pumping chamber		Backwash sequence disabled
4	LAH-2501	High level in backwash pumping chamber		Plant shut down

6.4.1.4 Chlorination Alarms

Chlorination Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	AAH-3401 Chlorine alarms are always active	Chlorine Leak	2 ppm	Ventilation in chlorine room stops. HN-3401 starts BA-3401 starts & Plant Dial Out

6.4.1.5 Fluoride, Orthophosphate & Hypochlorite Alarms

Fluoride, Orthophosphate & Hypochlorite Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	UA-3031	Zinc Orthophosphate Dosing Pump failure P-303		P-304 starts Plant Shutdown Plant Dial Out if UA-3041 is also active
2	UA-3041	Zinc Orthophosphate Dosing Pump failure P-304		P-303 starts Plant Shutdown Plant Dial Out if UA-3031 is also active
3	UA-3051	Hydro Fluorosilicic Pump failure P-305		P-306 starts Plant Shutdown Plant Dial Out if UA-3061 is also active
4	UA-3061	Hydro Fluorosilicic Pump failure P-306		P-305 starts Plant Shutdown Plant Dial Out if UA-3051 is also active
5	UA-3621	Pump failure		P-363 starts Plant Shutdown
6	UA-3631	Pump failure		P-362 starts Plant Shutdown

6.4.1.6 Waste Tankage Alarms

Waste Tankage Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	LAH-4001	High level in the backwash waste tank	3.1 m	Filters are locked out from backwashing and P-205 and P-206 shutdown & Plant Dial Out
2	LAH-4011	High level in the filter to waste tank	3.1 m	Filters are locked out from filter to waste mode & Plant Dial Out
3	FAH-4001	High flow out of backwash tank	10 L/s	FCV-4001 closes
4	FAH-4011	High flow out of filter to waste tank	5 L/s	FCV-4001 closes

6.4.1.7 Service Water Pumps Alarms

Service Water Pumps Alarms

No.	Alarm Tag	Alarm Description	Set Point	Consequence
1	UA-4101	Service Pump failure P-411		P-411 starts Plant Shutdown Plant Dial Out if UA-4011 is also active
2	UA-4111	Service Pump failure P-410		P-410 starts Plant Shutdown Plant Dial Out if UA-4101 is also active
3	PAL-4112	Low Pressure in service water	245 kPag	Plant Shutdown & Plant Dial Out

END OF CHAPTER 6

Chapter 7

MAINTENANCE

7.1 General Maintenance

7.1.1 Uninteruptable Power Supplies

Each of the uninteruptable power supplies (total of 4 – PLC cabinet, Plant PC, FCV 1001, and FCV2501) contains sealed lead acid batteries. These batteries will require annual inspection, and **replacement every 3 to 5 years**. Failure to do so will result in diminished or non performance of these power supplies and a resulting loss of control over the treatment process in event of a utility power failure. Refer to the UPS system manufacturers data for testing and battery replacement information.

7.1.2 pH analyzers (AIT 1002)

pH analyzers require routine calibration and maintenance. As a minimum, once every 6 months the pH analyzer should be calibrated. This calibration will also allow the operator an opportunity to clean and inspect the pH measurement probe itself. The measurement probe itself will have a fixed service life and will require regular replacement. If the measurement probe cannot be calibrated or the calibration of the probe drifts after calibration the probe will require replacement. The manufacturers data will provide information on both calibration procedures and probe replacement procedures. A last note of caution is do not keep more than one spare probe on hand as the probes will also use up their shelf life while sitting unused.

7.1.3 Turbidimeters (AIT-1001, 2101, 2111, 2121, 2131)

Turbidity analyzers require routine calibration and maintenance. As a minimum, once every 6 months the Turbidity analyzer should be cleaned and calibrated. The turbidity measurement is performed using an optic technique the quality of the measurement is directly related to the cleanliness of the analyzer optics. Process conditions will determine if the above mentioned maintenance interval is sufficient. Clean analyzer optics and perform analyzer calibration in accordance with the manufactures instructions.

7.1.4 Chlorine Gas Detection (AIT 3401)

In order to ensure the safety of plant personnel the chlorine gas detection system should be routinely tested to verify proper operation. As a minimum, once every 6 months the chlorine gas detection system should be tested and calibrated. Testing should include the operation of alarm horn, beacon and the alarm dial out system. Testing and calibration should be performed in accordance with Section 4 of the manufacturers service manual.

7.1.5 Residual Chlorine Analyzer (AIT 2501)

In order to ensure the accuracy of the residual chlorine measurement the residual chlorine analyzer must be regularly maintained. The manufacturers data outlines bi-monthly and semi-annual checks and calibrations. Performance of these routine maintenance intervals will require electrolytes and other consumable items. Ensure the required maintenance items are kept on hand. Testing and calibration should be performed in accordance with Section 4 of the manufacturers service manual.

END OF CHAPTER 7

Chapter 8

TESTING AND CERTIFICATION DATA

8.1 General

Refer to section 3 of Volume 2of this manual

END OF CHAPTER 8

Chapter 9

MANUFACTURER DATA AND SERVICE INFORMATION

9.1 General

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END OF CHAPTER 9

Chapter 10

APPENDIX

10.1 General

Paragraph Text

10.2 Photographs

Paragraph Text

10.3 Drawings

Paragraph Text

END OF CHAPTER 10