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1.0 OVERVIEW

This document is intended to provide a description of the PLC functionality for the Keewatin Underpass Pumping Station. It is written from a technical perspective, and is intended to be read along with the associated Process & Instrument Diagram (P&ID) drawings.

1.1 Associated Documents

The associated Automation drawings and Process and Instrumentation diagram drawings are listed below.

Drawing Number	Rev	Description
1-0304U-A0005-001	00	I/O Wiring Control Panel CP-U81 Discrete Inputs Rack 01, Mod 04
1-0304U-A0006-001	00	I/O Wiring Control Panel CP-U81 Discrete Inputs Rack 01, Mod 05
1-0304U-A0007-001	00	I/O Wiring Control Panel CP-U81 Discrete Outputs Rack 01, Mod 07
1-0304U-A0008-001	00	I/O Wiring Control Panel CP-U81 Analog Inputs Rack 01, Mod 09
1-0304U-A0009-001	00	I/O Wiring Control Panel CP-U81 Analog Inputs Rack 01, Mod 10
1-0304U-P0001-001	00	Process & Instrumentation Diagram HVAC & Miscellaneous
1-0304U-P0002-001	00	Process & Instrumentation Diagram Underpass Pumping

1.2 Definitions

Abbreviation	Description
AI	Analog Input
AO	Analog Output
DI	Discrete Input
DNP3	Distributed Network Protocol
DO	Discrete Output
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
I/O	Input / Output
MCC	Motor Control Centre
P&IDs	Process & Instrumentation Diagrams
PLC	Programmable Logic Controller
PSTN	Public Switched Telephone Network
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition

2.0 GENERAL

2.1 Human Machine Interface

See the City of Winnipeg - Water & Waste Department - HMI Layout and Animation Plan for details.

2.2 Program Language

Function block is to be used for all programming. Permission must be given by the Contract Administrator before using any language other than function block.

2.3 Tagname Convention

In case the Contractor is required to create internal PLC tags that are not defined in this document, refer to the City of Winnipeg – Water & Waste Department - Tagname Identification Standard for the tag naming convention.

2.4 Equipment and System General Requirements

2.4.1 I/O Signal Addresses

Refer to I/O list 276-2021_IO_List – Keewatin I/O List - PLC-U81 (665338-0000-48EL-0001) for physical I/O signal addresses.

2.4.2 HMI Interface Points

Not all points between the HMI and PLC are necessarily specified or listed under the HMI-PLC interface lists. In many cases the points listed as PLC I/O might also be part of the HMI-PLC interface. The requirement is based upon the HMI logging or display requirements.

2.4.3 HMI Interface Type Codes

Code	Description
R	HMI Read
RA	HMI Read, Alarmed
R/W	HMI Read/Write
W	HMI Write
W1	HMI Write, PLC will immediately reset to 0

2.4.4 HMI Display Codes

HMI Display Code	Description
-	Do not show on the HMI screen
A	Alarm Banner
DD-T	Show as text on the data display.
EF-G	Show as graphic on the faceplate, which will popup when the operator clicks on the specific piece of equipment
EF-L	Show as an indicator light on the equipment faceplate.
EF-T	Show as a text display on the faceplate
EF-TE	Show as a text entry on the faceplate
GD-A	Show as an animation on the graphic display.
GD-G	Show as a graphic on the graphic display.
GD-L	Show as an indicator light on the graphic display.
GD-T	Show as text on the graphic display.
SW-T	Show as text on a settings window.
T	Trend

Example:

HMI Display Code

Tag	Type	Description	0 State	1 State	Display
P-U01.Rdy	DI	Starter Ready	Not Ready	Ready	GD-T
P-U01.HS_Auto	DI	Starter in Automatic Mode	Not Auto	Auto	GD-T
P-U01.Run	DI	Starter is Running	Stopped	Running	GD-T

2.4.5 HMI Control Code

HMI Control Code	Description
-	Not Applicable
EF-PB	Show as a button on the equipment faceplate
EF-TE	Show as a text entry on the equipment faceplate
SW-CB	Show as a checkbox on the equipment settings window.
SW-TE	Show as a text entry on the equipment settings window.

2.4.6 Security Code

Security Code	Description
N	None
L	Low (Accessible to operator security level)
M	Medium (Accessible to mid-level maintenance technicians)
H	High (Accessible to senior personnel only)

2.5 Input Map and Output Map (Signal Conditioning) Routines

Provide an Input Map routine to map physical inputs to internal PLC tags. For analog instruments, scale the physical transmitter and internal PLC tag to the same engineering units.

Provide an Output Map routine to map internal PLC tags to physical outputs.

In most cases the physical equipment or instrument tag (eg. LSH-U500) is different from the PLC internal tag (eg. LAH_U500) to differentiate between the physical and software signals. Additionally, the physical equipment and instrument tags will utilize the hyphen ("-") character whereas software tags utilize the underscore ("_") character.

The I/O type (DI, DO, AI, AO) is listed in the "Physical I/O" sub-sections of this Functional Requirements Specification, and indicates the instrument scaling. This information is also provided on the I/O List.

2.6 SCADA Alarm Priority

Priority	Description
1	High Priority
2	Medium Priority
3	Low Priority

Note: The SCADA Alarm Priority is applicable to the City's SCADA HMI System at the McPhillips Control Centre.

2.7 Networked Signals

The internal PLC tags are monitored by the SCADA system at the McPhillips Control Centre. It is the responsibility of the Contractor to configure DNP3 addresses for all internal PLC tags so that they can be read by the SCADA system. Some of the DNP3 addresses are indicated on the I/O List for physical I/O signals, but it is the responsibility of the Contractor to define DNP3 addresses for PLC internal tags and signals that are generated by the PLC. Submit a listing of all DNP3 addresses to the Contract Administrator at least two (2) weeks prior to commissioning to allow the City to configure their SCADA system. These signals include, but are not limited to:

- All statuses, analog values, and alarms within the PLC.

2.8 Key Operating Parameters

The station is always activated with the controls are set to automatically start and stop the pumps. Key elevations for the Polson Flood Pumping Station are shown below:

Description		Geodetic Elevation (metres above sea level)	Reference Elevation Above Transducer Zero (metres)
Wet Well Transducer Head Elevation		228.151	7.557
High Wet Well Alarm Level		225.500	4.906
Wet Well Duty 1	- Start	224.500	3.906
	- Stop	223.300	2.706
	- Differential	1.200	
Wet Well Duty 2	- Start	225.100	4.506
	- Stop	223.300	2.706
	- Differential	1.800	
Wet Well Transducer Zero Elevation		220.594	0

When referring to the controls for the pump start and stop settings, the following items should be noted:

- There are no check valves on the pumps. When the pumps stop, reverse flow will occur with the water in the discharge boxes and discharge & suction piping draining back into the wet well. This would raise the wet well level and if the differential between the pump start and stop elevation settings are too small, the pump will start again. This would cause the pumps to cycle endlessly. Thus, the minimum differential setting is established with this consideration in mind.
- Pumps are electrically interlocked using interval timing relays to ensure the pumps have a staggered start up operation in order to reduce risk tripping out the 600V power. A delay of approximately ten (10) seconds is the time before another pump can start up if one (1) was previously called to run. This also prevents multiple pumps from starting at the same time from the PLC control logic (following a power failure but with a high Wet Well level high enough to call for both pumps to run).

3.0 IMPLEMENTATION

3.1 Graphic Displays

3.1.1 HVAC Graphics Tabs

Create a graphic (process mimic) display containing a representation of the process HVAC as shown on P&ID 1-0304U-P0001 Sheet 1. Note that all alarms on HVAC Graphics Tabs must also display on the Alarms Table Tab. Specific requirements include, but are not limited to:

- Motor Room HVAC
  - Show status and alarms of motor room cooling dampers FV-U671 and FV-U672. Any damper status shall be shown as either ‘CLOSED’ or ‘OPENED’. Note that both dampers are ‘OPEN’ when cooling fan SF-U67 is running and ‘CLOSED’ when cooling fan SF-U67 is off. Refer to drawing 1-0304U-E0015 for run status signal.
  - Show status and alarms of all 600V HVAC fans, including SF-U66 and SF-U67. Note that SF-U66 is running when light switch HS-U650 is on. Refer to drawing 1-0304U-A0026.
  - Display the current motor room temperature in degrees Celsius from TT-U603, i.e. ‘MOTOR ROOM TEMPERATURE: 23°C’.
- Generator Room HVAC
  - Show status of main floor ventilation dampers FV-U601, FV-U602 and FV-U603 as percentages open i.e. ‘25% OPEN’. Any damper status shall be shown as ‘CLOSED’ when percentage is ‘0’ or ‘FULLY OPENED’ when percentage is ‘100’. Refer to drawing 1-0304U-A0034 for damper status signals.
  - Show status of generator room cooling dampers FV-U691, FV-U692, FV-U693 and FV-U694 as percentages open i.e. ‘25% OPEN’. Any damper status shall be shown as ‘CLOSED’ when percentage is ‘0’ or ‘FULLY OPENED’ when percentage is ‘100’. Refer to drawing 1-0304U-A0016 for damper status signals.
  - Show status of generator room combustion damper FV-U694. Damper status shall be shown as ‘CLOSED’ or ‘OPENED’. Refer to drawing 1-0304U-A0033 for status signal.
  - Show status and alarms of 600V HVAC main floor supply fan SF-U63.
  - Display the current generator room temperature in degrees Celsius from TT-U695, i.e. ‘GENERATOR ROOM TEMPERATURE: 23°C’.

Provide access to the Maintenance Screen

3.1.2 Pump Graphic Tabs

Create a graphic (process mimic) display containing a representation of the process flood pumping as shown on P&ID 1-0304U-P0002 Sheet 1. Specific requirements include, but are not limited to:

Animate the wet well level using vertical fill animation. Also display the level value in the center of wet well in relative and absolute units. Display the wet well level setpoint as an animated slider on the side of the wet well.

Provide access to the following controller faceplates:

- LX-U500 – Wet Well Level Conditioning Function
- LC-U500 – Wet Well Level Conditioning Function
- YC-U001 – Pump Duty Sequencer

Provide access to the Maintenance Screen.

Display pumps P-U01 and P-U02. Pumps shall turn green when running and remain blue when off.

Display status of GEN-U72 and ATS-U72. Generator shall turn green when running and blue when off

Display generator room methane gas level in percent LEL from AIT-U550.Lvl, i.e. 'GENERATOR ROOM METHANE LEVEL: 10% LEL'.

Note that all alarms on Pump Graphics Tabs must also display on the Alarms Table Tab.

3.1.3 Settings Window

- Create a settings window with settings as indicated in Section 3.0.

3.1.4 Data Display Screen

Display the runtime hours and off time hours for each pump.

Display the pump seal water flow switch status for each pump.

3.2 Trend Displays

3.2.1 Trends

Create, at minimum, the following trend displays, with the indicated pens.

Pump Trend:

- Pens:
- LI_U500, Wet Well Level
- YLR_U010_S, Pump 1 Running Status
- YLR_U020_S, Pump 2 Running Status
- YLR_U030_S, Pump 3 Running Status
- Sample Rate: 5 seconds
- Vertical Scale: 221 – 231 m on left / 0 – 100% on right
- Horizontal Scale: 30 minutes

HVAC Trend:

- Pens:
- TT-U603, Motor Room Temperature
- TT-U695, Generator Room Temperature
- FV-U601, Damper Position
- FV-U602, Damper Position
- FV-U603, Damper Position
- FV-U691, Damper Position
- FV-U692, Damper Position
- FV-U693, Damper Position
- Sample Rate: 1 minute
- Vertical Scale: 0 – 300
- Horizontal Scale: 10 hours

3.2.2 Logging Settings

The following is applicable to Vijeo Touchscreen HMIs.

Create a new log file each day and keep log files for 14 days.

3.3 Networked Signals

There are some signals between the McPhillips control centre and the station that will be via the communication network. Set up and implement these signals. These signals include, but are not limited to:

- All statuses, analog values and alarms within the PLC.

4.0 EQUIPMENT AND SYSTEM REQUIREMENTS

4.1 Wet Well Level Software Controller – LX_U500

Wet Well Level Software Controller LX_U500 calculates the geodetic Wet Well level based on the level reading from the ultrasonic level transmitter, LIC-U500, which is mounted on Control Panel CP-U81 door. The Controller also commands the duty pumps to run based on wet well level from LIC-U500 and the float switches in the Wet Well.

4.1.1 HMI I/O

Physical Tag	PLC Tag	Description	PLC Location	I/O Type	Range	Range States	HMI Code	HMI Display
ESL-U72E1	EAL_U72E1	600V Power Present	Module: 04 Point: 07	DI	0, 1	0 = No 1 = Yes	R	EF-T
LIC-U500	LI_U500	Wet Well Level	Module: 10 Point: 00	AI	4 - 20 mA	4 mA = 0 m 20 mA = 7.56m	R	EF-T
-	LI_U500_P	Wet Well Level in Percent	-	-	0 – 100	0 = 0% 100 = 100%	R	EF-T
LSH-U500	LAH_U500	Wet Well Level High	Module: 04 Point: 02	DI	0, 1	0 = No 1 = Yes	R	EF-T
LSHH-U500	LAHH_U500	Wet Well Level High High	Module: 04 Point: 03	DI	0, 1	0 = No 1 = Yes	R	EF-T
ATS-U72. OnUtility	ATS-U72_U	ATS on Utility Power	Module: 05 Point: 00	DI	0, 1	0 = No 1 = Utility	R	EF-T
ATS-U72. OnGen	ATS-U72_G	ATS on Gen Power	Module: 05 Point: 01	DI	0, 1	0 = No 1 = Generator	R	EF-T
GEN-U72. Run	GEN-U72_R	Generator Running	Module: 05 Point: 03	DI	0, 1	0 = No 1 = Running	R	EF-T
GEN-U72. BkrOpen	GEN-U72_B	Gen Breaker Closed	Module: 05 Point: 03	DI	0, 1	0 = Closed 1 = Open	R	EF-T
GEN-U72.LB	GEN-U72_LB	Load Bank Breaker Shunt Trip	Module: 07 Point: 04	DO	0, 1	0 = Normal 1 = Shunt Trip	R	EF-T

4.1.2 Internal Constants

Tagname	Description	Range	Initial Setpoint	HMI Code	HMI Display	Security Code
LX_U500_Duty1_Start	Duty 1 Start Setpoint	0 – 7.56 m	3.906 m	RW	EF-TE	M
LX_U500_Duty1_Stop	Duty 1 Stop Setpoint	0 – 7.56 m	2.706 m	RW	EF-TE	M
LX_U500_Duty2_Start	Duty 2 Start Setpoint	0 – 7.56 m	4.506 m	RW	EF-TE	M
LX_U500_Duty2_Stop	Duty 2 Stop Setpoint	0 – 7.56 m	2.706 m	RW	EF-TE	M

4.1.3 Internal Variables

Tagname	Description	Type	Range	Range States
LI_U500_Geodetic	Geodetic Wet Well Level	Real	0 – 228.151 m	-
LX_U500_Duty1_Run	Duty 1 Run	Boolean	0, 1	0 = Off 1 = Run
LX_U500_Duty2_Run	Duty 2 Run	Boolean	0, 1	0 = Off 1 = Run

4.1.4 Discrete Alarms

Tagname	Description	Logic	Mask	SCADA Alarm Priority	Reset
LAH_U500	Wet Well Level High	LSH-U500 for > 3 sec	-	2	Auto
LAHH_U500	Wet Well Level High High	LSHH-U500 for > 3 sec	-	2	Auto
LX_U500_UAF	Wet Well Level Transmitter LIC-U500 Failure	YAF_U500 OR (LIC-U500 < 4mA or > 20mA)	-	2	Auto

4.2 Pump Control

Control of the pumps will be based on the ultrasonic level transmitter and electric motors. In order for the electric motors to start up, the following two (2) conditions must be met:

1. 600 VAC power is present at the pump starter, and
2. A high water level in the Wet Well.

LI_U500 is the Wet Well level from ultrasonic level transmitter/controller LIC-U500.

Compute the geodetic Wet Well level as: LI_U500_Geodetic = LI_U500 + 220.594

Start and stop the duty pumps based on Wet Well level and the duty pump start/stop setpoints, Duty1_Start, Duty1_Stop, Duty2_Start, and Duty2_Stop. The Duty pump run signals are Duty1_Run and Duty2_Run. Do not run the duty pumps if LX_U500_UAF is TRUE.

The level float switch LSHH-U500 along with level transmitter relay 5 (LSH-U500) are provided as alarms only to the PLC. Do not use level inputs for running and stopping the pumps.

4.2.1 Pump Duty Sequencer – YC_U001

The Pump Duty Sequencer is utilized to decide which physical pump or pumps will be called to run based on the duty pump run signals from the LX_U500 controller. Pump alternation is always used.

4.2.2 Internal Variables

Tagname	Description	Type	Range	Range States	HMI Code	HMI Display
YC_U001_P_U01_CmdRun	Pump P-U01 Run Command	Boolean	0, 1	0 = Off 1 = Run	R	EF-L
YC_U001_P_U02_CmdRun	Pump P-U02 Run Command	Boolean	0, 1	0 = Off 1 = Run	R	EF-L

4.2.3 Control Narrative

The duty pump run signals are defined in LX_U500 as LX_U500_Duty1_Run and LX_U500_Duty2_Run.

If a duty pump is called to start, start the physical pump that has been off the longest. If a duty pump is called to stop, stop all pumps running.

- Tag YC_U001_P_U01_CmdRun is passed to the YC_U010 pump controller to start physical pump P-U01.
- Tag YC_U001_P_U02_CmdRun is passed to the YC_U020 pump controller to start physical pump P-U02.

4.3 Natural Gas Generator Control

The station incorporates a backup natural gas generator to power one (1) pump if there is a utility power failure. Both pump starters are electronically interlocked such that only one pump can run (in either manual/automatic modes) if the generator is running and the transfer switch is set to the generator power source. In order for the PLC to allow the generator to power one (1) pump, the following four (4) conditions must be met:

1. Automatic Transfer Switch is on Generator Power,
2. Generator is running,
3. Generator breaker is closed, and
4. A high water level in the Wet Well.

4.4 Load Bank Shunt Trip

The station incorporates a connection for testing the generator on a temporary load bank. In the event that the generator is running for testing purposes and an underpass pump is called to run, the PLC is to shunt trip the Load Bank breaker. In order for the PLC to shunt trip the load bank breaker (Module 07, Point 04 contact closes), the following four (4) conditions must be met:

1. Automatic Transfer Switch is on Generator Power,
2. Generator is running,
3. Generator breaker is closed, and
4. A run command is sent to one (1) of the underpass pumps.

4.5 Underpass Pump P-U01 Control – YC-U010

P-U01 is an underpass pump driven by a soft starter, complete with bypass starter. The pump is driven by an electric motor only. Implement all I/O as listed in the I/O list and on the P&IDs.

P-U01 is an underpass pump driven by a soft starter, complete with a bypass starter. The pump can be started by the soft starter or across-the-line. The pump is driven by an electric motor only. Implement all I/O as listed in the I/O list and on the P&IDs. To clarify, the HMI system will not be used for manual control of the pump – the pump will be manually controlled from the pilot switches on MCC-U72E enclosure.

4.5.1 HMI I/O

Physical Tag	PLC Tag	Description	PLC Location	Type	Range	Range States	HMI Code	HMI Display
YL-U010	YL_U010	Ready	Module: 04 Point: 16	DI	0, 1	0 = Not Ready 1 = Ready	R	GD-L
YLR-U010	YLR_U010	Running	Module: 04 Point: 17	DI	0, 1	0 = Off 1 = Running	R	GD-L
YAF-U010	YAF_U010	Soft Starter Fault	Module: 04 Point: 18	DI	0, 1	0 = Normal 1 = Fault	R	GD-L
IA-U010	IA_U010	Overload Tripped	Module: 04 Point: 19	DI	0, 1	0 = Normal 1 = Overload	R	GD-L
HS-U010-4A	HS_U010_4A	Auto Mode	Module: 04 Point: 20	DI	0, 1	0 = Not Auto 1 = Auto Mode	R	GD-L EF-L
HS-U010-4M	HS_U010_4M	Manual Mode	Module: 04 Point: 21	DI	0, 1	0 = Not Manual 1 = Manual Mode	R	GD-L EF-L
HS-U010-1S	HS_U010_1S	Soft Starter (SS) Mode	Module: 04 Point: 22	DI	0, 1	0 = Not SS Mode 1 = SS Mode	R	GD-L EF-L
HS-U010-1A	HS_U010_1A	Across the Line (ATL) Mode	Module: 04 Point: 23	DI	0, 1	0 = Not ATL 1 = ATL Mode	R	GD-L EF-L
FSL-U011	FSL_U011	Low Seal Water Flow	Module: 04 Point: 24	DI	0, 1	0 = Alarm 1 = Normal	R	GD-L
TSH-U010	TSH_U010	Motor High Temperature	Module: 04 Point: 25	DI	0, 1	0 = Normal 1 = High Temp	R	GD-L
YCR-U010	YCR_U010	Run Command	Module: 07 Point: 00	DO	0, 1	0 = Off 1 = Run	R	GD-L
IT-U010	IT_U010	Motor Current	Module: 10 Point: 01	AI	4 - 20 mA	4 mA = 0 A 20 mA = 150 A	R	EF-T

4.5.2 Alarms

Tagname	Description	Logic	Mask	Priority	Reset
YC_U010_RunFlt	P-U01 Run Fault	NOT EAL_U72E1 AND HS_U010_4A AND ((YCR-U010 AND NOT YLR_U010) for 2 seconds OR (NOT YCR-U010 AND YLR_U010) for 8 seconds)	N/A	1	Auto
YC_U010_SS_Ult	P-U01 Soft Starter Fault	YAF_U010	N/A	1	Auto
YC_U010_OT_Ult	P-U01 Overload Trip	IA_U010 for 2 seconds	N/A	1	Auto
YC_U010_TH_High	P-U01 Motor High Temp	TSH_U010 for 2 seconds	N/A	1	Auto
FAL_U011	P-U01 Low Seal Water Flow	(YLR_U010 AND NOT FSL_U011) for 5 seconds	N/A	1	Auto

4.5.3 Interlocks

Initiating Event	Action	Description
NOT YC_U010_Rdy	Stop	Pump Not Ready
YC_U010_SS_Ult	Stop	Soft Starter Fault
YC_U010_OT_Ult	Stop	Overload Trip

To clarify, do not stop the pump upon a Motor High Temperature alarm. The pump is to continue running even if a motor higher temperature alarm is present.

4.5.4 Control Narrative

Operating states are as follows:

1. Pump not in Auto mode

   The PLC does not have control of the pump, so turn off the run outputs.

2. Pump in Auto mode

   Utilize the signals from Wet Well Level Software Controller LX_U500 and Pump Duty Sequencer YC_U001 to start and stop the pump.

4.6 Underpass Pump P-U02 Control – YC-U020

P-U02 is an underpass pump driven by a soft starter, complete with bypass starter. The pump is driven by an electric motor only. Implement all I/O as listed in the I/O list and on the P&IDs.

P-U02 is an underpass pump driven by a soft starter, complete with a bypass starter. The pump can be started by the soft starter or across-the-line. The pump is driven by an electric motor only. Implement all I/O as listed in the I/O list and on the P&IDs. To clarify, the HMI system will not be used for manual control of the pump – the pump will be manually controlled from the pilot switches on MCC-U72E enclosure.

4.6.1 HMI I/O

Physical Tag	PLC Tag	Description	PLC Location	Type	Range	Range States	HMI Code	HMI Display
YL-U020	YL_U020	Ready	Module: 05 Point: 16	DI	0, 1	0 = Not Ready 1 = Ready	R	GD-L
YLR-U020	YLR_U020	Running	Module: 05 Point: 17	DI	0, 1	0 = Off 1 = Running	R	GD-L
YAF-U020	YAF_U020	Soft Starter Fault	Module: 05 Point: 18	DI	0, 1	0 = Normal 1 = Fault	R	GD-L
IA-U020	IA_U020	Overload Tripped	Module: 05 Point: 19	DI	0, 1	0 = Normal 1 = Overload	R	GD-L
HS-U020-4A	HS_U020_4A	Auto Mode	Module: 05 Point: 20	DI	0, 1	0 = Not Auto 1 = Auto Mode	R	GD-L EF-L
HS-U020-4M	HS_U020_4M	Manual Mode	Module: 05 Point: 21	DI	0, 1	0 = Not Manual 1 = Manual Mode	R	GD-L EF-L
HS-U020-1S	HS_U020_1S	Soft Starter (SS) Mode	Module: 05 Point: 22	DI	0, 1	0 = Not SS Mode 1 = SS Mode	R	GD-L EF-L
HS-U020-1A	HS_U020_1A	Across the Line (ATL) Mode	Module: 05 Point: 23	DI	0, 1	0 = Not ATL 1 = ATL Mode	R	GD-L EF-L
FSL-U021	FSL_U021	Low Seal Water Flow	Module: 05 Point: 25	DI	0, 1	0 = Alarm 1 = Normal	R	GD-L
TSH-U020	TSH_U020	Motor High Temperature	Module: 05 Point: 25	DI	0, 1	0 = Normal 1 = High Temp	R	GD-L
YCR-U020	YCR_U020	Run Command	Module: 07 Point: 01	DO	0, 1	0 = Off 1 = Run	R	GD-L
IT-U020	IT_U020	Motor Current	Module: 10 Point: 02	AI	4 - 20 mA	4 mA = 0 A 20 mA = 150 A	R	EF-T

4.6.2 Alarms

Tagname	Description	Logic	Mask	Priority	Reset
YC_U020_RunFlt	P-U02 Run Fault	NOT EAL_U72E1 AND HS_U020_4A AND ((YCR-U020 AND NOT YLR_U020) for 2 seconds OR (NOT YCR-U020 AND YLR_U020) for 8 seconds)	N/A	1	Auto
YC_U020_SS_Ult	P-U02 Soft Starter Fault	YAF_U020	N/A	1	Auto
YC_U020_OT_Ult	P-U02 Overload Trip	IA_U020 for 2 seconds	N/A	1	Auto
YC_U020_TH_High	P-U02 Motor High Temp	TSH_U020 for 2 seconds	N/A	1	Auto
FAL_U021	P-U02 Low Seal Water Flow	(YLR_U020 AND NOT FSL_U021) for 5 seconds	N/A	1	Auto

4.6.3 Interlocks

Initiating Event	Action	Description
NOT YC_U020_Rdy	Stop	Pump Not Ready
YC_U020_SS_Ult	Stop	Soft Starter Fault
YC_U020_OT_Ult	Stop	Overload Trip

To clarify, do not stop the pump upon a Motor High Temperature alarm. The pump is to continue running even if a motor higher temperature alarm is present.

4.6.4 Control Narrative

Operating states are as follows:

3. Pump not in Auto mode

   The PLC does not have control of the pump, so turn off the run outputs.

4. Pump in Auto mode

   Utilize the signals from Wet Well Level Software Controller LX_U500 and Pump Duty Sequencer YC_U002 to start and stop the pump.

4.7 Alarm Test Mode

4.7.1 Control Narrative

Block all alarms from reaching the McPhillips Control Centre when Alarm Test Mode is active. Alarm Test Mode is selected via a physical switch on the front of the Control Panel CP-U81. This switch allows

personnel to test alarms at the Station without having the alarms transmitted to the McPhillips Control Centre. The alarms shall still be shown on the local HMI even when Alarm Test mode is active. This functionality is achieved by providing separate tags with a "_DNP3" suffix that are held in the normal state when Alarm Test mode is active.

4.8 Miscellaneous HMI Alarms Table

The following physical I/O is to be displayed on an HMI Alarms Table. Note that some of the I/O listed in the Sections above are also associated with the HMI Alarms Table.

4.8.1 Physical I/O Alarms

PLC Tag	Description	PLC Location	Type	Range	Range States	Logic	HMI Code	HMI Display
HS_U522	Alarm Test Mode	Module: 04 Point: 00	DI	0, 1	0 = Normal 1 = Alarm Test	HS-U522	R	EF-T
LAH_U500	Wet Well High High Level	Module: 04 Point: 01	DI	0, 1	0 = Alarm 1 = Normal	NOT LSH-U500 for > 3 sec	R	EF-T
LAHH_U500	Wet Well High High Level	Module: 04 Point: 02	DI	0, 1	0 = Alarm 1 = Normal	NOT LSHH-U500 for > 3 sec	R	EF-T
YAF_U500	Loss of Echo	Module: 04 Point: 04	DI	0, 1	0 = Alarm 1 = Normal	YAF-U500 for > 3 sec	R	EF-T
EAL_U72E1	600 VAC Power Fail	Module: 04 Point: 07	DI	0, 1	0 = Alarm 1 = Normal	NOT ESL-U72E1 for > 0.5 sec	R	EF-T
EAL_U528	120 VAC Power Fail	Module: 04 Point: 08	DI	0, 1	0 = Alarm 1 = Normal	NOT ESL-U528 for > 0.5 sec	R	EF-T
XA_U711	MCC-U71 TVSS Status	Module: 04 Point: 09	DI	0, 1	0 = Alarm 1 = Normal	NOT XS-U711 for > 0.5 sec	R	EF-T
YA_U543	UPS Alarm	Module: 04 Point: 11	DI	0, 1	0 = Alarm 1 = Normal	YA-U543	R	EF-T
PDAH_U610	Main Floor Supply Fan Air Filter Plugged	Module: 04 Point: 27	DI	0, 1	0 = Plugged 1 = Normal	PDSH-U610 for > 0.5 sec	R	EF-T
YA_U630	Main Floor Supply Fan Overload	Module: 04 Point: 29	DI	0, 1	0 = Normal 1 = Overload	YA-U630	R	EF-T
ATS_U72. Alm	Auto Transfer Switch Alarm	Module: 05 Point: 02	DI	0, 1	0 = Alarm 1 = Normal	ATS-U72.Alm	R	EF-T
GEN_U72. Alm	Generator Alarm	Module: 05 Point: 04	DI	0, 1	0 = Alarm 1 = Normal	GEN-U72.Alm	R	EF-T
GEN_U72. BkrOpen	Generator Breaker Open	Module: 05 Point: 05	DI	0, 1	0 = Alarm 1 = Normal	GEN-U72. BkrOpen	R	EF-T

FV.U694. Fail	Generator Room Combustion Air Damper Status	Module: 05 Point: 06	DI	0, 1	0 = Closed 1 = Opened	(NOT FV-U604.ZSO & GEN-U72.Run) >= 5 seconds	R	EF-T
AIT_U550.Flt	Generator Room Gas Detector Fault	Module: 05 Point: 09	DI	0, 1	0 = Alarm 1 = Normal	AIT-U550.Flt	R	EF-T
FV_U671. Fail	Motor Room Cooling Intake Damper Failed to Open	Module: 05 Point: 10	DI	0, 1	0 = Normal 1 = Alarm	FV-U671.Fail	R	EF-T
FV_U672. Fail	Motor Room Cooling Exhaust Damper Failed to Open	Module: 05 Point: 11	DI	0, 1	0 = Normal 1 = Alarm	FV-U672.Fail	R	EF-T
YA_U670	Motor Room Cooling Fan Overload	Module: 05 Point: 12	DI	0, 1	0 = Normal 1 = Overload	YA-U670	R	EF-T
PAL_U526	Motor Room Seal Water Loss	Module: 05 Point: 26	DI	0, 1	0 = Alarm 1 = Normal	PSL-U526 for > 0.5 sec	R	EF-T
TAH_U603	Motor Room High Temperature	Module: 10 Point: 04	AI	4 – 20 mA	4mA = -40°C 20mA = +60°C	TT-U603 >= +35°C	R	EF-T
TAL_U603	Motor Room Low Temperature	Module: 10 Point: 04	AI	4 – 20 mA	4mA = -40°C 20mA = +60°C	TT-U603 <= 5°C	R	EF-T
TAH_U604	Gen Room High Temperature	Module: 10 Point: 05	AI	4 – 20 mA	4mA = -40°C 20mA = +60°C	TT-U603 >= +35°C	R	EF-T
TAL_U604	Gen Room Low Temperature	Module: 10 Point: 05	AI	4 – 20 mA	4mA = -40°C 20mA = +60°C	TT-U603 <= 5°C	R	EF-T
AIT_U550. Alm	Gen Room Methane Gas Alarm	Module: 10 Point: 06	AI	4 – 20 mA	4mA = 0% 20mA = 100%	AIT-U550.Lvl >= 20%	R	EF-T

4.9 Miscellaneous HMI Status Table

The following physical I/O is to be displayed on the HMI. Provide separate Generator Room and Motor Room status windows.

4.9.1 Physical I/O Statuses

PLC Tag	Description	PLC Location	Type	Range	Range States	Logic	HMI Code	HMI Display
HS_U522	Alarm Test Mode	Module: 04 Point: 00	DI	0, 1	0 = Normal 1 = Alarm Test	HS-U522	R	EF-T
YS_U543_1	UPS on Battery	Module: 04 Point: 12	DI	0, 1	0 = Normal 1 = On Battery	YS-U543-1	R	EF-T
YS_U543_2	UPS Battery Charging	Module: 04 Point: 13	DI	0, 1	0 = Normal 1 = On Battery	YS-U543-2	R	EF-T

YC_U508_2	Station PLC Mode	Module: 04 Point: 14	DI	0, 1	0 = Not PLC 1 = PLC Mode	YC-U508-2	R	EF-T
YC_U508_1	Station Local Mode	Module: 04 Point: 15	DI	0, 1	0 = Not PLC 1 = PLC Mode	YC-U508-1	R	EF-T
HS_U600	Station Occupied	Module: 04 Point: 26	DI	0, 1	0 = Disabled 1 = Enabled	HS-U600	R	EF-T
YLR_U630	Main Floor Supply Fan Running	Module: 04 Point: 28	DI	0, 1	0 = Off 1 = Running	YLR-U630	R	GD-L
HS_U650	Wet Well Occupied	Module: 04 Point: 30	DI	0, 1	0 = Disabled 1 = Enabled	HS-U650	R	EF-T
ATS_U72. OnUtility	Transfer Switch on Utility Power	Module: 05 Point: 00	DI	0, 1	0 = Off 1 = On Utility	ATS-U72. OnUtility	R	GD-L
ATS_U72. OnGen	Transfer Switch on Gen Power	Module: 05 Point: 01	DI	0, 1	0 = Off 1 = On Gen	ATS-U72. OnGen	R	GD-L
GEN_U72. Run	Generator Running	Module: 05 Point: 03	DI	0, 1	0 = Off 1 = Running	GEN-U72.Run	R	GD-L
FV_U694. ZSO	Combustion Air Damper Status	Module: 05 Point: 06	DI	0, 1	0 = Closed 1 = Opened	FV-U604.ZSO	R	GD-L
FV_U671. ZSO	Motor Room Cooling Intake Damper Status	Module: 05 Point: 13	DI	0, 1	0 = Closed 1 = Opened	YLR-U670	R	GD-L
FV_U672. ZSO	Motor Room Cooling Intake Damper Status	Module: 05 Point: 13	DI	0, 1	0 = Closed 1 = Opened	YLR-U670	R	GD-L
YLR_U670	Motor Room Cooling Fan Running	Module: 05 Point: 13	DI	0, 1	0 = Off 1 = Running	YLR-U670	R	GD-L
FV_U691	Gen Room Cooling Intake Damper Status	Module: 09 Point: 00	AI	0-10 V	0V = Closed 10V = Open	FV-U662	R	GD-L
FV_U693	Gen Room Cooling Return Damper Status	Module: 09 Point: 01	AI	0-10 V	0V = Closed 10V = Open	FV-U663	R	GD-L
FV_U692	Gen Room Exhaust Cooling Damper Status	Module: 09 Point: 02	AI	0-10 V	0V = Open 10V = Closed	FV-U664	R	GD-L
FV_U601	Main Floor Ventilation Intake Damper Status	Module: 09 Point: 03	AI	0-10 V	0V = Closed 10V = Open	FV-U601	R	GD-L
FV_U602	Main Floor Ventilation Return Damper Status	Module: 09 Point: 04	AI	0-10 V	0V = Closed 10V = Open	FV-U602	R	GD-L

FV_U603	Main Floor Ventilation Exhaust Damper Status	Module: 09 Point: 05	AI	0-10 V	0V = Open 10V = Closed	FV-U603	R	GD-L
TT_U603	Motor Room Temperature	Module: 10 Point: 04	AI	4 - 20 mA	4mA = -40°C 20mA = +60°C	TT-U603	R	GD-L
TT_U695	Generator Room Temperature	Module: 10 Point: 05	AI	4 - 20 mA	4mA = -40°C 20mA = +60°C	TT-U695	R	EF-T
AIT_U550.L	Gen Room Methane Gas Level	Module: 10 Point: 06	AI	4 – 20 mA	4mA = 0% 20mA = 100%	AIT-U550.Lvl	R	EF-T

4.10 Miscellaneous I/O and Alarms

4.10.1 Control Narrative

Implement all I/O as listed in the I/O list and on the P&IDs.

4.11 Heartbeat

4.11.1 Control Narrative

A heartbeat signal is to be implemented in the PLC so that the station's RTU can determine if the PLC is in Run mode (i.e. the PLC has not faulted). Create a one second timer that increments a register, named "PLC_Heartbeat", every one second. Increment the register to a set value (preferably 32767), reset to 0, and continue incrementing. This register will be monitored by the City's SCADA system.