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Part 2 – Rietspruit Inlet Works Control and Instrumentation

1 SCOPE OF WORKS

The scope of works for the electronic installation covers the design, supply, delivery, installation, testing, commissioning and upholding during the Defects Notification Period of the following electronic equipment and materials for refurbishment of the inlet works at the Rietspruit Waste Water Treatment Works (WWTW):

- (a) A Supervisory Control and Data Acquisition (SCADA) system.
- (b) A Programmable Logic Controller (PLC)
- (c) A Human Machine Interface (HMI)
- (d) Floor standing panels, fully equipped for housing the PLC, the HMI and terminations to Field instrumentation
- (e) Field Instrumentation
- (f) Control and instrumentation cables
- (g) Uninterruptible power supplies for the PLC, HMI and instrumentation

2 ELECTRICITY SUPPLY

A single phase 231 v 50 Hz supply shall be provided from MCC.

The Contractor shall supply a UPS system complete with all necessary switchgear and wiring sufficient for all the requirements of the PLC, SCADA and Human Machine Interface (HMI) equipment.

Sufficient UPS capacity shall also be provided for the field instruments.

Please note that the battery capacity of the UPS need only be sufficient for the transition from mains supply to standby generator supply as if there is no power from either mains or the generator then there is no point in keeping the PLC etc. running.

3 CONTROL PHILOSOPHY

As part of the service offered the Contractor shall provide Work Operation Control Philosophies (WOCs) and Piping and Instrumentation Diagrams (P&IDs) for the inlet works

This is regarded as a Mechanical service and so is not described in detail in the electrical or C&I installation portion of the specification, nor is it included for pricing in the electrical and C&I sections of the Bill of Quantities.

The WOCs and P&IDs will represent the detailed control philosophy for the inlet works and the design of the MCCs and the SCADA system shall be based on these.

For the purposes of this section of the tender enquiry SCADA, which stands for Supervisory Control and Data Acquisition, shall be taken to mean the complete automation system and shall perform the following functions:

- Monitor outputs from instruments
- Based on these outputs and relevant algorithms automatically perform the following functions
 - Stopping and starting of motors
 - Speed control of motors
 - Opening or closing of valves
 - Raising alarms
 - Pictorial representation on a computer monitor of the operation of the works
- Store relevant data

For the purposes of tendering tables are included below indicating the quantities and natures of inputs to be monitored and control operations to be carried out. Tenderers shall in all cases allow for at least 20% capacity above what has been listed

SCADA shall be understood to include the following physical components:

- Programmable Logic Controllers (PLCs)
- Digital Communication Panels for interfacing between instruments and the PLC
- Human Machine Interface equipment (HMI) including keyboard and mouse facilities for inputting instructions, monitor for mimicking performance and showing reports and printer for providing hard copies of these

3.1 Options for Control of Motors

The following options shall be available for control of motors:

Motors without variable speed control

-
- 1 Manual starting, stopping and reversing (where applicable) from the MCC Room by means of push-buttons mounted on the motor starter cubicles In the MCCs.
 - 2 Manual starting, stopping and reversing (where applicable) by means of push-buttons mounted on field control stations placed next to the motors.
 - 3 Manual starting, stopping and reversing (where applicable) from the Control Room by means of a personal computer. Passwords shall be included in the software to ensure that only authorised individuals are able to operate the plant from the computer
 - 4 Automatic starting, stopping and reversing (where applicable) by computer.

Motors with variable speed control

- 1 As above but including for speed control

3.2 Selection of control options

Selection of control options shall occur primarily in the MCC room.

In each motor starter compartment a two position selector switch shall be installed. The positions shall be labelled as follows:

- 1 LOCAL
- 2 PLC

If Position 1 is selected the only control option shall be manual via the push-buttons on the MCC or in the field control station next to the motor..

If Position 2 is selected there shall be two control options i.e.

- a) Manual by means of the computer in the control room
- b) Automatic by means of the computer in the control room

Secondary selection of control options shall occur at the computer in the control room whereby either the manual or automatic mode can be selected.

The selector switches shall be of a type which can be padlocked in each of the two positions.

3.3 Automation

When automatic control is selected starting, stopping, reversing and speed control of motors shall occur in response to certain conditions such as:

Fluid levels
Flow rates
Dissolved oxygen levels

4 Supervisory Control and Data Acquisition (SCADA) System

4.1 Data Acquisition

In the case that local or field control is selected information on which motors are running, flow levels, dissolved oxygen levels, power consumption etc. needs to be able to be viewed from the computer screen in the control room.

SCADA refers both to the automatic control of plant as discussed above and to monitoring of information.

For both of these to occur information needs to be brought from the various field instruments (fluid level, flow rate, dissolved oxygen etc.) and from the MCCs to the computer.

The information shall be sent in digital form by means of the Profibus and Ethernet protocol and shall travel to the computer in two stages going firstly to a PLC and then to the computer.

Each instrument shall be addressable i.e. shall have a unique address. The information sent from an instrument to a junction box shall include the address of the instrument and a number indicating the quantity being measured by the instrument.

In some cases an instrument might be measuring two or more quantities e.g. flow rate and temperature. The data transmitted from the instrument shall include information on which quantity is being reported; hence only a single pair cable shall be required.

4.2 Programmable Logic Controller (PLC)

The programmable logic controller (PLC) shall be installed in a compartment forming part of the MCC

Security passwords shall be installed in the software so that only selected individuals shall have the ability to control the plant via computer.

4.3 Control of valves

Control of valves shall be done by signals sent from the computer via the PLC to the valves.

Cables shall therefore be installed linking the PLCs to the valves. These shall be Profibus DP type or other if recommended by the equipment manufacturer.

4.4 Control of Motors

Control of motors shall be done by signals sent from the computer via the PLC to the Motor Control Centre (MCC).

At the PLC starting, stopping and reversing of motors shall be effected by opening and/or closing of potential free contacts.

These shall be linked to the MCC by means of multi pair PVC insulated copper cored cables and shall operate 24 volt direct current relays in the MCC.

Where speed control of motors is required this shall be effected by digital signals sent from the computer via the PLC to the motor starters in the MCCs. The variable speed drives shall be of a type that is compatible with profibus (digital) control.

Cables for this shall be copper cored shielded cables complying with IEC 61158-2 Profibus DP type.

5 PROGRAMMABLE LOGIC CONTROLLER (PLC)

The PLC system installed shall be sufficient to monitor all incoming information as listed in the tables below and to make decisions and to carry out all control operations as listed with at least 20% capacity for expansion. Once the WOCs and P&IDs have been produced the adequacy of the PLCs as tendered for will be re-evaluated..

5.1 Programming and Software

All PLC programmes shall be stored on ROM CDs, from which it shall be possible to download using a Notebook type PC>. Master and back-up CDs shall be issued to the Employer upon completion of the works.

No special passwords or other protection shall be installed which may inhibit access to the software by the Employer.

6 HUMAN MACHINE INTERFACE (HMI)

6.1 General

A graphical human machine interface (HMI) shall be provided and mounted on the door of each PLC Panel and shall be configured to provide the operator with control system parameter adjustments, status information, current alarm lists and real time short-term graphical trends.

The HMI shall allow control parameter changes to the PLC which shall be password protected. Operator actions, selections or setting described in the control philosophy shall also be possible via the HMI Interface (and via the SCADA in case of the HMI not being available).

6.2 Equipment

Type	Colour LCD Display, 266 colours
Resolution (Pixels)	800 x 600
Backlight	CFL (60000hrs at 25deg C and 24hr operation)
Touch Panel / Screen	(40 x 30 screen grid)
Memory (Flash EPROM)	8 Mbyte or better
Data Backup (SRAM)	612 kilobyte or better
Interfaces Protocol	Serial (11.5 kbps), Ethernet IEEE802.3
Interface Port	SUB-DP, RJ45 respectively
Sound (for Alarm)	Built in or separate speaker / buzzer
Data Transfer	Via USB Memory Stick
Operating System	Propriety Graphic Interface

Status shall be indicated by different state colours (such as white for ready, green for running, amber for tripped and red for 'E-stop' or other fault states).

A trending page shall be provided showing all instantaneous measured value readings. Trends shall be configured to show an interval of readings suitable for the rate of change of the actual process value.

An alarm page shall be provided showing all current alarms. Alarms shall also be stored in a first in first out file stored in the HMI memory. It shall be possible to scroll backward and forward in the alarm list.

6.3 Installation, Inspection and Testing

The HMI shall be installed in the PLC Panel together with the PLC and at such a height that it can be easily used by an operator. It shall be installed above the PLC CPU and IO in such a way that the PLC CPU and IO are still visible through the glass door of the PLC panel when the door is closed.

The HMI, installation and software will be inspected and shall be tested in the factory together with the PLC it connects to before it is released to site.

Tenderers shall allow for at least three iterations of inspections and testing of the configuration before the HMI is released to site.

Simulation testing shall include communications with the PLC, switching of all states, testing of all alarms, setting of all parameters and correct layouts, colours and functionality of all mimics.

The Contractor shall also prove the logging and successful data export of all measurement values, historical trends and related log files.

7 ALARMS

Provision for the field instrumentation has been made to achieve the process control by effective monitoring of the whole process.

An alarm shall be raised when measured parameters deviate from set points as programmed on the PLC.

This shall also be done for the monitoring of the motor protection relays of the motors.

Below is a non-exhaustive list of equipment to be monitored for which alarms shall be generated.

Area	Monitoring	Alarm Type	
		Screen	Siren
Inlet Works	Ultrasonic Level Sensors	X	
	Screen Rakes	X	X
	Screw conveyors	X	
	Compressors		X
	Airlift Pumps	X	X
	Compactors	X	

7.1 Information to be logged

As well as information from the field instruments the SCADA system shall detect and log information from the MCC as follows:

For each motor:

- Running hours
- Status (ON, REVERSE, OFF, EMERGENCY STOP or TRIPPED)
- Speed (in the case of VSD driven motor)
- Control mode selected (MCC, FIELD or CONTROL ROOM)
- Supply voltage
- Running current
- Maximum running current to date

8 FIELD INSTRUMENTS

Field instruments shall be installed complete with final cables from Digital Control Panels plus all required transmitters and other accessories to the instruments as follows:

At Inlet Works:

Type	Description	Quantity
Radar Level Detectors	Endress & Hauser Radar level Sensor: Micropilot: FMR20-AAPBMWDEWFE1 or approved equivalent.	30

9 DRAWINGS

Tender drawings are issued as part of the electrical installation to this Contract but not for the C&I part.

Based on information contained in the WOCPs and P&IDs the Contractor shall submit Construction Drawings for review by the Engineer in terms of protocol as described in Clause 3.3 of the Standard C&I Installation specification.

Once these have been reviewed and passed for construction the Contractor shall install the works as shown on the drawings

10 INPUT AND OUTPUT LISTS

In addition to monitoring the outputs from the instruments listed under Section C8 above the SCADA system shall also monitor output from instruments, sensors, limit switches etc. supplied integrally with the electrical and mechanical equipment.

Examples of these are thermistors in the gearboxes of the aerators, pressure switches in the wash water pipelines etc.

Output functions to be generated by the SCADA system include the following:

- Starting, stopping and speed control of motors
- Opening and closing of valves
- Raising of alarms
- Pictorial representation of the process

Lists of expected input and output functions follow below:

General

Inputs/Outputs	Type	Quantity
Inputs	Level detection	30
Outputs	Reports	

Wash water for hydro conveyors and fine screens

Inputs/Outputs	Type	Quantity
Inputs	Level in tank	1

Outputs	Pressure in line	1
	Flow in line	1
	Motor start/stop	3
	Motor status	3
	Solenoid valves open/close	6
	Alarms	9

Wash water for screw compactors

Inputs/Outputs	Type	Quantity
Inputs	Level in tank	1
	Pressure in line	1
	Flow in line	1
Outputs	Motor start/stop	3
	Motor status	3
	Alarms	9

Wash water for de-gritting equipment

Inputs/Outputs	Type	Quantity
Inputs	Level in tank	1
	Pressure in line	1
	Flow in line	1
Outputs	Motor start/stop	3
	Motor status	3
	Solenoid valves open/close	3
	Valves status	3
	Alarms	9

Grit handling equipment

Inputs/Outputs	Type	Quantity
Inputs	Pressure probes	1
Outputs	Motor start/stop	5
	Motor status	5
	Solenoid valves open/close	14
	Actuated valves open/close	14
	Valves status	30
	Alarms	9

Screenings compaction equipment

Inputs/Outputs	Type	Quantity
Inputs	Pressure probes	2
Outputs	Motor start/stop/reverse	15
	Motor status	15
	Solenoid valves open/close	15
	Actuated valves open/close	15
	Valves status	30
	Alarms	10

Odour Control Equipment

Inputs/Outputs	Type	Quantity
Inputs	Detection of H ₂ S	1
Outputs	Alarm	1
	Motor Start/Stop	4
	Motor status	4