South East Water

Sewage Pump Station

PLC, RTU and SCADA Specification

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Primary Contact

For Technical issues related to this document please contact

Name	Matthew Murphy
Phone	+61 (3) 9552 3016
email	EMAIL: Matthew.Murphy@sew.com.au
Office Address	101 Wells St, Frankston 3199

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Acronyms, Abbreviations

All abbreviations and acronyms used in additional documentation, on PLCs, RTUs, HMI's and in software and code shall follow the conventions used through this and other related project documents.

Acronym	Description
3G 4G 5G	Cellular Communications Service
AFS	Auto Flushing Sequence
AI	Analogue Input
AO	Analogue Output
CCP	Critical Control Point
CHAZOP	Control Hazard and Operability Study
CPU	Central Processing unit
CS	Chemical storage
DB	Database
DI	Digital Input
DIN	German Institute for Standards (Deutsches Institut für Normung)
DNP3	Distributed Network Protocol (version 3)
DO	Digital Output
ED	Effluent Discharge
FAT	Factory Acceptance Test
FDS	Functional Description Specification
FOBOT	Fibre Optic Break Out Tray
FT	Flow Transmitter
FTC	Fail to Close
FTO	Fail to Open
FTS	Fail to Start
FW	Feed Water
GE	General Electric
HACCP	Hazard Analysis and Critical Control Point
HLBU	High Level Back Up
HMI	Human Machine Interface
ICS	Industrial Control system
iLO	integrated Lights Out
IO	Input Output
IT	Information Technology
ITMP	Installation Transition Management Plan
ITP	Inspection Test Plan
LC	Lucent Connector
LVD	Low Voltage Dropout
MCC	Motor Control Centre
MES	Manufacturing Enterprise Systems
MI	Miscellaneous
NTP	Network Time Protocol
OIU	Operator Interface Unit

Acronym	Description
OPC	OLE for Process Control
OTDR	Optical Time Domain Reflectometer
P&ID	Process & Information Diagram
PC	Personal Computer
PCCT	Primary Chlorine Contact Tank
PF	Power Factor
PID	Proportional Integral Derivative
PLC	Programmable Logic Controller
PSU	Power Supply Unit
PVC	Poly Vinyl Chloride
QCP	Quality Control Point
RDS	Remote Desktop Services
RODC	Read Only Domain Controller
RSA	RSA Security Encryption Algorithm
RTU	Remote Telemetry Unit
SAL	Site Alarm List
SAT	Site Acceptance Test
SCADA	Supervisory Control And Data Acquisition
CT	Current Transformer
SDM	System Design Matrix
SEW	South East Water
SFP	Small Form Pluggable
SMBS	Sodium Metabisulphite
SMS	Short Message Service
SOE	Standard Operating Environment
SP	Set point
SQL	Standard Query Language
STP	Sewage Treatment Plant
TBA	To be advised
TBC	To Be Confirmed
TTP	Tertiary Treatment Plant
UF	Ultra Filtration
UPS	Uninterruptable Power Supply
UV	Ultra Violet
VFD	Variable Frequency Drive
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
VSD	Variable Speed Drive
WAN	Wide Area Network

Units

The following Units are used in this document:

Unit	Description
H	Hour
kL	Kilolitre
m	Metre
mA	Milliampere
mg	Milligram
ML	Megalitre
L	Litre
s	Second
sec	Second
uS	Microsecond
w/v	Weight per Volume
A	Ampere
V	Volts
DC	Direct Current
AC	Alternating Current

Document Concept

This document provides information required and processes to be followed for PLC/RTU HMI and SCADA works on a new (Standard) pump station.

This general specification is to be read in conjunction with the site-specific specification for the works under contract.

Scope of this Document

This document is part of a set of documents created for the purpose of providing detailed information on a (Standard) pump station in relation to automation in the areas listed below:

- RTU and PLC Functional Descriptions
- RTU Hardware
- RTU installed spare points (see electrical standard)
- RTU Spare rack and power capacity requirements (may change with different RTUs)
- RTU IO List
- RTU Program Structure and configuration process
- RTU Variables List (see SP_Ladder details in Appendix)
- RTU Software Details
- RTU SCADA DNP3 points (see details in Appendix)
- PLC Hardware
- PLC IO List
- PLC Software
- HMI Model
- HMI Software

The following table lists the current document set for a pump station, along with an overview of the contents of each document (documents are available from SEW on request).

Document	Contents
AM2714 Electrical Equipment and Installation Specification	General electrical installation and equipment standards
KingfisherQuickStart_V1.2	Details file handling, software, serial connection, firmware / driver configuration and upload download process for Kingfisher PC1 RTUs
Commissioning Process Main Diagram	SEW document detailing commissioning process for new assets

RTU Hardware and IO

Standard BA-4 (4 slot) RTU Rack 1 Layout for a typical 2 Pump station with De-Rag

Slot	Device	Details
13	PC-1	RTU CPU Module
14	DI-5	Digital Input Module - 16 Inputs
15	IO-4	AI (2) DI(8) and DO (2) Module
16	DO-2	Digital Output Module - 16 Outputs

Extended BA-4 (4 slot) RTU Rack 2 Layout

Slot	Device	Details
29	Can Change	
30	Can Change	
31	Can Change	
32	Can Change	

The following IO cards can be used in Rack 1 and 2:

PC1 – RTU CPU Module

DI5 - Digital Input Module - 16 Inputs

IO4 - Digital / Analogue - Input / Output Module AI (2) DI (8) and DO (2) Module

DO2 - Digital Output Module - 16 Outputs

IO3 – Digital / Analogue - Input / Output Module AI (4) AO (1) DI (4) and DO (4)

IO Devices

There will be a base level of Input and Output devices at all sites that is required to provide basic control of a 2 pump station. There may be a requirement for additional Input and /or output devices to improve or help to optimise the process. Details of any extra devices, if required will be provided in the individual project scope.

Digital Input Devices

Input Device	Operation
Distribution Power Fail	MainsFail
Wet Well Spill Level Spill	Spill
High Level Pump Operation	HiLvlOper
Wet Well Level High	HighLevel
Pumpset 1 Auto	Pump1 Avail
Pumpset 2 Auto	Pump2 Avail
Pumpset 1 Running	Pump1 Run
Pumpset 2 Running	Pump2 Run
Pumpset 1 Failed	Pump1 Fault
Pumpset 2 Failed	Pump2 Fault
Access Door Open	Door Open
Control Power Fail	ControlPwr
Lamp test / Alarm Reset	Lamp Test
DC Supply Ok	DC Supply OK
HLBU OK	Inhibits RTU Pump control
Surge Protection Operated	SurgeProt

Digital Output Devices

Output Device	Operation
Pump 1 Run	Pump1 Start
Pump 2 Run	Pump2 start
PLC Failure	PLC Fail

Output Device	Operation
Station Under Remote Control	Remote
Spray Solenoid Wet Well	Spray Start
Spare	Spare
Spare	Spare
High Level Inhibit	HLBU Disable
Touch Screen Relay	Power saving for HMI
Remote Reset Relay	Remote Reset
Pump 1 De-Rag	Only some sites
Pump 2 De-Rag	Only some sites
Modem Reset Relay	Only some sites
Mixer Run Relay	Only some sites that have a Mixer
Vent Fan Start Stop	Vent Fan Start Stop

Instruments

Analogue Scaling

All IO device scaling (e.g. level transmitter LT1, Pump 1 Power JT1 etc.) shall be a 15 bit unsigned integer (0 to 32767) for any physical analogue input DNP3 points scaled for SCADA. See document **SEW Standard DNP3 Tags** for all IO DNP3 point scaling requirements / details.

Analogue Input Device	Operation
LT1 Wet Well Level	Well Level
24V DC Battery Voltage	
FM01 Pump station Flow	Flow Rate – used for De-Rag
Pump 1 Speed	Only used for De-Rag

Analogue Input Device	Operation
Pump 2 Speed	Only used for De-Rag
Pump 1 kW or Amps	Only used for De-Rag
Pump 2 kW or Amps	Only used for De-Rag

Control Philosophy Overview

Two Pump Station

A 2 pump stations main role is to keep the level of the wet well between the cut in and cut out level set points based on an analogue level sensor. Two pumps are provided for duty cycling and redundancy, if there are any issues with the duty pump. The RTU controls the pumps under normal conditions with backup control of the 2 pumps provided by a separate HLBU PLC and digital level switches. Only the RTU or the HLBU PLC can control the pumps at any one time. There are ancillary systems such as vent fans, mixers and sprayers along with several modes of control that are explained in more detail later in this document. The pump station site has a HMI for monitoring and controls. The SCADA system at SEW can also control and monitor some functions of the site. Some sites have an electricity generator installed that is monitored by the RTU.

Control Philosophy and Functional Descriptions (RTU)

Kingfisher PC1 RTU Program Sections:

Configure

The (Configure) section of the RTU program is where the site specific settings and configuration are to be completed. Below is a brief description of the areas in this section. The Configure ladder file name shall be changed to include the site name before the default file name. e.g. Configure_v2.LL changes to SP937_Configure_v2.LL for the site SP937 (Note the version number does not change). See section RTU Configuration and Programming for details on how to configure an RTU for a new site.

RTU Configuration and Programming

- **Ladder version** - not used
- **Get Driver info - See KF utilities doc for details.**

- **Define secondary address for Uniop coms -** see RTU Configuration and Programming section of this document for details
- **RTU DNP address define –** Address and branch provided by SEW SCADA group to match Clear SCADA address configuration – see RTU Configuration and Programming section of this document for details
- **Master address define** – Sets the SCADA Mater DNP3 address automatically based on the address of SCADA master when the RTU receives data from the master
- **DNP IO Flags configure** - Masks out DNP3 status flags. You don't need to touch this.
- **Special case flag for treatment plant large** - don't need to touch this
- **DNP3 IO counts configuration** – see RTU Configuration and Programming section of this document and RTU program comments for details
- **KF modules configure** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Pump Control Configuration** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Pumping level set points** – see RTU Configuration and Programming section of this document and RTU program comments for details
- **Slave RTU configuration** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Slave PLC configuration** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Pump alarms configuration** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Source digital inputs assign** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Source analogue inputs assign** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Destination digital outputs assign** - see RTU Configuration and Programming section of this document and RTU program comments for details
- **Sewer pump station initialization tasks** - Initialization and RTU warm start tasks
- **Prevent door open after warm start** – logic to prevent a false door open alarm after RTU restart or download
- **Prevent false pump runs after warm start –** logic to prevent false pump run status after RTU restart or download

Main

- **Warm start RTU if first time ladder loaded** – If the RTU has not been initialized – i.e. 1st time ladder file is loaded the sets a flag to initialize and warm start the RTU

- **Initialization (after power up / warm start)** - (sets up initial values for time and date stats, DNP3 point
- **RTU daily warm start counter** – resets counter each day
- **Force status fault after warm start or power up /ladder download** – forces an alarm for SCADA after a warm start or download
- **Miscellaneous system tasks** – logic for setup of always on (always clear) and always off (always set) flag bits
- **Decode prog version date** - Decode date from program version (no longer used)
- **RTU local fault detect** - detects local faults by calls to functions for fault detection. CD alarm update - is for radio carrier detect issues around carrier background noise being seen as data but is no longer used. Missing driver - checks if drivers are installed and version is OK (driver error). Stn fault logic – checks and sets alarm for RTU module faults, real time clock fault (4 minute delay on RTC fault), CPU fault, excessive warm starts, driver error and coms failed. The following faults have a 5 minute delay off time (module fault, CPU fault and CD alarm) all individual alarms have bits used to disable / mask the alarm
- **PC1 Supply Fail / Low batt DI, Battery/Temperature AI** – logic for RTU internal registers. Battery voltage scaling and clamp high, temperature scaling and clamping high, PC1 supply fail alarm and low battery alarm.
- **Power supply fail internal RTU bit –** Not used on most sites
- **Master communications fail stats** – Master comms fail detect - if comms times out (15 minutes) event log the coms fail
- **Warm start RTU if no master coms for > 1hour** – a Master communications fault after 1 hour warm starts the RTU and resets the coms fail timer.
- **Copy to local reg for diag** - Keep track of communications failures for diagnostic use only
- **DNP Tasks** – DNP3 events and reports (future)
- **Site custom ladder tasks** – calls all other ladder files SLAVERTUCMS, STNPLCCOMMS, STNDNPIOMAP, STNCONTROL, STNALARMS, STNUNIOPCOMS AND SITECUSTASKS)

Function Blocks

The function Blocks section of the RTU code sets up the DNP3 settings and alarms. Below is a brief description of the areas in this section.

- **DNP3INITIAl –** Initializes the DNP3 configuration and IO registers

- **INITDNP3ONL –** Sets DNP3 digital and analogue IO objects online by calling sub function SETOBJONLINE
- **DNP3EVENTS –** future event logging – not used – no code
- **DNP3REPORTS –** future report by exception – not used – no code
- **CHKMODTYPES –** checks IO modules and any comms modules
- **CHKKFRTCOK –** checks if the RTC is OK and valid to use
- **RADIOCDCHK –** checks if the radio CD (carrier detect) is stuck on – no longer used
- **PortStatus –** Checks RTU / PLC (Com 1 to 5) comms port status
- **Latch_DI –** de-bounce function for digital inputs
- **CALMTUADDR –** calculates and sets the DNP3 master address and branch number then checks coms status if coms status fails sets default address of 238 or 240 then increments address checking each up to 246
- **UPDATESTAT –** updates misc. status alarms (Driver error, Coms Failed, CD alarm, module flt, CPU fault, R-T-C, MTU not in Net list and Excessive warm starts). Updates Any Module Fault alarm, based on any module status alarms (slot 13 to 16 and 29 to 32). Updates Any CPU Faults based on any CPU status alarms (CPU IO scan disabled, Ladder Disabled, RAM Fault, IO Modules IO bus fault, CMB modules CMS bus fault and RTC failed). Latches any new status faults and warm starts the RTU if required due to status alarms. Event logs change of status

Control

The Control section of the RTU code has the functions for most of the main 2 pump station controls. Below are functional descriptions of the areas in the control section.

RTU 2 Pump Control

Pump Control

Background

The levels in the sewer wet well are controlled by the RTU that bases this off an analogue level transducer that starts and stops pumps based on-settable cut-in and cut-out levels.

The current duty pump is alternated on each pump cycle or if a pump is not available / faulted if selected to auto the other pump is set as the duty pump.

There are 2 pumps controlled by the RTU.

Common conditions around starting of a pump by the RTU.

- RTU Inhibit from HLBU PLC needs to be OFF
- Pump needs to be Available
- Pump needs to be NOT faulted
- Power Fail needs to be OK or if generator site generator OK
- Pump needs to be the Duty Pump

- Remote Stop NOT Enabled
- Pump needs to be in auto for duty and backup operation

There is one analogue well level transducer the RTU uses to activate and deactivate pumps on 3 level set points.

- Duty Start level set point
- Duty Stop Level set point
- Transfer level set point

The level sensor is located in the sewer well.

There is a two second de-bounce time delay before calling a pump to run on a level higher than the duty start level.
There is a twenty second de-bounce time delay before calling a pump to run on a level higher than the transfer start level.
There is a 2 second de-bounce time delay before calling a pump to stop on a level lower than the duty stop level

The Duty Pump can be called to run in 5 ways:

Pump Normal and Backup Operation (Both Pumps in Auto and AFS Not Enabled)

Pump runs between the start and stop levels:
The duty start level is used to start the current duty pump.
The duty stop level is used to stop the current duty pump.

If duty 1 is called to run and it is not available, then if available, non-duty pump will run and stop in its place.

Pump Transfer Operation

Transfer starts the non-duty pump on its own level set point (Back up Cut In) that is higher than normal duty pump start set point and with a longer start delay time of 20 seconds. Transfer would normally be activated to start the non-duty pump if the duty pump is not coping. Transfer commanded pump runs are stopped and snorting is used in the same way as the normal duty pump commanded runs.

Duty Assist

Both the duty commanded pump and the transfer (non-duty) commanded pump can run together if 2 pumps running (duty assist) is allowed.

Pump Test

Local RTU test bit – when online to RTU can force this bit ON to override the level control and start a pump

Pump Remote Start and Stop

Pumps can be Started and Stopped from SCADA

Both pumps can be commanded to run by remote start if the pumps are available

If both Pump 1 and Pump 2 are stopped remotely the HLBU PLC control is also disabled

Level Sample timer

Background

When the wet well level equals the sample level set point and both pumps are not running, sets a bit that Increments a level sample value each second until a pump starts or the well level goes back below the sample level. Works out the inflow rate.

Spray Control

Background

Used to keep the wet well walls clear.
Spray logic bit needs to be enabled.

Spray Control Operation

Spray is turned ON for 2 minutes after 12 hours when duty pump stops or when snorting is active. There is a 2 minute delay after snorting stops before the spray turns OFF.

Mixer

Background

Mixes or agitates the solids and liquids.
Mixer logic bit needs to be enabled.

Mixer Operation

If the mixer control is enabled for a site, the mixer will run every 10 or so duty pump starts for 60 or so seconds depending on set points. The initial power up / warm start set point values for how many starts and run time can be set in the RTU code.

Snorting

Background

Snorting is used to clean out the bottom of the wet well below the normal pump cut out level.

When snorting, the level loop fail is inhibited until the level rises back above the stop level. Snorting logic bit needs to be enabled.

Snorting Operation

Pump Snorting has selectable modes 1 and 2 and Snorting can be enabled or disabled.

Mode 1: Time based snorting sets the pump to continue running periodically next time it goes below the duty stop level and stops on a failsafe timer or when it goes above the duty stop level.

Mode 2: Pump Cycle based snorting sets the pump to continue running next time it goes below the duty stop level and stops on a failsafe timer or when it goes above the duty stop level. The number of starts between cycle based snorting is settable.

Snorting if enabled will operate the same way for a transfer activated pump run or a duty pump run.

Vent Fan

Background

Vent fan logic bit needs to be enabled.
Vent fan Not Failed.
Power OK.
There are 4 sets of start stop times for the vent fan, none to all 4 can be used.
Default on RTU initialization is set to use only 1 set of vent fan start stop times (start 23:00 and stop 07:00).
The 4 sets of vent fan start stop time set points and 24 hour ON are entered / enabled via the HMI.

Vent Fan Operation

To cover all time start stop time combinations when using a 24 hour clock and manual control, there are 4 sets of RTU logic conditions to start and stop the vent fan.

- Start time hour less than the stop time e.g. start 07:00 stop 15:00
- Start time hour greater than the stop time e.g. start 23:00 stop 07:00
- Start time hour equal to the stop time for when start and stop hour are the same only minutes different e.g. start 07:00 stop 07:59
- 24 Hour ON – runs all the time

SP_IO Map

Background

All mapping is shown in the SEW SP-Ladder document.

Telemetry Inputs – Maps RTU registers to DNP3 registers for digital and analogue points.

Pump Alarms

The (Pump Alarms) section of the RTU program is where alarm logic and mapping is done. Below is a brief description of the areas in this section. Alarms and points are also documented in SP Ladder document.

- **Get Pump Status** – bits used to trigger pump starts counting
- **Pump Starts Count** – increments start counter for each pump start
- **Reset Pumps Starts Count** – saves the last hours pump start stats and resets the count to zero for this hours starts for each pump every hour
- **Pumps Run Time / Continuous Run Time –** increments run time seconds counters to keep track of each pumps individual last start run time and total run time
- **Pump Starts per Hour Alarm –** Uses the pumps starts current and last hour values to check for excessive starts, set alarm if the number of starts are higher than set point – default set point = 8 starts per hour. All Pump start alarms can be masked
- **Pumps Continuous Runtime Alarm –** compares each current pump runtime seconds with a long run set point and sets an individual pump alarm if the pump runs for longer than the set point which in turn sets a single pump long run alarm – default set point = 3600 seconds – 1 set point for all pumps. All Pump runtime alarms can be masked.

PLC Comms

The (PLC Comms) section of the RTU program is where Modbus read and write communications is carried out to a Koyo PLC. The function is to read 10 registers from a Koyo PLC every second if not writing and write the RTU outputs to a Koyo PLC every 30 seconds or when any output changes value. Below is a brief description of the areas in this section.

- **Poll Koyo PLC Setup** – Check for valid (non zero) Koyo network address and set poll interval for Koyo PLC based on poll interval set point x 0.1 seconds – default poll interval set point is 10 (1 second). Set write interval to Koyo PLC based on o/ps update set point x 0.1 seconds – default o/ps set point is 300 (30 seconds)
- **Poll Koyo PLC for Digital Inputs** - If not writing o/ps and port is free then poll Koyo PLC for digital inputs (10 registers)
- **TX Outputs to Koyo** - If port is free and any RTU outputs have changed or every write interval (default 30 seconds) write 2 registers (32 digitals) to Koyo PLC
- **PLC Comms Failed to RTU –** sets a comms fail alarm after comms timeout period if communications from Koyo PLC failed and updates counters for successful and failed communications

SP Uniop

The (SP Uniop) section of the RTU program is where the RTU controls the HMI pages based on various statuses. Mapping details are listed in SP-Ladder document.

Although the ladder section is named SP Uniop, the HMI may be CMore or as per SEW standards – check current standards to confirm.

Below is a brief description of the areas in this section.

- **No Uniop** – If there is no HMI use local indication lamp routines – Calls function INDICATORLMP and returns.
- **Panel Time –** HMI reads hours and minutes values for its time from registers in the RTU
- **Panel Date –** HMI reads day, month and year values for its date from registers in the RTU
- **Alarm Outputs to Uniop –** HMI / RTU reset and lamp test mapping, logic to set the HMI to page 1 if all alarms are cleared
- **Page 02 Alarm Page –** sets HMI to page 02 on a generator fault if generator is installed
- **Page 03 Alarm Page –** sets HMI to page 03 on generator low fuel if generator is installed
- **Page 04 Alarm Page –** sets HMI to page 04 on a generator battery low if generator is installed
- **Page 05 Alarm Page –** sets HMI to page 05 on a control fail
- **Page 06 Alarm Page –** sets HMI to page 06 on a mains fail
- **Page 07 Alarm Page –** sets HMI to page 07 on a low level if not snorting
- **Page 08 Alarm Page –** sets HMI to page 08 on a loop fail if not snorting
- **Page 09 Alarm Page –** sets HMI to page 09 on surge protection
- **Page 10 Alarm Page –** sets HMI to page 10 on Pump 2 fault if power is OK
- **Page 11 Alarm Page –** sets HMI to page 11 on Pump 1 fault if power is OK
- **Page 12 Alarm Page –** sets HMI to page 12 on Transfer
- **Page 13 Alarm Page –** sets HMI to page 13 on High Level
- **Page 14 Alarm Page –** sets HMI to page 14 on Spill Level
- **Page 15 Alarm Page –** sets HMI to page 15 on Fan Failed
- **Page 16 Alarm Page –** sets HMI to page 16 on Pump 3 Fault if power is OK
- **Page 17 Alarm Page –** sets HMI to page 17 on Mixer fault
- **Page 18 Alarm Page –** sets HMI to page 18 on spare (De-Rag Pump 1 locked out)
- **Page 19 Alarm Page –** sets HMI to page 19 on spare (De-Rag Pump 2 locked out)
- **Page 23 Alarm Page –** HMI push buttons set HMI to page 23 (Vent Fan Configuration) or page 1
- **Page 24 Alarm Page –** HMI push buttons set HMI to page 24 (level set points) or page 1
- **INDICATORLMP -** This routine is used to map alarm / status indication to RTU outputs for lamps if there is no HMI installed, turn off all lamps when door is closed and turn all lamps on for a lamp test. A list of lamp outputs controlled is below:
    - Spill Indicator

- Hi Level Indicator
- Transfer Indicator
- Low Level Indicator
- Pump 1 Fault Indicator
- Pump 2 Fault Indicator
- Mains Failed Indicator
- Loop Fail Indicator
- Pump 3 Fault Indicator

Slave RTU Coms

The (Slave RTU Coms) section of the RTU program is where read and write communications is carried out to a slave RTU if installed. Mapping details are listed in SP-Ladder document.

- **SLAVERTUCMS** – Checks for a non-zero slave RTU address returns to call if zero
- **Poll RTU** – if communications port status is OK, poll the slave RTU for IO data and then write / send commands to the slave RTU
- **COMMS FAIL –** sets a comms fail alarm after comms timeout period if communications from slave RTU failed and updates counters for successful and failed slave RTU communications statistics
- **SLAVECOMSTAT –** on power on / warm start, restores / copies communications statistics. Every 15 minutes updates communications statistics for number of good, bad and % good communications.

Custom Site

The (Custom Site) section of the RTU program is where any non-standard site specific functions are programmed.

- **Battery Voltage** – Scales the 24vdc battery voltage analogue input. 9-45 v input ends up scaled to 0 to 32.76 volts and converted to 15 bit unsigned integer for SCADA.
- **Speed Control** – For a transfer or remote pump start, sets pump speed RTU analogue output for VSD speed to 20ma (32760 raw) for both pumps 1 and 2. For a normal pump start , sets pump speed RTU analogue output for VSD speed to approximately 16ma (26666 raw – configurable based on specific site) for both pumps 1 and 2 – 4 to 20ma.If pumps 1 and 2 are not being called to run set speed to 0 (4ma) (set speed signal is currently hard disabled with Not used bit in RTU logic)
- **Auto Flushing Sequence –** Based on set point hour, enable AFS one time per 24 hours. When AFS is activated the cut in level for the duty pump is moved from the duty start level to the transfer start level for one cycle. This provides a longer run time.

- **Remote Reset –** Reset a pump fault after 5 minutes if pump fault counter is less than 3 (maximum resets 3). If a successful pump down on that pump has occurred reset pump fault counter to zero. Increment individual pump fault counter on faults.
- Remote reset from SCADA (there may be a restrictions in SCADA for number of pump resets per 30 minute period).
- **De-Rag Set Points -** flow, amps and hourly / periodic set points from HMI. Time delay set points from HMI
- **De-Rag Lockout –** HMI set point to limit the number of De-Rag pump starts before locking out De-Rag
- **De-Rag enable -** Enable / Disable De-Rag from HMI and SCADA
- **Scale FT1 –** Scales flow transmitter analogue input
- **De-Raging Sequence –** When De-Rag is enabled if a pump is running and flow is below set point or amps are above set point (for delay time) or the - hour is equal to the periodic set point time, call De-Rag required for the running pump provided well level is below the high level operate and high level alarm. Pump will only be commanded to De-Rag if it's available and below maximum number of starts per hour. Increment the De-Rag starts per hour counter for the called pump. Reset the number of De-Rag starts per hour every 24 hours.
- **AI Scaling – Scales** pump speed and amps analogue inputs from VSDs

De-Rag

Background

The De-Rag feature is used to unblock pumps without the need for operator intervention.

This function is mostly implemented in the current RTU code. The Functional description below was compiled from existing documents and modified based on current Custom section RTU code.

De-Rag can only be implemented if the pumps are able to be reversed.

The purpose of the De-Rag feature is to free the pump impeller of debris in waste water applications so that the pump operates normally.

The De-Rag cycle/command will be initiated by the RTU but overall control will be setup in the VSD for duration and forward reverse control, known as De-Rag.

Only Auto mode is currently set up.

Auto Mode

The De-Rag command will be initiated in Auto mode from the RTU if enabled from HMI/SCADA and well is not above the high level set point when any of the following occurs:

If the flow rate for Pump 1 measured by flowmeter FT1, is less than a set value for greater than 30 seconds (in two consecutive pump runs not implemented in RTU code so only 1 pump run currently) . Then De-Rag will be activated for Pump 1.

If the amps for Pump 1, is greater than a set value for greater than 30 seconds (in two consecutive pump runs not implemented in RTU code so only 1 pump run currently). Then De-Rag will be activated for Pump 1

If the flow rate for Pump 2 measured by flowmeter FT2, is less than the flow set point for greater than 30 seconds (in two consecutive pump runs not implemented in RTU code so only 1 pump run currently). Then activate De-Rag for Pump 2.

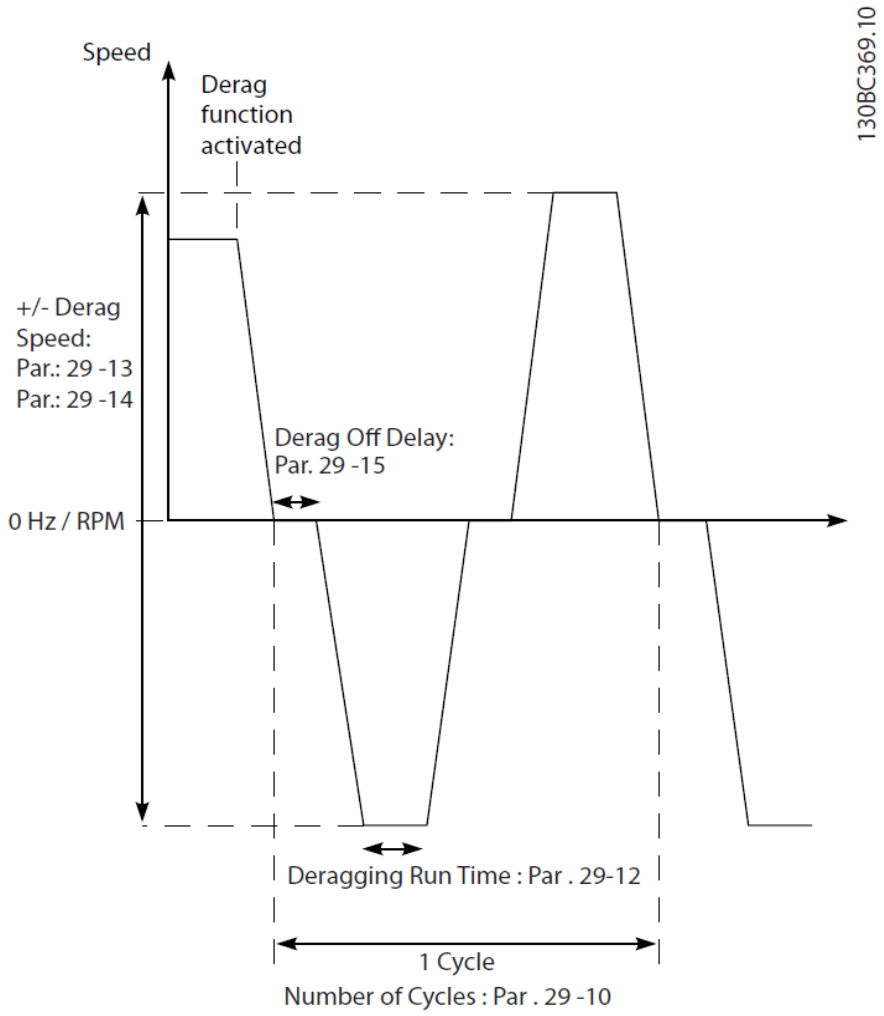
If the amps for Pump 2, is greater than a set value for greater than 30 seconds (in two consecutive pump runs not implemented in RTU code so only 1 pump run currently). Then De-Rag will be activated for Pump 1.

If enabled De-Rag every 24 hours based on the De-Rag period set point when a pump is running in the hour set by HMI.

Each site current and flow rate set points will need to be evaluated individually and will be confirmed at commissioning with the SEW representative.

Once a De-Rag is activated the VSD takes control of the pump as shown below.

Other De-Rag information



HLBU PLC Detailed Control Philosophy and Functional Description

HLBU PLC

The supported modes of control for HLBU are:

1. Auto
2. Inhibit

Background

The levels in the sewer wet well are normally controlled by the RTU that bases this off the level transducer that starts and stops pumps based on pre-set cut-in and cut-out levels. However, in the case of an RTU control system failure, causing the pumps to not run and wet well level to rise, this control would then be handed to the HLBU PLC.

There are 2 or 3 pumps controlled by the HLBU PLC.

Common conditions around starting of any pumps by the HLBU PLC.

- HLBU Inhibit needs to be OFF
- Pump needs to be in Auto and Available
- Power Fail needs to be OK
- For the time a HLBU PLC commands any pump to run it activates an interlock to disable RTU control of all pumps (Control of the pumps is handed back to the RTU if the HLBU PLC is not commanding any pump/s to run)

There are 2 float level switches the HLBU PLC used to activate and deactivate pumps.

- High level operate cut in float switch
- High level backup cut in float switch

The High level operate cut in float switch is located in the sewer well, above the normal RTU level transducer controlled operating range.
The High level backup cut in float switch is located in the sewer well, above the High level operate cut in float switch.

There is a 10 second de-bounce time delay before calling a pump to run on activation of either level switch.
There is a 5 minute de-bounce time delay before calling a pump to stop on de-activation the level switch that called it to run.

Normal High Level backup operation

The high level operate cut in float switch is normally used to start and stop Pump 1.
The high level backup cut in float switch is normally used to start and stop Pump 2 as well as stop Pump 1.

Under HLBU PLC control, Pump 1 is called to run on activation of the high level operate cut in and called to stop on de activation of the high level operate cut in (after de-bounce delay times).

If the sewer well level rises above the high level operate cut in and activates the high level backup cut in, if available Pump 2 will be called to run and Pump 1 stopped(after de-bounce delay times).

Other High Level backup operation

If pump 1 is called to run and it is not available, then if available, pump 2 will run and stop in its place.
If pump 2 is called to run and it is not available, then if available, pump 1 will run and stop in its place provided the high level operate cut in is also activated.

If Pump 1 is called to run and both pump 1 and 2 are not available, then if available, pump 3 will run and stop in its place.

If pump 2 is called to run and it is not available, then if available, pump 3 will run and stop in its place.

Reset and Lamp Test

When the reset and lamp test button is pressed Pump 1 will stop if high level operate cut in is NOT ON.

When the reset and lamp test button is pressed Pump 2 will stop if high level backup cut in is NOT ON.

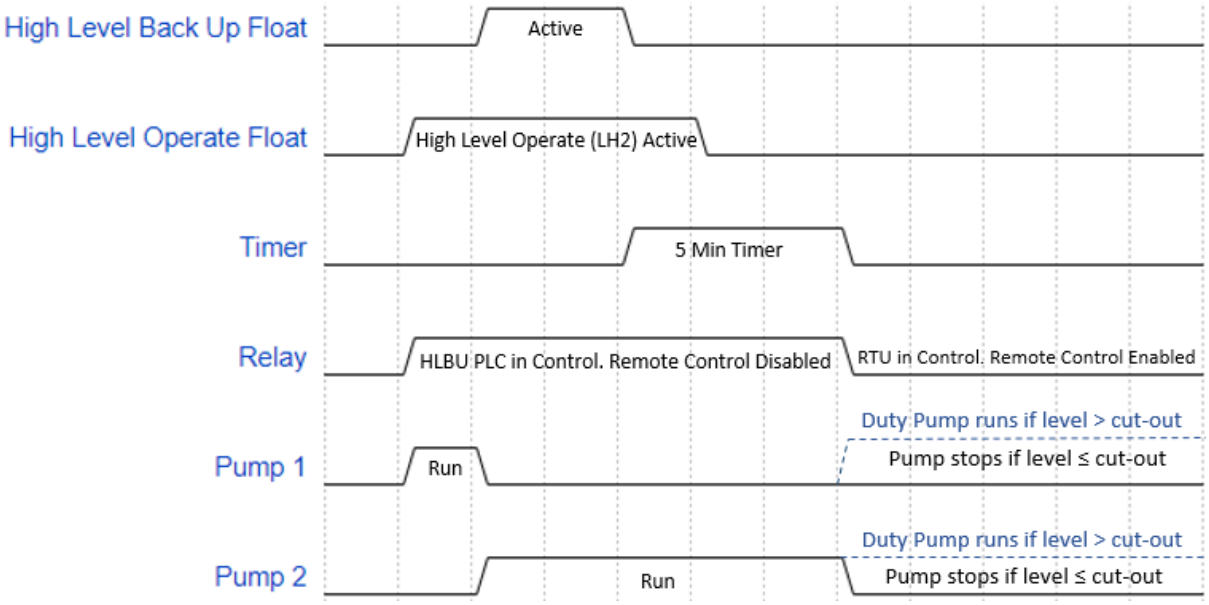
When the reset and lamp test button is pressed the HLBU PLC controlled indication lights (high level operate and backup high level operate) should both come ON.

Internal HLBU PLC error

The internal HLBU PLC error / alarm digital output signal is connected as a digital input to the site RTU.

Other information

Figure 1: Timing Diagram - High Level Back Up (Worst Case Scenario)



HLBU PLC Digital Inputs

Address	Description
X0	Power Fail Relay Input
X1	HLBU Inhibit
X2	High level operate cut in float switch
X3	High level backup cut in float switch
X4	Spare
X5	Pump 1 Available
X6	Pump 2 Available
X7	Pump 3 Available
X8	Spare
X9	Spare
X10	Spare
X11	Reset and Lamp Test

HLBU PLC Digital Outputs

Address	Description
Y0	Pump 1 Run
Y1	Pump 2 Run

Address	Description
Y2	Pump 3 Run
Y3	High level operate light
Y4	Backup High level operate light
Y5	Cut Off Normal RTU Control
Y6	Spare
Y7	PLC Fail

SYSTEM SPECIFICATIONS

RTU Rack Layout and Power Budget Specifications

Enter details here: leave as is for new system

Spare capacity - hardware / licencing / memory etc.

Enter details here: leave as is for new system

HLBU PLC specification

The PLC is to be as per AM2714 Elec Standards

Digital Inputs are to use positive logic 1 wire

Digital Outputs are to be relay

HMI specification

The HMI is to be as per AM2714 Elec Standards

Network Communications

Implementation for the following communications interfaces are shown in drawings.

RTU

RTU to SCADA – DNP3 serial over IP (Cellular)

HLBU PLC

HLBU PLC to RTU (hard wired digital IO)

HMI

RTU to HMI – (Modbus RTU serial RS232)

(Future) Remote to HMI – Web or Virtual HMI

RTU to VSD

Analogue, Digital and network (future)

PROGRAMMING GUIDELINES

RTU Configuration and Programming

The Kingfisher PC1 RTUs are programmed with Toolbox 32 software.
The standard 2 pump station RTU code will be used and modified for any additional requirements.

Initial New Site Setup Requirements for RTU Configure Ladder File

- **Define secondary address for Uniop Coms –** RTU address for Modbus coms to HMI – is always 247 for Uniop and 248 for CMore in RTU. Change based on HMI type
- **RTU DNP Address define** – Enter the sites 3 or 4 digit DNP3 address (as provided by SEW) in the copy instruction.
- **DNP3 IO counts configuration** – If required, change the number of DNP3 IO points in copy instructions for communication to SCADA (DI DO AI and AO points) – see ladder file comments for further details (Note –DI in multiples of 8 only)
- **KF modules configure** – Set the RTU card type for each slot in Rack 1 (slot 13 to 16) and Rack 2 (Slots 29 to 32). The slot module types are configured by the user set number. Change the number and comment to match the modules used in each slot. Module numbers to be used are shown in ladder file comments
- **Pump Control Configuration** – Enable or disable functions for the specific site e.g. vent fan, snorting etc. (0 to disable 1 to enable). Enable / disable ladder files / logic for a Generator site (0 to disable 1 to enable) and Uniop HMI (1 to disable 0 to enable)
- **Pumping level set points** – On first scan of the RTU all set points are initialized to zero then default values set points and instrument range loaded. The default set point values will need to be changed in the RTU code for a specific site. Note that any set point values entered from the HMI will be automatically wiped and default set points from this area loaded on each first scan of the RTU (warm start / download)
- **Slave RTU configuration** – Only needed if there is a slave RTU with coms. Enable / disable and setup slave RTU coms configuration parameters (see RTU code comments for information)
- **Slave PLC configuration** - Only needed if there is a slave PLC with coms. Enable / disable - setup slave PLC coms configuration parameters (see RTU code comments for information)
- **Pump alarms configuration** - configure the number of pumps in the copy instruction to (default is 2 pumps). Set the default set points for starts per hour and long run time alarms (can be overwritten by SCADA)

- **Source digital inputs assign** – Standard points are already pre mapped. Add mapping for any non-standard physical digital inputs to memory registers – see document SP ladder and site IO drawings for mapping details
- **Source analogue inputs assign** - Standard points are already pre mapped. Add mapping for any non-standard physical analogue inputs to memory registers – see document SP ladder and site IO drawings for mapping details
- **Destination digital outputs assign** - Standard points are already pre mapped. Add mapping for any non-standard physical digital outputs to memory registers – see document SP ladder and site IO drawings for mapping details

Initial New Site Setup Requirements for Kingfisher RTU SDB file

- Make sure Kingfisher DNP3 Address has already been configured in the configure ladder file - RTU DNP address define section. The SEW provide 3 or 4 digit RTU DNP3 address number is a combination of a branch number and RTU address. The branch number is the first digit for a 3 digit number or first 2 digits for a 4 digit number. RTU address is the second and third digits plus a fixed 100 offset. E.g. setting 935 in the Copy instruction would be Branch 9, RTU address 135 (35 plus 100), 564 would be Branch 5 RTU address 164.
- In Toolbox 32 with the project file opened - double click the top SDB file to open and view current settings
- Configuration -> Address and Description - then change site address, name and description (site address is set as per above RTU address)
- With the SDB open select from menu Configuration -> Port List – check settings – usually don't need to change – check and confirm DNP-3 security level is set to Level 3 and Mbus SCADA is Level 0
- With the SDB open select Configuration -> Network List – edit settings if required. Need to keep RTU 50 and 238 lines. The other line (second line) is the branch number plus 50 offset. e.g. 59 would be calculated from Branch 9 Plus 50 = 59

PLC Configuration and Programming

The Koyo HLBU PLCs are programmed with DirectSoft software version 5.
S7 1200 HLBU PLC are programmed with TIA portal software version 14.
The standard 2 pump station PLC code will be used and does not generally require any changes.

HMI Programming

The CMore HMIs are programmed using CMoreMicro Software. The standard 2 pump station HMI code will be used and modified for any additional requirements.

HMI User Security Levels

Enter details here: leave as is for new system

Documentation and process requirements for new code / functions added

RTU

Any new logic or functions added that are site specific should be added and self-documenting in the RTU ladder file CustomSite.

HLBU PLC

No changes generally required – if changes required consult SEW M&E / operational technology groups.

HMI

No major changes generally required – if changes required consult SEW M&E / operational technology groups.

APPENDICES:

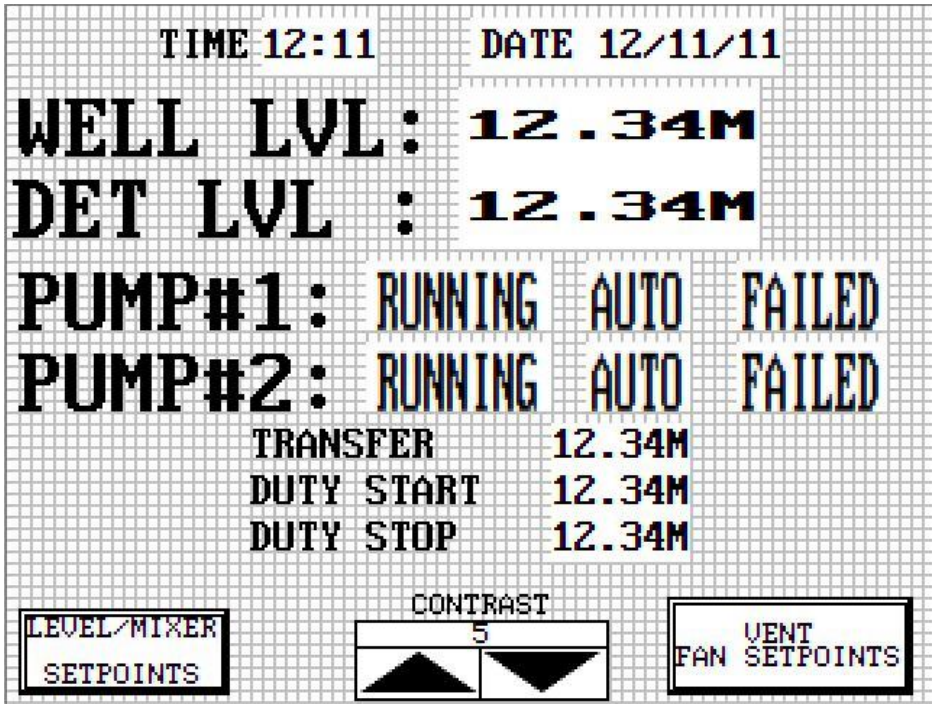
ALARM and DNP3 Points List

Reference Excel spreadsheet –SEW Standard DNP3 tags.
Latest copy is stored on SEW X drive (X:\ElectricalInstrumentation\DNP3 Standard Tags\).

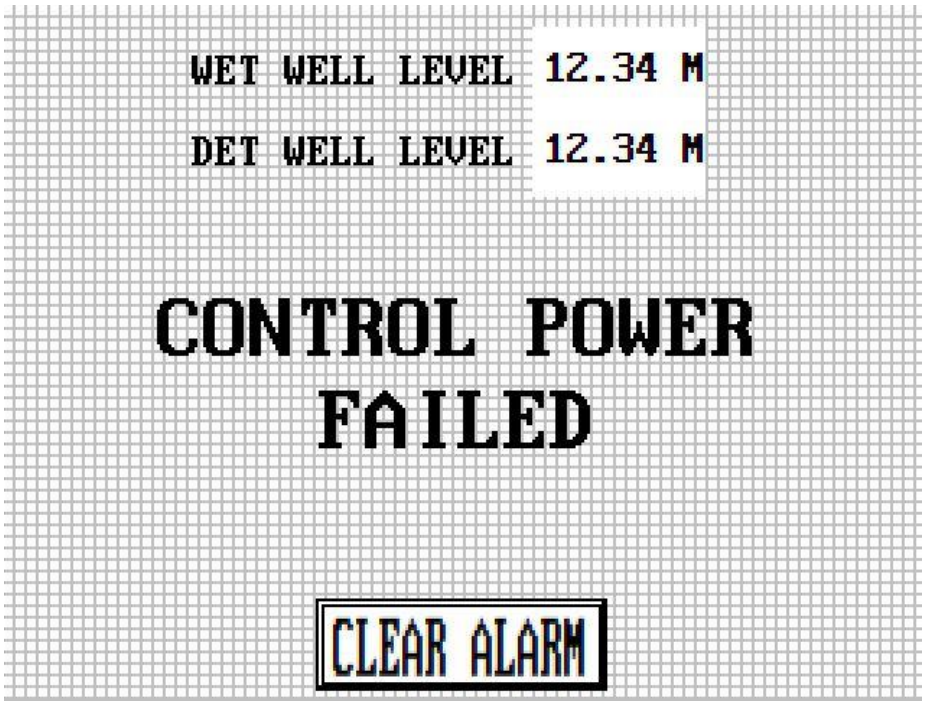
HMI SCREENS LAYOUTS

Examples of 3 types of screens (Main, Alarm and Set points) in the HMI project are below:

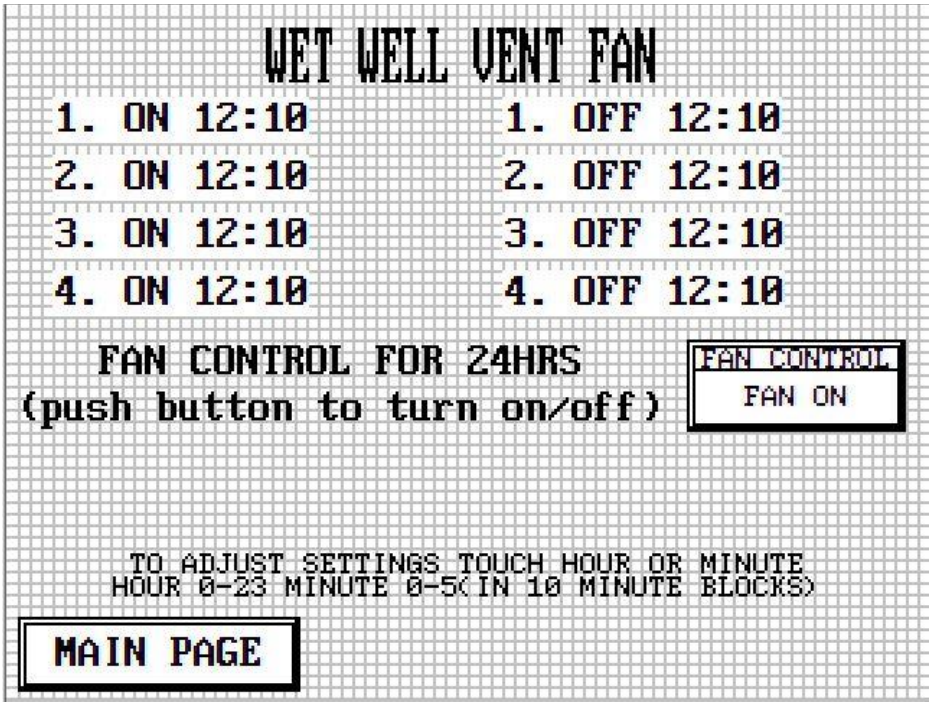
Main Screen 1



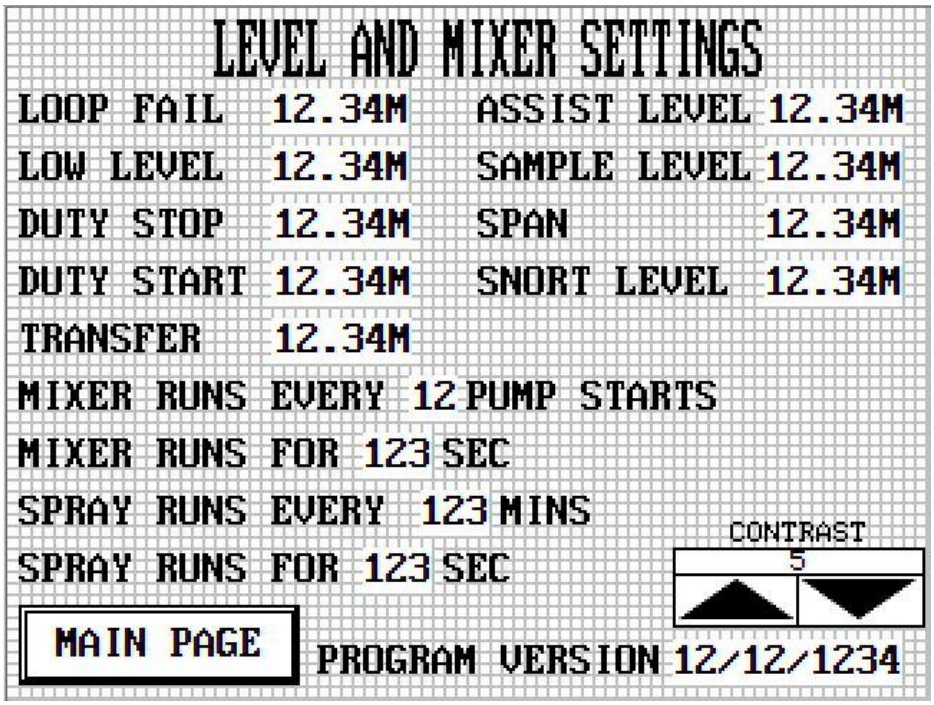
Alarm Screen 5



Set points Screen 23



Set points Screen 24



Appendix

Document List

- High Spill Backup - Latest copy is stored on SEW X drive at (X:\ElectricalInstrumentation\Standard Programs\Site Level Calculations\)
- SP_Ladder - Latest copy is stored on SEW X drive at (X:\ElectricalInstrumentation\Standard Programs\Kingfisher RTU Projects\Doc\)
- High Level Backup PLC code - Latest copy is stored on SEW X drive at (X:\ElectricalInstrumentation\Standard Programs\High Level Backup\)