SNC·LAVALIN	FUNCTIONAL REQUIREMENTS SPECIFICATION	Document Code:	648185-48ER-0001
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Client: City of Winnipeg	Project: Metro Route 20 Underpass Pumping Station	Package / Area:	

PREPARATION		Professional Seal
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PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

REVISION REGISTER

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00	Issued for Tender, Bid Opp. 475-2018	2018/05/09	B. Cleven	B. Cleven	B. Cleven

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1.0 OVERVIEW

This document is intended to provide a description of the PLC functionality for the Metro Route 20 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 Process and Instrument Diagrams and Loop Diagrams are listed below.

Drawing Number	Rev	Description
1-0309U-P0001	00	P&ID, Underpass Pumping
1-0309U-P0002	00	P&ID, HVAC and Misc.

1.2 Definitions

Abbreviation	Description
DI	Discrete Input
DO	Discrete Output
AI	Analog Input
AO	Analog Output
I/O	Input/Output

2.0 GENERAL

2.1 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.

2.2 Tagname Convention

In case the Contractor is required to create internal PLC tags that are not defined in this document, refer to the Tagname Identification Standard 475-2018_Tag_Naming_Standard (612620-0014-40ER-0001) for the tag naming convention.

2.3 I/O Signal Addresses

Refer to I/O list 475-2018_IO_List (648185-48EL-0001) for physical I/O signal addresses.

2.4 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 hypen ("-") 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 indicate the instrument scaling. This information is also provided on the I/O List.

2.5 SCADA Alarm Priority

Pri	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.

2.6 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.

3.0 EQUIPMENT AND SYSTEM REQUIREMENTS

3.1 Wet Well Level Software Controller – LX_U500

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

3.1.1 Physical I/O

Physical Tag	PLC Tag	Description	Type	Range
LIC-U500	LI_U500	Wet Well Level	AI	0 – 5.00 m
LSLL-U500	LALL_U500	Wet Well Level Low-Low	DI	0, 1
LSH-U500	LAH_U500	Wet Well Level High	DI	0, 1
LSHH-U500	LAHH_U500	Wet Well Level High-High	DI	0, 1

3.1.2 Internal Constants

Tagname	Description	Type	Range
LX_U500_Duty1_Start	Duty 1 Start Setpoint	Real	0 – 5.00 m
LX_U500_Duty1_Stop	Duty 1 Stop Setpoint	Real	0 – 5.00 m
LX_U500_Duty2_Start	Duty 2 Start Setpoint	Real	0 – 5.00 m
LX_U500_Duty2_Stop	Duty 2 Stop Setpoint	Real	0 – 5.00 m

3.1.3 Internal Variables

Tagname	Description	Type	Range
LI_U500_Geodetic	Geodetic Wet Well Level	Real	0 – 230.000 m
LX_U500_Duty1_Run	Duty 1 Run	Boolean	0, 1
LX_U500_Duty2_Run	Duty 2 Run	Boolean	0, 1

3.1.4 Discrete Alarms

Tagname	Description	Logic	Mask	SCADA Alarm Priority	Reset
LX_U500_UAF	Wet Well Level Transmitter LIC-U500 Failure	LIC-U500 < 4mA or > 20mA	-	2	Auto

3.1.5 Control Narrative

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

Compute the geodetic wetwell level as: LI_U500_Geodetic = LI_U500 + 221.385

Start and stop the duty pumps based on wetwell 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 float switches, LSLL-U500, LSH-U500, and LSHH-U500 are provided as a backup to the ultrasonic level transmitter/controller LIC-U500. Stop both pumps upon LSLL-U500. Start the first duty pump upon LSH-U500. Start both duty pumps upon LSHH-U500.

3.2 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.

3.2.1 Internal Variables

Tagname	Description	Type	Range
YC_U001_P_U01_CmdRun	Pump P-U01 Run Command	Boolean	0, 1
YC_U001_P_U02_CmdRun	Pump P-U02 Run Command	Boolean	0, 1

3.2.2 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 the physical pump that has been running the longest.

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.

3.3 Underpass Pump P-U01 Control – YC-U010

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

3.3.1 Physical I/O

Physical Tag	PLC Tag	Description	Type	Range
YL-U010	YL_U010	Ready	DI	0, 1
YLR-U010	YLR_U010	Running	DI	0, 1
YAF-U010	YAF_U010	SS Fault	DI	0, 1
IA-U010	IA_U010	O/L Tripped	DI	0, 1
HS-U010-4A	HS_U010_4A	Auto Mode	DI	0, 1
HS-U010-4M	HS_U010_4M	Manual Mode	DI	0, 1
HS-U010-1S	HS_U010_1S	Soft Start (SS) Mode	DI	0, 1
HS-U010-1A	HS_U010_1A	Across The Line (ATL) Mode	DI	0, 1
YCR-U010	YCR_U010	Run Command	DO	0, 1
IT-U010	IT_U010	Motor Current	AI	0-100 Amps

3.3.2 Alarms

Tagname	Description	Logic	Mask	Pri	Reset
YC_U010_RunFlt	P-U01 Run Fault	NOT EAL-U721 AND HS_U010_4A AND ((YCR-U010 AND NOT YLR_U010) for 2 seconds OR (NOT YCR-U010 AND YLR_U010) for 8 sec)	N/A	1	Auto
YC_U010_SS_Flt	P-U01 Soft Starter Fault	YC_U010_SS_Flt	N/A	1	Auto
LAL_U012	P-U01 Oil Reservoir Level Low	LAL_U012	N/A	1	Auto

3.3.3 Interlocks

Initiating Event	Action	Description
NOT YC_U010_Rdy	Stop	Pump Not Ready
YC_U010_SS_Flt	Stop	SS Fault

LAL_U012	Stop	Oil Reservoir Low Level
LSLL_U500	Stop	Wet Well Low Level Interlock

3.3.4 Control Narrative

Operating states are as follows:

1. Pump not in Auto

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

2. Pump in Auto

   Utilize the signals from Wet Well Level Software Controller LX_U500 and Pump Duty Sequencer YC_U001 to start and stop the pump. Only allow one pump to run when on generator power.

3.4 Underpass Pump U-U02 Control – YC-U020

Pump P-U02 is identical to P-U01. Use P-U01 as the basis for P-U02.

3.5 Alarm Test Mode

3.5.1 Control Narrative

Block all alarms from field devices when Alarm Test Mode is active. Alarm Test Mode is selected via a physical switch on the front of the control panel. This switch allows personnel to test alarms at the Station without having the alarms transmitted to the McPhillips Control Centre.

3.6 Miscellaneous I/O and Alarms

3.6.1 Control Narrative

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

3.7 Heartbeat

3.7.1 Control Narrative

A heatbeat 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 RTU.