

Project Report 2320629

by James Summers

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Good use of tables

TATA Steel

Built in 1951 Trostre Steelworks, originally owned by the Steel Company of Wales, then later as British Steel and Corus Group. Before being bought by Indian steel makers TATA. Trostre site now known as packaging steel specialises in coatings and customer distribution. It contains 13 different lines which include pickling, annealing, reduction mills coatings in tin/chrome/Protact, coil inspection and then packaging. Trostre specialises in Tin and Chrome coating from its electrolytic tinning line and Electrolytic chrome coated steel line. Trostre is the lead producer for large companies such as Heinz and Crown Holdings.



Figure 1 - TATA Steel Logo

Introduction & Background Research

CAPL Sump Pump System Upgrade

The project goal is to upgrade the sump pump system used in the CAPL (Continuous Annealing Processing Line) Exit basement. The old system had become damaged and unreliable causing the basement to flood on a regular basis, resulting in health and safety issues. The upgrade would involve removing the old system, and replacing it with a new panel with more modern components, which would improve site safety and reliability. *Good description of problem*

The old system had multiple issues, including a lack of reliability due to the aged components, and requiring large amounts of maintenance, which required spending vast amounts of time and money to ensure it remained in operation. Due to this, the company has suggested installation of a newer more modern system. The new system would rectify these issues, providing better safety and reliability and longevity to the line. *Good argument for project*

Research

The new sump pump system could be controlled using multiple different methods, therefore a range of research will be undertaken to investigate these. This will support the solution selected later on in the project. *Good pointer for solutions*

Ultrasonic Measurement

The first suitable method could be to use an ultrasonic level sensor. Ultrasonic sensors operate by emitting a high frequency sound waves towards the liquid, the time taken for the echo to return to the device is measured and converted into a distance. This allows for non-contact measurement. (Vega, 2025)

Ultrasonic sensors are used commonly in industrial applications and have a variety of uses. Due to the non-contact method of measurement, they are a popular choice for level measurement when chemicals are involved. Ultrasonic sensors can vary in price based upon brand and their measurement range, this can vary from £400 for a device that's capable of measuring 5m and £1500 for a device that can measure up to 30m. (RS, n.d)

Good information and ref source



Good supporting image

Figure 2 - Ultrasonic Sensor (RS, n.d)

Correct citation

Float Switch System

The second suitable method to control the level would be use float switches. These switches contain a magnet that travels along a guide stem, which is moved up and down based upon the orientation of the float. Float switches are usually 2-3 wire devices that can contain both normally open and closed contacts, that are used to control contactors in relay logic style circuits. They are commonly used to control fluid levels in sewage systems. Float switches are an appealing option due to their low cost and reliability. (Tameson, n.d)

Good explanation with ref source



Figure 3 - Float Switch (Tanks Direct, n.d)

Microcontroller System

A third suitable method to control the level would be a microcontroller. A microcontroller is a circuit that is programmed to complete specific actions, an example of this is Arduino which is an open source platform which was developed for prototyping aimed at students in particular. This style of system would again use an ultrasonic style sensor to complete the measurement however the actions would be controlled using code. The main advantage to a system of this nature is that it can be configured to whatever the system required making it versatile in industrial applications. Arduino is usually written in the C programming language. (Arduino, 2025)

Good explanation

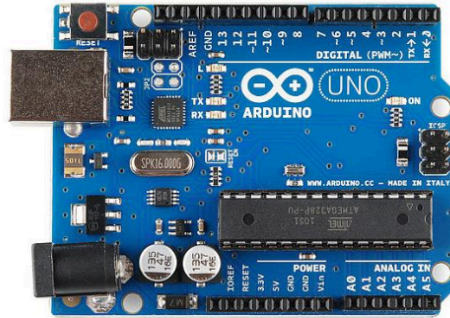


Figure 4 - Arduino Image (SparkFun, n.d)

Specification

Project Outcomes

The project must upgrade the existing sump pump system in the CAPL Exit basement to ensure it can reliably manage and control rising water levels. The system must automatically activate the sump pump when the water reaches a defined level, and stop the pump when the water has been sufficiently drained. It must also include a manual control option via a 3-way switch, allowing operators to control the system manually if required. A high-level alarm must be installed to immediately alert operators if the water level gets too high, helping to prevent any flooding or damage to electrical and mechanical equipment in the basement. The system must provide safe maintenance access through the installation of a lockable isolator.

Good description of requirements

Time and Budgeting Constraints

The new upgrade must meet the strict timeline of 24 weeks from beginning to end, to allow it be installed during the annual maintenance period. The project budget is £3000 and the estimated cost is expected to fall between £2500 and £3000, to cover all the necessary equipment. Close management of both time and budget is critical to ensure that the project meets its goals without exceeding the timeframe or set budget.

User needs, Maintenance and Reliability

The system must be easy to use and understand. The sump pump system must work automatically under normal conditions, switching on and off using float switches without needing constant attention. Manual control must be available through a 2-way switch, therefore it can be changed when required. The system must feature clear visual and audible alarms if the water level becomes

too high. Maintenance needs to be straightforward; the system will be added to the existing six-week maintenance checks, ensuring that it remains reliable and functional without excessive service demands. The system reliability is crucial due to its safety requirements.

Health and Safety

To meet health & safety requirements, the system must feature a fully lockable isolator to allow safe maintenance. This is to meet the TATA Steel lock-out/tag-out procedure to prevent accidental pump reconnection during maintenance work. All electrical and mechanical installations must comply with UK regulations and be rated for safe use in wet or confined environments. A risk assessment for the system was created to ensure all risks had been considered and control measures are put in place.

Good relevant explanations of requirements

Table 1 - Project Risk Assessment

Risk	Likelihood	Severity	Risk Rating	Control Measures	Residual Risk
Electrical Shock During Installation or Maintenance	Medium	High	High	- Lockable isolator installed for safe lock-out/tag-out.	Low
Pump or Equipment Malfunction	Medium	High	High	- Regular maintenance checks every 6 weeks.	Medium
Slip, Trip, and Fall Hazards (due to water leaks)	Medium	Medium	Medium	- Ensure proper drainage and spill containment. - Regular floor cleaning and checks.	Low
Exposure to Hazardous Chemicals (if water contains contaminants)	Low	High	Medium	- Use of PPE (Personal Protective Equipment) - Chemical safety training.	Low

Good simple risk assessment

Sustainability

The new system must effectively complete the actions that are required safely and effectively. The system will comprise of new components that come from green suppliers to ensure it maintains the longevity of the environment to align with Tata Steel's green policies.

This is relevant to the industry

Planning

To ensure the project was completed within a set time frame a gantt chart was completed with a proposed timeline, with key dates included for each stage within the design process. The project was dedicated a 24-week time period.

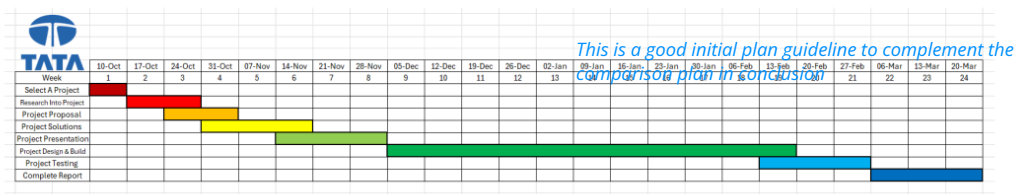


Figure 5 - Proposed Gantt Chart

A second gantt chart (Figure 27 See Conclusion) was created with the actual dates over the time frame, this shows how the project progressed against the predicted timeline. Along with a gantt chart, a system test plan was created, ensuring the new system operated to the correct standards and procedures.

Point is made that there is a comparison plan

Table 2 - Proposed Testing Table

Test Number	Test Description	Purpose	Acceptance Criteria	Pass/Fail	Comments
1	Continuity of Earthing Conductors	Ensure all earthing points are secure and connected	Continuity at all earth points within the system		
2	Insulation Resistance Test	Verify insulation between live conductors and earth	>1 MΩ at 500V DC as per (BS 7671 minimum requirement)		
3	Pump Polarity Check	Ensure correct wiring for pump	Correct polarity of pump		
4	Auto Start via Start Float	Confirm pump starts automatically at high water level (start float)	Pump energizes when start float is made		

5	Auto Stop via Stop Float	Confirm pump stops automatically when stop float is reached	Pump de-energizes when stop float is made		
6	High Level Alarm	Confirm alarm triggers when high level is reached	Audible alarm activates at high level		
7	Manual Control Test	Verify the system works when the 2-way switch is set to manual and start pump is pressed	Manual switch energizes and de-energizes pump		
8	Isolator Functionality Test	Confirm the lockable isolator disconnects supply for safe maintenance	Isolator Functionality Check		

Good work here

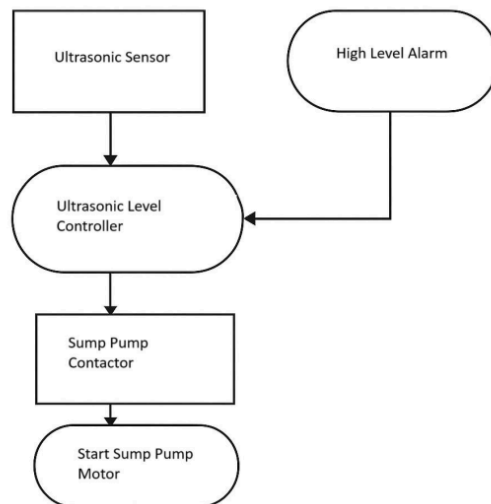
The testing plan will be used later on in the project to check the installation is successful and if any further work is required.

Considered Solutions

To ensure the project met the specification, a series of solutions had to be considered. The background research was evaluated and suitable solutions were investigated.

Solution 1 – Vega Ultrasonic Sensor

Solution 1 is a level control system using a Vega ultrasonic sensor. To set the device up a Vega software package is required, in addition to the sensor itself. The sensor completes all the calculations internally, based upon parameters entered into the software. The sump pit will require measurements such as height and width, to calculate the level and any deadbands if required. A simple block diagram was created to represent the system.



Good supporting block diagram

Figure 6 - Vega Ultrasonic Sensor Block Diagram

A table of estimated costings for this method was created, providing a rough estimate of the total price of the system.

Table 3 - Vega Ultrasonic Sensor System Estimated Costing

Item	Description	Estimated Cost (£)
1. VEGA Ultrasonic Sensor	VEGA Sensor	£500 – £1000
2. Signal Cable / Wiring	Shielded signal and power cables, connectors	£100 – £250
3. Software License / Configuration	VEGA Tools software	£250
4. Pump Controller	Controller	£250 – £500
5. Contactor Panel	Enclosure, 3-phase contactor, thermal overload, din rail, terminals, etc.	£250– £500
6. Power Supply (Transformer)	24V DC for control circuit	£100 – £200
7. Mounting Accessories	Brackets, junction boxes, hardware	£200 – £400
Total Cost		£1310 - £3050

Using this method the system would come to around £4500 with the labour of installation included. The ultrasonic sensor costs around £1000 without the software package that is required to configure the device. Besides the cost aspect, this solution would be suitable and meet the set specification. As the main advantages to this system are there is no maintenance required to the device itself, the device is non-contact meaning it doesn't touch the liquid, therefore maintenance is made safer due to having no potential interference with contaminated liquid. The disadvantages to this system are the cost implication and the system setup will require further training meaning there could be potential for further required costs.

Good argument as a solution

Solution 2 – Float Switch System

Solution 2 is a Float switch system with a stop start contactor based panel. This features a circuit wired up using relay logic with a series of normally open and closed contacts to start and stop the pump. The system follows a similar design to the old panel that was removed, however the design is modernised and more reliable using newer environmentally-friendly components. This design would be a suitable solution as it meets the design specification. A basic block diagram for the system was created to show its operating procedure.

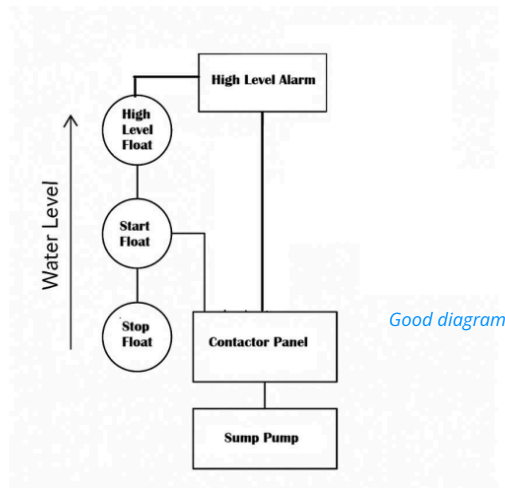


Figure 7 - Float Switch System Block Diagram

A table of estimated costings for this method was created, providing a rough estimate of the total price of the system.

Table 4 - Float Switch System Estimated Costing

Item	Description	Estimated Cost (£)
1. Start Float Switch	Normally open (NO), rated for pump control	£20 – £50
2. Stop Float Switch	Normally closed (NC), rated for pump control	£20 – £50
3. High Level Float Switch	NO or NC, triggers alarm only	£20 – £50
4. Contactor Panel	Includes contactor, overload relay, terminals	£250 – £500
5. High Level Alarm	Audio/visual beacon or panel alarm	£50 – £150
6. Enclosure / Mounting & Consumables	Weatherproof or IP-rated box, DIN rail, brackets	£250– £500
Total Cost		£610 - £1300

The main advantage to this solution is the low cost of implementation, which can be seen from the estimated costing table for this system. Along with the low cost, the technology has been used in previous systems and there is a large knowledge base of this on the site. The systems simplicity allows for simpler fault finding and the system is overall easy to design and build. The main disadvantage to this system is that the float comes into contact with the potentially hazardous liquid, therefore extra safety precautions will be required to undertake maintenance.

Solution 3 – Arduino Level Control

Solution 3 is to use Arduino to control the level in the sump pit, the system would comprise of a non-contact sensor that would then be connected to a driver board. The system would still require a contactor panel to control the pump. A LCD would be used to display the water level, this would be completed by writing a C program for the system. A basic block diagram for the system was created to show its operating procedure.

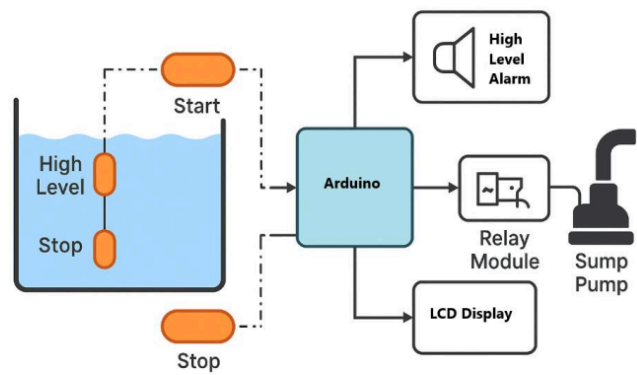


Figure 8 - Arduino Level Control System Block Diagram

The main advantages of this solution is the low cost implementation which can again be seen from the table of estimated costings, this system is also very compact in design making it suitable for applications with small spaces. However, there are multiple disadvantages to this solution, the first is the complexity of the coding required for the systems operation, along with this there are very few tools available to help fault find on the equipment. A table of estimated costings for this method was created, providing a rough estimate of the total price of the system.

Table 5 - Arudino Level Controller Estimated Costing

Item	Description	Estimated Cost (£)
1. Arduino Board	Arduino Driver Board	£30 - £50
2.Ultrasonic Sensor	Level Sensor	£50 - £75
3.Relay Module	Controls Outputs and Interfaces Control Voltages	£100 – £200
4.Power Supply	Provides Control Voltages	£50 - £100
5.Panel Enclosure & Mounting Consumables	Weatherproof or IP-rated box, DIN rail, brackets	£250– £500
Total Cost		£480 - £925

Comparison of Solutions

To select the most suitable method a comparison table was created to weigh up the advantages and disadvantages of each solution.

Table 6 - Solution Comparison Table

Comparison Category	Solution 1 – Vega Ultrasonic Sensor	Solution 2 – Float Switch System
Cost	This is the most expensive solution coming in at £3000 just for components	This is the cheaper solution with components coming in at around £1300
Complexity of System	This system is complex to setup, due to the training required to use the software package	This system is simple to build, the technology is widely used on site
Size	Medium Sized Panel	Medium Sized Panel
Which suits the project objectives?	Solution 1 would be a suitable option for the system however the cost and complexity of the project it would be unsuitable for the timeframe	Solution 2 is the best option for the system as it meets all the criteria set out for the project across all aspects
Additional Comments	This solution would be unsuitable for the project as the additional cost and training requirements would mean the project would run significantly over budget and would exceed the 24 week time plan	This is the best solution for the project as relay logic is widely used on site making it easy to fault find on. It also meets all the criteria and cost implications set out in the specification

Selected Solution

From the comparison table it is possible to see that solution 2 is the best choice making it the chosen solution for the project. This solution was chosen due to its simplicity and low cost to implement, falling well within the budget for the project. The technology used for this system is already widely used on plant, proving its reliability. To implement this design there would be no need for additional training will provide a large advantage over the other solutions as there is a lack of knowledge in ultrasonic and microcontroller based systems. *Good argument for the chosen solution*

The solution will contain an incoming 415v supply, fed into a lockable isolator. This will feed the mains part of the system which drives the pump. The mains will have 3 fuses that feed into the line contactors and a thermal to prevent the pump from overworking. A step down transformer will be tapped off from one of the phase to take the voltage down from 415v to 24v for the control circuit. The control circuit will contain the float switches, relays and indication for the automatic control. Pushbuttons will be included with a two way switch to override the system and control it manually. An emergency stop will be implemented to stop the system in the event of an incident.

Implementation

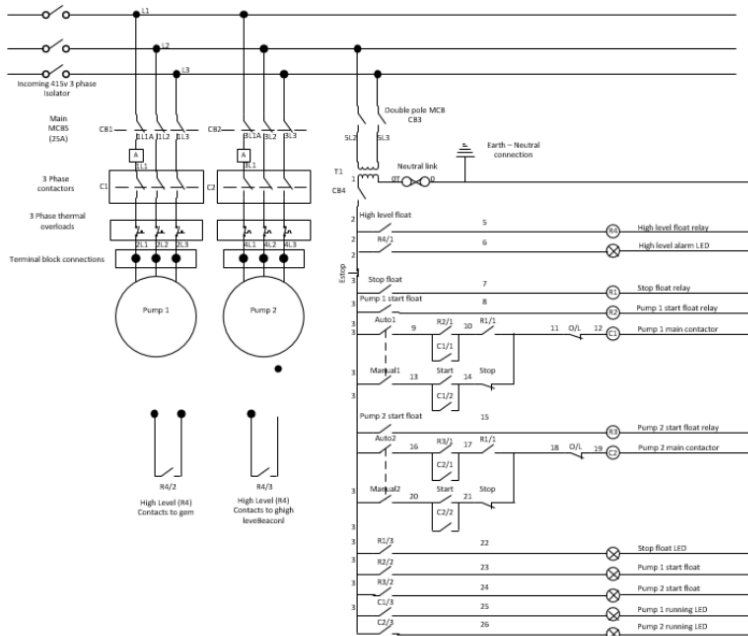
Before the implementation stage could progress, all the items required for the chosen system were ordered by the production lines engineer. A cost breakdown for the whole system is shown in the table below. To reduce the cost of the system, some of the items were used from the internal stores department.

	Component	Quantity	Cost Per Unit (£)	Total Cost (£)
	Schneider Electric Panel 500mm x 500mm	1	157.8	157.8
	Green Pushbutton NO (Normally Open)	1	19.14	19.14
	Red Pushbutton NC (Normally Closed)	1	13.34	13.34
	Emergency Stop	1	37.78	37.78
	White LED	3	4.43	13.29
	Green LED	1	3.9	3.9
	2 Way Switch NO (Normally Open)	1	15.2	15.2
	RS 3 Phase Isolator	1	49.23	49.23
	Ammeter 0-60A	1	12.17	12.17
	Schneider Electric Transformer 415v-24v	1	78.17	78.17
	Schneider Electric 3 Phase MCB 25A	1	112.05	112.05
	Schneider Electric 3 Phase contactor	1	106.49	106.49
	ABB Single Phase MCB 6A	1	56.3	56.3
	ABB Single Phase MCB 1A	1	12.49	12.49
	Omron 24v AC Relay	3	9.6	28.8
	Neutral Link	1	6.1	6.1
	6mm Mains Cable	1	0	0
	1mm Control Cable	1	0	0
	Float Switches	3	202.3	606.9
	Trunking	1	0	0
	Unistrut 5m Length	1	0	0
	Total Cost (£)		1329.15	

Figure 9 - Final Solution Costings

Good costings breakdown, but would be better suited in the spec or design requirements

Once all the items had arrived the assembly process could begin. The line engineer provided a drawing for the system, which would fit the standard across the site and match up with similar systems on the line.



Good cct diagram

Figure 10 - Sump Pump Circuit Diagram

The items were accumulated from stores department and were marked against the purchase list to ensure all the components had arrived. Fortunately, all the items had arrived on time ensuring the implementation stage could commence on time with the project gantt chart. (Figure 11)



Figure 11 - System Components

The process began by assembling components onto the back plate of the panel, lengths of trunking were measured and cut before having pilot holes drilled and secured using self tapping screws. (Figure 12).

Good evidence

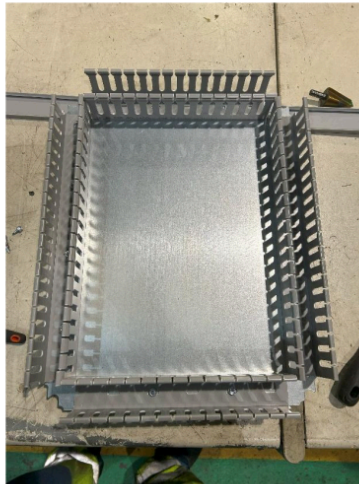


Figure 12 - System Back Plate Assembly

The components were then loosely placed onto the back plate to create a template layout for the design to ensure everything fitted correctly and looked neat and tidy. Once a template design was made, the backplate was measured and marked to be ready for drilling. (Figure 13)

Good evidence



Figure 13 - System Design Template

A template for the front of the panel was also created, this ensured all the pushbuttons and lights were symmetrical and suitably spaced apart. A small pilot hole was then drilled before using a holesaw to fit the pushbuttons and LEDs.

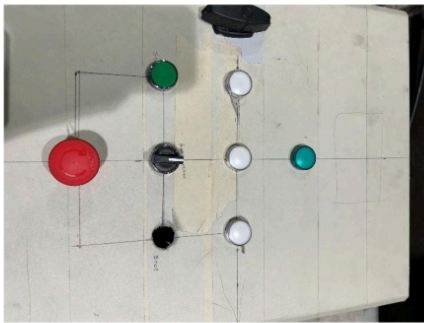


Figure 15 - Completed Panel Door

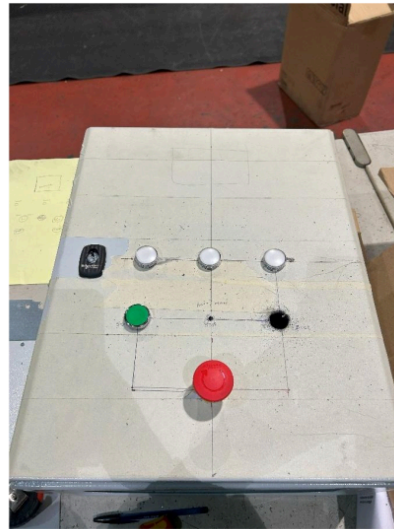


Figure 14 - System Panel Door Assembly

Once fixed to the backplate, the system wiring could then begin. A final drawing was then created with the finalized cable schedule and the ferruling numbers for the system. The 415V mains for the system was wired first, before the smaller 24V control.

Upon completion of the wiring the system was thoroughly tested to ensure correct operation. (See testing results in testing section). This was completed in the workshop to ensure that the panel was fully operational and to iron out any teething issues before the installation. Before conducting the testing plan small checks such as the tidiness of wiring and security of the connections were completed.

Good evidence with panel build



Figure 16 - Completed System Wiring

The panel was then tested as per the agreed testing plan (Table 2 from Section 3) and was tested thoroughly using the approved equipment. The system passed all the testing procedures allowing the system to be installed at the next maintenance stop. The lines engineer was then notified of the progress made with the system and a job was then placed onto the SAP system for the maintenance to install the new panel.

Before installation of the new system could commence, the old panel had to be removed safely. Upon inspection of the job, the basement was found to be severely flooded, this was due to the supply of the old system being switched off with the maintenance isolations a couple of days prior. The lines engineer was contacted to report the safety issue. Due to this safety issues the installation was paused until the water level had dropped. Two temporary submersible 110v pumps were obtained to drop the level. (Figure 16).



Figure 17 - Flooded Basement

After the water level had dropped the job safety was then reviewed, a one minute risk assessment was completed to ensure the area was free from any further hazards. The old system was then tested to ensure there was no voltage present and was disconnected/dismantled safely. The new system was then transported using correct manual handling techniques to the basement ready for installation. (Figure 17)

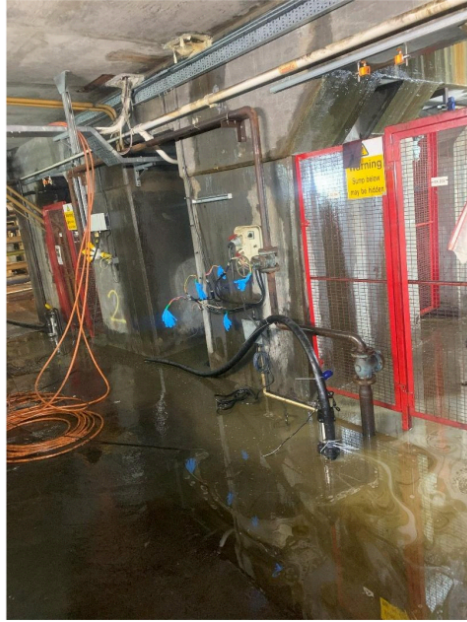


Figure 18 - Removal of Old System

Once the old system was removed, the new panel could be prepared ready for installation, lengths of Unistrut were measured and cut to suitably fix the panel to the wall. Once the panel was fixed to the wall all the supply cables were measured, cut then glanded using IP rated glands into the bottom of the panel. The supplies were connected into the terminal blocks at the bottom of the panel. All the cables were secured properly with the appropriate clips to ensure neatness.

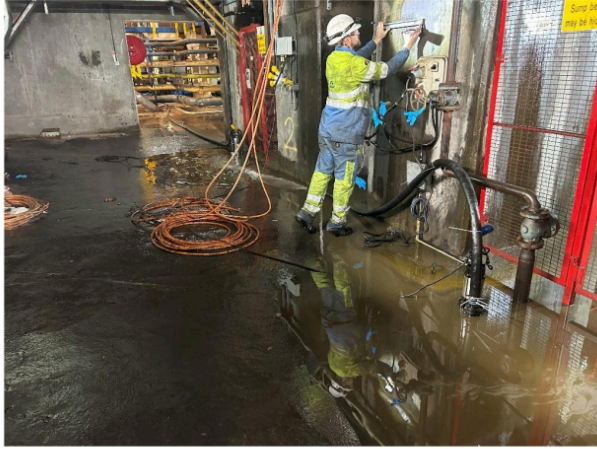


Figure 19 - Installation of Brackets for New Panel

Another two lengths of Unistrut were then measured and cut to place the cables for the float and sump pump into for protection. These were again connected to the terminal rail connections in the panel.



Figure 21 - Sump Pump Cable Unistrut



Figure 20 - Sump Pump Cable

To finish the installation the panel was labelled to ensure the system was used correctly by the operator.

A good panel design with functions



Figure 22 - Completed Installation

Testing & Results

The proposed testing plan (Table 2 from Section 3) was then used to check the installation met the original outcomes and specification. All testing was carried out using approved testing meters and GS38 approved testing leads.



Figure 23 - Approved Testing Leads (Silvertronic, n.d)



Figure 24 - Approved Testing Meter (Farnell, n.d)

Table 7 - Completed Testing Table

Test Number	Test Description	Purpose	Acceptance Criteria	Pass/Fail	Comments
1	Continuity of Earthing Conductors	Ensure all earthing points are secure and connected	Continuity at all earth points within the system	Pass	Acceptable value achieved (Figure 25)
2	Insulation Resistance Test	Verify insulation between live conductors and earth	>1 MΩ at 500V DC as per (BS 7671 minimum requirement)	Pass	Acceptable value achieved
3	Pump Polarity Check	Ensure correct wiring for pump	Correct polarity of pump	Pass	Pump went correct direction and water level dropped
4	Auto Start via Start Float	Confirm pump starts automatically at Start float level	Pump energizes when start float is made	Pass	Pump started when switched into auto
5	Auto Stop via Stop Float	Confirm pump stops automatically when stop float is reached	Pump de-energizes when stop float is made	Pass	Pump stopped when water level dropped to the stop float (Figure 26)
6	High Level Alarm	Confirm alarm triggers when high level is reached	Audible alarm activates at high level	Pass	High level alarm activated when water level was high
7	Manual Control Test	Verify the system works when the 2-way switch is set to manual and start pump is pressed	Manual switch energizes and de-energizes pump	Pass	Pump started and stopped when switched into manual control
8	Isolator Functionality Test	Confirm the lockable isolator disconnects supply for safe maintenance	Isolator Functionality Check	Pass	Isolator worked correctly disconnecting supply

The first test was to check the continuity of all earthing conductors in the system, this involved checking all the earth points and ensuring they were clean, secure and connected properly. An acceptable reading was obtained meaning the system passed.



Good evidence

Figure 25 - Test 1 - Continuity of Earthing Conductors

The second test was to conduct an insulation resistance test to check the insulation between the live conductors and earth the system passed with an acceptable result over 1m ohm.

The third test was to check the polarity of the sump pump, this involved starting the pump manually and see if the water level dropped. The system passed.

The fourth and fifth test in the table is to check the pump started when the start float was activated, the pump started, and the water level dropped and stopped when the level reached the stop float. This system satisfied these tests.



Good evidence

Figure 26 - Test 5 - Stop Float Activated

The sixth test was to check that the high level alarm was operational when the water level became high. The system passed this test.

The seventh test was to control the system in manual, this meant turning the two way switch into manual mode and starting and stopping the pump. This test proved to be successful.

The final test was to prove that the lockable isolator was functional. It was turned to the off position and a multimeter was used to check the incoming supply to the mains of the system. There were no volts present proving the isolator was working correctly.

Good explanations

Discussion, Conclusion & Recommendations

In conclusion the project can be considered successful, this is due to the project outcomes and specification being met and the project be completed and installed on time. This can be seen on the completed timeline gantt chart (Figure 25). The gantt chart planner proved crucial in the execution of the project as it allowed progress to be made and tracked every week. This ensuring the research, design and development stages could be completed successfully. Whilst some sections were not completed as per the estimated time the project was completed on time. Another successful aspect of the project was that all the work was completed under the set budget of £3000, the amount used was £1329 meaning it was £1671 under.



Figure 27 - Completed Gantt Chart

After all the testing was completed, it is possible to see the project is completely operational and fit for purpose. This is due to all the testing criteria and original specification being met. All the maintenance procedures have been adapted to suit the new system and a recurring weekly check for the system have been put in place. All operators of the line have been notified of the update of the panel and have received a training session about how to operate the panel. A small document with this information was also created by the lines manager as a point of reference also. #

The project has demonstrated sustainability by efficiently utilizing local resources, such as using existing stock of items or ordering from local companies. All the components used were from recycled material ensuring less of a carbon footprint and any waste product was disposed of correctly as per Tata's recycling policies. By completing all these measures it has improved the sustainability of the project.

The main recommendation for this project would be to implement a HMI or SCADA screen, with a visual representation of the sump pit and the water level. This would allow the operator to receive live feedback of the state of the system and provide an accurate idea of the water level. It would provide aid in the event of a malfunction as the operator would be able to see the rising level and would able to do something about it sooner.

Good relevnt recommendation that would need a cost

Log Sheet

1

Log No	1
No hrs	5
Running total hrs	5

TATA Steel

Built in 1951 Trostre Steelworks, originally owned by the Steel Company of Wales, then later as British Steel and Corus Group. Before being bought by Indian steel makers TATA. Trostre site now known as packaging steel specialises in coatings and customer distribution. It contains 13 different lines which include pickling, annealing, reduction mills coatings in tin/chrome/Protact, coil inspection and then packaging. Trostre specialises in Tin and Chrome coating from its electrolytic tinning line and Electrolytic chrome coated steel line. Trostre is the lead producer for large companies such as Heinz and Crown Holdings.



Figure 1 - TATA Steel Logo

Introduction & Background Research

CAPL Sump Pump System Upgrade

The project goal is to upgrade the sump pump system used in the CAPL (Continuous Annealing Processing Line) Exit basement. The old system had become damaged and unreliable causing the basement to flood on a regular basis, resulting in health and safety issues. The upgrade would involve removing the old system, and replacing it with a new panel with more modern components, which would improve site safety and reliability.

Introduction, background information about the company and beginning of the research was conducted

Student signature	<u>J. Summers</u>
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	2
No hrs	10
Running total hrs	15

Research

The new sump pump system could be controlled using multiple different methods, therefore a range of research will be undertaken to investigate these. This will support the solution selected [later on](#) in the project.

Ultrasonic Measurement

The first suitable method could be to use an ultrasonic level sensor. Ultrasonic sensors operate by emitting a high frequency sound waves towards the liquid, the time taken for the echo to return to the device is measured and converted into a distance. This allows for non-contact measurement. (Vega, 2025)

Ultrasonic sensors are used commonly in industrial applications and have a variety of uses. Due to the non-contact method of measurement, they are a popular choice for level measurement when chemicals are involved. Ultrasonic sensors can vary in price based upon brand and their measurement range, this can vary from £400 for a device that's capable of measuring 5m and £1500 for a device that can measure up to 30m. (RS, n.d)



Research into level measurement was conducted. Looking into the different types of measurement available and suitable options for the new Sump Pump system.

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Lecturer Signature	

Log Sheet

Log No	3
No hrs	10
Running total hrs	25

Float Switch System

The second suitable method to control the level would be use float switches. These switches contain a magnet that travels along a guide stem, which is moved up and down based upon the orientation of the float. Float switches are usually 2-3 wire devices that can contain both normally open and closed contacts, that are used to control contactors in relay logic style circuits. They are commonly used to control fluid levels in sewage systems. Float switches are an appealing option due to their low cost and reliability. (Tameson, n.d)



Figure 3 - Float Switch (Tanks Direct, n.d)

Research into methods of level measurement was continued, now investigating contact methods of measurement. (Where the measuring device meets the liquid).

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Lecturer Signature	

Log Sheet

Log No	4
No hrs	8
Running total hrs	33

Specification

Project Outcomes

The project must upgrade the existing sump pump system in the CAPL Exit basement to ensure it can reliably manage and control rising water levels. The system must automatically activate the sump pump when the water reaches a defined level, and stop the pump when the water has been sufficiently drained. It must also include a manual control option via a 3-way switch, allowing operators to control the system manually if required. A high-level alarm must be installed to immediately alert operators if the water level gets too high, helping to prevent any flooding or damage to electrical and mechanical equipment in the basement. The system must provide safe maintenance access through the installation of a lockable isolator.

Time and Budgeting Constraints

The new upgrade must meet the strict timeline of 24 weeks from beginning to end, to allow it be installed during the annual maintenance period. The project budget is £3000 and the estimated cost is expected to fall between £2500 and £3000, to cover all the necessary equipment. Close management of both time and budget is critical to ensure that the project meets its goals without exceeding the timeframe or set budget.

User needs, Maintenance and Reliability

The system must be easy to use and understand. The sump pump system must work automatically under normal conditions, switching on and off using float switches without needing constant attention. Manual control must be available through a 2-way switch, therefore it can be changed when required. The system must feature clear visual and audible alarms if the water level becomes

A specification for the new system was written, including what the system must achieve, budgeting and time constraints, user needs and health and safety.

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Log Sheet

Log No	5
No hrs	15
Running total hrs	48

Planning

To ensure the project was completed within a set time frame a gant chart was completed with a proposed timeline, with key dates included for each stage within the design process. The project was dedicated a 24-week time period.

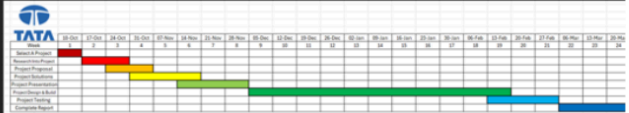


Figure 5 - Proposed Gantt Chart

A second gant chart (Figure 27 See Conclusion) was created with the actual dates over the time frame, this shows how the project progressed against the predicted timeline. Along with a gant chart, a system test plan was created, ensuring the new system operated to the correct standards and procedures.

Table 2 - Proposed Testing Table

Test Number	Test Description	Purpose	Acceptance Criteria	Pass/Fail	Comments
1	Continuity of Earthing Conductors	Ensure all earthing points are secure and connected	Continuity at all earth points within the system		

A project gant chart was created to ensure the project was completed on time and met the time restriction of 24 weeks, a test plan for the system was also created.

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Log Sheet

Log No	6
No hrs	15
Running total hrs	63

Considered Solutions

To ensure the project met the specification, a series of solutions had to be considered. The background research was evaluated and suitable solutions were investigated.

Solution 1 – Vega Ultrasonic Sensor

Solution 1 is a level control system using a Vega ultrasonic sensor. To set the device up a Vega software package is required, in addition to the sensor itself. The sensor completes all the calculations internally, based upon parameters entered into the software. The sump pit will require measurements such as height and width, to calculate the level and any deadbands if required. A simple block diagram was created to represent the system.

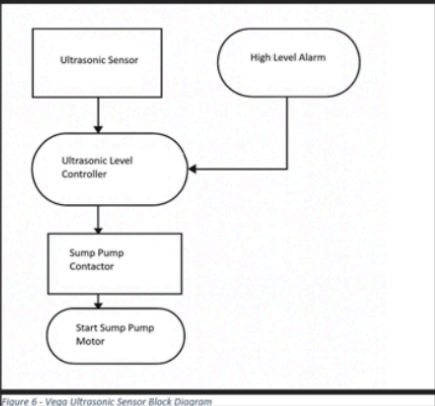


Figure 6 – Vega Ultrasonic Sensor Block Diagram

Using the research obtained, a range of solutions were considered and the advantages and disadvantages were debated to see the most suitable one.

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Log Sheet

Log No	7
No hrs	7
Running total hrs	70

Comparison of Solutions

To select the most suitable method a comparison table was created to way up the advantages and disadvantages of each solution.

Table 6 - Solution Comparison Table

Comparison Category	Solution 1 – Vega Ultrasonic Sensor	Solution 2 – Float Switch System
Cost	This is the most expensive solution coming in at £3000 just for components	This is the cheaper solution with components coming in at around £1300
Complexity of System	This system is complex to setup, due to the training required to use the software package	This system is simple to build, the technology is widely used on site
Size	Medium Sized Panel	Medium Sized Panel
Which suits the project objectives?	Solution 1 would be a suitable option for the system however the cost and complexity of the project it would be unsuitable for the timeframe	Solution 2 is the best option for the system as it meets all the criteria set out for the project across all aspects
Additional Comments	This solution would be unsuitable for the project as the additional cost and training requirements would mean the project would run significantly over budget and would exceed the 24 week time plan	This is the best solution for the project as relay logic is widely used on site making it easy to fault find on. It also meets all the criteria and cost implications set out in the specification

To make a suitable decision the advantages and disadvantages were placed into a comparison table to decide the most suitable solution.

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Log Sheet

Log No	8
No hrs	20
Running total hrs	90

Implementation

Before the implementation stage could progress, all the items required for the chosen system were ordered by the production lines engineer. A cost breakdown for the whole system is shown in the table below. To reduce the cost of the system, some of the items were used from the internal stores department.

	Component	Quantity	Cost Per Unit (£)	Total Cost (£)
	Schneider Electric Panel 500mm x 500mm	1	157.8	157.8
	Green Pushbutton NO (Normally Open)	1	19.14	19.14
	Red Pushbutton NC (Normally Closed)	1	13.34	13.34
	Emergency Stop	1	37.78	37.78
	White LED	3	4.43	13.29
	Green LED	1	3.9	3.9
	2 Way Switch NO (Normally Open)	1	15.2	15.2
	RS 3 Phase Isolator	1	49.23	49.23
	Ammeter 0-60A	1	12.17	12.17
	Schneider Electric Transformer 415v-24v	1	78.17	78.17
	Schneider Electric 3 Phase MCB 25A	1	112.05	112.05
	Schneider Electric 3 Phase contactor	1	106.49	106.49
	ABB Single Phase MCB 6A	1	56.3	56.3
	ABB Single Phase MCB 1A	1	12.49	12.49
	Omron 24v AC Relay	3	9.6	28.8
	Neutral Link	1	6.1	6.1
	6mm Mains Cable	1	0	0
	1mm Control Cable	1	0	0
	Float Switches	3	202.3	606.9
	Trunking	1	0	0
	Unistrut 5m Length	1	0	0
	Total Cost (£)		1329.15	

Figure 9 - Final Solution Costings

The implementation phase could then begin, the project components were gathered allowing the system to start being built.

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Log Sheet



Log No	9
No hrs	20
Running total hrs	110

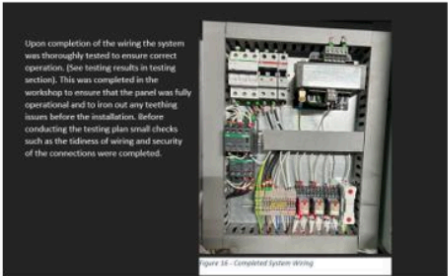


Figure 18 - Completed system wiring

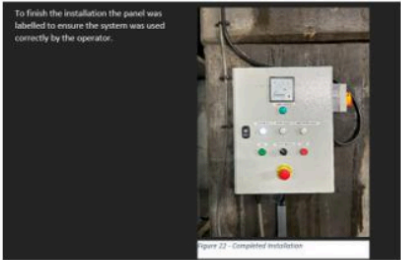


Figure 19 - Completed installation

The implementation stage continued, the project was assembled and installed into the basement.

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Log Sheet

Log No	10
No hrs	10
Running total hrs	130

Testing & Results

The proposed testing plan (Table 2 from Section 3) was then used to check the installation met the original outcomes and specification. All testing was carried out using approved testing meters and GS38 approved testing leads.



Figure 23 - Approved Testing Leads (Silvertronic, n.d)



Figure 24 - Approved Testing Meter (Fornell, n.d)

The system was tested using approved testing equipment as per the test plan created.

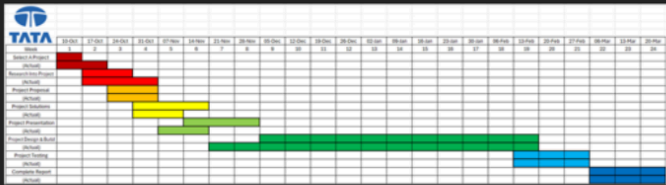
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Lecturer Signature	

Log Sheet

Log No	11
No hrs	5
Running total hrs	135

Discussion, Conclusion & Recommendations

In conclusion the project can be considered successful, this is due to the project outcomes and specification being met and the project be completed and installed on time. This can be seen on the completed timeline gantt chart (Figure 25). The gantt chart planner proved crucial in the execution of the project as it allowed progress to be made and tracked every week. This ensuring the research, design and development stages could be completed successfully. Whilst some sections were not completed as per the estimated time the project was completed on time. Another successful aspect of the project was that all the work was completed under the set budget of £3000, the amount used was £1329 meaning it was £1671 under.



The final findings of the project were drawn up, the project met the 24 week timeline and the initial budget constraints set out. The testing conducted was successful meaning the project met the criteria and outcomes.

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Lecturer Signature	

Reference List

1. **VEGA** (2023) *Vegason 61*. Available at: <https://www.vega.com/en> (Accessed: 15 May 2025). - <https://www.vega.com/en-uk/products/product-catalog/level/ultrasonic/vegason-61>
2. **RS Components** (n.d.) *VEGASON 61 Ultrasonic Level Sensor, 0.25 → 5m Detection Range, Analogue Output*. Available at: <https://uk.rs-online.com/web/p/level-sensors/4683441> (Accessed: 15 May 2025).
3. **Tameson** (n.d.) *Sump Pump Float Switch*. Available at: <https://tameson.com/pages/sump-pump-float-switch#:~:text=A%20sump%20pump%20float%20switch,on%20%20158%20for%20more> (Accessed: 15 May 2025).
4. **Tanks Direct** (n.d.) *Float Switch Product Image*. Available at: https://www.tanks-direct.co.uk/images/products/large/46129_23886.jpg (Accessed: 15 May 2025).
5. **SparkFun** (n.d.) *What is an Arduino?* Available at: <https://learn.sparkfun.com/tutorials/what-is-an-arduino/all> (Accessed: 15 May 2025).
6. **Silvertronic** (n.d.) *1000V GS38 Compliant Fuse Probe Kit – Slim Front*. Available at: <https://silvertronic.com/catalogue/fused-probe-kits/1000v-gs38-compliant-fuse-probe-kit-slim-front/> (Accessed: 15 May 2025).
7. **Farnell** (n.d.) *Fluke 179 Multimeter Product Image*. Available at: https://uk.farnell.com/productimages/large/en_GB/fluke-179-40.jpg (Accessed: 15 May 2025).
8. **Arduino** (2025) *Introduction to Arduino*. Available at: <https://www.arduino.cc/en/Guide/Introduction/> (Accessed: 15 May 2025).

Good number of ref sources

Project Report 2320629

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

70/100

PAGE 1

PAGE 2

Text Comment. Good table of contents

PAGE 3

Text Comment. Good list of figures

PAGE 4

Text Comment. Good use of tables

PAGE 5

Text Comment. Good description of problem

Text Comment. Good argument for project

Text Comment. Good pointer for solutions

Text Comment. Good point with ref source

PAGE 6

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PAGE 7

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PAGE 8

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PAGE 9

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PAGE 10

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PAGE 11

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PAGE 12

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PAGE 13

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PAGE 14

Text Comment. Good arguments for solution and the ref sources are in the research section

PAGE 15

Text Comment. Good argument for the chosen solution

Text Comment. Good explanation

PAGE 16

Text Comment. Good costings breakdown, but would be better suited in the spec or design requirements

Text Comment. Good cct diagram

Text Comment. Good evidence

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Text Comment. Good evidence of implementation

Text Comment. Good panel layout

Text Comment. Good evidence with panel build

Text Comment. Good helpful evidence for the panel build and location

Text Comment. A good panel design with functions

Text Comment. Good image with ref source

Text Comment. Good table of results

Text Comment. Good evidence

Text Comment. Images of the panel indicators should be included to support test results

Text Comment. Good evidence

Text Comment. Good explanations

Text Comment. There should be a reason given for discrepancies

Text Comment. Good Gantt chart with comparative timeline

Text Comment. Good environmental strategy

Text Comment. Good relevant recommendation that would need a cost effective evaluation

PAGE 29

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PAGE 39

PAGE 40

Text Comment. Good number of ref sources

GRADING FORM: CSG-RUBIC

JAMES SUMMERS

0

RESEARCH-INFORMED LITERATURE



Good research with good number of ref sources.
There should be more content for the requirements.
The solutions have been investigated and include ref sources for each.

13/20

KNOWLEDGE AND UNDERSTANDING



Spec has good points specific to requirements, however there should be more logic details of the operation. Table method would be suitable. The spec has enough to describe the requirements.

6/10

Solutions considered are explained with good arguments and ref source for each. There is also an evaluation and a good argument to justify solution. 7/10

13/20

ANALYSIS



Table of results includes good set of test results which are full explained in the table. there could have been more images of the panel to show the conditions during the test. However there is a test image of the panel and meter readings. 6.5/10
Good conclusion and recommendation. 7.5/10

14/20

PRACTICAL APPLICATION AND DEP.



Good initial plan and also plan with comparative timeline. 4/5

Solutions considered are explained with good arguments for practical implementation and ref source for each. There is also an evaluation and a good argument to justify solution. 7/10

Implementation includes many ordered supporting images with good explanations. 7/10

18/25

SKILLS FOR PROFESSIONAL PRAC.



Good structured report with content in good logical order.

12/15