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1. Executive Summary

The project is based in a power station at a local steelworks. In light of a recent Hazardous Operations (HazOp) meeting it was highlighted that there was no interlocking system on the Cold Blast Valves (CBVs) supplying cold blast air to the Blast Furnaces, meaning that any valve could be incorrectly operated at any time. Loss of cold blast air to the Blast Furnaces would result in a shutdown of a Blast Furnace and potentially cost the business a loss of £1m a day. To best protect ^{the} our critical assets from vulnerabilities such as this, a project will be delivered to prevent these instances occurring, at a budget specified at £40,000 by the company.

This project is called the 'Cold Blast Valves Control System Upgrade'. The focus of this project is to upgrade the current system to provide an interlocking system to prevent incorrect operation of the valves supplying cold blast air to the Blast Furnaces, due to it causing serious disruption to critical assets and a significant loss in production and therefore turnover.

On completion of the literature review into 3 possible solutions for the control system; Delta V, Siemens S7-1200 or relay control. It was decided to use the Delta V control system for the software programming. A Gantt chart, risk assessment, costing spreadsheet and work breakdown structure were produced to ensure the quality of the project will be ^a of high standard and carried out safely during design, implementation, and commissioning.

The conclusion of the report identified the absence and importance of an interlocking system for the CBVs, as it poses a significant operational risk. Recognizing the potential £1m daily loss, a ^{repetition} £40,000 project prioritizes safety, functionality, ethics, and sustainability. The comprehensive Function Design Specification, testing plan, and chosen Delta V control system ensure a high-quality, secure, and efficient implementation. The integrated approach, including a ^{repetition} Gantt chart, risk assessment, costing spreadsheet, and work breakdown structure, demonstrates the commitment to excellence throughout the project's lifecycle.

2. Introduction

This report will provide the reader with a good understanding of the flow of work and the research into the project, which enabled the author to come to a decision on which solution to choose for the project and the constraints that will be faced. It begins by providing a background to the project and the definition of the problem. This information will be used to construct the FDS and the testing plan. Once that is complete, a review of 3 solutions will be carried out and a decision will be made on ^{one} 1. The planning task will provide a good knowledge base for management techniques and quality management systems in the workplace. The project will then be ready for implementation once this is complete.

3. Project Background and Problem Definition and Constraints

3.1 Project Background:

The project is based in a local power station which currently has two operational Steam driven axial air compressors, referred to as Turbo Blowers (TB5 and TB3) supplying Blast Furnaces BF No 5 and BF No 4 respectively with 'cold blast air' for a local Steel works. A crossover valve is also present to facilitate cross blowing when required.

a block diagram of the system would have been helpful here

The Cold Blast Main which facilitates the transfer of cold blast air from the Turbo Blowers to the Blast Furnace Stoves is populated with CBVs. CBVs are intended to facilitate the complete separation of the blast furnaces from the cold blast main.

3.2 Problem definition:

A Hazardous Operations (HazOp) meeting, which assesses the process and its potential hazardous operations, found that there are no safeguards in place in the control system of the CBVs to prevent an operator from opening and closing the CBV's at the wrong time.

The intention is to install interlocks so that an operator cannot open/close a CBV at the panel unless its respective blower is at the correct speed.

The issue that exists in the current system is that there is no interlocking which prevents an operator from opening/closing an incorrect CBV, this can cause a blast furnace to go offline, which is a major issue to the running of a steelworks and causes up to £1m losses per day for when ^{one} 1 blast furnace is offline.

3.3 Constraints:

3.3.1 Ethical Engineering

There are several ethical concerns to consider when carrying out ^{its} ~~the~~ project. A major consideration for this project will be to minimise the environmental impact of ^{redundant words} the project by taking into consideration the waste generation from the materials used, the pollution created in the manufacturing of these materials and the resource depletion.

According to the (Royal Academy of Engineering, 2022), the 4 fundamental ethical principles for engineers to stick by are:

- Accuracy and Rigour
- Honesty and Integrity
- Respect for Life, Law and the Public Good
- Responsible Leadership: Listening and informing.

These principles will be upheld throughout the project by ensuring that all work will be carried out within the scope of competence of those working on it, develop other engineers working on the project to bridge skill gaps and acquire knowledge from others. Risks will be quantified by carrying out risk assessments to identify and evaluate them. To maintain honesty and integrity, all deceptive acts will be avoided, and steps will be taken to prevent corrupt practices and professional misconduct. It will be ensured that there are no conflicts of interest in the project as this could potentially influence the outcome of the project (Barros-Castro, et al., 2022).

To respect life, law and the public good, all work carried out will be lawful and justified with the reputation and dignity of the profession always upheld. Any adverse effect on society or natural environment because of the project will be minimised and where present, justified.

3.3.2 Sustainability

When designing the project, it will be taken into consideration the environment which it will be installed and the typical demographic of people that will be using it, although the product will be required to be user friendly for all types of workers in the plant, to ensure inclusivity. An example of how this will be implemented will be the height at which a panel will be mounted on a wall. There will be ergonomic factors which dictate the recommended height it shall be installed to ensure that it can be accessed easily and used in a safe manner (Fernandes, 2020).

Strategies will be implemented for the re-use, recycling, decommissioning and disposal of the components and materials used to ensure that waste is disposed of correctly. To ensure material wastage is as low as possible, it will be designed as efficiently as possible to keep costs and resources as low as possible. This will ensure that the project is following the guidelines set by the UK Standard for Professional Engineering Competence (Engineering Council, 2020).

3.3.3 Legal / Commercial

There are several codes of practice that will be followed during the project design and implementation, these will be to consider health and safety, legislation and commercial. The list below includes the potential codes of practice to be followed, depending on which solution gets chosen:

It would be far better if you had read each of these documents, extracted the relevant information and cited them as sources.

- BS7671 - 18th Edition Wiring Regulations
- HSG253 - The safe isolation of plant and equipment
- BS EN 60204 - Safety of Machinery

- Health And Safety at Work Act 1974
- Electricity at Work Act 1990
- PUWER
- IEC 60529 - Degree of Protection Provided by Enclosure (IP Code)
- EIS006 - Fire Protection of electrical cables
- IEC 529 - Ingress Protection
- IEC 61131-3 - Standard Programming Language
- IEC 61508 & 61511 - Functional Safety
- Pressure Systems Safety Regulations 2000

A management of change process will be used when the project gets implemented to ensure that it will be safe to use. This process will be beneficial for exploring all potential outcomes of the changes made and how it will change the process for the better, whilst highlighting how best to evaluate and mitigate risks associated with the project (Prosci, 2020).

By proactively addressing intellectual property considerations, this project can safeguard innovations, mitigate risks, and foster a culture of respect for intellectual property rights. Collaboration between engineers, legal experts, and project stakeholders is key to successfully managing intellectual property. Below are the commitments that will be made during this project to ensure the careful consideration of intellectual property (Huang, 1996).

3.3.3.1 Identify and Document Intellectual Property:

Clearly identify and document all potential intellectual property associated with the project. This includes inventions, designs, software code, trade secrets, and any other innovative aspects.

3.3.3.2 Understand Ownership and Rights:

Determine the ownership of intellectual property rights. Clearly define and document who owns the rights to any innovations or creations that arise during the project, considering both individual and organisational contributions.

3.3.3.3 Non-Disclosure Agreements (NDAs):

Implement NDAs with team members, contractors, and any external parties involved in the project. NDAs can help protect sensitive information and prevent unauthorised disclosure (Thomson Reuters, 2022).

These are general statements and should be specific to your project

3.3.3.4 Trademark Considerations:

If the project involves the development of new products or brands, consider trademark protection for names, logos, or other distinctive elements associated with the project (Leng & Mital, 1998).

3.3.3.5 Open-Source Software and Licensing:

You are instructing your reader instead of explain how this relates to your project

Be cautious about using open-source software and understand the licensing terms. Ensure compliance with licensing agreements and avoid any conflicts with the project's intellectual property (Snyk, 2020).

3.3.3.6 Collaboration Agreements:

You are instructing your reader instead of explain how this relates to your project

If the project involves collaboration with external partners or organisations, establish clear collaboration agreements that address intellectual property ownership, usage rights, and responsibilities (Sakusupapchon & Willoughby, 2019).

4. Functional Design Specification and Test Plan

4.1 Functional Design Specification

4.1.1 Control Panel

The control panel which will allow for the operation of the opening and closing the CBV's described in the project background, the make of these valves is Auma model SA14.5 - F14.

The panel will house the equipment to meet the following requirement:

FDS Item No.	Specification
1.1	Toggle switch for each valve on the front of the panel, to drive the valves open and closed.
1.2	Ammeter at bottom of the control panel to provide a visual confirmation to the operator that the valve is opening or closing indicated by its drawing current.
1.3	Key switch for CBV4 for cross-blowing activity on the front of the panel.
1.4	Override key switch on the front of the panel to bypass the control system and drive the valves open/closed from the panel alone.
1.5	Warning light for override 'enabled' on front of the panel signifying that the override key switch has been enabled and that the valves are now available to be operated without oversight from the control system. This will be an amber light labelled "Warning: Override Key Switch Enabled".
1.6	Indication lamps for each valve for open/closed. Green lamp for Open, Red lamp for closed. Located on front of the panel
1.7	Panel must be fixed on the control room wall at an ergonomic height for ease of use
1.8	Wiring must comply with BS7671 - 18th Edition Wiring Regulations
1.9	Control Panel must be rated to at least IP54 (IEC 60529 - Degree of Protection Provided by Enclosure)

Table 1 - FDS Control Panel

4.1.2 Control System/Software Upgrade

FDS Item No.	Specification
2.1	<u>T/B3 in normal operation (blowing to BF4)</u> Machine running @ minimum revs (3750 rpm): • Allow opening of CBV's 12, 11, 2 and 8 Machine running < minimum revs (<3750 rpm): • Allow closing of CBV's 12, 11, 2 and 8
2.2	<u>T/B5 in normal operation (blowing to BF5)</u> Machine running @ minimum revs (3750 rpm): • Allow opening of CBV's 5 and 6 Machine running < minimum revs (<3750 rpm): • Allow closing of CBV's 5 and 6
2.3	<u>Cross- Blowing T/B3 blowing to BF5.</u> Machine running @ minimum revs (3750 rpm): • Allow opening of CBV's 12, 11, 4 and 6 Machine running < minimum revs (<3750 rpm): • Allow closing of CBV's 12, 11, 4 and 6
2.4	<u>Cross- Blowing T/B5 blowing to BF4.</u> Machine running @ minimum revs (3750 rpm): • Allow opening of CBV's 5, 4, 2 and 8 Machine running < minimum revs (<3750 rpm): • Allow closing of CBV's 5, 4, 2 and 8
2.5	When Cross-Blow is active, CBV4 must NOT be permitted to close.
2.6	Programming language must be written according to IEC 61131-3 protocol.

Table 2 - FDS Control System

4.1.3 Budget and Timescale

FDS Item No.	Specification
3.1	The project spend must not exceed the budget set of £40,000
3.2	Project must be implemented by the end of April 2024.

Table 3 - Budget and Timescale

4.2 Testing Plan

Test	FDS Item No.	Item	Test	Expected Outcome	Actual Outcome	Pass/Fail	Evidence
1	1.1	Toggle Switch	Operate toggle switch to drive the following valves open: CBV5, CBV6, CBV4, CBV12, CBV11, CBV2, CBV8	Valves should open			
2	1.1	Toggle Switch	Operate toggle switch to drive the following valves closed: CBV5, CBV6, CBV4, CBV12, CBV11, CBV2, CBV8	Valves should close			
3	1.2	Ammeter	Check the ammeter is working for every valve operation.	Ammeter should provide a current reading when valves are operated. Current reading should be between 1A-3A when a valve is opening/closing.			

4	1.3	Cross -Blow key switch	Operate cross-blowing key switch and then drive open CBV4.	CBV4 should be allowed to operate open/close.				
5	1.4	Override key switch	Operate Override key switch on the front of panel to bypass the control system and drive open/closed any valve required.	Valves should be able to be operated without control system interlocks/bypasses.				
6	1.5	Override warning lamp	Override key switch operated to illuminate warning lamp	Warning lamp should illuminate.				
7	1.6	Valve position indication lamps	Operate every valve to test indication lamps	Open lamp should illuminate green when valves are fully open. When fully closed, the red indication lamps should illuminate.				
8	2.1	TB3 (normal operation) control system	Run machine @ 3750 rpm and <3750 rpm and monitor which valves are permitted to open/close.	@ 3750rpm, CBV's 12, 11, 2 and 8 should be allowed to open and CBV4 not allowed to open. < 3750 rpm CBV's 12, 11, 2 and 8 should be allowed to close and CBV4 not allowed to open.				
9	2.2	TB5 (normal operation) control system	Run machine @ 3750 rpm and <3750 rpm and monitor which valves are permitted to open/close.	@ 3750rpm, CBV 5 and 6 should be allowed to open and CBV4 not allowed to open. < 3750 rpm CBV 5 and 6 should be allowed to close and CBV4 not allowed to open.				
10	2.3	TB3 Cross-Blowing control system	Run machine in cross-blow operation @ 3750 rpm and <3750 rpm and monitor	@ 3750rpm, CBV 12, 11, 4 and 6 should be allowed to open.				

11	2.4	TB5 Cross-Blowing control system	which valves are permitted to open/close. Run machine in cross-blow operation @ 3750 rpm and <3750 rpm and monitor which valves are permitted to open/close.	< 3750 rpm CBV 12, 11, 4 and 6 should be allowed to close. @ 3750rpm, CBV 5, 4, 2 and 8 should be allowed to open. < 3750 rpm CBV 5, 4, 2 and 8 should be allowed to close.				
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Table 4 - Testing Plan

5. Literature Review and Choice of Final Solution

In this literature review, 3 potential solutions will be researched and compared to make a final choice on a solution to solve the problem specified in the FDS.

The 3 solutions are all different ways of implementing the control for CBVs:

- Delta V Distributed Control System (DCS)
- Siemens S7-1200 PLC
- Hard-wired relay control

5.1 Solution One

5.1.1 Setup Overview

Figure 1 shows an overview of how the system will be integrated to provide the final solution to the problem. This solution is to use Delta V to write the software controlling the CBV's. This is a DCS which is manufactured by Emerson, which is already in place at the workplace where this project is going to be implemented but isn't being used for the control of the CBVs currently.

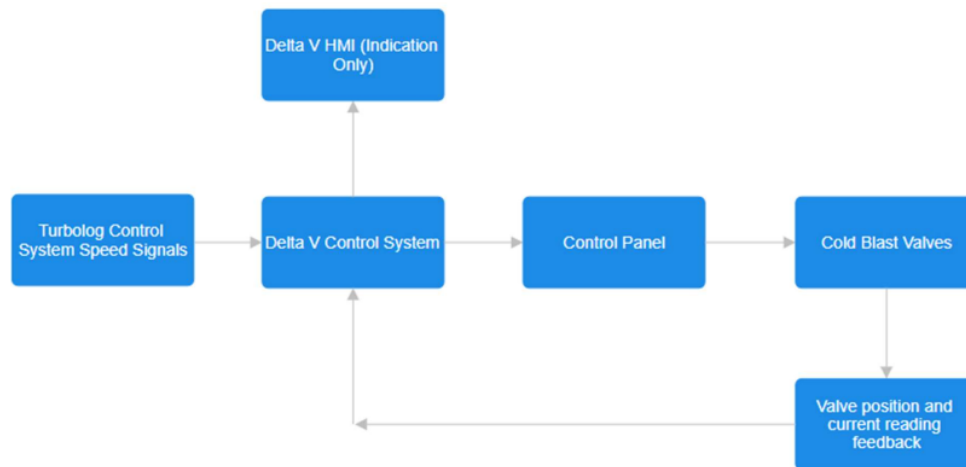


Figure 1 - Solution 1 Block Diagram

5.1.2 Operation

The Turbogol control system, which is controlling the Turbo Blowers will provide 24Vdc digital outputs to the Delta V DCS for when the following instances are active:

- Turbo Blower 3 running @ minimum revs (3750 rpm)
- Turbo Blower 3 running < minimum revs (<3750 rpm)
- Turbo Blower 5 running @ minimum revs (3750 rpm)
- Turbo Blower 5 running < minimum revs (<3750 rpm)

same thing?
Software will be written and programmed on Delta V in Function Block Diagram (FBD) and Structured Text (ST) languages to provide the control of when each CBV will be allowed to open or close. The instances of when each valve is allowed to open or close can be viewed in Table 2 as item No. 2.1, 2.2, 2.3 and 2.4. There will be a Delta V HMI screen on the Delta V workstations for the operators to see which valves are in the open or closed positions and which ones are permitted to open or close. It will also show which valves are on which pipeline from either TB5 to BF5 or TB3 to BF4. This HMI will be for indication purposes only, as it was specified that they wanted to operate the valves via push buttons on the control panel front.

The permissive signals will go from Delta V and into the control panel to energise relays which will put control voltage onto the relevant push buttons, depending on plant conditions, to allow the valves to be opened/closed. These open/close commands will go to the valves to drive them open/closed, and the limit switches on the valves will send a feedback signal to the control system and the control panel to provide position feedback for the operators. A current reading will also be provided on an ammeter on the panel, and on the Delta V HMI screen from a current transformer on the outgoing cables to the valves.

5.1.3 Software Review

incorrect citation method
FBD and ST are the only 2 programming languages used in Delta V. According to (John & Tiegkamp, 2010), FBD is a graphical language which originates from the field of signal processing. The function blocks are carrying out controlling actions for the plant, and these can vary in capabilities and operations. They are interconnected with horizontal or vertical lines and define the systematic flow of the process, making it relatively easy to follow and maintain.

ST will also be implemented on the Delta V software; this stands out as a high-level textual language closely resembling C or Pascal. In comparison to graphical languages such as ladder, ST programming demonstrates greater flexibility. This linguistic approach proves advantageous in addressing the escalating intricacies of PLC (Programmable Logic Controller), enabling the definition of intricate function blocks, which is what it will be used for in this system. A key merit of ST language lies in its ability to divide complex programs into smaller, more manageable segments, mitigating the risk of errors and facilitating ease of troubleshooting (Bryan & Bryan, 2012). *good reasoning*

5.1.4 Costing

The total cost of solution 1 is expected to be around £10,927, as calculated in Table 7. *in the appendix*

5.2 Solution Two

5.2.1 Setup Overview

Figure 2 shows how this solution differs from the first solution. A Siemens S7-1200 PLC will be used for this and the only indication for the operators will be on the control panel itself via LEDs indicating valve position feedback and which valves are permitted to open or close.

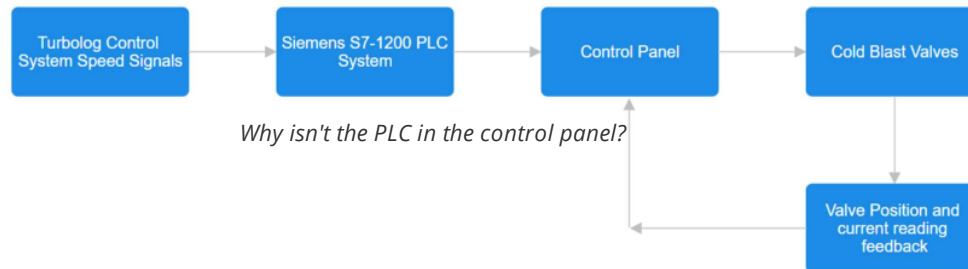


Figure 2 - Solution 2 Block Diagram

5.2.2 Operation

The operation of this system is the same as solution one, the only difference is the control system which is being used to control the valves. This solution is using a Siemens S7-1200 PLC. The functionality of the system will have to meet the same requirements regardless of which system is in use. There will be no HMI with this PLC, it will be used purely for controlling the valves. The operators will be using the control panel for operation via push buttons and LED lamps will be used for position feedback and which permissive's are active.

5.2.3 Software Review

This PLC uses a programming application called STEP 7 TIA Portal for writing the software configuration. There are 3 languages available to be used with this software package and PLC, these are FBD, Ladder (LAD) and Structured Control Language (SCL), which is universally known as ST (Perez, et al., 2013). These languages are varied in complexity and capabilities, but they can all provide high-level control. An example of how they vary in complexity can be explained by a simple execution of a subtraction. For instance, to subtract two input values in SCL, a written equation would need to be done, but in LAD, this would be a visual subtraction block where you can see the two inputs on one side of the block, with a labelled 'SUB' block, with the result of the subtraction on the output side of the block. This makes the LAD language easy to read as it flows with the execution of the logic and is in simple form, whereas SCL is more complex looking, however it can carry out more complex functions (Aghajani, 2020).

5.2.4 Costings

The total cost of this solution is expected to be around £13,500, as calculated in Table 8.

5.3 Solution Three

5.3.1 Setup Overview

Figure 3 shows this solution will be using relay control for the CBV's, as opposed to a control system. The relays will receive digital signals from the Turbolog, then the operators will be able to control the valves via push buttons on the front of the panel, in the same way that they would do it for the previous two solutions.

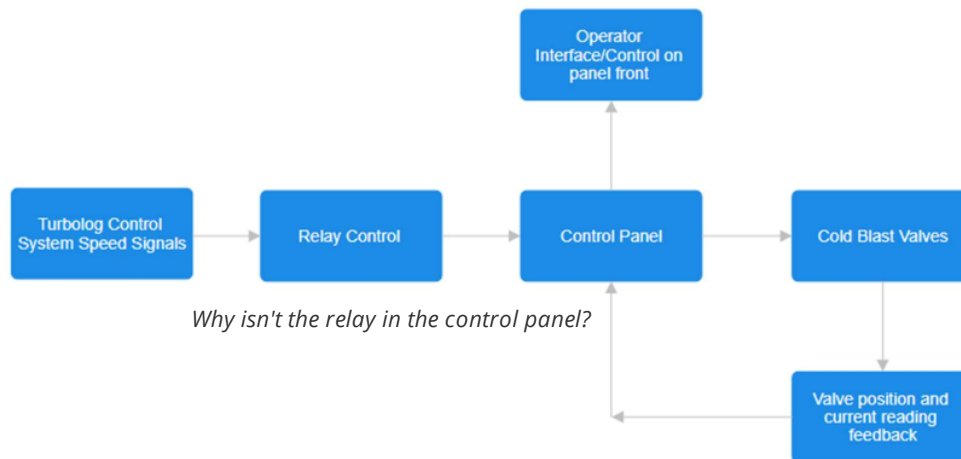


Figure 3 - Solution 3 Block Diagram

5.3.2 Operation

The outputs from the Turbolog will energise relays in the control panel depending on the plant conditions. These relays will be used for providing the permission to each valve to open/close when plant conditions allow them to. The rest of the operation will function in the exact same way as the previous solutions.

5.3.3 Control Logic Review

This solution is a relatively straightforward solution and wouldn't require any software to operate. The relays will be wired in such a way to satisfy the requirements set out in the FDS. The benefits of this solution are that it requires no advanced programming which will make installation simpler, but it also offers limited expandability once it's been installed. Whereas PLC based systems are far more expandable and customisable (Egan, 2021).

Relays will also take up a lot more space in a control panel compared to a PLC as there will be far more internal panel wiring for the control circuit. The electromechanical switches in a relay are also less reliable compared to the solid-state components in a PLC (Baradi & Xavier, 2018).

Looks like the Relay is in the Control Panel after all

5.3.4 Costings

The total cost of this solution is expected to be around £11,320, as calculated in Table 9.

in the appendix

5.4 Comparison of solutions

The key points of difference between each solution with regards to their advantages and disadvantages are shown in Table 5.

Solution	Advantages	Disadvantages
1 - Delta V DCS	- System is already in place at the site, so engineers and technicians are already familiar with programming, commissioning, installing and fault finding. - System can be easily expanded. - Existing spare I/O, meaning no extra cost to install additional I/O - FBD and ST programming languages can provide complex functions if system requires	- FBD and ST programming languages can be quite complex for fault finding depending on level of experience of engineer/technician. - Not a massively popular control system in industry, so in-house training will be key for ease of maintenance.
2 - Siemens PLC	- Highly used control system in industry, making it likely that more engineers will be familiar with it in the future. - Can be programmed in LAD which resembles an electrical schematic, making it easy to understand and maintain. - Easily expandable with regards to I/O and new control functions in the program	- System isn't being currently used elsewhere on plant, so it will be new to everyone. - Most expensive solution out of the 3 - Would require a new software licence and application for the engineering laptop/workstation as Siemens isn't currently in use.
3 - Relay Control	<i>by how many volts are they biased?</i> - Familiar with all electrically biased engineers when it comes to maintenance and fault finding. - No programming required and engineers won't have to rely on a workstation/laptop to access the control system. - Quicker installation compared to the first 2 solutions due to no programming.	- Not very expandable when it comes to changing the function of the system, compared to an automation system. - Takes up more room than a PLC. - Electromechanical switches inside the relays don't tend to last as long as the solid-state components of a PLC.

Table 5 - Choice of Solution

5.5 Choice of Solution

Good choice of solution

The chosen solution for this project is going to be solution 1, which is the Delta V DCS solution. A scoring matrix was used for this, using a scoring range of 1 - 3, with 1 being the lowest score and 3 being the highest. The result from this scoring is illustrated in the radar diagram below (Figure 4), where it is clear that solution 1 meets every requirement. Table 5 aided the selection of scores for each solution as this gave a comparison of each solution and their pros and cons.

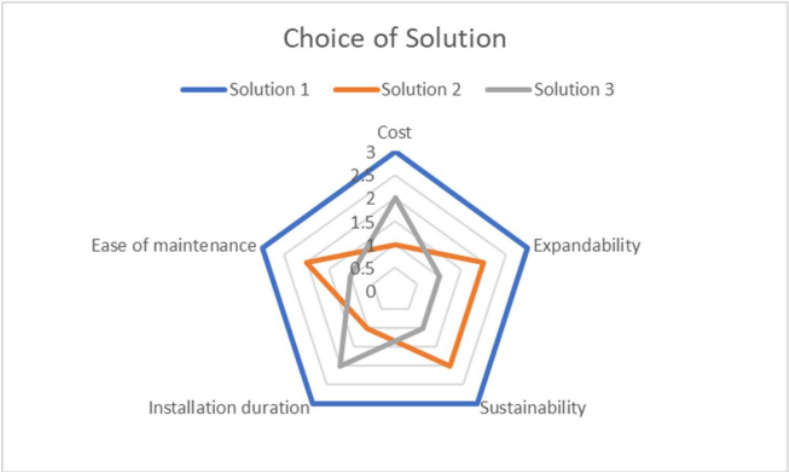


Figure 4 - Radar Diagram

6. Project Planning, Work Breakdown Structure and Management Techniques

To ensure this project implementation runs smoothly, there are a few tasks that need to be carried out during this planning phase that will ensure the management of the project will run smoothly to have an efficient installation and handover. The critical topics that will ensure a successful project are health and safety, budget control, work breakdown and scheduling.

To control these key parts of the project to ensure it will be delivered safely, timely, effectively and within budget, a series of documents have been created that will be of benefit as the project is ongoing. To ensure the project is delivered safely, a risk assessment was carried out and this can be found in the appendix as Figure 5. This will be present at the project to demonstrate to the working parties that all potential safety concerns have been accounted for and how they have been minimised as best as possible. As well as occupational safety concerns with the project, process safety will also be considered prior to the project implementation. This will be done by carrying out a Management of Change, which is a systematic process used to manage changes to the system in a way that minimizes risks and ensures the continued safe and efficient operation of the system. This will help with addressing potential issues before the project has started, so the required changes will be made during the design stage as opposed to after installation.

To maintain control of the budget, a costing spreadsheet (Figure 8) has been created, this will be used as a tracker spreadsheet as the project is ongoing to total the spend against the budget.

A work breakdown structure chart was constructed, as seen in the appendix as Figure 6, to provide a breakdown of each stage of the project. Each of these breakdowns and sub-breakdowns were then inputted into a Gantt chart (Figure 7) to create a detailed time schedule of each breakdown to illustrate the timings of each stage being carried out and the milestones that needed to be hit. Each breakdown is classed as a milestone, and these have dates set on the Gantt chart for these milestones to be hit. To reach these milestones, the sub-breakdowns are scheduled on the Gantt chart with their own timelines, which if conducted correctly, will ensure a timely project implementation.

Quality management systems are implemented in the project in the form of documentation, which will define the standards and expectations of the installation. These will come in the form of detailed cable schedules, termination drawings, electrical schematics and testing procedures and plans for both the software and the control panel. An example of how quality

assurance will be implemented is that a Factory Acceptance Test (FAT) will be carried out in the suppliers' workplace to ensure the control panel complies with the FDS expectations.

7. Conclusions and Recommendations

To gain a systematic understanding of project design and quality management techniques, as set out in the aims of this report, a variety of tasks were carried out to achieve this. To gain the full understanding of the workflow of a project, these tasks had to be carried out in a particular order. This provided a good understanding of how a project is developed in the early stages before implementation by highlighting a problem at the workplace. The background to the project needed to be investigated as shown in section 3 of the report and then the problem definition was written, which highlighted to the reader the requirement for the project to be carried out. The constraints of the project were researched, which gave the author an understanding on the considerations which would need to be made to ensure the project was carried out ethically and sustainably whilst maintaining its quality in both technical and safety aspects.

The FDS identified the deliverable project outcomes. Due to the nature of this project, it was decided that it was best to split the FDS into 3 sections to provide greater clarity. These were split for the control panel, control system/software upgrade and then the final one was for the budget and timescale. Upon looking back, it was a good decision to do it this way as the FDS will be used at the end of the project to decide whether it was a success or not, and it will also be used as a point of reference for the test planning task. This will make the test planning table simpler to construct and segregate, which will minimise the chance of mistakes being made during testing.

To deliver a successful project, there needed to be a review of 3 possible solutions to rectify the problem. The literature review of the 3 solutions alongside the research into academic papers and books provided a good knowledge base to make comparisons between the solutions and make an informed decision based on major factors such as cost, sustainability, safety, and reliability. The scoring matrix provided a simple comparison table to make this informed decision and it showed the advantages of using the chosen solution against the 2 which weren't selected.

The systematic approach was highly involved in the final task of the report for the project planning, work breakdown structure (WBS) and management techniques. A risk assessment was carried out for the first stage of this task to ensure the safe working of employees and contractors and make them aware of the potential hazards involved in the project and how these have been prevented as much as they can be. The work breakdown structure broke down the stages of the project and segmentized them to create a diagram to illustrate the different stages of implementation. This was especially useful for creating the Gantt chart which will be used as a management tool for ensuring the delivery of the project is timely and

efficient. The segments from the WBS were used in the Gantt chart to create separate tasks and put a timeline against them. The Gantt chart will be used as a live tracker as the project is ongoing to see whether it is running on time or not. The costing spreadsheet will be used as a budget management tool when the project is ongoing to keep track of its costs against the budget.

To ensure the project implementation runs efficiently, the plans will be shared with the contracting parties and employees involved with the installation prior to beginning so that everyone knows what is expected from the project and how and when we will carry out the required tasks.

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9. Appendix

9.1 Project Proposal

PROJECT PROPOSAL DOCUMENT

Student Name: Matthew Davies

Project Title: Cold Blast Valve Safety Upgrade

Date: 05/10/2023

Budget: £40,000

Description of Project

A process safety upgrade project on the Cold Blast Valves at a local Power Station which feeds electricity to a local steel works is required from a Hazardous Operations (HazOp) meeting which highlighted the potential risk of closing/opening one of many Cold Blast Valves incorrectly which would put offline a Blast Furnace, which could potentially cost the business £1m a day. This problem applies to two Blast Furnaces. There are 7 valves in each Blast Furnace affected by this project.

The project is already underway within the company with 3 other engineers working on the solution. My part in the project will be the installation of a new panel, cabling, control system, as well as software programming for the control logic of the valves. The software development will include an interlocking system which will only allow specific valves to be opened at a time depending on the state of the plant requirements.

There will be 2 engineers running the whole project, with myself focusing on the software development, testing the software and hot and cold commissioning.

The deadline is the end of April 2023 for this project to be completed. However, the specific date in April isn't yet specified as it needs to be aligned with a Blast Furnace scheduled shutdown. A budget of £40,000 has been agreed for this project.

Agreement for project proposal

Student Signature: MD Date: 05/10/2023

Industrial Supervisor Signature: DJ Date: 05/10/2023

Academic Tutor Signature: RD Date: 13/10/2023

9.2 Risk Assessment for implementation phase

RISK ASSESSMENT

ID NO.	RISK or HAZARD DESCRIPTION	RESOURCES IMPACTED e.g. personnel, machinery	EXISTING CONTROL MEASURES	PROBABILITY LEVEL	IMPACT LEVEL	PREVENTION MEASURES	START DATE	DUE DATE	LEVEL KEY
1.2	Hand Injuries	Personnel	PPE/Gloves shall be worn at all times when working practically	Medium	Low	PPE to be worn at all times, especially gloves. Only approved tools to be used by personnel.	11/03/2024	25/04/2024	Medium
1.3	Eye Injuries	Personnel	Safety glasses to be worn at all times when working practically.	Low	Medium	Safety Glasses to constantly be worn when working. Ensure signs are posted on site to remind staff.	11/03/2024	25/04/2024	Low
1.4	Electrocution	Personnel	Permit systems must be in place before working on live conductors. Insulated tools must be used.	Low	High	Low Voltage permit to be issued prior to work commencing.	11/03/2024	25/04/2024	
1.5	Hazardous Process gases	Personnel	Fixed gas monitors on plant. Under normal plant conditions, all gases should be contained within their pipework.	Medium	High	3in1 personal gas monitor to be worn at all times. No equipment that can cause a spark/ignition should be present at work area. Area induction and Gas Awareness must be complete.	11/03/2024	25/04/2024	
1.6	Noise	Personnel	Peltor Ear defenders to be worn when working in areas greater than 85dB.	High	Low	Ear defenders to always be worn when working in areas louder than 85dB.	11/03/2024	25/04/2024	
1.7	Loss of wind to Blast Furnace	Plant	Shielding around valve push buttons to prevent accidental pressing of button to move the valves.	Low	High	Ensure shielding is intact around valve push buttons. Stay clear of area where existing control panel is.	11/03/2024	25/04/2024	

Figure 5 - Risk Assessment

9.3 Scoring Matrix for solutions

Solution	Cost	Expandability	Sustainability	Installation duration	Ease of maintenance	Total
1	3	3	3	3	3	15
2	1	2	2	1	2	8
3	2	1	1	2	1	7

Table 6 - Scoring Matrix

9.4 Work Breakdown Structure Chart

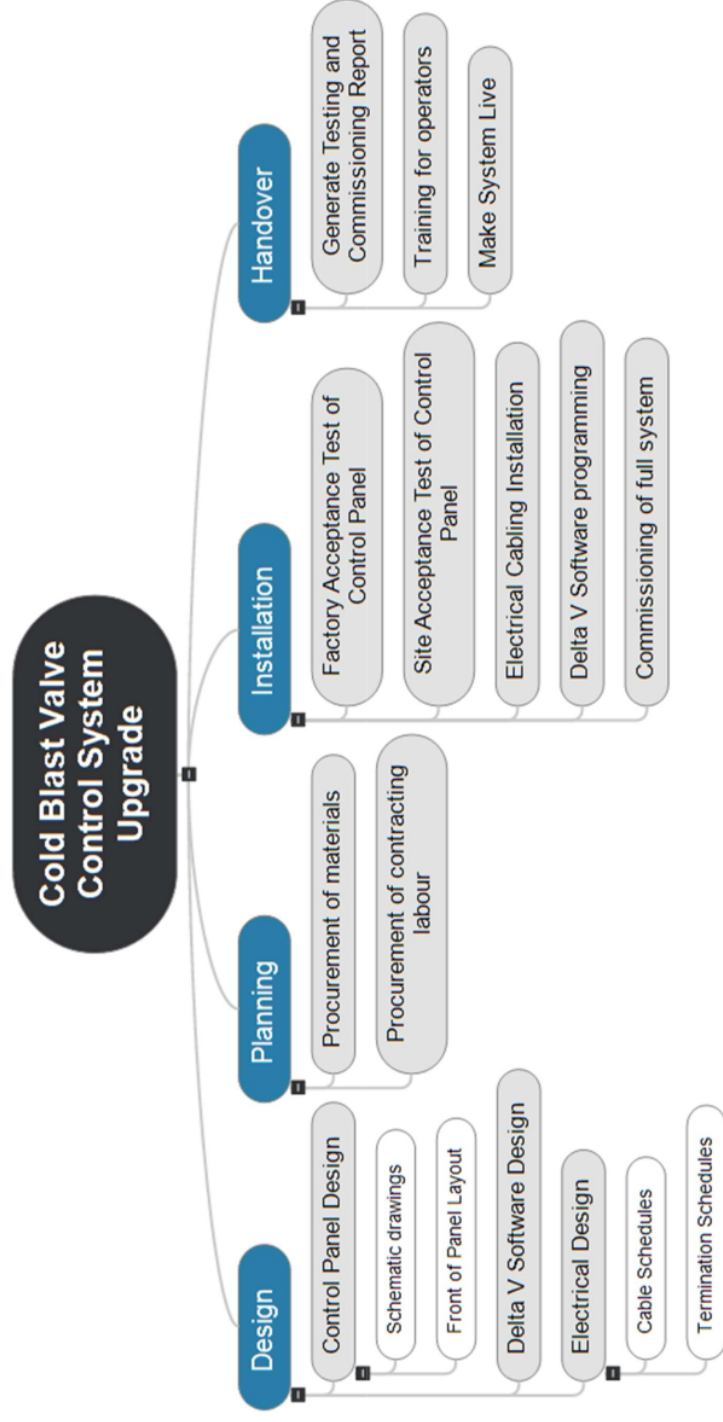


Figure 6 - Work Breakdown Structure

9.5 Gantt Chart

WEEKLY GANTT CHART

PROJECT: Cold Blast Valve Control System
Project Manager: Matthew Davies

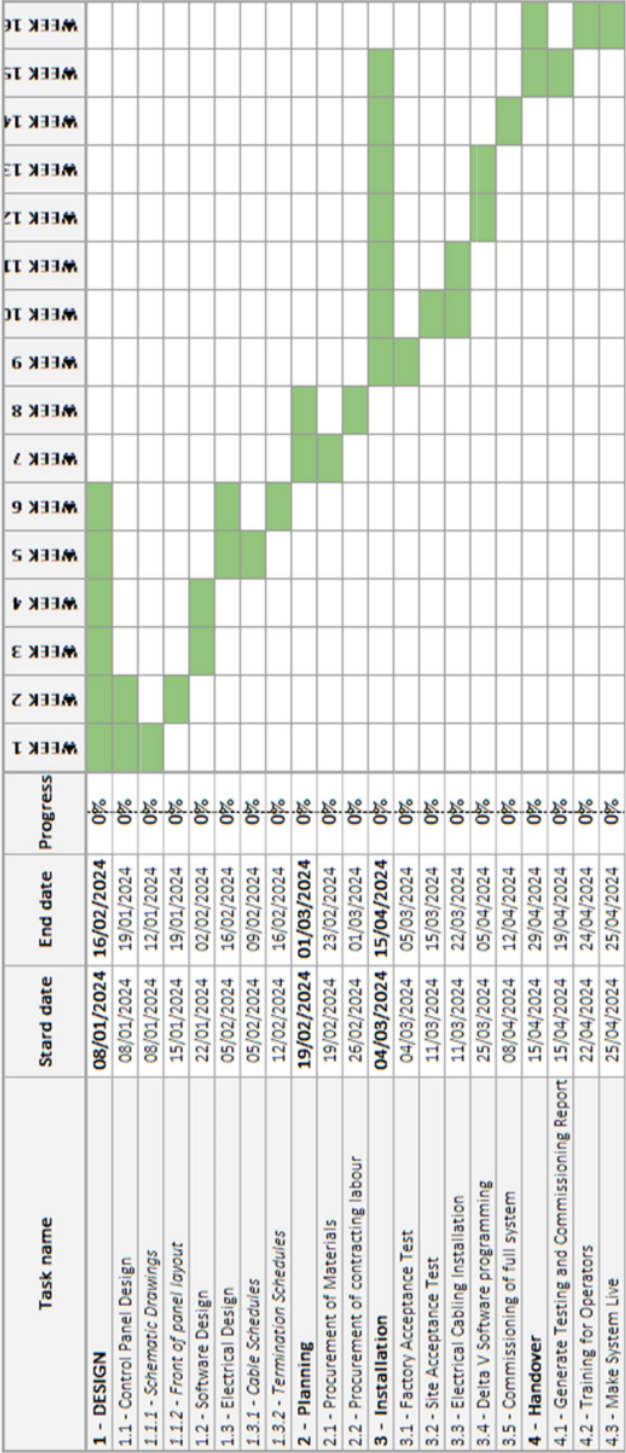


Figure 7 - Gantt Chart

9.6 Costing Spreadsheet

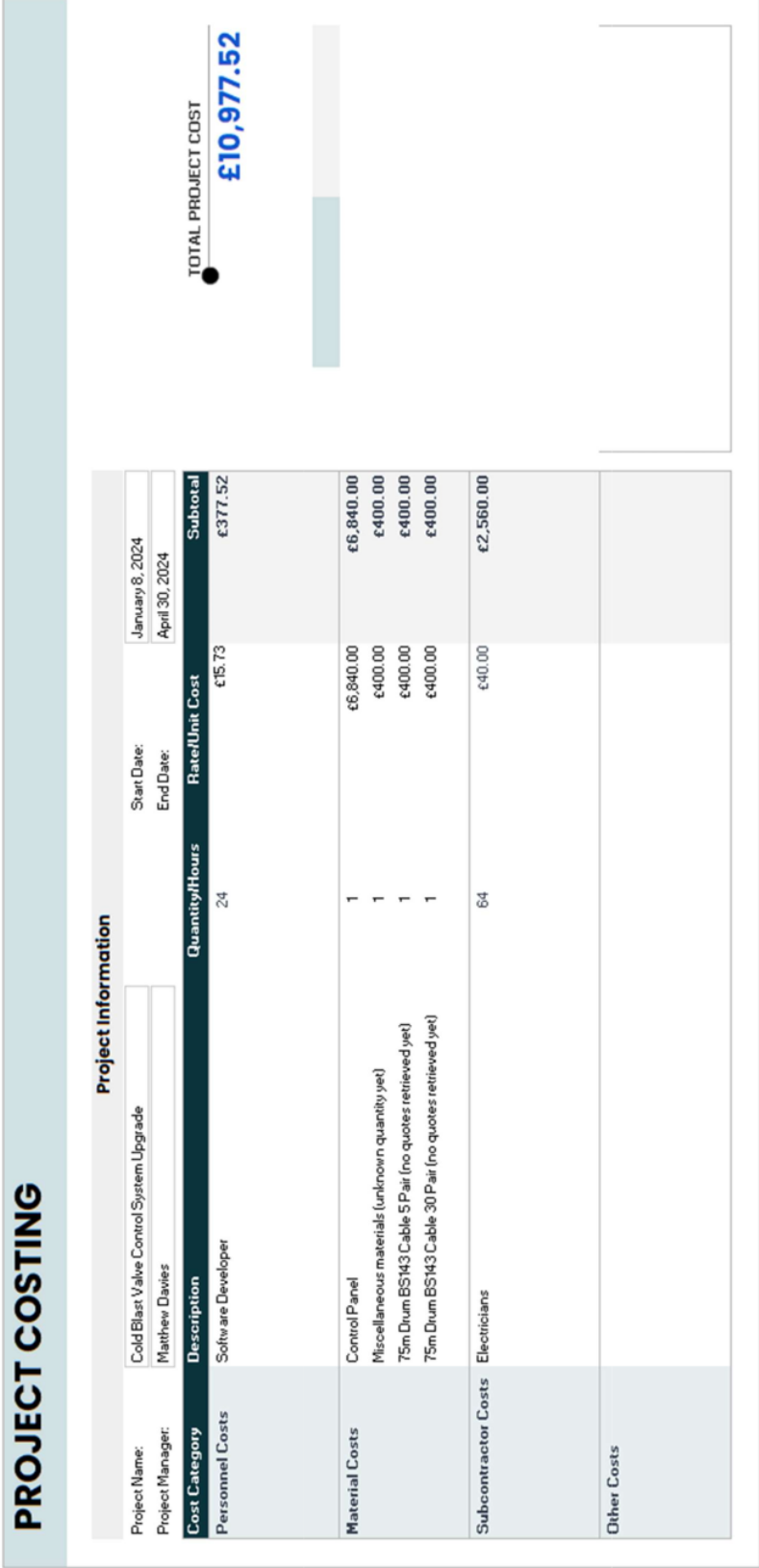


Figure 8 - Costing Spreadsheet

9.7 Solution Costing Tables

9.7.1 Solution 1

Item	Cost	Total Cost
Control Panel	Quoted at £6,840	£6,840
Labour for Electricians (cable installation and terminating)	£2,560	£9,400
Labour for software programming	£377.50	£9,777.50
Miscellaneous materials (cable ferrules, cable ties, cable tray/containment)	£400	£10,177.50
75 metre drum of BS143 5 pair cable	No quotes retrieved at this given time but will allow for up to circa. £750 for both cable drums for purpose of costing exercise	£10,927.50
75 metre drum BS143 30 pair cable		

Table 7 - Solution 1 Costings

9.7.2 Solution 2

Item	Cost	Total Cost
Control Panel with PLC installed and programmed	Quoted at £9,791	£9,791
Labour for Electricians (cable installation and terminating)	£2,560	£12,351
Miscellaneous materials (cable ferrules, cable ties, cable tray/containment)	£400	£12,751
75 metre drum of BS143 5 pair cable	No quotes retrieved at this given time but will allow for up to circa. £750 for both cable drums for purpose of costing exercise	£13,501
75 metre drum BS143 30 pair cable		

Table 8 - Solution 2 Costings

9.7.3 Solution 3

Item	Cost	Total Cost
Control Panel with relay control circuit	£7,610	£7,610
Labour for Electricians (cable installation and terminating)	£2,560	£10,170
Miscellaneous materials (cable ferrules, cable ties, cable tray/containment)	£400	£10,570
75 metre drum of BS143 5 pair cable	No quotes retrieved at this given time but will allow for up to circa. £750 for both cable drums for purpose of costing exercise	£11,320
75 metre drum BS143 30 pair cable		

Table 9 - Solution 3 Costings

SGEL6000
Independent Project
Log Book

Matthew Davies
Control System Safety Upgrade
2023-2024

Summary of Entries

Log Entry	Date	Brief Description of Activity	Duration (hrs)	Accumulated time (hrs)
1	29/09	Potential project ideas and planning	4	4
2	02/10	Discussion and shortlisting projects	4	8
3	13/10	Problem definition and solution	12	20
4	20/10	Project background, definition and constraints	4	24
5	27/10	Project background, definition and constraints	4	28
6	03/11	Project background, definition and constraints	2	30
7	10/11	Functional Design Specification	4	34
8	17/11	Functional Design Specification	4	38
9	24/11	Functional Design Specification	4	42
10	01/12	Functional Design Specification and Test Planning	4	46
11	08/12	Literature Review	6	52
12	15/12	Literature review and planning	4	56
13	22/12	Planning, WBS and conclusions	6	62

Log Entry Sheet

Log Number	1
Date	29/09/2023
Duration (hrs)	4
Accumulated time (hrs)	4

Record of activities and achievements

Comparing a selection of project ideas for the independent project.

Shortlisted 3 potential projects subject to commitment from line manager;

- 'Blast Furnace Water Systems' control system upgrade and installation (moving from Eurotherm PLC to Delta V)
- Demineralisation Water Treatment Plant Delta V installation for Resistivity and Conductivity water analysers.
- No.10 Turbine Alternator control system upgrade and installation (moving from Eurotherm PLC to Siemens PLC)

Plans for next week

Discuss the project ideas with the line manager and get commitment on budget from the manager for the chosen project.

Construct a project proposal for the chosen project and present it to the line manager and college lecturer for signatures, if it meets the project criteria.

Signed *R.Davies*

Log Entry Sheet

Log Number	2
Date	02/10/2023
Duration (hrs)	4
Accumulated time (hrs)	8

Record of activities and achievements

Sat down to have a conversation with my line manager about the 3 projects previously mentioned in the first log entry. We discussed the pro's and con's of each project and their suitability as a college project. Decided to discard the Water Treatment Plant project due to a lack of scope in the project to cover the criteria. Also discarded the Blast Furnace Water Systems project due to the difficulty in justifying cost savings due to the nature of the project.

We highlighted the No.10 Turbine Alternator (10TA) project as the front-runner to be the chosen project due to the potential scope of the project.

Plans for next week

Gather information on the budget for the project and discuss possible solutions.

Signed *R. Davies*

Log Entry Sheet

Log Number	3
Date	13/10/2023
Duration (hrs)	12
Accumulated time (hrs)	20

Record of activities and achievements

Attended a HazOp meeting where a potential process safety issue was highlighted about the operation of the Cold Blast Valves which allow cold blast air from the Turbo Blowers in Margam B Power Station to be supplied to the stoves at the Blast Furnaces. Currently there are no interlocking/permissive systems in place which prevent the incorrect valves being opened/closed, which could create a potential to shut off the cold blast air feed to the stoves, which in turn would shut down a Blast Furnace, which has major cost implications to the business as a whole, as well as process issues at the blast furnaces. It was also mentioned that the current control panel used isn't inside the control room, which means that 2 operators have to leave the control room to carry out the procedure, and rely on the communication from the operator inside the control room who is monitoring it on the HMI screens in the control room.

This issue created the potential for a new project to be developed to implement a safety upgrade to the system.

Discussed with my line manager how we could achieve the solution of the issue highlighted with the Cold Blast Valves and we came up with the 3 possible solutions of: using relays to provide the interlocking, installing a new PLC and new software for it, or implementing it onto Delta V.

We decided that we would implement it onto Delta V for various reasons.

We also decided to discard the 10TA project at this point as the Cold Blast Valve project was a better project for the requirements of the course.

Met with the engineers who will be involved in the project to discuss the definition of the problem to create the functional design specification after a solution was agreed. Once the solution is agreed, the functional design specification can be written, which will be used when going out to tender with the different companies who will supply the panel etc.

Plans for next week

Discuss the possible solutions to this issue.

Agree on the design requirements for the project with the Power Plant operations and management team and then start the construction of the Functional Design Specification, software development and schematic drawings for the new panel so that it can go out to tender.

Construct an FDS and send out to tender to retrieve quotes.

Signed ____ *R. Davies*

Log Entry Sheet

Log Number	4
Date	20/10/23
Duration (hrs)	4
Accumulated time (hrs)	24

Record of activities and achievements

Project background and problem definition written up.
Started research into project constraints which includes ethical engineering, legal/commercial and sustainability topics.

Plans for next week

Complete task 4 and make a start on the Functional Design Specification.

Signed ____ *R. Davies*

Log Entry Sheet

Log Number	5
Date	27/10
Duration (hrs)	4
Accumulated time (hrs)	28

Record of activities and achievements

Work continued on the project background task, mainly focusing on the constraints section of the report this week. carried out research into the IEEE code of ethics for engineers, which needs to be followed for ethical engineering practices during the project.

Plans for next week

complete the project background, definition and constraints task.

Signed ____ *R. Davies*

Log Entry Sheet

Log Number	6
Date	03/11/23
Duration (hrs)	2
Accumulated time (hrs)	30

Record of activities and achievements

Completed research into the constraints section of the report ready for the write up to be complete in the google docs section.

Plans for next week

Hand in the task for project background, problem definition and constraints.

Signed *R. Davies*

Log Entry Sheet

Log Number	7
Date	10/11/23
Duration (hrs)	4
Accumulated time (hrs)	34

Record of activities and achievements

Task 4 handed in and the FDS write up started.

Plans for next week

Signed *R. Davies*

Log Entry Sheet

Log Number	8
Date	17/11/2023
Duration (hrs)	4
Accumulated time (hrs)	38

Record of activities and achievements

Construction of the FDS write up started. Focused on the Control Panel FDS for this week as I am sectioning my FDS between control panel and the control system. Confirmed with work colleagues during the week what is expected on the control panel and its functionality so that the FDS will be as accurate as possible.

Plans for next week

Complete the Control Panel FDS and begin working on the control system FDS.

Signed *R. Davies*

Log Entry Sheet

Log Number	9
Date	24/11/2023
Duration (hrs)	4
Accumulated time (hrs)	42

Record of activities and achievements

Completed the control panel FDS write up and began working on the control system FDS. As I did with the control panel FDS, I collaborated with colleagues to confirm the full functionality specification so that an accurate FDS could be constructed for the control system.

Plans for next week

Complete the control system FDS and test planning.

Signed *R. Davies*

Log Entry Sheet

Log Number	10
Date	01/12/2023
Duration (hrs)	4
Accumulated time (hrs)	46

Record of activities and achievements

The Control System FDS was complete this week and started working on the test planning task. Constructed tables which matched the FDS contents, making for an accurate testing plan and an easy reference back to the FDS during testing.

Plans for next week

Begin working and complete the literature review and discuss the 3 possible solutions.

Signed *R. Davies*

Log Entry Sheet

Log Number	11
Date	08/12/2023
Duration (hrs)	6
Accumulated time (hrs)	52

Record of activities and achievements

Completed Task 6 - test planning using testing tables constructed from the FDS items.
Began working on the Literature Review and researching the 3 different solutions.
Constructed block diagrams for each solution.

Plans for next week

Complete the literature review, project planning, work breakdown structure and management techniques.

Signed *R. Davies*

Log Entry Sheet

Log Number	12
Date	15/12/2023
Duration (hrs)	4
Accumulated time (hrs)	56

Record of activities and achievements

Literature review into 3 solutions: Siemens, Delta V and Relay control. Block diagrams created and costings for each solution. Added these into the assignment report.

Plans for next week

Complete Tasks 8 and 9 to finish off the assignment.

Signed *R. Davies*

Log Entry Sheet

Log Number	13
Date	22/12/2023
Duration (hrs)	6
Accumulated time (hrs)	62

Record of activities and achievements

Tasks 8 and 9 complete.

Planning, WBS and management techniques covered using spreadsheets etc. diagrams added in report.

Conclusions and recommendations for the project complete.

Put report together and completed it to meet deadline.

Plans for next week

Signed *R. Davies*

FINAL GRADE

GENERAL COMMENTS

68/100

PAGE 1

PAGE 2

PAGE 3

QM

Good Structure

Report is structured exactly as stated in the assignment brief.

PAGE 4

PAGE 5

Text Comment. the

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Text Comment. repetition

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PAGE 6

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PAGE 7

Text Comment. a block diagram of the system would have been helpful here

Text Comment. one

Text Comment. this

Text Comment. its

Text Comment. redundant words

PAGE 8

Text Comment. It would be far better if you had read each of these documents, extracted the relevant information and cited them as sources.

PAGE 9

Text Comment. These are general statements and should be specific to your project

PAGE 10

Text Comment. You are instructing your reader instead of explain how this relates to your project

Text Comment. You are instructing your reader instead of explain how this relates to your project

PAGE 11

Strikethrough.

PAGE 12

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PAGE 17

Text Comment. same thing?

Text Comment. incorrect citation method

Text Comment. good reasoning

Text Comment. in the appendix

PAGE 18

Text Comment. Why isn't the PLC in the control panel?

Text Comment. in the appendix

PAGE 19

Text Comment. Why isn't the relay in the control panel?

Text Comment. Looks like the Relay is in the Control Panel after all

PAGE 20

Text Comment. in the appendix

PAGE 21

Text Comment. by how many volts are they biased?

PAGE 22

Text Comment. Good choice of solution

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GRADING FORM: NEW CSG-RUBRIC

1. ENGAGEMENT WITH LITERATURE



Sections 3 and 5: Engagement in research, judicial use and critical evaluation sources for project constraints and literature review of solutions. Engagement with a wide range of research-informed literature, including sources retrieved independently.

(7/10)

Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing.

Selection of relevant and credible sources. Very good use of referencing, with no/very few inaccuracies or inconsistencies. (7/10)

14

2. KNOWLEDGE AND UNDERSTANDING



Section 3: Project background and problem definition

Clearly defined yet a block diagram of the existing system would have helped your reader understand the system better. (4/5)

Section 3: Project constraints: Ethical.

Good but some of this is very general. (3/5)

Section 3: Project constraints: Sustainability

Good but some of this is very general. (3/5)

13

Section 3: Project constraints: Legal/Commercial
Good but some of this is very general. (3/5)

3. COGNITIVE AND INTELLECTUAL



Section 4: Functional Design Specification
Brief and clearly stated giving scope for test planning. (3/5)

15

Section 4: Test planning
A good section with clear methods of testing. (4/5)

Section 5: Evaluation of solutions and justification of final solution
Advantages and disadvantages of each presented with a radar diagram to justify the choice. (4/5)

Section 7: Conclusions and Recommendations
A good section that presents all that has been achieved. (4/5)

4. PRACTICAL APPLICATION



Section 6: Project Plan
Plan is basic with some detail and linear without contingencies. (3/5)

11

Section 6: Working breakdown structure, costing exercise and management techniques
Some level of detail included. (3/5)

Appendix: Risk assessment for implementation phase
A good chart with some detail. (3/5)

Appendix: Planning phase log-book entries.
Up to date but many entries are very brief and lacking in detail. (2/5)

5. TRANSFERABLE SKILLS



Section 1: Executive summary
Quite good but has some repetition (3/5)

15

All Sections: Presentation quality of the report, diagrams, charts, tables, figure numbering, page, and section numbering etc
Very good overall quality (4/5)

All Sections: Quality of the writing style, use of punctuation and grammar
Generally well written (4/5)

Word count limit not exceeded
Not exceeded yet some of your chart are images and should have been part of the word count. (4/5)