

SGEL6000 Independent Project

2020-2021

DOUBLE MARKING SHEET AND COMBINED STUDENT FEEDBACK

Assessment 1 of 4

Assignment 1: Project Definition, Research and Quality Planning

Agreed mark

44

Student Name: Carl Jones

Student Number 1910607

capped to 40%

Generic Assessment Criteria	Marks available	1st Marker (RD)	2nd Marker (MH)	Agreed Mark
1. Engagement with Literature Skills.				
Section 5: Engagement in research, judicial use and critical evaluation sources, depth of literature review of solutions (3/10) Some evidence of research but no citations from sources (RD) Evidence of research was demonstrated, however this was mainly limited to Welsh Water company policy documents (MH)	10	3	4	3
Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing (2/5) There must be some reading from the information contained in the report. However, citation is disappointing as it is far too small for a level 6 honours project report and there are no citations contained in the report (RD) Additional research on wider issues using a diverse range of sources could have been employed (MH)	5	1	2	2
Total	15	4	6	5
2. Knowledge and Understanding Skills				
Section 3: Project background and context, commercial, economic and social context (5/10) Some information provided that sets the project in context. However, it is not clear which parts are being delivered by the author of the report. (RD) Project explained as the requirement for a new pumping and treatment installation (MH)	10	5	7	5
Section 3: Project constraints, professional and ethical conduct, codes of practice, standards, security, intellectual property, legal requirements etc. (5/10) Some explanations given. (RD) Constraints were limited to technical issues, no consideration of wider issues (MH)	10	5	4	5
Section 3: Environmental and sustainability limitations and promotion of sustainable development (1/5) Little or no references made to these requirements (RD) No consideration of wider issues, ethical engineering or sustainability (MH)	5	1	0	1
Section 3: Project risks, health and safety etc. (0/5) No risk assessment provided (RD) No consideration of risks to the project's success (MH)	5	0	0	0
Total	30	11	11	11

3. Cognitive and Intellectual Skills				
Section 3: Problem Definition (2/5) Briefly explain but reads more like an FDS (RD) The problem was only defined as a requirement due to 120 properties requiring sewage services. (MH)	5	2	2	2
Section 4: Functional Design Specification (6/10) Detailed and an in depth information given. However, actual author's objectives are not clear leaving the reader unsure as to how much of the project will be delivered by the author. No budget specified. (RD) A detailed description of the system was described in the FDS (MH)	10	6	7	6
Section 4: Test planning (3/5) Plenty of scope for testing though the table should contain expected and actual results before signatures can be added. (RD) A test plan with some performance metrics to gauge success was included, tolerances on results would have been good. (MH)	5	3	3	3
Section 7: Conclusions and Recommendations (3/5) Some helpful statements made but it is unclear as to where the project stands at present. (RD) Light on technical detail going forward, written a bit too generically (MH)	5	3	2	3
Total	25	14	14	14
4. Practical Application Skills				
Section 5: Critical choice and justification of final solution (1/5) Only one solution consider, justification is based on client rules only. No scope allowed for scoring solutions. No review of literature and no citations given. (RD) Alternative solutions were not offered in the report (MH)	5	1	1	1
Section 6: Project Planning, working breakdown structure and management techniques. (5/10) A good plan but no work-breakdown structure provided (RD) No WBS was devised but a detailed Gantt was used to control timings (MH)	10	5	5	5
Total	15	6	6	6
5. Transferable Skills for Life and Professional Practice				
Section 1: Executive summary (2/5) Contains some useful information but does not summaries what has been done. (RD) Very brief and didn't give the reader much idea on the project's scope (MH)	5	2	1	2
All Sections: Quality of the report – (3/5) Good quality of presentation but contains many spelling errors (RD) Generally well written and presented (MH)	5	3	3	3
Word count – (4/5) Exceeded (RD) 3890 words declared (MH)	5	4	5	4
Total	15	9	9	9

Grand Total	100	44	46	45
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Capped to 40% due to late submission

1910607-SEGL6000- Assignment specifications

by Carl Jones

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Contents

Table of figures	3
1. Executive Summary	4
2. Introduction	5
3. Project Background and Problem Definitions and Constraints	6
3.1 Project Information	6
3.2 scope of work	6
3.3 Standards and codes of practice	7
3.4 Project Constraints	8
4. Functional Design Specifications and Test Plan	9
4.1 Functional design introduction	9
4.2 SAF lift Pumping station Control Philosophy	9
4.3 test Plan	16
5. Literature Review	18
6. Project Planning, Work breakdown and Management Techniques	21
7. Conclusions and Recommendations	24
8. Citation List	25
Bibliography	25
9. Appendix	26

Table of figures

Figure 1MS project task breakdown	21
Figure 2 MS Project Critical Path and Mile Stones.....	22
Figure 3 MS Project resource table.....	22
Figure 4 Labour hours completed for each task	23
Figure 5 Budget hours, hours worked and cost of labour for tasks worked.....	23

1. Executive Summary

This is an unnecessary statement (RD)
This assignment provides a detailed process that a project must undertake to be successful. The project background has been detailed and all the constraints set by law and the client to deliver the project.

You could have started by saying something about the pumping station. (RD)
The functional design specification (FDS) has been layout to underline requirements for the new pumping station and how the site will function in Automatic, manual and the integration between package plants installed by other contractors.

What is a packaged plant? (RD)
A test plan was created from the FDS allowing full testing of require designed sequences the pumping station must achieve to meet the specifications.

A literature review has been carried out into the device available for the design, a new instrument was selected which hasn't been used before and looks like it will be used a lot more in the future to remove the need of PLCs and having to carry laptops with various device software installed. It will make it easier for breakdowns for the average maintenance Electrician.

Spelling (RD)
This assignment as produce a working design specification and a programme of works to implement the successful delivery.

2. Introduction

Don't instruct your reader, be informative (RD)

The design process is an important part of any project and its successful delivery. It is important to fully understand each step, this assignment will define each step as an actual project that has to be delivered to a client effectively. The project background will be discussed with all constraints which will influence the direction the project design will go. This will then create the platform for creating the functional design specification to create the final design to be installed and tested. A project plan will also be produced, this will set out the work activities in a systematic work structure to deliver the project on time, as designed and to budget.

In this section, you should have stated the aims and objectives of the project. (RD)

3. Project Background and Problem Definitions and Constraints

3.1 Project Information

A housing developer has requested to connect 120 new properties to an existing Wastewater Treatment works in a village outside of Cardiff.

Welsh Water have granted connection of 30 properties, however the other 90 properties require the treatment works to be upgraded to process the additional flow and load to comply with consent documentation granted by the government for treated wastewater.

To achieve this a new pumping station and treatment plant needs to be installed.

The treatment plant will be designed and installed by another contractor called Jacopa.

3.2 scope of work

The scope of work for the client is to design, supply and install the following

1. Submerged Aeration Filter (SAF) lift pumping station control panel.

The pump station consists of two centrifugal submersible pumps with an ultrasonic level instrument and a level float switch providing a Hi-Hi level for emergency pump-down level control. An inline flow meter will be mounted on pump pipework to SAF unit to monitor pumped flows

The two pumps will be variable speed and shall ramp up and down based on level and flow. The level controller will monitor the level in the pumping station wet well and provide a 4-20mA signal to the for speed control. The operating regime is to be duty / standby, with automatic daily changeover of the duty pump.

This is more of a list of requirements and reads like an FDS. You should be explaining the background to the problem. (RD)

2. Mains in-come and manual Generator changeover panel.

The panel will a 100 Amp changeover fuse switch and must facilitate safe and easy connection of a temporary generator via five single pole panel mounted Power-safe drain connector plugs.

3. Power Distribution board and cabling.

Power distribution board will be 400 Volts three phase and neutral and will provide feeds for the following

- SAF Lift pump station Control panel
- SAF Lift pump station building services
- SAF Aeration Blower control panel (panel designed and installed by others)

- SAF De-sludge Pump control panel(panel designed and installed by others)
- SAF Package plant building services
- Power Distribution building services
- SAF pumping station & Sludge tank trace heating controllers

Cable lengths will need to be measured on site and loading of devices will need to be worked out to calculate the cable core sizes for current carrying capacity.

4. Instrumentation associated with the treatment works

- Flowmeter to monitor pumped flow to package plant
- Ultrasonic level instrument to monitor levels in wet well
- Pressure transducer to monitor levels in the sludge holding tank.

5. A telemetry outstation will be installed by Welsh Water to remotely monitor any fault alarms which occur during plant operation. Cables will be installed to connect all the relevant alarms to telemetry digital inputs and all analogue inputs for level monitoring.

6. The site is currently unpowered and will be fed from a new three phase 100 kVA pole transformer. The Earthing arrangement for the site will be a TT system, this mean that the Electrical Company won't supply the earth. An Earthing study will need to be carried out of the site.

3.3 Standards and codes of practice

The design and installation shall conform to all relevant Health and Safety regulations, Electricity at work Regulation, British, IEC standards and the Welsh Water Technical standards including the following:-

- Welsh Water Electrical Specification ES302 – LV Switchgear and Control gear Assemblies
- Welsh Water Electrical Specification ES304 – Pumping Station Design Requirements
- Welsh Water Electrical Specification ES306 - Variable Speed Drives
- Welsh Water Electrical Specification ES319 - Low Voltage Installations
- Welsh Water Specification SS101-1A Small Wastewater Submersible Pumping Stations

A Comprehensive list of all Welsh Water Technical specification is detailed in the Appendix.

- WIMES 3.01 – Low voltage(LV) Switchgear and Control gear Assemblies.
- WIMES 3.02 – Low Voltage Electrical Installations,
- WIMES 3.04 – Low Voltage Electrical Specification for Package Plant,
- WIMES 3.05 – Electrical components (for use in LV Assemblies).
- WIMES 8.03 – Mechanical Installation.

The equipment and installation shall comply with all relevant European Community (EC) directives, UK statutory regulations and the latest edition of harmonised international, European and British Standards at the time of Design and:

- BS 7671:2018 Requirements For Electrical Installation
- BS 6739: 2009 Code of Practice for instrumentation in process control systems, installation, design and practice.
- BS 7430:2011 Code of practice for protective earthing of electrical installations

All equipment installed must comply with the Waste Electrical and Electronic (WEEE) regulations and shall be marked in accordance with BS EN 50419.

*citations ?
(RD)*

3.4 Project Constraints

All assembly components shall be selected from Welsh Water's Electrical Framework manual, and all assemblies shall be constructed using intelligent, integrated protection, control and monitoring devices.

All assemblies shall be designed to satisfy the operational and functional requirements, and for ease of maintenance over a 20 year lifecycle period.

The construction of the panel shall be designed for safe, robust and reliable operation. It shall be constructed to an internal form of separation required from the client specifications

Pumps driven by Variable speed drives (VSD) shall be assessed to determine the harmonic voltage and current distortion level and effects on the supply distribution network. VSDs provided must be compliant with IEC61000-3-2.

All design drawings and cable calculations must be issued to the client as proposed for review and can only be used once they have been marked up as construction and been stamped as "Accepted"

If any technical issues arise with design conflict, then a technical query can be sent to DCWW technical staff to overcome issues.

As the treatment works upgrade is a collaboration between different supply contractors meetings shall be held to create and effective program of works to deliver and achieve the best outcome.

The site installation will require a risk assessment and method statement to be created and approved by the client before any work on site can be started. The risk assessment will highlight all the risks on site and preventative measures but in place to reduce the risk. The method statement will be a detailed plan of how the work is going to be carried out.

Details of the installation team shall be given to the client to prove technical education and experience.

4. Functional Design Specifications and Test Plan

4.1 Functional design introduction

The Functional Design Specification is a key site document and provides a comprehensive description of the site control system. This document is to be updated on an ongoing basis, as required, to provide an accurate and up to date record of the control system. Any modification during the delivery of the project shall be captured within this document. A detailed description of each element of the control system is provided.

4.2 SAF lift Pumping station Control Philosophy

The Pumping Station Pumps shall operate in a Duty / Standby configuration in normal conditions, when all pumps are available. Duty rotation shall be automatic and selected by the Pump Controller.

Duty Pump shall start when the Pumping Station level is ^{or}at/above the 'Pump Start Level' set point (adjustable, set at commissioning). When the Pumping Station level falls below the 'Pump Stop Level' set point (adjustable, set at commissioning), the operating Pump shall stop.

Under normal operating conditions, the Pumps operate to maintain a pre-set 'Pumping Station Target Level' set point (adjustable, set at commissioning). The running pump shall be speed controlled, via the 'Pump Speed' set point derived from a PID control algorithm within the pump controller to maintain the 'Pumping Station Target Level' within the pumping station.

The pumped output should not exceed a flow rate of 2 litre/sec (l/s) (adjustable, set at commissioning) as read by the inline flow-meter during normal operation. The pump's speed is limited by the pump controller to a frequency rating, equivalent of 2l/s. On start up the pumps shall ramp up to a full speed set point (adjustable, set at commissioning) for a short period (adjustable, set at commissioning) for a flushing regime, before reverting to normal operation.

If the flow reaches the Low-flow alarm set point (set at commissioning) the duty pump changeover shall be triggered. The flow meter shall be relayed back to the pump controller and a high flow alarm shall be raised by the pump controller if flow exceeds 2l/s for a set time (adjustable, set at

commissioning). The analogue signal from the flowmeter will be taken back to the remote telemetry unit (RTU) for flow monitoring.

If there is a loss of signal from the ultrasonic level transmitter for a time period greater than 1 minute a failsafe 'Loss level control' alarm will be sent to the RTU and the pumping station will be effectively under emergency pump-down level control until the fault is rectified and manually reset. The pumps shall operate at a fixed speed (set during commissioning) and use the wet well Hi-Hi float switch (emergency pump down) for pump operation.

Upon receipt of a 'High Wet Well Level' signal from the Hi-Hi float switch, the control system shall transmit a 'Back-up Control System Activated' alarm to the RTU. The back-up control mode shall be configured as a control system operating independently of the intelligent station controller by including for a hardwired emergency fail safe pump-down circuit.

The duty pump shall continue to start on each operation of the Hi-Hi level float switch until the intelligent control of the pump units is restored. The Emergency Pump-down Timer period of operation shall be set to that which would empty the well to a safe level (set at commissioning) i.e. one that does not endanger the pump from dry running in excess of the pump manufacturer's recommendations.

If the duty pump fails to start in back-up control mode, the standby pump shall start and subsequently run every time the Hi-Hi level float switch is operated.

If the duty pump fails when running in back-up control mode, the standby pump shall start and run until the pump timer expires. Subsequently, the standby pump shall run every time the Hi-Hi level float switch is operated.

Duty changeovers shall be inhibited in back-up control mode.

On rectification of the fault that resulted in the emergency pump-down control mode, the control system shall require manual intervention to de-latch the circuit and allow the control to revert to pump unit control via the pumping station controller.

An increasing level in the Pumping Station shall require the duty pump operating speed to increase to maintain the 'Pumping Station Target Level'. The speed of the pump will be fixed when the target flow rate of 2l/s is reached.

A decreasing level in the Pumping Station shall require the pump operating speed to decrease to maintain the 'Pumping Station Target Level'. The operating pump shall ramp down to the 'Pump Speed' set point to maintain the 'Pumping Station Target Level'.

An inactivity timer shall be provided to monitor if the pumping station remains inactive for an extended period. An alarm shall be raised if either pump fails or if the inactivity timer has been triggered by the pumps not running for a set time (adjustable, to be set during commissioning).

If both pumps fail, flow will build up in the chamber and overflow via the emergency overflow line to the existing reed bed. An alarm shall also be raised if a Hi-Hi level is reached in the chamber.

Pump control shall incorporate an anti-rag reversal function controlled from the Ultrasonic pump controller subject to confirmation that pumps are appropriate for this function.

An interlock shall be provided to prevent both pumps running together in automatic and manual operation. Maximum flow to the SAF unit should not exceed 2l/s.

Normal automatic operation

Drive	Enabler(s)	Disabler(s)	Modifiers(s)
P1002 SAF Lift Pump No.1	Pump is Duty And Pump is Available And Pump is Healthy And Wet well level is at or above start level setpoint	Pump is Standby or Pump is Unavailable or Pump is Failed or Wet well level is at or below stop level setpoint	SAF Lift Pumping Station Level Transmitter, Target level setpoint
P1003 SAF Lift Pump No.2	Pump is Duty And Pump is Available And Pump is Healthy And Wet well level is at or above start level setpoint	Pump is Standby or Pump is Unavailable or Pump is Failed or Wet well level is at or below stop level setpoint	SAF Lift Pumping Station Level Transmitter, Target level setpoint

Abnormal automatic operation

Failure/Abnormal Condition	Resultant Control Action	Reset Method
SAF Lift Pump No.1 - Failed	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.1 – Unavailable	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.2 - Failed	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.2 – Unavailable	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump Station Flowmeter - Failed	Raise alarm on telemetry And Continue pumping regime	Automatically reset upon condition(s) being cleared
SAF Lift Pumping Station Level Transmitter - Failed	Raise 'Loss level control' alarm on telemetry after >1 minute And Stop duty pump.	The pumping station will be effectively under emergency pump-down level control until the fault is rectified Via Manual intervention and reset.
Loss of Comms between outstation and pump controller	Pump Controller to continue operation	Automatically reset upon condition(s) being cleared

Backup control process

Event	Cause	Result
HH Wet Well Level	HI-HI Float tipped	Raise 'High Wet Well Level' alarm And Begin emergency pump down procedure under backup control

Backup Control Safety

Event	Cause	Result
SAF Lift Pump No.1 - Estop	Manual Action	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.1 - Overload	Drive Overload	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.1 - Over Temperature	Motor Thermistor HH	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 - Estop	Manual Action	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 - Overload	Drive Overload	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 -Over Temperature	Motor Thermistor HH	Trip/inhibit drive And Raise alarm on telemetry.

Manual Control

Plant	Selection	Actions
SAF Lift Pump No.1	VSD operator interface panel	Start & Stop the drive via the VSD Operator Control Panel Start/Stop buttons, Interlock to prevent SAF Lift Pump No.2 (P1003) from operating.
SAF Lift Pump No.2	VSD operator interface panel	Start & Stop the drive via the VSD Operator Control Panel Start/Stop buttons, Interlock to prevent SAF Lift Pump No.1 (P1002) from operating.

Supervisory Control

Setpoint Group	Setpoint	Comment
SAF Lift Pumping Station Level Transmitter	High High/High/Low/Low Low/Dead band/Alarm Delay 'Pumping Station Target Level' setpoint 'Pump Start Level' setpoint 'Pump Stop Level' setpoint Inactivity timer (pumping station remains inactive for an extended period)	Pump level controller software to be utilised
SAF Lift Pump No.1	'Pump Speed' setpoint derived from a PID control algorithm	Pump level controller software to be utilised
SAF Lift Pump No.2	Pump Speed' setpoint derived from a PID control algorithm	Pump level controller software to be utilised
SAF Lift Pump Station Flowmeter	High High/High/Low/Low-Low/Dead band/Alarm Delay	RTU software to be utilised

Alarm Data for telemetry outstation (RTU)

Name	Type	Priority	Comment
SAF Lift Pump No.1 Run Status	Digital input		
SAF Lift Pump No.1 Failure Status	Digital input		
SAF Lift Pump No.1 Available Status	Digital input		
SAF Lift Pump No.1 Trip Status	Digital input		
SAF Lift Pump No.1 Emergency Stop Status	Digital input		
SAF Lift Pump No.2 Run Status	Digital input		
SAF Lift Pump No.2 Failure Status	Digital input		
SAF Lift Pump No.2 Available Status	Digital input		
SAF Lift Pump No.2 Trip Status	Digital input		
SAF Lift Pump No.2 Emergency Stop Status	Digital input		
SAF Lift Pumping Station Level Switch - Hi-Hi Float	Digital input		
SAF Lift Pumping Station Level Transmitter - Wet Well Level	Analogue input		
SAF Lift Pumping Station Level Transmitter – 'Loss level control'	Digital input		

SAF Lift Pump Station Flowmeter - Pumped Flow	Analogue input		
Back-up Control System Activated'	Digital input		

Additional site equipment installed by other contractors

- De- sludge Pumps control panel
- SAF Aeration Blower Control panel

Alarms for the equipment is part of this design

Alarm Data for telemetry outstation (RTU)

Name	Type	Priority	Comment
PST Pump Run Status	Digital input		
PST Pump Failure Status	Digital input		
PST Pump Available Status	Digital input		
HST Pump Run Status	Digital input		
HST Pump Failure Status	Digital input		
HST Pump Available Status	Digital input		
Blower No.1 Run Status	Digital input		
Blower No.1 Failure Status	Digital input		
Blower No.1 Available Status	Digital input		
Blower No.2 Run Status	Digital input		
Blower No.2 Failure Status	Digital input		
Blower No.2 Available Status	Digital Input		
Sludge tank pressure sensor No.1	Analogue input		
Sludge tank pressure sensor No.2	Analogue Input		
Inhabit all pumps.	Digital Output		

4.3 test Plan

Your testing table should contain a columns for (i) expected result (2) actual result and (3) pass or fail (RD);

SAF pumping station factory acceptance test (FAT) will be witnessed by the client before panel is allowed to be delivered to site for installation. Other check sheets are in appendix A

Operation details	Setpoint value	Tested By	Witnessed by
SAF Pump No.1 operates at start level setpoint	1.0 mtr		
SAF pump No.1 switches off at stop level	0.5 mtrs		
SAF pump No. 1 running displayed at telemetry outstation			
SAF pump No 1 failed Alarm displayed at telemetry outstation			
SAF Pump No.2 operates at start level setpoint	1.0mtrs		
SAF pump No.2 switches off at stop level	0.5 mtrs		
SAF pump No. 2 running displayed at telemetry outstation			
SAF pump No 2 failed Alarm displayed at telemetry outstation			
SAF pump No.1 VSD speed to keep 2l/s	Level speed 1.0m 80Hz 1.5m 50 Hz 1.8m 45 Z		
SAF pump No.1 VSD speed to keep 2l/s	Level speed 1.0m 80Hz 1.5m 50 Hz 1.8m 45 Z		
SAF pumps running Duty/Standby alternates after every stop cycle			
SAF Pump on Standby starts with backup float if duty pump is in fault			
Ultrasonic levels checked at telemetry outstation to match control values off 4-20mA	4mA – 0mtrs 12mA – 1.0mtrs 20mA – 2.0mtrs		
Hi level alarm activates from ultrasonic level	1.9mtrs		
Flow meter flow value checked at telemetry outstation	4mA – 0 l/s 12mA – 1 l/s 20mA – 2 l/s		
SAF pumps 1 & 2 Emergency stop Alarms to telemetry outstation			
Ultrasonic level sensor failed Loss of Echo Alarm at outstation			
Mains failure alarm checked at outstation			

Onsite Testing (SAT) will be carried out with all contractors involve so that all the process plant can be tested complete.

Electrical test will be carried out on all cables installed to BS7671 and will be recorded so that certification can be given.

As the site will be a TT system, earth values will be tested, this determines how many Earth electrode need to be installed to reach the acceptable resistance reading according to BS 7671 and Welsh Water specification ES319.

Both test sheets are in Appendix A

What is your budget? (RD)

5. Literature Review

5.1 SAF lift pump station control panel design

The design is to implement a PID loop to control the pump speeds to produce a constant flow to the treatment plant.

You should still have reviewed what was completed for a client then only specified
As the work is being completed for a client then only specified frame work components are allowed to be used. For this reason the following components have to be used

The VSDs have been requested to be ABB, as the pumps are 2.2kw, an ABB ACQ580 has been selected.

Citations needed (RD)

The flow meter selected must be a Siemens MAG5100W, this is an inline flanged mounded flow sensor designed for waste water. The reference No. for this item is DN65 PN16 this is due to the diameter of the pump pipe work being fitted. The flow meter requires a signal converter this is a MAG 6000 signal convertor, rated voltage 110 – 230 Vac and will require the wall mounting kit as it will be install in building with pump control panel.

Level will be monitored in the sludge holding tank by two pressure transmitter, these will be Siemens Sitrans P300 Hydrostatic sensors. They will be loop powered 4- 20mA so will need to be supplied with 24vdc power. This sensor has been designed for sludge tank levels and must be used. The pressure sensor will read between to range 0 – 1 bar g

Pumping station wet well level sensors must be ultrasonic there are a number of controllers and sensors available.

Siemens LUT420- This is a simple ultrasonic level controller designed for measuring level and volume of liquids, slurries and solids, as it is a basic controller it has 3 relay outputs and basic pump control functions, also basic data logging capability. Measuring Accuracy +/- 1mm plus 0.17% of measured distance. Dis-advantages with this controller are that it is bulky and when mounted to a panel door it takes the depth need to be considered not to interfere with other components. The controller can be programmed for using the keys on the front but a manual is need to explain the parameters and selection of values.

Cost of Controller =£370 with a 1-2 week delivery time

HydroRnger 200 HMI – This is an advanced ultrasonic controller and offers single or dual point monitoring. It has a easy to use HMI display with menu driven parameters and a support Wizard for quick setup applications. There is removable terminal block for ease of wiring.

Citations needed (RD)

It has built in Modbus RTU via RS485 for communication. It has 6 relay outputs and 4 – 20mA input and output connections. The unit has auto false Echo suppression for fixed obstruction avoidance which will help in a small wet well where it is tight on space due to the pipes and pumps.

Cost of Controller £430.00 with a 1-4 week delivery time

Pulsar Ultra 5. – This level controller provides flexible and reliable non contacting ultrasonic level and volume measurements. This controller has a built in wizard for quick setup of applications. Can record data on to a Micro SD card. It has 5 control relays and 1 analogue output. Analogue input is an extra which needs to be asked for.

Cost of controller = £690.00 with a 3-4 week delivery time.

The advantage of using a pulsar ultrasonic controller is the sensor. Each ultrasonic sensor whether its Siemens or Pulsar have an Echo blanking range.

Siemens blanking range for a XRS5 sensor is 300mm

Pulsar blanking range for dB3 sensor is 120mm

The blanking range can play a key part when distance is an issue as if level reach into these ranges then level values will no longer be measured and the ultrasonic will fault to loss of echo.

The choice of level controller is between the Pulsar ultra 5 and Siemens Hydromat 200.

After discussions with the client and selected by the operation staff of Welsh Water as personal preference the Pulsar Ultra 5 is to be used

Welsh water specification, ^{state} specify that their pumping station must be intelligent control and require ^{Citations needed (RD)} a PLC with HMI interface. The framework PLC is a Mitsubishi Q series with GT27 HMI. Using a PLC makes PID control easy as all Digital input/ output and analogue cards can be bought and fitted. This makes future development and expansion easier.

The client decided to change the constraints of the project and find another solution to remove the use of a PLC and find a device that is on the frame work which had the ability to carry out the function of PID. The purpose of this was to cut costs as PLC programming can only be done by frame work selected companies and they tend to be expensive, another reason is that the operations team wanted to find a simple device that they can access and replace without the use of laptops and software.

Research and communication between frame work suppliers lead to the new Pulsar Ultimate controller.

This controller combines ultrasonic level, flow measurement. RTU and advanced pump control all in to one easily programmed module unit. It has dedicated web server remote control and a touch screen HMI

The ultimate controller also can be expanded with extra modules, it has built in pre- selected features for pump blockage detection, automatic resets and can select the most efficient pump.

For cost saving this unit combines HMI, PLC and level controller all into one unit.

The analogue input allows for the Siemens Flowmeter inverter output to be connected to it and two analogue outputs, one of which will be connected to the telemetry unit for remote monitoring of the wet well levels and the other for speed control of the VSDs.

Cost of controller and sensor £1280.00 with 2 weeks delivery time.

The proposal was put forward to Welsh Water and the client as a technical query and was accepted as a preferred design. This is the first time this unit has been trailed to run a pumping station as a PID loop.

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D)

6. Project Planning, Work breakdown and Management Techniques

Where is your work-breakdown structure?

As the project is client driven and there are various contractor companies working on the project, collaboration meetings were held over MS Teams to produce an agreed programme of works.

A project plan has been produced using MS project and the full program of works is in Appendix C.

The detailed work structure has been broken down into all key elements from creating design drawings and get them approved too getting all materials to site for the installation.

Figure 1 below shows a snip of the task breakdown.

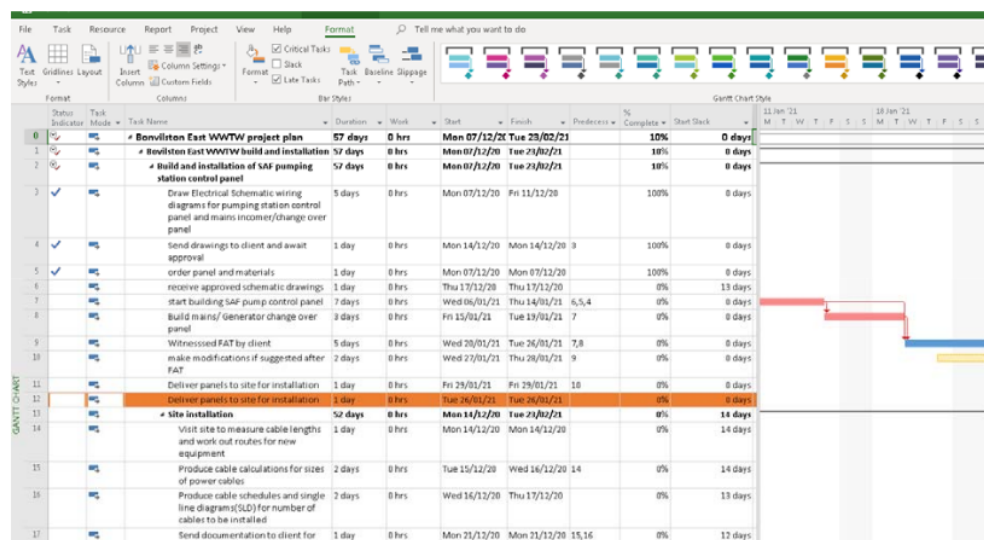


Figure 1MS project task breakdown

Using critical path and miles stones on MS project as highlighted all the tasks that need to be completed by a specific date to meet the deadlines set by the client. Figure 2 below shows the critical path for the build of the SAF pumping station control panel and the mile stone delivery to site date. It also shows that the whole build stage to delivery is critical as the client has set tight time lines.

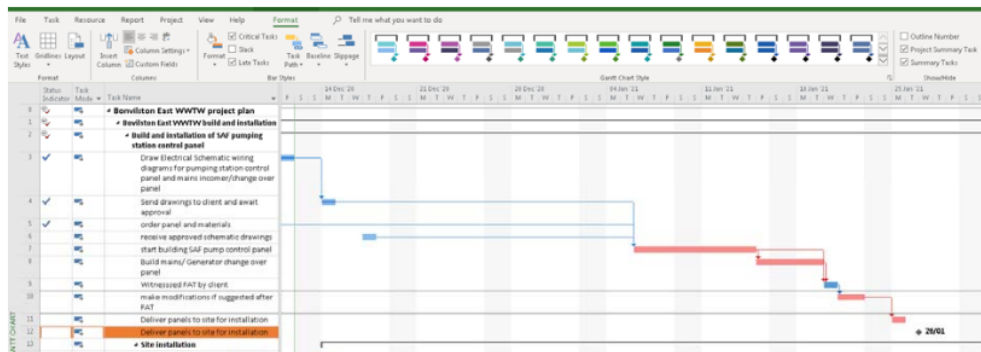


Figure 2 MS Project Critical Path and Mile Stones

Each task will be allocated labour, by using the resource table in MS project each person can be added as a resource and the cost per hour. All the tasks on the breakdown structure will then be allocated resource Figure 3 shows the resource table.

Task	Resource	Report	Project	View	Help	Format	Tell me what you want to do						
													
Assign Resources Pool		Add Resources	Information	Notes	Details	Level Selection	Level Resource	Level All	Leveling Options	Clear Leveling	Next Overallocation		
Assignments													
Insert													
Properties													
Level													
Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt.	Cost/Use	Accrue	Base	Code	BUDGET CAT.	
Carl Jones	Work		C		100%	£43.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
	Work				100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
	Work				100%	£43.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
Doug	Work		D		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
Phil	Work		P		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
Jack	Work		J		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF	
BUDGET STAFF	Work		B						Prorated	Standard		STAFF	

Figure 3 MS Project resource table

The budget labour hours for the work is 656 hours, using MS Project a staff budget recourse name was made up, this allows the hours and cost of the labour to be monitored as the tasks are completed an the hours are entered. Figure 4 and 5 show the hours enter against each task and the costs.

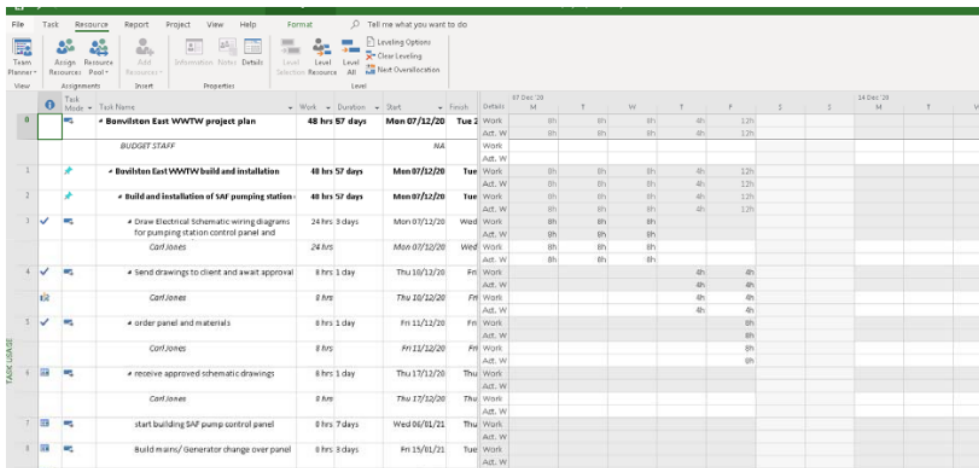


Figure 4 Labour hours completed for each task

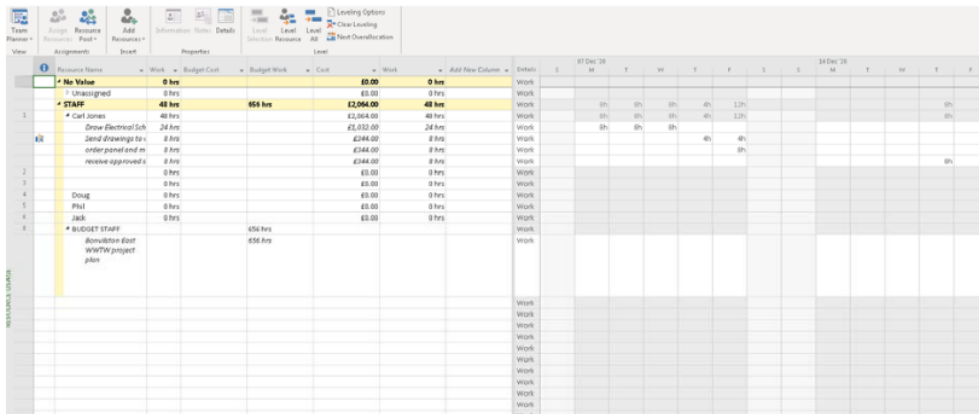


Figure 5 Budget hours, hours worked and cost of labour for tasks worked

The program has to be updated every day and percentages on work complete entered this allows any slippages in tasks to be picked up. As part of the contract with the client a program of completed works must be issued each month. Payment for work completed from is from an activity schedule issued to the client, percentages are place against each payment and the client will compare to the up to date programme of works at that date. The activity schedule is in appendix D

7. Conclusions and Recommendations

To conclude the assignment, all objective set out in the assignment brief have been achieved.

The understanding of the project background was fully explained and all the constraints for the project which have been set by the client and the technical specification and standard regulations that must be adhered to.

A full functional design specification was achieved which form the factory and site test plans were derived.

Research into the design brief and to what equipment could be used, as the project is client based then, a lot of their technical specification had to be used and their agreed framework suppliers

You should still have reviewed what else could have been used and as this was a literature review, you should have cited your sources. (RD)

A fully created program of works was created and will be used to achieve a successful project to be delivered on time and to the clients agreed specification.

No
citat
ions
give
n
(RD)

8. Citation List

Bibliography

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<https://pulsarmeasurement.com/ultimate-controller.html>

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<https://assets.new.siemens.com/siemens/assets/api/uuid:8473bb40-23f9-4980-93dc-779ee6d...>

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Water, W. (july 2020). Electrical Specifications ES302 - LV switchgear and control assemblies.

Water, W. (july 2020). Electrical specifications ES306 - Variable Speed drives.

Water, W. (july 2020). Electrical Specifications ES319 -Low voltage installations.

You have listed but not cited (RD)

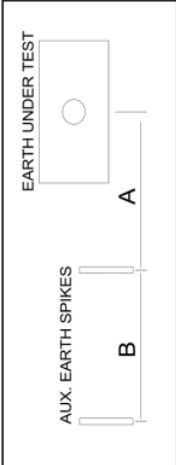
A far bigger listed was expected for a level 6 honours degree project. This is very disappointing (RD)

9. Appendix

You should have included the project proposal in the appendix. (RD)

*All material included in this section should be referred to
in the main report (RD)*

SOIL RESISTIVITY TEST

Tester:		Address/Location:		Type of Supply:		Instruments:	
Test Date:				TN-S		Loop Impedance:	
Signature:				TN-C-S		Continuity:	
Project No.				TT		Insulation:	
				Ze at Origin:		ohms	
				PFC:		kA	
Method of Protection Against Direct Contact:							
Description of Work: Main earth point on DNO cutout to be tested for soil resistivity							
							
Tester specification							
Make		Kewtech					
Model		KT65 8 in 1 tester					
Earth Frequency		825Hz					
Range		20/200/2000Ω					
Accuracy		20Ω range : ±(3%rdg+0.1Ω) 200/2000Ω range : ±(3%rdg+3dgt) (Auxiliary earth resistance 100±5%)					
Test type applied		3 point					
Test		Test No.1		Test No.2		Test No.3	
Distance A							
Distance B							
Direction (N/S/E/W)							
Ground type							
Weather condition (wet/dry)							
Time of day							
Test results				Ω		Ω	
Description of direction tested from earth under test:							

Bonvilston East WWTW

Our ref. 20.22.057

A1 Activity Pricing Schedule Rev.P1

01/12/2020

Item	Activity	Quoted amount	Revised amount
1.0	Supply and installation of cable containment, local junction box stands	£3,500.00	
2.0	Supply and installation of 1 No. 'Power Distribution Board' - Wall mounted, TP&N, 50Hz 8 Way Distribution Board	£1,900.00	
3.0	Design, Supply and installation of 1 No. 'SAF Lift Pump Station LCP Wall mounted Form 2 panel with 2 No. standalone VSD starters.	£13,990.00	
4.0	Supply of 1 No. IP55 min rated enclosure to house a 24V power supply and associated terminations for Sludge Holding Tank level transmitters	£1,010.00	
5.0	Design, Supply and installation of 1 No 100A Wall Mounted Main Incomer & Generator changeover fused switch panel & Portable Generator socket.	£2,850.00	
6.0	Supply and installation of power cabling from the 'Power Distribution Board' to 'SAF Lift Pump Station' Control Panel.	£750.00	
7.0	Supply and installation of control & status cabling from the 'SAF Lift Pump Station LCP' to the Telemetry Outstation	£680.00	
8.0	Supply and installation of power cabling from the 'DNO Cut-out' to 'Main Isolator Fuse Switch Panel'.	£817.00	
9.0	Supply and installation of power cabling from the 'Main Isolator Fuse Switch Panel' to the 'Power Distribution Board'.	£817.00	
10.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'Power Distribution Kiosk Building Services Board'.	£380.00	
11.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Lift Pumping Station Kiosk Building Services Board'.	£465.00	
12.0	Supply and installation of power cabling from the 'Power Distribution Board' to the SAF Lift Pump Station & Sludge Tank Pipework Trace Heating Controllers	£860.00	
13.0	Supply and installation of control/signal cabling from the SAF Lift Pump Station & Sludge Tank Pipework Trace Heating Controllers to the Telemetry Outstation	£993.00	
14.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Aeration Blower Package plant LCP'	£1,100.00	
15.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Desludge Pump Package plant LCP'	£1,056.00	
16.0	Supply and Installation of all control / signalling cabling between the 'SAF Aeration Blower LCP' and the Telemetry Outstation.	£1,025.00	
17.0	Supply and Installation of all control/ signalling cabling between the 'SAF Desludge Pump LCP' and the Telemetry Outstation.	£1,025.00	
18.0	Supply and installation of all power and control cabling for all drives and Instruments fed from the 'SAF Lift Pump Station' LCP to the following;		
19.0	SAF Lift Pumps 1 & 2	£1,490.00	

[illegible]

1910607-SEGL6000- Assignment specifications

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

Text Comment. This is an unnecessary statement (RD)

Text Comment. You could have started by saying something about the pumping station. (RD)

Text Comment. What is a packaged plant? (RD)

Text Comment. Spelling (RD)

PAGE 5

Text Comment. Don't instruct your reader, be informative (RD)

Text Comment. In this section, you should have stated the aims and objectives of the project. (RD)

PAGE 6

Text Comment. Use full text justification for paragraphs (RD)

Text Comment. This is more of a list of requirements and reads like an FDS. You should be explaining the background to the problem. (RD)

Text Comment. spelling ? (RD)

Text Comment. citations ? (RD)

Text Comment. spelling (RD)

Text Comment. spelling (RD)

Text Comment. or

Text Comment. Your testing table should contain a columns for (i) expected result (2) actual result and (3) pass or fail. (RD)

Text Comment. What is your budget? (RD)

Text Comment. You should still have reviewed what was available from other sources (RD)

Text Comment. Citations needed (RD)

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Text Comment. Citations needed (RD)

PAGE 20

Text Comment. Citations needed (RD)

PAGE 21

Text Comment. Where is your work-breakdown structure?

PAGE 22

PAGE 23

PAGE 24

Text Comment. No citations given (RD)

Text Comment. You should still have reviewed what else could have been used and as this was a literature review, you should have cited your sources ! (RD)

PAGE 25

Text Comment. You have listed but not cited (RD)

Text Comment. A far bigger listed was expected for a level 6 honours degree project. This is very disappointing (RD)

PAGE 26

Text Comment. You should have included the project proposal in the appendix. (RD)

Text Comment. All material included in this section should be referred to in the main report (RD)

PAGE 27

PAGE 28

PAGE 29

PAGE 30

CARL JONES**45****1. ENGAGEMENT WITH LITERATURE**

Section 5: Engagement in research, judicial use and critical evaluation sources, depth of literature review of solutions (3/10) Some evidence of research but no citations from sources (RD) Evidence of research was demonstrated, however this was mainly limited to Welsh Water company policy documents (MH) Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing (2/5) There must be some reading from the information contained in the report. However, citation is disappointing as it is far too small for a level 6 honours project report and there are no citations contained in the report (RD) Additional research on wider issues using a diverse range of sources could have been employed (MH)

5**2. KNOWLEDGE AND UNDERSTANDING**

Section 3: Project background and context, commercial, economic and social context (5/10) Some information provided that sets the project in context. However, it is not clear which parts are

11

being delivered by the author of the report. (RD)
Project explained as the requirement for a new
pumping and treatment installation (MH) Section 3:
Project constraints, professional and ethical
conduct, codes of practice, standards, security,
intellectual property, legal requirements etc. (5/10)
Some explanations given. (RD) Constraints were
limited to technical issues, no consideration of
wider issues (MH) Section 3: Environmental and
sustainability limitations and promotion of
sustainable development (1/5) Little or no
references made to these requirements (RD) No
consideration of wider issues, ethical engineering
or sustainability (MH) Section 3: Project risks,
health and safety etc. (0/5) No risk assessment
provided (RD) No consideration of risks to the
project's success (MH)

3. COGNITIVE AND INTELLECTUAL



Section 3: Problem Definition (2/5) Briefly explain
but reads more like an FDS (RD) The problem was
only defined as a requirement due to 120
properties requiring sewage services. (MH) Section
4: Functional Design Specification (6/10) Detailed
and an in depth information given. However, actual
author's objectives are not clear leaving the reader
unsure as to how much of the project will be
delivered by the author. No budget specified. (RD)
A detailed description of the system was described
in the FDS (MH) Section 4: Test planning (3/5)
Plenty of scope for testing though the table should
contain expected and actual results before
signatures can be added. (RD) A test plan with
some performance metrics to gauge success was

included, tolerances on results would have been good. (MH) Section 7: Conclusions and Recommendations (3/5) Some helpful statements made but it is unclear as to where the project stands at present. (RD) Light on technical detail going forward, written a bit too generic

4. PRACTICAL APPLICATION

 Section 5: Critical choice and justification of final solution (1/5) Only one solution considered, justification is based on client rules only. No scope allowed for scoring solutions. No review of literature and no citations given. (RD) Alternative solutions were not offered in the report (MH) Section 6: Project Planning, working breakdown structure and management techniques. (5/10) A good plan but no work-breakdown structure provided (RD) No WBS was devised but a detailed Gantt was used to control timings (MH)

6

5. TRANSFERABLE SKILLS

 Section 1: Executive summary (2/5) Contains some useful information but does not summarise what has been done. (RD) Very brief and didn't give the reader much idea on the project's scope (MH) All Sections: Quality of the report – (3/5) Good quality of presentation but contains many spelling errors (RD) Generally well written and presented (MH) Word count – (4/5) Exceeded (RD) 3890 words declared (MH)

9

SECOND MARKER - MH

Course: BSc (Hons) Electrical and Electronic Engineering

Module: SGEL6000 Independent Project

Assignment: 1. Project Definition, Research and Quality Planning

Name: Carl Jones

University Number: 1910607

Date Submitted: 11/12/2020

Word Count: 3890

WITHIN 10% LIMIT

Contents

Table of figures	3
1. Executive Summary	4
2. Introduction.....	5
3. Project Background and Problem Definitions and Constraints	6
3.1 Project Information	6
3.2 scope of work	6
3.3 Standards and codes of practice.....	7
3.4 Project Constraints	8
4. Functional Design Specifications and Test Plan	9
4.1 Functional design introduction	9
4.2 SAF lift Pumping station Control Philosophy	9
4.3 test Plan	16
5. Literature Review	18
6. Project Planning, Work breakdown and Management Techniques.....	21
7. Conclusions and Recommendations.....	24
8. Citation List.....	25
Bibliography	25
9. Appendix.....	26

Table of figures

Figure 1MS project task breakdown	21
Figure 2 MS Project Critical Path and Mile Stones.....	22
Figure 3 MS Project resource table.....	22
Figure 4 Labour hours completed for each task	23
Figure 5 Budget hours, hours worked and cost of labour for tasks worked.....	23

1. Executive Summary

This assignment provides a detailed process that a project must undertake to be successful. The project background has been detailed and all the constraints set by law and the client to deliver the project.

The functional design specification (FDS) has been layout to underline requirements for the new pumping station and how the site will function in Automatic, manual and the integration between package plants installed by other contractors.

A test plan was created from the FDS allowing full testing of require designed sequences the pumping station must achieve to meet the specifications.

A literature review has been carried out into the device available for the design, a new instrument was selected which hasn't been used before and looks like it will be used a lot more in the future to remove the need of PLCs and having to carry laptops with various device software installed. It will make it easier for breakdowns for the average maintenance Electrician.

This assignment as produce a working design specification and a programme of works to implement the successful delivery.

THE READER SHOULD GET A BASIC
UNDERSTANDING OF THE WHOLE
PROJECT FROM THIS

2. Introduction

The design process is an important part of any project and its successful delivery. It is important to fully understand each step, this assignment will define each step as an actual project that has to be delivered to a client effectively. The project background will be discussed with all constraints which will influence the direction the project design will go. This will then create the platform for creating the functional design specification to create the final design to be installed and tested. A project plan will also be produced, this will set out the work activities in a systematic work structure to deliver the project on time, as designed and to budget.

Too Brief

3. Project Background and Problem Definitions and Constraints

3.1 Project Information

A housing developer has requested to connect 120 new properties to an existing Wastewater Treatment works in a village outside of Cardiff.

Welsh Water have granted connection of 30 properties, however the other 90 properties require the treatment works to be upgraded to process the additional flow and load to comply with consent documentation granted by the government for treated wastewater.

To achieve this a new pumping station and treatment plant needs to be installed.

The treatment plant will be designed and installed by another contractor called Jacopa.

A SUMMARY
IF YOU WOULD
HAVE STATED
YOUR EXECUTIVE
SUMMARY

3.2 scope of work

The scope of work for the client is to design, supply and install the following

1. Submerged Aeration Filter (SAF) lift pumping station control panel.

The pump station consists of two centrifugal submersible pumps with an ultrasonic level instrument and a level float switch providing a Hi-Hi level for emergency pump-down level control. An inline flow meter will be mounted on pump pipework to SAF unit to monitor pumped flows

The two pumps will be variable speed and shall ramp up and down based on level and flow. The level controller will monitor the level in the pumping station wet well and provide a 4-20mA signal to the for speed control. The operating regime is to be duty / standby, with automatic daily changeover of the duty pump.

2. Mains incomer and manual Generator changeover panel.

The panel will a 100 Amp changeover fuse switch and must facilitate safe and easy connection of a temporary generator via five single pole panel mounted Power-safe drain connector plugs.

3. Power Distribution board and cabling.

Power distribution board will be 400 Volts three phase and neutral and will provide feeds for the following

- SAF Lift pump station Control panel
- SAF Lift pump station building services
- SAF Aeration Blower control panel (panel designed and installed by others)

- SAF De-sludge Pump control panel(panel designed and installed by others)
- SAF Package plant building services
- Power Distribution building services
- SAF pumping station & Sludge tank trace heating controllers

Cable lengths will need to be measured on site and loading of devices will need to be worked out to calculate the cable core sizes for current carrying capacity.

4. Instrumentation associated with the treatment works

- Flowmeter to monitor pumped flow to package plant
- Ultrasonic level instrument to monitor levels in wet well
- Pressure transducer to monitor levels in the sludge holding tank.

5. A telemetry outstation will be installed by Welsh Water to remotely monitor any fault alarms which occur during plant operation. Cables will be installed to connect all the relevant alarms to telemetry digital inputs and all analogue inputs for level monitoring.

6. The site is currently unpowered and will be fed from a new three phase 100 kVA pole transformer. The Earthing arrangement for the site will be a TT system, this mean that the Electrical Company won't supply the earth. An Earthing study will need to be carried out of the site.

3.3 Standards and codes of practice

The design and installation shall conform to all relevant Health and Safety regulations, Electricity at work Regulation, British, IEC standards and the Welsh Water Technical standards including the following;-

- Welsh Water Electrical Specification ES302 – LV Switchgear and Control gear Assemblies
- Welsh Water Electrical Specification ES304 – Pumping Station Design Requirements
- Welsh Water Electrical Specification ES306 - Variable Speed Drives
- Welsh Water Electrical Specification ES319 - Low Voltage Installations
- Welsh Water Specification SS101-1A Small Wastewater Submersible Pumping Stations

A Comprehensive list of all Welsh Water Technical specification is detailed in the Appendix.

- WIMES 3.01 – Low voltage(LV) Switchgear and Control gear Assemblies.
- WIMES 3.02 – Low Voltage Electrical Installations,
- WIMES 3.04 – Low Voltage Electrical Specification for Package Plant,
- WIMES 3.05 – Electrical components (for use in LV Assemblies).
- WIMES 8.03 – Mechanical Installation.

The equipment and installation shall comply with all relevant European Community (EC) directives, UK statutory regulations and the latest edition of harmonised international, European and British Standards at the time of Design and:

- BS 7671:2018 Requirements For Electrical Installation
- BS 6739: 2009 Code of Practice for instrumentation in process control systems, installation, design and practice.
- BS 7430:2011 Code of practice for protective earthing of electrical installations

All equipment installed must comply with the Waste Electrical and Electronic (WEEE) regulations and shall be marked in accordance with BS EN 50419.

3.4 Project Constraints

All assembly components shall be selected from Welsh Water's Electrical Framework manual, and all assemblies shall be constructed using intelligent, integrated protection, control and monitoring devices.

All assemblies shall be designed to satisfy the operational and functional requirements, and for ease of maintenance over a 20 year lifecycle period.

The construction of the panel shall be designed for safe, robust and reliable operation. It shall be constructed to an internal form of separation required from the client specifications

Pumps driven by Variable speed drives (VSD) shall be assessed to determine the harmonic voltage and current distortion level and effects on the supply distribution network. VSDs provided must be compliant with IEC61000-3-2.

All design drawings and cable calculations must be issued to the client as proposed for review and can only be used once they have been marked up as construction and been stamped as "Accepted"

If any technical issues arise with design conflict, then a technical query can be sent to DCWW technical staff to overcome issues.

As the treatment works upgrade is a collaboration between different supply contractors meetings shall be held to create an effective program of works to deliver and achieve the best outcome.

The site installation will require a risk assessment and method statement to be created and approved by the client before any work on site can be started. The risk assessment will highlight all the risks on site and preventative measures but in place to reduce the risk. The method statement will be a detailed plan of how the work is going to be carried out.

Details of the installation team shall be given to the client to prove technical education and experience.

YOU NEEDED TO COVER THE WIDER
ISSUES OF ETHICAL ENGINEERING AND
SUSTAINABILITY.

4. Functional Design Specifications and Test Plan

4.1 Functional design introduction

The Functional Design Specification is a key site document and provides a comprehensive description of the site control system. This document is to be updated on an ongoing basis, as required, to provide an accurate and up to date record of the control system. Any modification during the delivery of the project shall be captured within this document. A detailed description of each element of the control system is provided.

4.2 SAF lift Pumping station Control Philosophy

The Pumping Station Pumps shall operate in a Duty / Standby configuration in normal conditions, when all pumps are available. Duty rotation shall be automatic and selected by the Pump Controller.

Duty Pump shall start when the Pumping Station level is at/above the 'Pump Start Level' set point (adjustable, set at commissioning). When the Pumping Station level falls below the 'Pump Stop Level' set point (adjustable, set at commissioning), the operating Pump shall stop.

Under normal operating conditions, the Pumps operate to maintain a pre-set 'Pumping Station Target Level' set point (adjustable, set at commissioning). The running pump shall be speed controlled, via the 'Pump Speed' set point derived from a PID control algorithm within the pump controller to maintain the 'Pumping Station Target Level' within the pumping station.

The pumped output should not exceed a flow rate of 2 litre/sec (l/s) (adjustable, set at commissioning) as read by the inline flow-meter during normal operation. The pump's speed is limited by the pump controller to a frequency rating, equivalent of 2l/s. On start up the pumps shall ramp up to a full speed set point (adjustable, set at commissioning) for a short period (adjustable, set at commissioning) for a flushing regime, before reverting to normal operation.

If the flow reaches the Low-flow alarm set point (set at commissioning) the duty pump changeover shall be triggered. The flow meter shall be relayed back to the pump controller and a high flow alarm shall be raised by the pump controller if flow exceeds 2l/s for a set time (adjustable, set at

commissioning). The analogue signal from the flowmeter will be taken back to the remote telemetry unit (RTU) for flow monitoring.

If there is a loss of signal from the ultrasonic level transmitter for a time period greater than 1 minute a failsafe 'Loss level control' alarm will be sent to the RTU and the pumping station will be effectively under emergency pump-down level control until the fault is rectified and manually reset. The pumps shall operate at a fixed speed (set during commissioning) and use the wet well Hi-Hi float switch (emergency pump down) for pump operation.

Upon receipt of a 'High Wet Well Level' signal from the Hi-Hi float switch, the control system shall transmit a 'Back-up Control System Activated' alarm to the RTU. The back-up control mode shall be configured as a control system operating independently of the intelligent station controller by including for a hardwired emergency fail safe pump-down circuit.

The duty pump shall continue to start on each operation of the Hi-Hi level float switch until the intelligent control of the pump units is restored. The Emergency Pump-down Timer period of operation shall be set to that which would empty the well to a safe level (set at commissioning) i.e. one that does not endanger the pump from dry running in excess of the pump manufacturer's recommendations.

If the duty pump fails to start in back-up control mode, the standby pump shall start and subsequently run every time the Hi-Hi level float switch is operated.

If the duty pump fails when running in back-up control mode, the standby pump shall start and run until the pump timer expires. Subsequently, the standby pump shall run every time the Hi-Hi level float switch is operated.

Duty changeovers shall be inhibited in back-up control mode.

On rectification of the fault that resulted in the emergency pump-down control mode, the control system shall require manual intervention to de-latch the circuit and allow the control to revert to pump unit control via the pumping station controller.

An increasing level in the Pumping Station shall require the duty pump operating speed to increase to maintain the 'Pumping Station Target Level'. The speed of the pump will be fixed when the target flow rate of 2l/s is reached.

A decreasing level in the Pumping Station shall require the pump operating speed to decrease to maintain the 'Pumping Station Target Level'. The operating pump shall ramp down to the 'Pump Speed' set point to maintain the 'Pumping Station Target Level'.

An inactivity timer shall be provided to monitor if the pumping station remains inactive for an extended period. An alarm shall be raised if either pump fails or if the inactivity timer has been triggered by the pumps not running for a set time (adjustable, to be set during commissioning).

If both pumps fail, flow will build up in the chamber and overflow via the emergency overflow line to the existing reed bed. An alarm shall also be raised if a Hi-Hi level is reached in the chamber.

Pump control shall incorporate an anti-rag reversal function controlled from the Ultrasonic pump controller subject to confirmation that pumps are appropriate for this function.

An interlock shall be provided to prevent both pumps running together in automatic and manual operation. Maximum flow to the SAF unit should not exceed 2l/s.

Normal automatic operation

Drive	Enabler(s)	Disabler(s)	Modifiers(s)
P1002 SAF Lift Pump No.1	Pump is Duty And Pump is Available And Pump is Healthy And Wet well level is at or above start level setpoint	Pump is Standby or Pump is Unavailable or Pump is Failed or Wet well level is at or below stop level setpoint	SAF Lift Pumping Station Level Transmitter, Target level setpoint
P1003 SAF Lift Pump No.2	Pump is Duty And Pump is Available And Pump is Healthy And Wet well level is at or above start level setpoint	Pump is Standby or Pump is Unavailable or Pump is Failed or Wet well level is at or below stop level setpoint	SAF Lift Pumping Station Level Transmitter, Target level setpoint

THIS LARGE TABLE IS BETTER
PLACED IN THE ANNEX.

Abnormal automatic operation

Failure/Abnormal Condition	Resultant Control Action	Reset Method
SAF Lift Pump No.1 - Failed	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.1 – Unavailable	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.2 - Failed	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump No.2 – Unavailable	Raise alarm on telemetry And Start Standby when required	Reset push button
SAF Lift Pump Station Flowmeter - Failed	Raise alarm on telemetry And Continue pumping regime	Automatically reset upon condition(s) being cleared
SAF Lift Pumping Station Level Transmitter - Failed	Raise 'Loss level control' alarm on telemetry after >1 minute And Stop duty pump.	The pumping station will be effectively under emergency pump-down level control until the fault is rectified Via Manual intervention and reset.
Loss of Comms between outstation and pump controller	Pump Controller to continue operation	Automatically reset upon condition(s) being cleared

Backup control process

Event	Cause	Result
HH Wet Well Level	HI-HI Float tipped	Raise 'High Wet Well Level' alarm And Begin emergency pump down procedure under backup control

Backup Control Safety

Event	Cause	Result
SAF Lift Pump No.1 - Estop	Manual Action	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.1 - Overload	Drive Overload	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.1 - Over Temperature	Motor Thermistor HH	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 - Estop	Manual Action	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 - Overload	Drive Overload	Trip/inhibit drive And Raise alarm on telemetry.
SAF Lift Pump No.2 -Over Temperature	Motor Thermistor HH	Trip/inhibit drive And Raise alarm on telemetry.

Manual Control

Plant	Selection	Actions
SAF Lift Pump No.1	VSD operator interface panel	Start & Stop the drive via the VSD Operator Control Panel Start/Stop buttons, Interlock to prevent SAF Lift Pump No.2 (P1003) from operating.
SAF Lift Pump No.2	VSD operator interface panel	Start & Stop the drive via the VSD Operator Control Panel Start/Stop buttons, Interlock to prevent SAF Lift Pump No.1 (P1002) from operating.

Supervisory Control

Setpoint Group	Setpoint	Comment
SAF Lift Pumping Station Level Transmitter	High High/High/Low/Low Low/Dead band/Alarm Delay 'Pumping Station Target Level' setpoint 'Pump Start Level' setpoint 'Pump Stop Level' setpoint Inactivity timer (pumping station remains inactive for an extended period)	Pump level controller software to be utilised
SAF Lift Pump No.1	'Pump Speed' setpoint derived from a PID control algorithm	Pump level controller software to be utilised
SAF Lift Pump No.2	Pump Speed' setpoint derived from a PID control algorithm	Pump level controller software to be utilised
SAF Lift Pump Station Flowmeter	High High/High/Low/Low-Low/Dead band/Alarm Delay	RTU software to be utilised

Alarm Data for telemetry outstation (RTU)

Name	Type	Priority	Comment
SAF Lift Pump No.1 Run Status	Digital input		
SAF Lift Pump No.1 Failure Status	Digital input		
SAF Lift Pump No.1 Available Status	Digital input		
SAF Lift Pump No.1 Trip Status	Digital input		
SAF Lift Pump No.1 Emergency Stop Status	Digital input		
SAF Lift Pump No.2 Run Status	Digital input		
SAF Lift Pump No.2 Failure Status	Digital input		
SAF Lift Pump No.2 Available Status	Digital input		
SAF Lift Pump No.2 Trip Status	Digital input		
SAF Lift Pump No.2 Emergency Stop Status	Digital input		
SAF Lift Pumping Station Level Switch - Hi-Hi Float	Digital input		
SAF Lift Pumping Station Level Transmitter - Wet Well Level	Analogue input		
SAF Lift Pumping Station Level Transmitter – 'Loss level control'	Digital input		

SAF Lift Pump Station Flowmeter - Pumped Flow	Analogue input		
Back-up Control System Activated'	Digital input		

Additional site equipment installed by other contractors

- De- sludge Pumps control panel
- SAF Aeration Blower Control panel

Alarms for the equipment is part of this design

Alarm Data for telemetry outstation (RTU)

Name	Type	Priority	Comment
PST Pump Run Status	Digital input		
PST Pump Failure Status	Digital input		
PST Pump Available Status	Digital input		
HST Pump Run Status	Digital input		
HST Pump Failure Status	Digital input		
HST Pump Available Status	Digital input		
Blower No.1 Run Status	Digital input		
Blower No.1 Failure Status	Digital input		
Blower No.1 Available Status	Digital input		
Blower No.2 Run Status	Digital input		
Blower No.2 Failure Status	Digital input		
Blower No.2 Available Status	Digital Input		
Sludge tank pressure sensor No.1	Analogue input		
Sludge tank pressure sensor No.2	Analogue Input		
Inhabit all pumps.	Digital Output		

4.3 test Plan

SAF pumping station factory acceptance test (FAT) will be witnessed by the client before panel is allowed to be delivered to site for installation. Other check sheets are in appendix A

Operation details	Setpoint value	Tested By	Witnessed by
SAF Pump No.1 operates at start level setpoint	1.0 mtr		
SAF pump No.1 switches off at stop level	0.5 mtrs		
SAF pump No. 1 running displayed at telemetry outstation			
SAF pump No 1 failed Alarm displayed at telemetry outstation			
SAF Pump No.2 operates at start level setpoint	1.0mtrs		
SAF pump No.2 switches off at stop level	0.5 mtrs		
SAF pump No. 2 running displayed at telemetry outstation			
SAF pump No 2 failed Alarm displayed at telemetry outstation			
SAF pump No.1 VSD speed to keep 2l/s	Level speed 1.0m 80Hz 1.5m 50 Hz 1.8m 45 Z	} TOLERANCE ?	
SAF pump No.1 VSD speed to keep 2l/s	Level speed 1.0m 80Hz 1.5m 50 Hz 1.8m 45 Z		
SAF pumps running Duty/Standby alternates after every stop cycle			
SAF Pump on Standby starts with backup float if duty pump is in fault			
Ultrasonic levels checked at telemetry outstation to match control values off 4-20mA	4mA – 0mtrs 12mA – 1.0mtrs 20mA – 2.0mtrs		
Hi level alarm activates from ultrasonic level	1.9mtrs		
Flow meter flow value checked at telemetry outstation	4mA – 0 l/s 12mA – 1 l/s 20mA – 2 l/s		
SAF pumps 1 & 2 Emergency stop Alarms to telemetry outstation			
Ultrasonic level sensor failed Loss of Echo Alarm at outstation			
Mains failure alarm checked at outstation			

Onsite Testing (SAT) will be carried out with all contractors involve so that all the process plant can be tested complete.

Electrical test will be carried out on all cables installed to BS7671 and will be recorded so that certification can be given.

As the site will be a TT system, earth values will be tested, this determines how many Earth electrode need to be installed to reach the acceptable resistance reading according to BS 7671 and Welsh Water specification ES319.

Both test sheets are in Appendix A

5. Literature Review

5.1 SAF lift pump station control panel design

The design is to implement a PID loop to control the pump speeds to produce a constant flow to the treatment plant.

As the work is being completed for a client then only specified frame work components are allowed to be used. For this reason the following components have to be used

The VSDs have been requested to be ABB, as the pumps are 2.2kw, an ABB ACQ580 has been selected.

The flow meter selected must be a Siemens MAG5100W, this is an inline flanged mounded flow sensor designed for waste water. The reference No. for this item is DN65 PN16 this is due to the diameter of the pump pipe work being fitted. The flow meter requires a signal converter this is a MAG 6000 signal convertor, rated voltage 110 – 230 Vac and will require the wall mounting kit as it will be install in building with pump control panel.

Level will be monitored in the sludge holding tank by two pressure transmitter, these will be Siemens Sitrans P300 Hydrostatic sensors. They will be loop powered 4- 20mA so will need to be supplied with 24vdc power. This sensor has been designed for sludge tank levels and must be used. The pressure sensor will read between to range 0 – 1 bar g

Pumping station wet well level sensors must be ultrasonic there are a number of controllers and sensors available.

Siemens LUT420- This is a simple ultrasonic level controller designed for measuring level and volume of liquids, slurries and solids, as it is a basic controller it has 3 relay outputs and basic pump control functions, also basic data logging capability. Measuring Accuracy +/- 1mm plus 0.17% of measured distance. Dis-advantages with this controller are that it is bulky and when mounted to a panel door it takes the depth need to be considered not to interfere with other components. The controller can be programmed for using the keys on the front but a manual is need to explain the parameters and selection of values.

Cost of Controller =£370 with a 1-2 week delivery time

HydroRnger 200 HMI – This is an advanced ultrasonic controller and offers single or dual point monitoring. It has a easy to use HMI display with menu driven parameters and a support Wizard for quick setup applications. There is removable terminal block for ease of wiring.

It has built in Modbus RTU via RS485 for communication. It has 6 relay outputs and 4 – 20mA input and output connections. The unit has auto false Echo suppression for fixed obstruction avoidance which will help in a small wet well where it is tight on space due to the pipes and pumps.

Cost of Controller £430.00 with a 1-4 week delivery time

Pulsar Ultra 5. – This level controller provides flexible and reliable non contacting ultrasonic level and volume measurements. This controller has a built in wizard for quick setup of applications. Can record data on to a Micro SD card. It has 5 control relays and 1 analogue output. Analogue input is an extra which needs to be asked for.

Cost of controller = £690.00 with a 3-4 week delivery time.

The advantage of using a pulsar ultrasonic controller is the sensor. Each ultrasonic sensor whether its Siemens or Pulsar have an Echo blanking range.

Siemens blanking range for a XRS5 sensor is 300mm

Pulsar blanking range for dB3 sensor is 120mm

The blanking range can play a key part when distance is an issue as if level reach into these ranges then level values will no longer be measured and the ultrasonic will fault to loss of echo.

The choice of level controller is between the Pulsar ultra 5 and Siemens Hydorranger 200.

After discussions with the client and selected by the operation staff of Welsh Water as personal preference the Pulsar Ultra 5 is to be used

Welsh water specification, specify that their pumping station must be intelligent control and require a PLC with HMI interface. The framework PLC is a Mitsubishi Q series with GT27 HMI. Using a PLC makes PID control easy as all Digital input/ output and analogue cards can be bought and fitted. This makes future development and expansion easier.

The client decided to change the constraints of the project and find another solution to remove the use of a PLC and find a device that is on the frame work which had the ability to carry out the function of PID. The purpose of this was to cut costs as PLC programming can only be done by frame work selected companies and they tend to be expensive, another reason is that the operations team wanted to find a simple device that they can access and replace without the use of laptops and software.

Research and communication between frame work suppliers lead to the new Pulsar Ultimate controller.

This controller combines ultrasonic level, flow measurement. RTU and advanced pump control all in to one easily programmed module unit. It has dedicated web server remote control and a touch screen HMI

The ultimate controller also can be expanded with extra modules, it has built in pre- selected features for pump blockage detection, automatic resets and can select the most efficient pump. For cost saving this unit combines HMI, PLC and level controller all into one unit.

The analogue input allows for the Siemens Flowmeter inverter output to be connected to it and two analogue outputs, one of which will be connected to the telemetry unit for remote monitoring of the wet well levels and the other for speed control of the VSDs.

Cost of controller and sensor £1280.00 with 2 weeks delivery time.

The proposal was put forward to Welsh Water and the client as a technical query and was accepted as a preferred design. This is the first time this unit has been trailed to run a pumping station as a PID loop.

6. Project Planning, Work breakdown and Management Techniques

As the project is client driven and there are various contractor companies working on the project, collaboration meetings were held over MS Teams to produce an agreed programme of works.

A project plan has been produced using MS project and the full program of works is in Appendix C.

The detailed work structure has been broken down into all key elements from creating design drawings and get them approved too getting all materials to site for the installation.

Figure 1 below shows a snip it of the task breakdown.

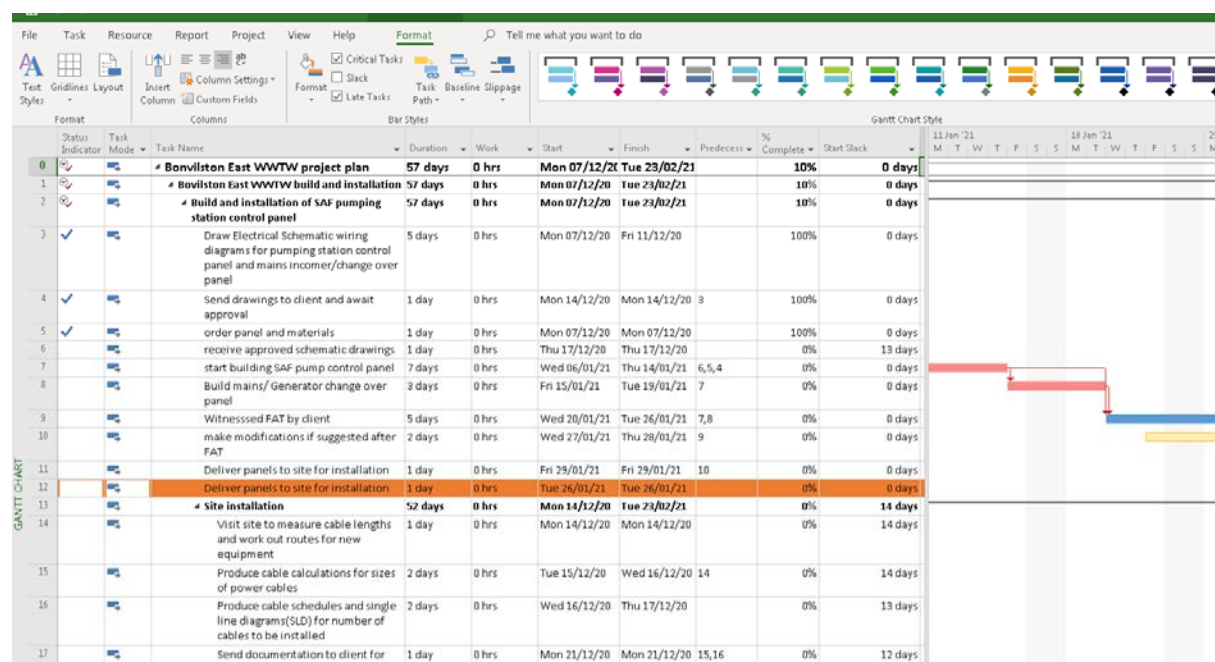


Figure 1MS project task breakdown

Using critical path and miles stones on MS project as highlighted all the tasks that need to be completed by a specific date to meet the deadlines set by the client. Figure 2 below shows the critical path for the build of the SAF pumping station control panel and the mile stone delivery to site date. It also shows that the whole build stage to delivery is critical as the client has set tight time lines.

DETAILED, BUT A BIT LINEAR.

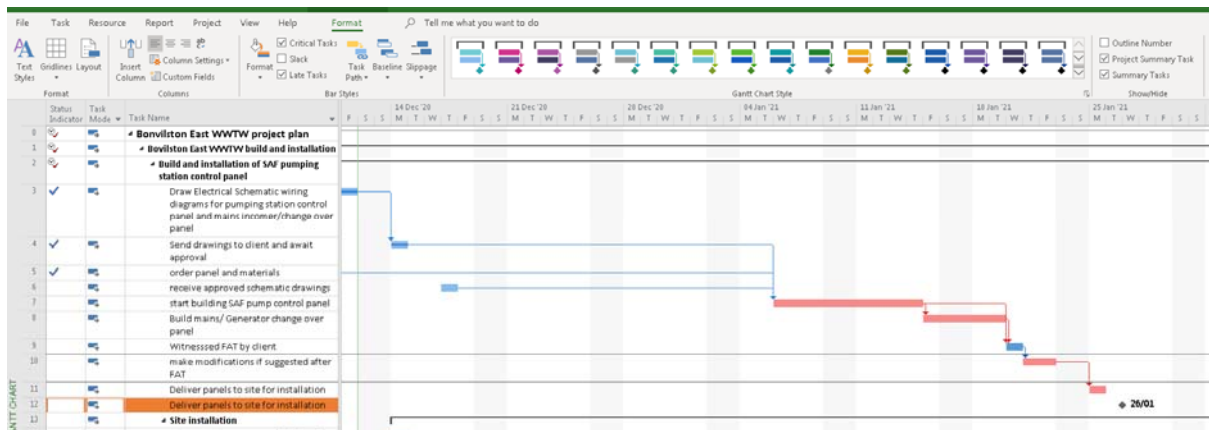


Figure 2 MS Project Critical Path and Mile Stones

Each task will be allocated labour, by using the resource table in MS project each person can be added as a resource and the cost per hour. All the tasks on the breakdown structure will then be allocated resource Figure 3 shows the resource table.

Task

Resource

Report

Project

View

Help

Format

Tell me what you want to do

Assign Resources

Resource Pool

Add Resources

Information

Notes

Details

Level Selection

Level Resource

Level All

Leveling Options

Clear Leveling

Next Overallocation

Assignments

Insert

Properties

Level

Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt.	Cost/Use	Accrue	Base	Code	BUDGET CAT.
Carl Jones	Work		C		100%	£43.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
	Work				100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
	Work				100%	£43.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
Doug	Work		D		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
Phil	Work		P		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
Jack	Work		J		100%	£30.00/hr	£0.00/hr	£0.00	Prorated	Standard		STAFF
BUDGET STAFF	Work		B						Prorated	Standard		STAFF

Figure 3 MS Project resource table

The budget labour hours for the work is 656 hours, using MS Project a staff budget recourse name was made up, this allows the hours and cost of the labour to be monitored as the tasks are completed an the hours are entered. Figure 4 and 5 show the hours enter against each task and the costs.

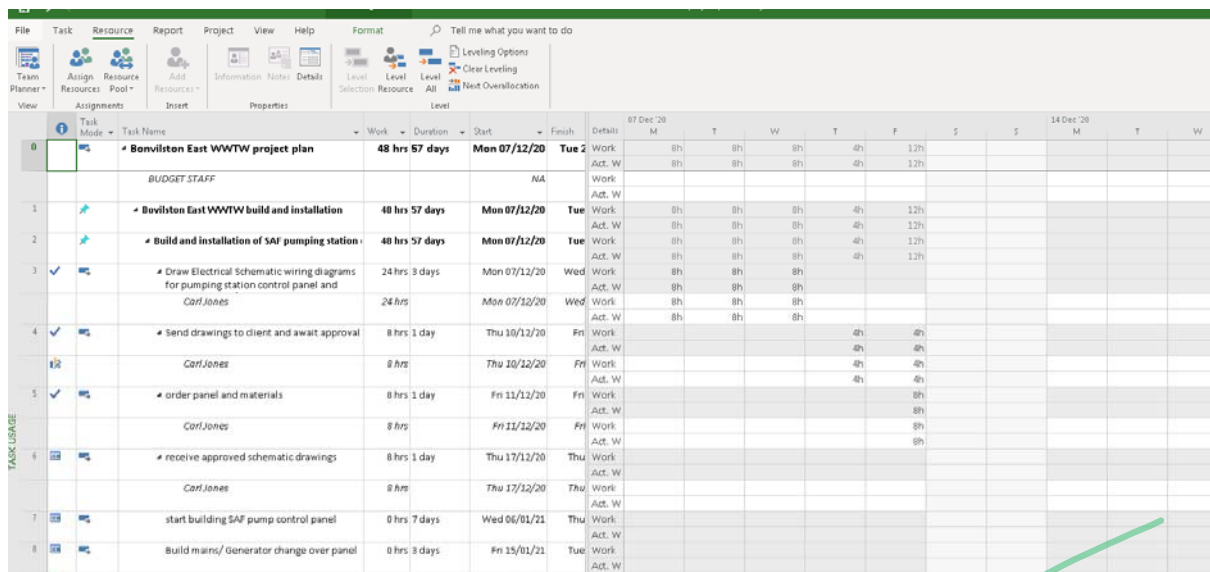


Figure 4 Labour hours completed for each task

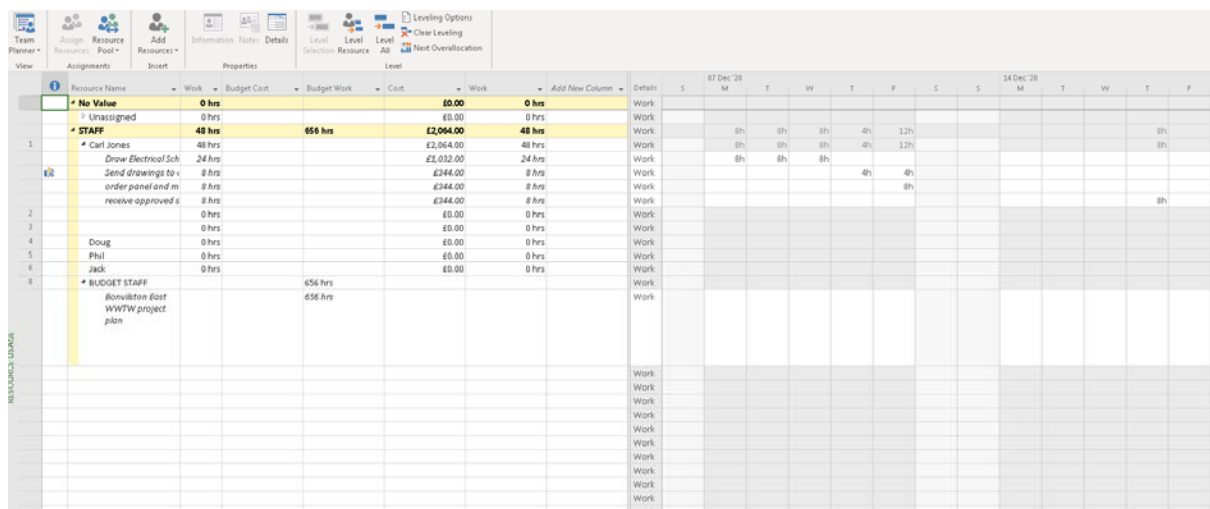


Figure 5 Budget hours, hours worked and cost of labour for tasks worked

The program has to be updated every day and percentages on work complete entered this allows any slippages in tasks to be picked up. As part of the contract with the client a program of completed works must be issued each month. Payment for work completed from is from an activity schedule issued to the client, percentages are place against each payment and the client will compare to the up to date programme of works at that date. The activity schedule is in appendix D

7. Conclusions and Recommendations

To conclude the assignment, all objective set out in the assignment brief have been achieved.

The understanding of the project background was fully explained and all the constraints for the project which have been set by the client and the technical specification and standard regulations that must be adhered to.

A full functional design specification was achieved which form the factory and site test plans were derived.

Research into the design brief and to what equipment could be used, as the project is client based then, a lot of their technical specification had to be used and their agreed framework suppliers

A fully created program of works was created and will be used to achieve a successful project to be delivered on time and to the clients agreed specification.

VERY BRIEF FOR A
MAJOR PROJECT. NO
CRITICAL ANALYSIS.

8. Citation List

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9. Appendix

SOIL RESISTIVITY TEST

Tester:		Address/Location:		Type of Supply:		Intstruments:			
Test Date:				TN-S		Loop Impedance:			
Signature:				TN-C-S ←		Continuity:			
Project No.				TT		Insulation:			
				Ze at Origin: ohms		RCD Tester:			
Method of Protection Against Direct Contact:				PFC: kA					
Description of Work: Main earth point on DNO cutout to be tested for soil resistivity									
AUX. EARTH SPIKES B EARTH UNDER TEST A									
Tester specification									
Make		Kewtech							
Model		KT65 8 in 1 tester							
Earth Frequency		825Hz							
Range		20/200/2000Ω							
Accuracy		20Ω range : ±(3%rdg+0.1Ω) 200/2000Ω range : ±(3%rdg+3dgt) (Auxiliary earth resistance 100±5%)							
Test type applied		3 point							
Test		Test No.1		Test No.2		Test No.3		Test No.4	
Distance A									
Distance B									
Direction (N/S/E/W)									
Ground type									
Weather condition (wet/dry)									
Time of day									
Test results						Ω		Ω	
Description of direction tested from earth under test:									

SCHEDULE OF TEST RESULTS

Tester:	Address/Location of Distribution Board:	Type of Supply:	Instruments:
Test Date:		TN-S	Loop Impedance:
Signature:		TN-C-S	Continuity:
Project No.		TT	Insulation:
		Ze at Origin:	RCD Tester:
Method of Protection Against Direct Contact:		PFC:	

[illegible]

Deviations From Wiring Regulation and Special Notes:

01/12/2020

Item	Activity	Quoted amount	Revised amount
1.0	Supply and installation of cable containment, local junction box stands	£3,500.00	
2.0	Supply and installation of 1 No. 'Power Distribution Board' - Wall mounted, TP&N, 50Hz 8 Way Distribution Board	£1,900.00	
3.0	Design, Supply and installation of 1 No. 'SAF Lift Pump Station LCP Wall mounted Form 2 panel with 2 No. standalone VSD starters.	£13,990.00	
4.0	Supply of 1 No. IP55 min rated enclosure to house a 24V power supply and associated terminations for Sludge Holding Tank level transmitters	£1,010.00	
5.0	Design, Supply and installation of 1 No 100A Wall Mounted Main Incomer & Generator changeover fused switch panel & Portable Generator socket.	£2,850.00	
6.0	Supply and installation of power cabling from the 'Power Distribution Board' to 'SAF Lift Pump Station' Control Panel.	£750.00	
7.0	Supply and installation of control & status cabling from the 'SAF Lift Pump Station LCP' to the Telemetry Outstation	£680.00	
8.0	Supply and installation of power cabling from the 'DNO Cut-out' to 'Main Isolator Fuse Switch Panel'.	£817.00	
9.0	Supply and installation of power cabling from the 'Main Isolator Fuse Switch Panel' to the 'Power Distribution Board'.	£817.00	
10.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'Power Distribution Kiosk Building Services Board'.	£380.00	
11.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Lift Pumping Station Kiosk Building Services Board'.	£465.00	
12.0	Supply and installation of power cabling from the 'Power Distribution Board' to the SAF Lift Pump Station & Sludge Tank Pipework Trace Heating Controllers	£860.00	
13.0	Supply and installation of control/signal cabling from the SAF Lift Pump Station & Sludge Tank Pipework Trace Heating Controllers to the Telemetry Outstation	£993.00	
14.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Aeration Blower Package plant LCP'	£1,100.00	
15.0	Supply and installation of power cabling from the 'Power Distribution Board' to the 'SAF Desludge Pump Package plant LCP'	£1,056.00	
16.0	Supply and Installation of all control / signalling cabling between the 'SAF Aeration Blower LCP' and the Telemetry Outstation.	£1,025.00	
17.0	Supply and Installation of all control/ signalling cabling between the 'SAF Desludge Pump LCP' and the Telemetry Outstation.	£1,025.00	
18.0	Supply and installation of all power and control cabling for all drives and Instruments fed from the 'SAF Lift Pump Station' LCP to the following;		
19.0	SAF Lift Pumps 1 & 2	£1,490.00	

[illegible]