PLC Supervisory Control And Data Acquisition -Wastewater Treatment Plant

WASTEWATER TREATMENT PLANT SCADA

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PROJECT OBJECTIVES

•Replace existing control systems with modern controls during a major plant expansion.

•New motor controls, instruments, and valve actuators, use networked communications whenever possible.

•Automate each process from a local PLC based "RTU". Integrate all OEM controls including HMI screens into the local RTU.

•Link all RTUs together with a high speed redundant communications network allowing operation and monitoring of any process from all locations.

• Provide a SCADA (Supervisory Control And Data Acquisition) system that includes detailed alarming, data collection, and automated reporting.

• Secure local and remote operation.

SCADA - RTU – Process Communications



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RTU with touch screen user interface



An Allen Bradley ControlLogix PLC system with redundant power supplies is the heart of each RTU. I/O, communication modules, and enclosure type varied depending on the location's requirements. UPS provides backup power. RTU network communications is via redundant fiber optics. Touch screen operation using an Allen Bradley VersaView with RSView FactoryTalk Station.

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Redundant fiber optic ring for high speed RTU to RTU/ SCADA communications.



Each RTU contains a Phoenix fiber optic switch with redundant ports using Rapid Spanning Tree Protocol to ensure a reliable high speed connection. Multiple copper ports on each switch are for connection to the ControlLogix, VersaView, and any other local devices requiring an Ethernet connection.

RTU communicates to local devices and control systems using various protocols and methods.



DeviceNet, MODBUS, Ethernet, and others, in addition to discrete and analog I/O signals, are ways the RTU communicates and controls the process in its location.

RTU – L UV Disinfection



UV Building

RTU-L is in the UV Disinfection Building. It communicates with the UV system's control panel.

- UV HMI screens and alarms integrated into RTU HMI / SCADA
- Effluent Flow transmitted to UV
- Effluent Sampler
- Building Intrusion



OEM UV Control Panel

RTU-L and MCC

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RTU – L UV Disinfection



The main screen for RTU-L displays an overview of the UV operation. Local alarm status is displayed along with a system wide alarm window at the bottom. This is typical of each RTU's main screen. The alarm window appears on all screens. Navigation is via on-screen selections. Pressing "UV MAIN" displays the OEM UV screens. "OVERVIEW" displays the Plant Overview screen. All RTU screens are available at each RTU location

RTU – M Digester & Mixing Pumps



Digester and Mixing Pumps



RTU-M is located in the Digester building. It controls the Mixer Pump panels via hardwire connections.

- Ultrasonic Levels
- ORP, PH, and Temperatures
- Mixing Pump Control
- Building Intrusion

Ultrasonic Level Transducer

RTU – M Digester & Mixing Pumps



This is the main screen for RTU-M displaying an overview of the Digester and Mixing Pump operations. Pressing "CONTROLS" displays the Digester Setpoint & Pump Control screen. Navagation to other areas is done by pressing the location name inside the dotted line box, such as "AREATION" shown above.

RTU – M Digester & Mixing Pumps



Digester setpoints are set on this screen, grouped by Digester. Setpoints are entered by either moving the slider on each level bargraph or by clicking on the value and entering the value using an on-screen keyboard. Next to the setpoints are alarms related to each Digester. On the right side of the screen are indicators and controls for each Mixing Pump.



Blower Building

RTU-G is located in the Blower building. Standby generator and incoming power are also located here.

- Blower HMI screens and alarms integrated into RTU HMI / SCADA
- Generator Status
- Switchgear and Power Monitoring
- Building Intrusion













RTU-G

ModBus



Motor Control Center



Valve Operator



Generator & Switchgear

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This is the main screen for RTU-G displaying an overview of the Blower operations. In the upper left corner is a series of navigation buttons. "BLOWERS" displays the first OEM Blower screen.

) Plano - FactoryTalk View SE Client			
OVERVIEW RTU-G	GENERATOR ST	ATUS	
RTU-G MAIN SWITCHGEAR STAGING SETUP GENERATOR ALARMS OVERCURRENT OVERLOAD OVERSPEED UNDER FREQUENCY E-STOPPED / PULLED FAILED TO RUN HIGH AC VOLTAGE LOW AC VOLTAGE AC CHARGER FAILURE HIGH BATTERY VOLTAGE DOW BATTERY VOLTAGE PRE HIGH ENGINE TEMP HIGH ENGINE TEMP CHECK GENSET	GENSET STATUS RUNNING AUTO NOT IN AUTO FUEL TANK ALARMS LOW FUEL LEVEL DESEL FUEL LEVEL PRE LOW OIL PSI DIESEL FUEL LEAK DIESEL FUEL LEAK DIESEL LOW FUEL DIESEL LOW FUEL GAS FUEL LEAK GAS TANK ALARM GAS TANK ALARM	GENERA AMPS A AMPS B AMPS C VOLTS A VOLTS A VOLTS C VOLTS C VOLTS C-A WATTS VARS VA FREQUENCY HARMONICS PERCENT AMPS A PERCENT AMPS A PERCENT AMPS B PERCENT AMPS C PERCENT AMPS C PERCENT AMPS C PERCENT MATTS ENGINE STARTS FAULT TYPE POWER FACTOR	TOR STATUS 0.0 A 0.0 A 0.0 A 0.0 V 0.0 KW 0.0 KVAR 0.0 KVA 0.0 KVA 0.0 % 0.0 % 0.0 % 0.0 % 0.0 RPM 26 0 0
Display G-GeneratorMain			ClearClear A

Pressing "GENERATOR" on RTU-G's main screen displays the Generator Status screen. Generator alarms and status as well as fuel tank alarms are displayed here.

) Plano - FactoryTalk View SE Client				-08
OVERVIEW RTU-G	SWITCHGEAR ST	ATUS		
GENERATOR				
ALARM STATUS		•		
	GENERATOR MAIN STATU	<u>></u>		
	POWER WATTS	0.0 W		
		0 VAR		
		004		
		0.0 4		
	CURRENT LINE C	0.0 A		
	VOLTAGE A-B	0.0 V		
	VOLTAGE B-C	0.0 V		
	VOLTAGE C-A	0.0 V		
	VOLTAGE AVERAGE	0.0 V		
	FREQUENCY	0.00 Hz		
	UTILITY MAIN STATUS			
	POWER WATTS	345900 W		
	POWER VARS	-185390 VAR		
	POWER VA	390840 VA		
		478.1 A		
		409.4 A		
		4/5.8 A		
	VOLTAGE B-C	480.0 V		
	VOLTAGE C-A	481.0 V		
	VOLTAGE AVERAGE	480.5 V		
	FREQUENCY	60.00 Hz		
				ALARM RESET
1			F	ALARM HISTORY
<u>/</u>				
Display G-Switchgear				📑 <u>C</u> lear Clear <u>A</u> ll

Pressing "SWITCHGEAR" on RTU-G's main screen displays the Switchgear Status screen. Status of Generator and Utility Mains are displayed.



Pressing "ALARM STATUS" on RTU-G's Switchgear Status screen displays the Switchgear Alarm Status screen. Status of all switchgear alarms are displayed.



Screening and Grit Building



Radar Level



Ultrasonic Level

Equalization Tank levels are measured and flow rates regulated. Bar Screen and Grit systems are monitored and controlled.

- Bar Screen Control Panels
- Grit Control Panel
- Blowers and Conveyors via MCC
- Ultrasonic and Radar Levels
- Modulating Flow Valves on DeviceNet
- Magnetic Flow Metering
- Sampler Pacing
- Combustible Gas Detection
- Building Intrusion



Motor Control Center

DeviceNet



Screening and Grit



RTU-C

Hardwired

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This is the main screen for RTU-C displaying an overview of the Bar Screen operations. In the upper left corner is a series of navigation buttons. Each button is used to navigate to that section of RTU-C's operation.



Pressing "BAR SCREENS" on the RTU-C main screen displays the Bar Screen, Compactor, and Conveyor screen. Controls and indicators are grouped together for each unit.



Pressing "GRIT SYSTEM" on the RTU-C main screen displays the Grit System screen. Controls and indicators are grouped together for each unit.

			GRITSTSTE	M SETPOINTS		
NO WASHER		NO PUMP				
ARE SE	LECTED AS THE	LEAD		MANUAL CYCLE S	TART SCHEDULE	
				12:00 AM	12:00 PM	
				1:00 AM	1:00 PM	
NO WASHER	AND	NO PUMP		2:00 AM	2:00 PM	
ARE S	ELECTED AS TH	E LAG		3:00 AM	3:00 PM	
				5:00 AM	5:00 PM	-
				6:00 AM	6:00 PM	
GRI	CYCLE SETPOIN	ITS		7:00 AM	7:00 PM	
LEAD P	UMP DURATION	10 MIN		8:00 AM	8:00 PM	
LAG PUN	P START DELAY			9:00 AM	9:00 PM	
				10:00 AM	10:00 PM	
	UMP DURATION	10		11:00 AM	11:00 PM	
MAN	UAL CYCLE STA	RT				
						ALARM RES
	NO WASHER ARE SET NO WASHER ARE SE GRIT LEAD P LAG PUM LAG P	NO WASHER AND ARE SELECTED AS THE NO WASHER AND ARE SELECTED AS THI GRIT CYCLE SETPOIN LEAD PUMP DURATION LAG PUMP DURATION LAG PUMP DURATION MANUAL CYCLE STA	NO WASHER AND NO PUMP ARE SELECTED AS THE LEAD NO PUMP NO WASHER AND NO PUMP ARE SELECTED AS THE LAG SELECTED AS THE LAG GRIT CYCLE SETPOINTS LEAD PUMP DURATION 10 MIN LAG PUMP START DELAY 1 MIN LAG PUMP DURATION 10 MIN MANUAL CYCLE START	NO WASHER AND ARE SELECTED AS THE LEAD NO WASHER AND NO WASHER ARE SELECTED AS THE LAG GRIT CYCLE SETPOINTS LEAD PUMP DURATION LAG PUMP START DELAY MANUAL CYCLE START MANUAL CYCLE START	NO WASHER AND NO PUMP ARE SELECTED AS THE LEAD 1200 AM NO WASHER AND NO PUMP ARE SELECTED AS THE LAG 2200 AM GRIT CYCLE SETPOINTS 3300 AM LEAD PUMP DURATION 10 MIN LAG PUMP DURATION 10 MIN LAG PUMP DURATION 10 MIN MANUAL CYCLE START MIN 900 AM MANUAL CYCLE START MIN 11:00 AM	NO WASHER AND NO PUMP ARE SELECTED AS THE LEAD 1200 AM 1200 PM NO WASHER AND NO PUMP ARE SELECTED AS THE LAG 100 AM 100 PM ARE SELECTED AS THE LAG 300 AM 300 PM GRIT CYCLE SETPOINTS 300 AM 500 PM LEAD PUMP DURATION 10 MIN 600 AM 600 PM LAG PUMP START DELAY 1 MIN 800 AM 800 PM LAG PUMP START DELAY 1 MIN 1000 AM 1100 PM MANUAL CYCLE START 10 MIN 1100 PM 1100 PM

Pressing "SETPOINTS" on the RTU-C's Grit System displays the Grit System Setpoints screen. Cycle start schedule and setpoints are entered on this screen.



Pressing "EQUALIZATION" on the RTU-C main screen displays the Equalization Basin screen. Equalization levels are displayed along with their operational setpoints. Operators and indicators are grouped together for each modulating valve.

Plano - FactoryTalk View SE Client				
RTU-C	PO	WER MONITOR FOR MCC	C-C	
RTU-C MAIN				
r	MCC	-C STATUS	1	
			-	
	PHASE A	3.7 A		
	PHASE B	3.0 A		
	PHASE C	2.4 A		
	VOLTS A	277.0 V		
		275.5 V		
		275.5 V		
		4/8.9 V		
	VOLTS C-A	476.1 V 479.1 V		
	POWER	1212.2 W		
	REACTIVE POWER	2174.3 VAR		
	APPARENT POWER	2454.6 VA		
	FREQUENCY	60.0 Hz		
-			-	
				ALARM RESET
				ALARM HISTORY
Display C-PowerMonitorMcc-C				Clear Clear All

Pressing "MCC-C" on the RTU-C main screen displays the Power Monitor MCC-C screen. Power status for MCC-C is displayed.



Pressing "GENERATOR" on the RTU-C main screen displays the Generator Staging – Bar Screen screen. Each unit can be assigned to a start up stage or disabled when the plant is operating on generator power. This prevents overloading the generator by starting all the operating equipment at the same time.



Secondary Control Building



Magnetic Flow Meter



Modulating Flow Valves

Secondary Control processes, such as RAS and MLSS flows, Non-Potable Water, and Clarifiers are controlled .

- Non-Potable Water Control Panel
- Motors and Pumps via MCC
- Ultrasonic Levels
- Modulating Flow Valves on DeviceNet
- Magnetic Flow Metering
- Pressures
- Building Intrusion



Motor Control Center



DeviceNet

Non-Potable Water





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This is the main screen for RTU-K displaying an overview of the Secondary Control operations. In the upper left corner is a series of navigation buttons. Each button is used to navigate to that section of RTU-K's operation.



Pressing "RAS OVERVIEW" on the RTU-K main screen displays the RAS Overview screen. Levels, controls, and indicators are grouped together for each item.



Pressing "RAS CONTROL" on the RAS Overview screen displays the RAS Control screen. Levels, controls, and status are grouped together for each pump and valve.



Pressing "AS CALC" on the RAS Overview screen displays the AS Calculation screen. Values for setpoints can be entered directly into the equation and the flow recalculated.



Pressing "WAS CONTROL" on the RTU-K main screen displays the WAS Control screen. Levels, controls, and indicators are grouped together for each item. Wasting schedule and auto wasting setpoints are entered here.



Pressing "WAS CALC" on the RAS Overview screen displays the WAS Calculation screen. Values for setpoints can be entered directly into the equation and the flow recalculated.



Pressing "DR PUMPS" on the RTU-K main screen displays the Drain Pump Control screen. Levels, controls, and indicators are grouped together for each item.



Pressing "MLSS SPLIT" on the RTU-K main screen displays the MLSS Split screen. Levels, controls, and indicators are grouped together for each item.

Plano - FactoryTalk View SE Client			
OVERVIEW	RTU-K	NON-POTABLE WATER SYSTEM	
RTU-K MAIN	R IU-R	NUMPORABLE WATER STOTEM	
			ALARM RESET
L			ALARM HISTORY
Display K-NpwControl			Clear Clear All

Pressing "NPW SYSTEM" on the RTU-K main screen displays the Non-Potable Water System screen. Levels, controls, and indicators are grouped together for each item.

Plano - FactoryTalk View SE Client OVERVIEW RTILK	POW		C-K	
RTU-K MAIN	FON		<u> </u>	
	Mcc-K	STATUS	7	
			7	
	PHASE A	67.8 A		
	PHASE B	51.7 A		
	PHASE C	55.3 A		
	VOLTS A	275.5 V		
	VOLTS B	275.4 V		
	VOLTS C	276.0 V		
	VOLTS A-B	476.6 V		
	VOLTS B-C	477.7 V		
	VOLTS C-A	4/7.9 V		
		44565 W		
	APPARENT POWER	48216 VA		
	FREQUENCY	60.0 Hz		
				ALARM RESET
				ALARM HISTORY
Display K-PowerMonitorMcc-K				<u>Clear</u> Clear <u>A</u> ll

Pressing "MCC-K" on the RTU-K main screen displays the Power Monitor MCC-K screen. Power status for MCC-K is displayed.

Aeration Building and Tanks

Thermal Mass Flow Meter

Modulating Flow Valves

Aeration Gallery process control, such as WAS and MLSS flows, and Dissolved Oxygen content.

- Selector Pump Control Panels
- WAS Pump Control Panel
- Modulating Flow Valves on DeviceNet
- Magnetic Flow Metering
- Thermal Mass Flow Metering
- Temperature
- Building Intrusion

Dissolved Oxygen

MODBUS

Aeration and Pump Control Panels

RTU-K

Hardwired

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This is the main screen for RTU-H displaying an overview of the Aeration Gallery operations. In the upper left corner is a series of navigation buttons. Each button is used to navigate to that section of RTU-H's operation.

Pressing "SELECTOR TANKS" on the RTU-H main screen displays the Selector Tanks screen. Levels, controls, and indicators are grouped together for each item.

OVERVIEW	RTU-H	AIR VALVES & THERMAL F	LOW METERS	
RTU-H MAIN				
	AIR VALVE 1	AIR VALVE 2	AIR VALVE 3	
	OPEN STOP CLOSE	OPEN STOP CLOSE	OPEN STOP CLOSE	
	REMOTE THERMOSTAT	REMOTE THERMOSTAT	CREMOTE THERMOSTAT	
		OPEN JAMMED		
	CLOSED BATTERY LOW	CLOSED BATTERY LOW	CLOSED BATTERY LOW	
	47.9 % OPEN	20.1 % OPEN	36.8 % OPEN	
	351 SCFM	466 SCFM	237 SCFM	
		ALVE 4 AIR V/	ALVE 5	
	OPEN ST	TOP CLOSE OPEN ST	TOP CLOSE	
			THERMOSTAT	
			JAMMED	
		BATTERY LOW	BATTERY LOW	
	100. 9	6 OPEN 100. %	6 OPEN	
	ТИГРИАЛ			
	THERMA	L METER 4 THERMA		
	361	SCFM 371	SCFM	
			ALA	RM RESET
			ALAIN	MINISTORI
H-AerationValvesMeters				Clear Clear A

Pressing "VALVES & METERS" on the RTU-H main screen displays the Air Valves & Thermal Flow Meters screen. Levels, controls, and indicators are grouped together for each item.

Pressing "OXYGEN & TEMP" on the RTU-H main screen displays the Dissolved Oxygen & Temperature Setpoints screen. Levels, controls, and indicators are grouped together for each item.

RTU – N Administration

Administration

RTU-N is located in the Administration building. It coordinates date and time settings as well as alarm operations for all the RTUs. Operates autodialer for announcing plant alarms for on call personnel.

- Centrifuge Control Panel
- Chemical Storage
- Sludge Storage
- Coordinated Date / Time
- Coordinated Alarm Acknowledge / Reset
- Building Intrusion
- Autodialer

Ethernet

Centrifuge Control

RTU-N

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SCADA Overview screen

This is the main Overview screen for the SCADA system. In the upper left corner is a series of navigation buttons. Each button is used to navigate to a section of the plant. In addition, touching the screen on a location will navigate to that RTU's main screen.

SCADA Intrusion Control

Pressing "INTRUSION CONTROL" on the SCADA Overview screen will display the Intrusion Control screen. All setpoints and selections related to intrusion monitoring at each RTU location is available here.

SCADA Alarm Enables

Pressing "ALARM ENABLES" on the SCADA Overview screen will display the Alarm Enable screen. All selections related to alarm monitoring at each RTU location is available here.

Pressing "PLANT FLOW" on the SCADA Overview screen will display the first Plant Flow screen. Realtime flows and statistics are shown on the flow diagram. Buttons in the upper left corner navigate to the two other flow diagrams. Pressing the large arrows on the sides of the screen can also be used to access the other diagrams.

Pressing "DIAGRAM P.2" on one of the Plant Flow Diagram screens will display the second Plant Flow screen. Realtime flows and statistics are shown on the flow diagram. Buttons in the upper left corner navigate to the two other flow diagrams. Pressing the large arrows on the sides of the screen can also be used to access the other diagrams.

Pressing "DIAGRAM P.3" on one of the Plant Flow Diagram screens will display the second Plant Flow screen. Realtime flows and statistics are shown on the flow diagram. Buttons in the upper left corner navigate to the two other flow diagrams. Pressing the large arrows on the sides of the screen can also be used to access the other diagrams.

Pressing "FLOW TOTALS" on one of the Plant Flow Diagram screens will display the Plant Flow Totals Current screen. Realtime flow statistics for all flows on the current day are shown here. Buttons in the upper left corner navigate to the flow diagrams and previous day totals.

PROJECT OBJECTIVES ACHIEVED and RESULTING BENEFITS

• *Replace existing control systems with modern controls during a major plant expansion.*

New controls and communication networks provide the foundation for the sophisticated monitoring and control features of this system. Service and parts are now readily available.

• New motor controls, instruments, and valve actuators, use networked communications whenever possible.

New motor control centers, instruments, and actuators all take advantage of the enhanced communications provided by DeviceNet, MODBUS, and Ethernet networks.

• Automate each process from a local PLC based "RTU". Integrate all OEM controls including HMI screens into the local RTU.

In each part of the plant, a PLC based RTU supervises and controls all the elements associated with the process at that location. If an OEM control panel is one of the elements, any HMI screens present are integrated into the RTU's screens and shared throughout the facility.

PROJECT OBJECTIVES ACHIEVED and RESULTING BENEFITS

•Link all RTUs together with a high speed redundant communications network allowing operation and monitoring of any process from all locations.

A redundant fiber optic network provides high speed communications between RTUs and the SCADA system. All RTUs have the full complement of process screens so that any operation can be monitored from any location.

• Provide a SCADA (Supervisory Control And Data Acquisition) system that includes detailed alarming, data collection, and automated reporting.

Monitored data, alarms, and other runtime information is collected and recorded for analysis and reporting. Automated report generation eliminates the need for the operator to record the data and create the report by hand while minimizing errors. Preventative maintenance schedules automatically generate daily reports of items to be serviced.

•Secure local and remote operation.

All access to the system from the SCADA and RTU screens is password protected. Operator activities are logged. Remote operation is by secure dialup connection. This presentation of a case study in Waste Water Treatment Plant SCADA was produced by:

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