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by David Thomas

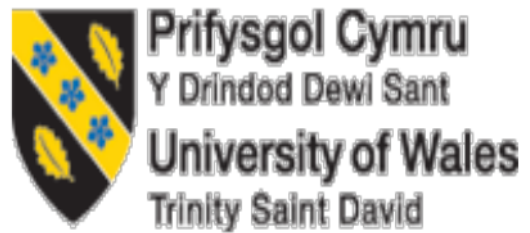
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1. Executive Summary

what does the company produce?

The proposed project upgrade for the North Basement substation ventilation has been evaluated and planned. Although the system is fully functional, there is currently little control over system operation; it is in full fixed speed operation 24 hours a day, 7 days a week, regardless of the substation ambient conditions. Replacing the current ventilation system control with variable speed drives will create a more efficient operation, reducing energy consumption and subsequent costs. *what was the budget?*

what were they?

Subsequent to project approval, three variable speed drive solutions were considered, each ensuring compliance with both company and regulatory requirements and standards. Following analysis of those proposed, the most suitable solution is to be implemented, providing energy usage reduction, cost saving, and greater safety. *which one did you choose?*

Execution of the project has been broken-down and planned with considerations for the environment, sustainability, safety and ethics. Initial project costings were concluded, and a work breakdown structure established, from which a Gantt chart was developed. Implementation will begin January 3rd, 2023, with completion for the project anticipated to be before the deadline of 31st March 2023.

a short summary but doesn't contain enough information

2. Introduction

The project involves a control system upgrade for ventilation fans situated within an electrical substation, with the aim of improving efficiency and reducing operating costs. Justification of the project is provided by consideration of the current economic climate and soaring energy costs. Research and costing of three possible solutions will be performed, and a design specification detailing the required criteria composed. From this a test plan is created, the ideal solution for the project chosen as the one that best conforms to the functional design specification and company requirements. Relevant engineering standards and company policies will be considered throughout design specification, test planning, solution selection and implementation planning.

3. Project Background, Problem Definition and Constraints

3.1. Project Background

The company requiring the project is a multinational steel manufacturing business, employing approximately 8,000 people, with an annual steelmaking capacity of 3.2 million tonnes in the United Kingdom (Steel, 2021). The plant is one of the company's packaging facilities and the company's only UK-based tin plate facility. Secondary processing of steel strip coil products includes; chemical and heat treatment, and further gauge reduction to produce tinplate, electro chromium and plastic laminated steel products.

Based in one substation basement within the plant are several transformers. As the basement has no natural airflow, force-cooling by ventilation fans is a necessity to keep the transformers cool under operation, improving performance and reducing heat losses. The current ventilation system comprises of two belt-driven 3phase motors, one 7.0kW and one 7.5kW. The motors are operated via a direct-online (DOL) starter i.e., start button connected to a set of contacts either connected 'on' or 'not-connected' off. When on, the motors are in continuous operation at a fixed speed, regardless of substation ambient temperature. *You could have said more about the background*

3.2. Problem Definition

The various plant production lines require several services to maintain operation, all of which require electricity to operate. With the current economic climate and soaring energy prices, the company ^{is} looking to minimise production costs and improve sustainability (Marwede., 2017), whilst remaining a competitive provider of steel packaging products. Various cost-saving initiatives have been proposed to reduce energy consumption and associated costs.

Currently, the ventilation fans are in continuous fixed speed operation, resulting in continuous energy consumption, and high operating costs. Combined current energy consumption for both motors is calculated at 369.36 kW per day, at a cost of £76.32 per day (see appendix 9.2 for calculations). If operational control can be implemented, even at higher ambient temperatures, a slight reduction in motor speed by 10% can result in energy and cost savings without compromising motor/ventilation operation (output). A further decrease in motor operation/output to 50%, where lower ambient temperature conditions require less cooling, would significantly reduce energy usage, and increase ventilation efficiency, reducing running/operation costs. (IDS, 2022).

*You have not referred to figure 1 in your report and have provided no explanation of this graph
poor image, some text cannot be read*

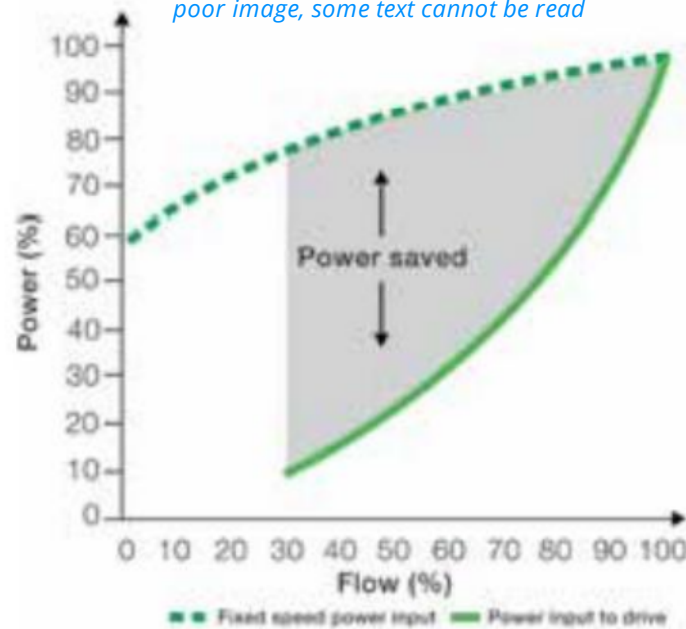


Figure 1 - Potential Savings from VSD

(IDS, 2022)

For energy reduction and efficiency, it has been proposed to replace each DOL starter with a variable speed drive (VSD), a programmable logic controller (PLC) for the control system, human machine interface (HMI) for display and user interface, and a thermostat for temperature control. This control will provide a feedback mechanism to enable speeds to be reduced when the ambient temperature is at a defined level, providing energy savings and greater motor efficiency.

Due to the ventilation fans' location, the air intakes have filters fitted which must be periodically replaced to ensure optimised airflow. Installation of airflow sensors will ensure airflow to and from the vent fans is optimal. Inclusion of physical indicator to signal a reduction in intake airflow provides early warning of the need for replacement. As the fans are belt driven from induction motors, airflow sensors will also monitor for zero air intake during operation, indicating damage to the fan belts and need for replacement.

This part reads like an FDS whereas you should be only focusing on the problem

3.3. Constraints

3.3.1. Ethical Engineering *This sub-section was worth 5 marks.*

Throughout the project all involved must act in accordance with the company's professional and ethical code of conduct, which reflects that laid down in the Royal Academy of Engineering statement of ethical principles. These include honourable behaviour with a focus on diversity in business and culture, the project ensuring it is inclusive, recognising, and utilising individuals' values as part of equal opportunities (Royal Academy of Engineering, 2019).

Ethical sourcing of materials and labour will be ensured by following the company's code of conduct and adhering to pre-approved vendors and suppliers (Tata Steel, 2013). Safety of individuals is paramount, with safety regulations and standards complied with throughout.

3.3.2. Sustainability *This sub-section was worth 5 marks.*

The company is committed to environmental and economic sustainability. Successful project execution will significantly reduce energy expenditure, complying with the company's current direction and pledge to become carbon neutral (Tata Steel Europe, 2020). Improvements will also result in reduction of generated waste, with less maintenance as a result of an extended lifespan of the equipment.

3.3.3 Legal and Commercial

Responsibilities of UK employers (to employees and public) and employees (to themselves and one another) in relation to occupational health and safety is a legal requirement and is primarily contained within the 1974 Health and Safety at Work Act (HSWA). The legal authority of HSWA is such that incorporated within the legislation is the provision for further health and safety regulation to be embedded without Parliamentary Act (HSE, 2022). Industry standards are to be followed during the project, with particular attention given to those listed in the functional design specification.

The Management of Change (MoC) process, a company procedure, covers any significant change to an installation or process, ensuring control over health and safety, as well as environmental risks and hazards affected by a change to an organisation's facility, equipment, processes/operations, technology, or workforce. An evaluation of any substantial change is made, ensuring acceptable levels of safety, to both personnel and continued operation. Following review by approved personnel, proposed changes can be implemented, amended for improvement, or rejected. (Inspectioneering, 2022).

As part of the change, risk assessments are required not only for immediate hazards created, but also for unseen risks proposed to the business/organisation, project structure, size, conformity, and experience, taking into consideration

applicable legislation or codes. In general, a more structured project equates to more control and lesser risk. Similarly, project size and experience are also comparative to risk, with larger projects incorporating higher costs, staff and time allocation posing greater risk (One Stop Testing, 2022) (See appendix 9.5 for risk assessment, MoC process, project performance level and application flow chart to ensure conformance to required Directives). In accordance with the company's MoC process, initial risk assessments are limited to the areas listed above. Once approved in principle, considerations of the risk/impact associated with actual implementation of the change will be dealt with in a separate dedicated risk assessment.

Commissioning following implementation, provides documented evidence of adherence to the required design specification and standards. Ongoing monitoring of ventilation operation and energy usage will determine if the project has been successful.

All materials and contracting are to be procured in accordance with the company's code of conduct, ensuring fairness, openness, and collection of competitive information through legally permitted sources and means (Tata Steel, 2013). Although considered, the project was deemed not to encroach intellectual property rights.

3.3.4. Additional Risks

Additional constraints have been identified, placing limitations on design.

1. Current global economic climate limiting material and component availability, cost, and increased lead time.
2. Company guidelines for standardising equipment for ease of replacement, repair, and training.

4. Functional Design Specification and Test Plan

4.1. Functional Design Specification (FDS)

Ventilation fans must provide the required cooling to maintain suitable ambient temperature within the substation. When the substation is at a defined temperature set point of less than 20°C, ventilation fan speeds must be reduced, providing energy efficiency and reduction in operation costs. Airflow monitors are to be used to measure air velocity being drawn into the ventilation, as intake filters are susceptible to blockage, resulting in a reduced airflow. Airflow monitoring is also to be used to identify zero airflow, providing indication that belts operating the ventilation fans have broken.

You may be able to save more money by making the fan speed proportional to the temperature error which could be calculated as the difference between ambient and 10 degrees.

4.1.1. Performance

1. Fans must be variable speed controlled.
2. Installation must make use of exiting ventilation fans and ducting.
3. Ambient temperature of substation to be monitored. Fan speeds to automatically change in response to ambient temperature set point, as per table 1.

You could even use PID. A process model might help you decide the PID parameters. The drive may even have the ability to do this for you.

Ambient Temperature Set point	Ventilation Fan Output
> 20°C	100%
10°C to 19.9°C	50%
< 10°C	0%

Table 1 - Ventilation Control Temperature Set Points

4. Intake airflow to be monitored for reduction in intake air velocity and zero air intake velocity. Indication to be present when intake speed has been reduced, as per table 2.

How will you determine what the airflow should be at reduced fan speeds?

Intake Airflow Set Point	Indication
> 70%	No indication for filter replacement
< 70% intake 1	Indication for intake 1 filters to be replaced
< 70% intake 2	Indication for intake 2 filters to be replaced
0% intake 1	Indication for belt failure for motor 1
0% intake 2	Indication for belt failure for motor 2

Table 2 - Ventilation Intake Airflow Set Point

5. Installation must be completed within allocated timescale.

4.1.2. Functionality

1. System must start, stop, and reset through use of local control via HMI, or push buttons.
2. System must stop via use of local physical emergency stop button.
3. Ventilation system must be automatically operated and loaded according to ambient temperature.
4. System to have indication for intake filter replacement when intake air speed is reduced.
5. System is to have a physical local isolator, lockable by use of padlock or multi-lock hasp.
6. Indication must be present through use of HMI. Indication must include:
 - Power supply health and failure.
 - Motor running.
 - Fan/Motor operating speed set points.
 - Current fan operation/loading (2 fan system).
 - Low suction pressure, indicating ventilation filters are blocked.
 - Zero suction pressure, indicating motor belt failure. *What if the motor has stopped, it may not be the belt.*
 - Current ambient temperature.

4.1.3. Environment

1. Any new products installed must withstand ambient temperatures >40°C. *What is the correct IP rating?*
2. Any new products must have appropriate IP rating to withstand dust and liquid ingress.

4.1.4. Product Life Span

1. New products supplied and installed must be available on the market for a duration of 5 years.
2. Spare parts should be readily available.

4.1.5. Life in Service

1. Equipment must be suitable to operate continuously
2. System and components used must operate for a period of at least 5 years
3. System must continue to satisfy performance criteria specified in 4.1.1.

4.1.6. Maintenance

1. Equipment installed is expected to be maintenance free, excluding any periodical filter change and annual maintenance interval.
2. Filter replacement should not require isolation or stopping of the ventilation system.
3. No special tools should be required for maintenance.
4. Spare parts should be readily available and remain available for a duration of 5 years.

4.1.7. Ergonomics

1. All installed equipment is to be accessible for maintenance activities.
2. Emergency stops to be installed in suitable and accessible locations.
3. Control panels to be installed in suitable and accessible locations.
4. Panel to be appropriately sized to house the required VSDs and accommodating equipment.
5. Panel to be wall mountable. If too heavy for wall mounting, support legs are to be fitted.

4.1.8. Quality and Reliability

1. Ventilation system should not fail in service and should maintain delivery of adequate ventilation and cooling to the substation. *How do you define adequate ventilation?*
2. Power supply must be suitably rated and protected from overcurrent. *What are the voltage and current ratings?*

4.1.9. Company Constraints

1. The company is standardising equipment in use for ease of maintenance, spares, and training. The PLC and HMI must be Siemens.
2. Ventilation system and control are to undergo significant changes and are subject to company's MoC process.

4.1.10. Target Costs

1. The entire project is not expected to exceed £15,000.00.
2. Due to current economic climate, an additional contingency of 25% is allocated to ensure completion.
3. A separate budget has been made available for recommended and required spares.

4.1.11. Standards & Specifications

1. BS7671:2022 Requirements for Electrical Installations. (IET, 2022)
2. IEC60085 Electrical Insulation. (iTeh, Inc, 2013)
3. BSEN 60529 Degree of Protection Provided by Enclosure. (British Standards Institution, 1992)
4. BSEN 13602 Copper & Alloys for Conductors. (European Standards, 2022)
5. BSEN-ISO 13850 Emergency Stops. (GT Engineering, 2015)
6. BS5801:2017 Industrial Fans - Performance Testing. (BSI, 2017)
7. BSEN 61439 Low Voltage Switchgear and Control Gear Assemblies. (Michael Smith Switchgear, 2022)
8. BSEN 60947 Low Voltage Switch Gear and Control Gear. (BSI, 2021)
9. BSEN 61800 Adjustable Speed Electrical Power Drive Systems. (IEC, 2021)

*It would have been better to have read through these regs and cited specifically relevant material for your project rather than just listing them here.
However, your appendix does contain some explanations in table form*

10. BSEN 50598 Eco-Design for Power Drive Systems, Motor Starters, Power Electronics and their Driven Applications. (iTeh, Inc, 2015)
11. BSEN 60204-1:2018 Safety of Machinery - Electrical Equipment of Machines. (Procter Brothers, 2018)
12. BSEN 60034-1:2022 Rotating Electrical Machines Rating and Performance. (Eueopean Standards, 2022)
13. BSEN 13849 Safety of Machinery. Safety-related parts of control systems. (BSI., 2022)

See appendix 9.3 for relation of standards to project.

4.1.12. Safety

1. Risk assessment to be provided prior to commencing work, ensuring minimum safety requirements are met in accordance with BSEN 13849. See appendix 9.5 for current Performance Level rating.
2. The system must feature safety trip systems and interlocks, preventing starting during a trip or fault, as per BSEN 13849.
3. Emergency stop buttons must be clearly identified and accessible as per BSEN 13849.
4. Electrical supply must be locally isolated and lockable.
5. LV equipment cabinets shall have a minimum degree of ingress protection. Enclosure to IP4X, internal compartments enclosure to IP2X. No live terminals shall be exposed.
6. Installation must comply with 4.1.11.

4.1.13. Testing

1. All electrical installation work is to be tested to BS7671:2022.
2. Conformity checks to follow guidance provided by BSEN 60204-1:2018 Safety of machinery - Electrical equipment of machines.
3. Post-energisation testing to include all testing set in the test plan.
4. Monitoring of air ventilation system performance to be conducted periodically throughout the first year of operation.

4.1.14. Installation

1. Installation is to take place during first quarter of 2023.
2. Installation is expected to be completed and fully operational by Easter 2023

4.1.15. Documentation

1. Complete annotated drawings must support all installed equipment.
2. Maintenance and troubleshooting/repair manuals must be provided for all installed equipment.

4.1.16. Disposal

1. All materials removed from the existing installation is to be disposed of in appropriate recycling bins and skips provided.

4.2. Test Plan

The ventilation systems' test plan and conformity checks incorporate several elements. In accordance with the Machinery Directive, commissioning must be performed after major changes have taken place (Gov.UK, 2022). Commissioning documents drafted by the Accountable Engineer, following guidance provided by BSEN 60204-1:2018 (Procter Brothers, 2018), is to include both conformity and functional checks, proving the system is functioning as intended.

Commissioning conducted by a competent person is required for the ventilation system, with commissioning documents recorded and signed off by the Accountable Engineer, to confirm successful completion (see Appendix 9.4 for test plan).

5. Literature Review

VSDs surfaced in the early 1980s; an electronic power controller able to provide speed and torque control via alteration of electrical supply. Ventilation fans are a perfect example of the use in motor applications requiring a degree of variation in speed and torque. Appropriate use of VSDs can reduce energy consumption, with a reduction from 100% to 80% output saving anything up to 50% of energy consumption. Utilising this to reduce unnecessary motor output, and energy consumption makes business sense, as well as climate change and business reputation (Carbon Trust, 2018).

The three viable solutions present in this report aim to conform to the FDS and company requirements. Company requirements have resulted in certain equipment detailed within the FDS not being subject to change and used in each viable solution.

5.1. Company Required Equipment

Siemens PLC

Siemens S7 1200 series PLC have a variety of different technological specifications, such as high-speed counters (HSC), pulse train output/pulse width modulation (PTO/PWM) and motion control, as well as integrated communications, such as serial communication, PROFIBUS, IO-Link, PROFINET and Industrial Ethernet, making it the ideal choice for performing automation tasks at the lesser end of performance scale. (Siemens, 2022)

The 1214C DC/DC/relay used for this project is a compact central processing unit, with a working memory of 100KB (Parmley Graham, 2022). Analogue inputs from the PLC are used for the responses from temperature and pressure sensors. Due to the limited number of analogue inputs, a Siemens analogue input RTD is connected to the PLC, providing an additional four resistance temperature detector inputs (Parmely Graham, 2021). Digital inputs from the PLC are used for the responses and conditions of the VSDs and safety circuits. PLC digital outputs are used for the desired control, such as high or reduced speed for each drive.

Siemens HMI

Siemens offer different classifications of second-generation HMI basic panel, with many suitable options within each classification. The Simatic KTP700 HMI is a basic HMI, making it the ideal choice for performing simple visualisation tasks for lower to medium-performance range with Siemens S7 1200 series PLC (Global Siemens, 2022). Recent reported issues with cyber security are not considered to impact on its use within this project as there will be no connection to the company's network. (SecAlerts, 2022)

Communications between the SIMATIC HMI, KTP700 Basic and S7 1200 series PLC is via Profinet, ensuring communications are delivered at appropriate speed (Bowne, 2021). Profinet connections between the PLC and HMI are via a Siemens Ethernet Switch, allowing for future Profinet expansions and direct local connection by an external computer.

5.2. Project Solutions

Although there are several VSD designs, the basic functionality remains the same; conversion of incoming supply with fixed frequency and voltage to a variable one. The complexity and level of precision of speed and torque provided by a VSD will significantly vary based on the application and its needs, however for simple applications such as ventilation fan design, basic designs are most suited both from a financial and maintenance requirement (Carbon Trust, 2018).

VSDs from three manufacturers were considered and compared for the project solution. Solution 1 utilises the Siemens 6SL3220-3YE24-0UF0 VSD from the SINAMICS G120 range (Siemens Industry Mall, 2022). Solution 2 utilises the ABB ACS380-040S-17A0-4 VSD from the ABB ACS range (ABB, 2022). Solution 3 utilises the Danfoss FC-101P7K5T4E5AH2XA VSD from the VLT HVAC Basic Drive FC 101 range (Danfoss, 2022).

The Siemens and Danfoss solutions are Heating, Ventilation and Air Conditioning (HVAC) VSDs. These are simpler versions of VSDs from the manufacturers, with fewer standard features than a comparable drive from the manufacturer's complex range, designed to operate simple, yet effective functions at a competitive cost (Falke, 2021). The ABB solution is a basic model of a VSD, placed in a comparable price range as per those from Siemens and Danfoss

The block diagram below demonstrates the project solution which is applicable to all three drives (see appendix 9.6 for individual block diagrams). Whilst there are little differences between each solution presented, the different solutions would require different drive digital configurations as each manufacturer has different digital input and relay output configurations. Power, analogue and Profinet configurations would remain untouched for all three solutions.

You could have considered doing the safety through the PLC using the Siemens F Series as another solution

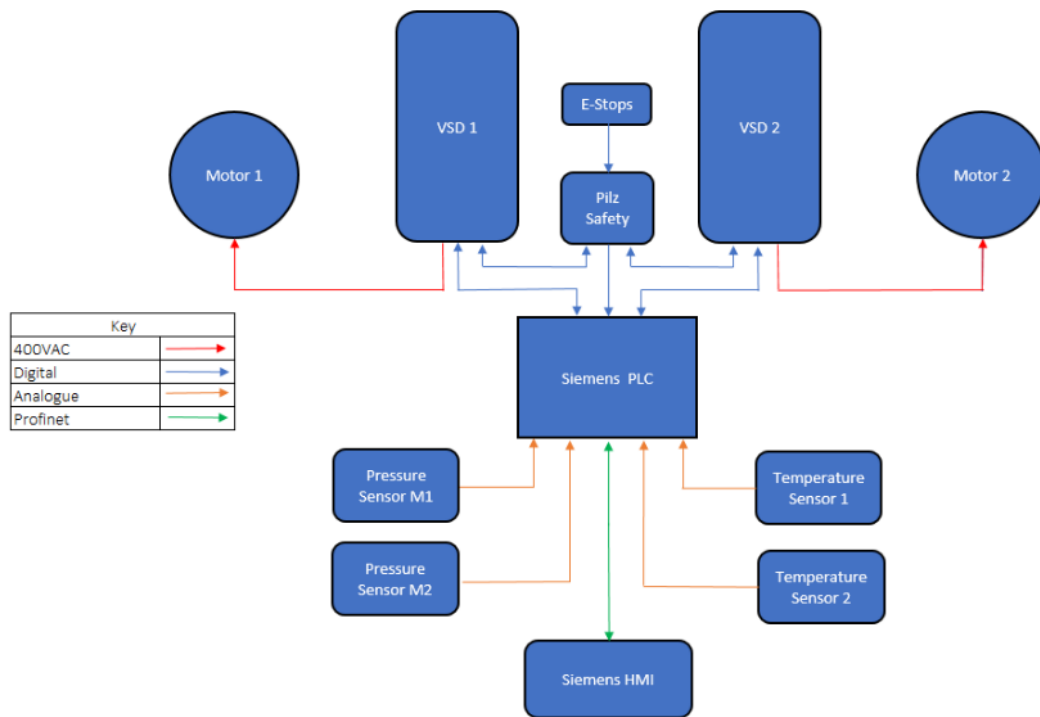


Figure 2 - Solution Block Diagram

Signal	To	From	Description
400VAC	Motor 1	VSD 1	Power from VSD to operate motor 1
400VAC	Motor 2	VSD 2	Power from VSD to operate motor 2
Profinet	HMI	PLC	Communications between HMI and PLC
Profinet	PLC	HMI	Communications between PLC and HMI
RTD	PLC	Temperature Sensor 1	Substation ambient temperature for Motor 1 operation
RTD	PLC	Temperature Sensor 2	Substation ambient temperature for Motor 2 operation
Analogue	PLC	Pressure Sensor 1	Airflow pressure for Motor 1 air intake
Analogue	PLC	Pressure Sensor 2	Airflow pressure for Motor 2 air intake
Digital	PLC	VSD 1	Signal from PLC to indicate required operation speed for motor 1
Digital	PLC	VSD 2	Signal from PLC to indicate required operation speed for motor 2
Digital	VSD 1	PLC	VSD 1 Healthy Indication from VSD to PLC
Digital	VSD 2	PLC	VSD 2 Healthy Indication from VSD to PLC
Digital	E-Stop	Pilz Relay	Indication of Healthy E-Stop Circuit or E-Stop Operation to Pilz Relay
Digital	Pilz Relay	PLC	Indication of Healthy E-Stop Circuit or E-Stop Operation to PLC
Digital	Pilz Relay	VSD 1	Indication of Healthy E-Stop Circuit or E-Stop Operation to VSD
Digital	Pilz Relay	VSD 2	Indication of Healthy E-Stop Circuit or E-Stop Operation to VSD
Digital	VSD 1	Pilz Relay	STO healthy indication to Pilz Relay
Digital	VSD 2	Pilz Relay	STO healthy indication to Pilz Relay

Table 3 - Solution Signal Designation

To operate the ventilation system, as shown in table 3, digital signals from the PLC indicate to the drive to operate the ventilation system at full speed, reduced speed or system stop. Operation speed and functions are determined by analogue signals from the temperature sensors. Analogue signals from pressure sensors indicate air pressure in the ventilation system; reduced air pressure during operation will indicate on the HMI that ventilation system filters require replacing, whilst zero air pressure during operation will indicate that ventilation system fan belts have failed.

Integrated into the drive's safety features is Safe Torque Off, STO, meaning certified safety contactors and dual safety contactor circuits are no longer required. Digital signals from the Pilz relay indicate to the drive that the safety circuit is healthy, along with PLC digital signals indicating the motor circuit is healthy. Confirmation of a healthy STO signal is essential for the drive to run if required. Failure of a healthy STO signal on the VSD results in no system operation, regardless of the input command. (Engineers Corner , 2017).

5.3. Solution Comparison and Choice

Illustrated in table 4, is a comparison of the three VSDs from the manufacturers considered for the project solutions. Demonstrated by the comparable specifics of the VSDs, there are little differences between the solutions, with each comparable in most categories. The ABB ACS380 however does have greater communication methods and complies with more standards than the Siemens and Danfoss solutions. As the ABB VSD is the only drive that is not a HVAC VSD, the additional advantages in these categories are expected. From information and comparable data gathered, nine project evaluation criteria were selected, to evaluate the solutions.

	Solution 1	Solution 2	Solution 3
Manufacturer	Siemens	ABB	Danfoss
Model	6SL3220-3YE24-0UFO	ACS380-040S-17A0-4	FC-101P7K5T4E5AH2XA
Rated Data			
HVAC Model	Yes	No	Yes
Variable Speed Drive	Yes	Yes	Yes
Number of Phases	3	3	3
Line Voltage	380v - 480v	380v - 480v	380v - 480v
Line Frequency	47 - 63Hz	50-60Hz	50-60Hz
Rated Current at 400v	17A	17A	17.1A
Rated power at 400v	7.5KW	7.5KW	7.5KW
Pulse Frequency	4KHz	1 to 16KHz, Default 4 KHz	4KHz
General Technical Specifications			
Communication	Profinet, Ethernet/IP	Fieldbus protocols (Ethernet/IP™, Modbus TCP, Ether CAT®, ROFIBUS, PROFINET, CAN open®)	Profinet, Ethernet/IP
Safety Function	Safe Torque Off	Safe Torque Off	Safe Torque Off
Power Loss	0.259KW	0.208KW	0.159KW
Inputs/Outputs			
Digital inputs	6	4	4
Fail Safe Inputs	1	2	1
Digital outputs	2	2	2
Output Voltage	0-30VDC	0-24VDC	0-24VDC
Analogue Inputs	2	2	2
Ambient Conditions			
Cooling	Air cooled	Air Cooled	Air Cooled
Ambient operation	-20°C to +45 °C	-10 °C to +50 °C	-20 °C to +50 °C
Max humidity	95% at 40 °C	5% to 95%	5% to 95%

	Solution 1	Solution 2	Solution 3
Standards			
Compliance Standards & CE Marking	EMC Directive 2004/108/EC, Low Voltage Directive 2006/95/IEC. UL, cUL, CE, C-Tick, (RCM), EAC, KCC, SEMI F47, REACH	CE, 2006/95/EC, EN 61800-5-1: 2007, Machinery Directive 2006/42/EC, EN 61800-5-2: 2007 EMC Directive 2004/108/EC, EN 61800-3: 2004 + A1: 2012 UL, cUL certification pending ITÜV certification for functional safety pending, Quality assurance system ISO 9001 Environmental system ISO 14001 Waste electrical and electronic equipment directive (WEEE) 2002/96/EC RoHS directive 2011/65/EU	CE, C-tick, UL-listed, EN/IEC 61800-5-1, UL 508C. EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3. EN 61800-3, EN 61000-3-12, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6. EN ISO 13849-1, EN IEC 61508, EN IEC 62061, EN IEC 61800-5-2, EN
Citations			
Reference	(Siemens Industry Mall, 2022)	(Galco Industrial Electronics, 2022)	(Danfoss, 2022)

Table 4 - Solution Comparison

A radar graph was produced as a visual indication to evaluate the project solutions. Of the nine selected criteria, from an engineering perspective they were scored 1-5, 5 being excellent and 1 being poor (see appendix 9.7 for scoring matrix). With all selected solutions, current global economic climate and material shortages presents concerns for product availability. (Drives & Controls, 2021)

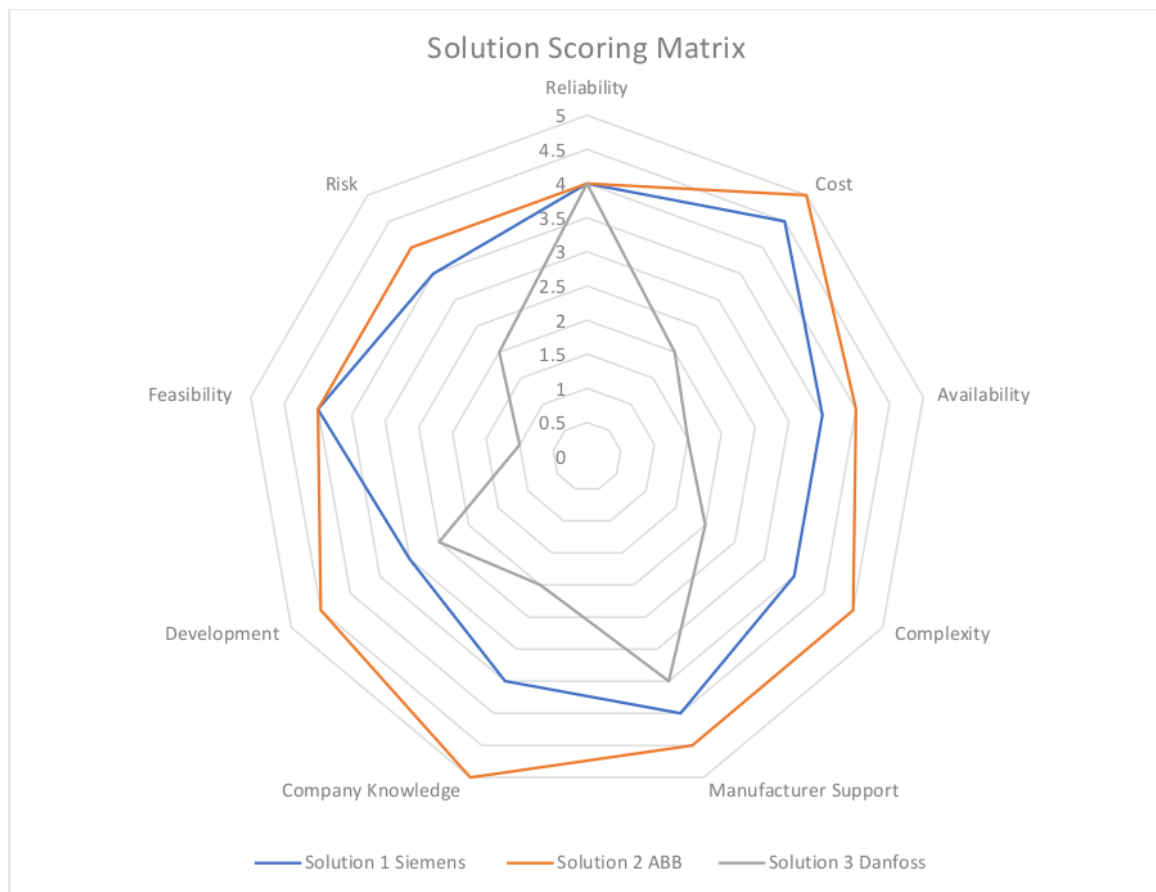


Figure 3 - Solution Comparison Radar Diagram

As demonstrated by the radar graph above, the ABB solution is the most appropriate, unsurpassed in all categories. ABB is only equalled by the other solutions in two categories as product availability has resulted in lower scoring for project risk and feasibility. Feasibility of ABB and Siemens are matched, and reliability of ABB, Siemens and Danfoss solutions have been scored equally.

Despite scoring less than ABB in all but two categories, the Siemens solution remains a viable option. The overall score was skewed by the considerably lower value attained for company knowledge and drive complexity impacting on project development and risk categories.

The Danfoss solution scored as the least viable solution. This is due to numerous low scoring categories, with product availability and company knowledge having a knock-on effect resulting in poor scoring for project deliverables.

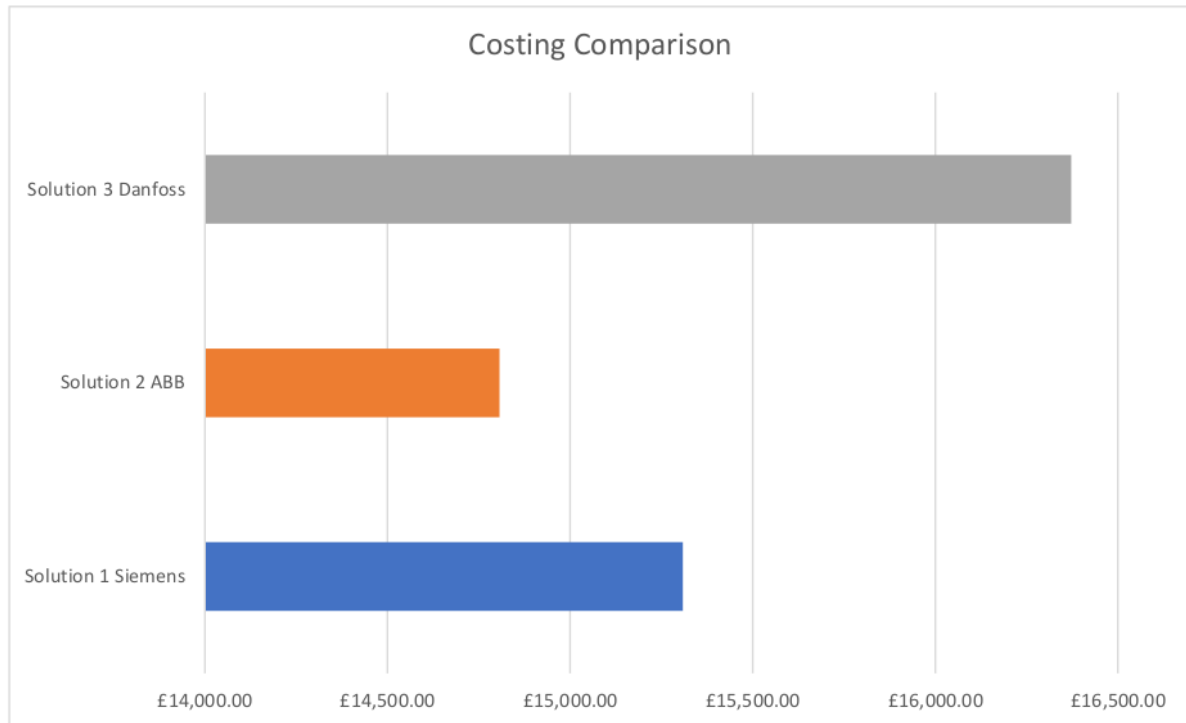


Figure 4 - Costing Comparison Graph

The graph in figure 4 was used as a visual indication to evaluate costings of the three project solutions. Although there are little differences between the solutions' costings, from a financial perspective ABB is the preferred solution. ABB is the only solution that has remained within the targeted project cost, without the need to use the contingency budget (see appendix 9.7 for costing matrix). Furthermore, company experience has shown that for effective programming of both Siemens and Danfoss solutions, a laptop and associated cable is required, whilst ABB's feature rich keypad offers full access to all software features.

6. Project Planning, Work Breakdown and Management Techniques

6.1. Project Planning

Project implementation is planned to begin during week 1 of 2023, with installation and commissioning expected to be completed prior to the set deadline of end of week 13, 2023. It is envisioned the deadline will remain, allowing for any slippage within the planned schedule, and for a duration of operation under supervision gathering analytical data to establish if the project has been successful (see appendix 9.9 for Gantt chart). Operation and maintenance manuals will be compiled at the end of the project.

The project costing plan, shown in appendix 9.10, displays the chosen project solution. It is constructed on two categories: materials and labour. During implementation, hours spent will be documented. The final costing of actual project spend can then be compared with initial project budget; the gathered data providing information as to where budgeting improvements can be made in future.

6.2. Work Breakdown Structure (WBS)

The WBS shown in appendix 9.8, displays each part of the project structure and purpose. The project has been divided into different disciplines; each discipline broken down further into areas of execution. Dividing the project into identifiable sections and subsections, allows for visual indication of each process step, defining and organising required work as well as developing the planning schedule in order for the project to be completed within the allotted timeframe. (University of Waterloo, 2022)

6.3. Management Techniques

Due to the current economic climate and worldwide shortage in certain materials and components, an 'adaptive' approach to project management technique has been followed. The adaptive approach allows for adjustments to project tasks as required to successfully accomplish the project obligations. The project budget and timeline has remained constant (Indeed Editorial, 2021). Although a Gantt chart was initially envisioned from the WBS, following the adaptive management technique, strategies and tasks were able to change to fulfil the project outcome.

7. Conclusions and Recommendations

At the current stage, project planning has been taken as far as possible and the project is ready for implementation. Considerations to numerous evaluation categories as well as potential threats to the project deliverables have been carefully assessed. From the evaluations, the most suitable solution was identified.

To enable completion within the desired time frame, whilst allowing for a period of analysing and evaluation, efforts have been made to develop a suitable WBS to assist with planning and identifying of plausible deadlines, including an allowance for slippage due to current global manufacturing shortfalls, for individual tasks.

During the project planning stage, adaptations were made, to ensure completion within budget and allocated timeframe. One significant adaptation from the project proposal was to omit vibration monitoring. The decision was made from an engineering perspective; vibration monitoring would not be a cost-effective expenditure for such small induction motors. Additionally, as the ventilation system is belt driven, numerous vibration monitoring sensors would be required, increasing cost and complexity for such a small-scale project.

Considerations were given to using different fieldbuses for the project. As it involves a basic ventilation system and is not incorporated into any of the company's numerous production lines, it was deemed an unnecessary addition and expense to have the ventilation system communicate via Profinet or Supervisory Control and Data Acquisition. Compliance with IEC/TR 61641 (Gambica, 2017) was considered, however without destructive testing this would be difficult to prove. This would not be feasible for such a bespoke small-scale project.

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9. Appendix

9.1. Project Proposal

why does this photo not appear in the main report?

SGEL6000 INDEPENDENT PROJECT

PROJECT PROPOSAL DOCUMENT

Student Name: Mathew Thomas

Project Title: North Basement Ventilation Fans

Date: 29-09-22

Budget: £15,000.00 +25% contingency

Description of Project



Currently in the North basement substation, the transformers are force cooled by ventilation fans. The ventilation is necessary to keep the transformers cooler under operation, improving performance and reducing heat losses. The current ventilation system comprises of two, 3phase motors, one 7.5kW and one 7kW. The motors are supplied from a direct online (DOL) start/stop unit, and operate continuously.

It is proposed to replace each DOL start/stop unit with a variable speed drive (VSD), a computer for logic programming, and a thermostat for a temperature control allowing a temperature setpoint to be set for an adequate ambient temperature. This must provide control of the motor, allowing speeds to be reduced when the ambient temperature is at a suitable level, thus providing cost savings and greater efficiency from the motors.

Due to the location of the ventilation fans, the air intakes have filters fitted which have to be periodically replaced to ensure an optimised airflow. Installation of an air flow sensor will ensure that the air flow to and from the vent fans is at optimum flow. An air flow set point will be applied for the intake airspeed, if the intake air speed is reduced below the set point, a physical indicator will be present, to indicate the intake filters are in need of replacing.

Due to the age of the ventilation fans, vibration monitors must also be installed to monitor the fans' mechanical components, detecting and preventing equipment failure and therefore minimising downtime. In addition, the vibration monitors must be used to detect any possible resonance within installation, as the use of a VSD to provide motor control is likely to cause the legacy ventilation fans and ducting to resonate as a result of motor speed and frequency changes.

The project is required to be completed by March 31st, 2023. Involved in the project will be Graham Mathias, Tata Projects Engineer, who will be assisting with the logic programming. Local electrical contractors, Electechs, who will be constructing and installing the panels and required project components.

Agreement for project proposal

Student Signature:

Date: 28/10/22

Industrial Supervisor Signature:

Date: 20/10/22

Academic Tutor Signature:

Date: 21/10/22

Figure 5 - Project Proposal

9.2. Project Background and Problem Definition and Constraints

Calculated Consumption of motor 1

$$\frac{I \text{ Line} \times V \text{ Line} \times \sqrt{3} \times PF}{1000} = kW = \frac{14.57 \times 415 \times \sqrt{3} \times 0.8}{1000} = 8.38kW$$

Equation 1 - Motor 1 Calculated Power Consumption

Calculated Consumption of motor 2

$$\frac{I \text{ Line} \times V \text{ Line} \times \sqrt{3} \times PF}{1000} = kW = \frac{12.19 \times 415 \times \sqrt{3} \times 0.8}{1000} = 7.01kW$$

Equation 2 - Motor 2 Calculated Power Consumption



Figure 6 - Motor 1 & 2 Current Readings

Average electricity cost per kWh to date for 2022,

$$\frac{182.80 + 161.94 + 250.41 + 176.78 + 124.81 + 159.55 + 242.72 + 370.28 + 270.71 + 119.25}{10} = £205.968MWh$$

Equation 3 - Mean Electricity Cost per MWh

UK

NO2

TABLE

CHART

HOURLY

DAILY

WEEKLY

MONTHLY

YEARLY

OCT 2022

GBP

GBP/MWh

	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Jan	182,80	80,26	35,72	60,84	49,80	52,86	36,32	39,31	47,16	48,65
Feb	161,94	54,42	30,62	50,18	51,15	49,19	33,37	42,94	44,81	51,14
Mar	250,41	57,04	31,69	44,30	57,03	41,92	34,23	40,45	44,07	60,24
Apr	176,78	66,36	24,18	43,55	50,70	41,07	33,48	44,11	41,29	51,96
May	124,81	74,39	22,17	41,36	53,29	41,11	34,40	40,46	39,50	48,26
Jun	159,55	78,24	26,49	39,70	53,94	37,88	37,30	41,36	36,72	47,37
Jul	242,72	93,52	29,45	41,05	56,87	40,82	37,53	42,04	35,42	48,53
Aug	370,28	106,83	36,28	38,15	60,59	42,43	35,57	40,62	37,82	46,85
Sep	270,71	189,11	43,78	36,20	66,47	45,98	45,63	41,55	42,96	48,94
Oct	119,25	179,32	43,39	36,87	64,31	45,70	49,26	40,23	44,25	47,35
Nov	-	185,01	44,01	44,43	61,94	50,24	59,71	37,63	47,29	52,24
Dec	-	244,69	54,98	39,11	62,63	54,79	48,44	34,82	44,14	50,37
	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013

9.3. Functional Design Specification

This is an excellent table but it belongs in the main report

	Standards & Specifications	Relevance to Project	Citation
1	BS7671:2022 Requirements for Electrical Installations	Apply to design, erection, and verification of electrical installations, including additions and alterations to existing installations	(IET, 2022)
2	IEC60085 Electrical insulation:	Distinguishing between thermal classes of electrical insulation systems and electrical insulating materials. Establishes criteria for evaluating thermal endurance of electrical insulating materials	(iTeh, Inc, 2015)
3	BSEN 60529 Degree of Protection Provided by Enclosure	Providing adequate degree of protection against access to hazardous parts, protection of equipment against ingress of foreign objects	(British Standards Institution, 1992)
4	BSEN 13602 Copper & Alloys for conductors	Specifies composition, property requirements including electrical properties, and dimensional tolerances for drawn round copper wire. Manufacture of electrical conductors intended for production of bare and insulated cables and flexible	(European Standards, 2022)
5	BSEN ISO 13850 Emergency Stops	Emergency Stop Function to stop hazardous functions of machinery as quickly as possible, without creating further risks.	(GT Engineering , 2015)
6	BS 5801:2017 Industrial fans - performance testing:	Specifying procedures to determine performance of fans of all types	(BSI, 2017)
7	BSEN 61439 Low Voltage Switchgear and Control Gear Assemblies:	Standard that low-voltage switchgear and motor control panels must be manufactured to	(Michael Smith Switchgear, 2022)
8	BSEN 60947 Low Voltage Switch Gear and Control Gear:	Applies to equipment with rated voltage not exceeding 1000VAC or 1500VDC	(BSI, 2021)
9	BSEN 61800 - Adjustable speed electrical power drive systems:	Applies to adjustable speed power drive systems, including means for control, protection, monitoring, and measurement of AC motors.	(IEC, 2021)
10	BSEN 50598 - Eco-design for power drive systems, motor starters, power electronics and their driven applications:	Specifies a process and requirements to implement environmentally conscious product design principles, to evaluate eco-design performance	(iTeh, Inc, 2015)
11	BSEN 60204-1:2018 - Safety of machinery - Electrical equipment of machines:	Requirements and recommendations relating to electrical equipment of machines in order to promote safety of people and property, consistency of control responses, and ease of operation and maintenance	(Procter Brothers, 2018)
12	BSEN 60034-1:2022 - Rotating electrical machines rating and performance:	Applicable to all rotating electrical machines	(European Standards, 2022)
13	BSEN 13849 Safety of Machinery. Safety-related parts of control systems.	Safety standard which applies to parts of machinery control systems that are assigned to providing safety functions	(BSI., 2022)

Table 5 - Standards and Specifications

9.4. Test Plan

Test Plan					
Item	Description of Test	Expected Outcome	Actual Outcome	Pass/Fail	Evidence
General					
1.1	Main Isolator - Power ON	Panel Powers Up			
1.2	Main Isolator - Power ON	Operates with a nominal supply voltage less than 1000VAC, 1500VDC.			
1.3	Main Isolator - Power ON	Power Supply Healthy			
1.4	Main Isolator - Power ON	Power On VSD 1			
1.5	Main Isolator - Power ON	Power On VSD 2			
1.6	Main Isolator - Power ON	Power on Logic Computer			
1.7	Main Isolator - Power ON	Power on Display/Indication			
1.8	Main Isolator - Power ON	No operation of Fans			
1.9	Simulate Supply Failure. (Remove supply fuse)	System Shutdown. No operation of system			
1.10	Simulate Supply Failure (Operate Emergency Stop)	Indication of Emergency Stop activated. No operation of system			
System Operation					
2.0	System Run - Fans On	Are electric motors and associated fans operating with the correct rotation (Clockwise)			
2.1	System Run - Fans On	Display for current operation of motors and ambient temperature			
2.2	System Run - Simulate temp > 20°C	Fans operate at 100% capacity			

2.3	System Run - Simulate temp > 20°C	Display for current operation of motors and ambient temperature			
2.4	System Run - Simulate temp between < 20°C	Fans operate at 50% capacity			
2.5	System Run - Simulate temp between <20°C	Display for current operation of motors and ambient temperature			
2.6	System Run - Simulate temp < 10°C	Fans stop			
2.7	System Run - Simulate temp < 10°C	Display for current operation of motors and ambient temperature			
2.8	System Run - Simulate air flow reduction <70% for Intake 1	Indication requiring for intake 1 filter change			
2.9	System Run - Simulate nominal air flow for intake 1	Indication for intake 1 filter change reset			
2.10	System Run - Simulate no air flow for Intake 1	Indication for belt failure for motor 1			
2.11	System Run - Simulate nominal air flow for intake 1	Indication for motor 1 belt failure reset			
2.12	System Run - Simulate air flow reduction <70% for Intake 2	Indication requiring for intake 2 filter change			
2.13	System Run - Simulate nominal air flow for intake 2	Indication for intake 2 filter change reset			
2.14	System Run - Simulate no air flow for Intake 2	Indication for belt failure for motor 2			
2.15	System Run - Simulate nominal air flow for intake 1	Indication for motor 1 belt failure reset			

2.16	System Run - Fans on. Press Emergency Stop	System shutdown. No restart whilst E-Stop is active. E-Stop indication			
2.17	Operation - Energy Consumption	Monitor operation to calculate energy average consumption. Compare with previous energy usage			

Table 6 - Test Plan

9.5. Risk Assessment

My MoC's

MOC number:
400013162
North Basement Vent Fans

Overview - Authorization Requested

Title

400013162 - North Basement Vent Fans

Description

[28.11.2022 13:45:44 CET Mathew Thomas (B073448) Phone +44 1554 712274]
Replacement of North Basement Vent Fans control.
Control changed from DOL to VSD.
Reason for change, energy saving and greater efficiency for operation
[28.11.2022 13:45:59 CET Mathew Thomas (B073448) Phone +44 1554 712274]
Notification accepted

Functional Location:

3200-321-5250-0058 - N/BSMT TRANSFORMER VENT FANS

Type of change

Permanent Change

Change date

31-03-2023

Initiator

Mr Mathew Thomas

MoC Manager

Mr Mathew Thomas

MoC Authorizer

Mr Leighton Howell

View RIF

[Click to view RIF](#)

View RA

[Click to view RA](#)

Figure 8 - MOC Front Page

Summary new MoC notification

Title

North Basement Vent Fans

Description

Replacement of North Basement Vent Fans control.
Control changed from DOL to VSD.
Reason for change, energy saving and greater efficiency for operation

Functional Location

3200-321-5250-0058 N/BSMT TRANSFORMER VENT FANS

Type of change

☐ Temporary ☒ Permanent

Change date

31-03-2023

Email

MATHEW.THOMAS@TATASTEEL EUROPE.COM

MoC Manager

1073448 Mr Mathew Thomas

Cancel

Edit

Save

Figure 9 - MOC Summary

MOC: 400013162 // Overview - Authorization Requested // Risk Analysis (RA)

RA Team

Risk Analysis

Assurance

Planning & Scheduling

Person To Inform

Risk Area	Scenario	Effect	Risk value	Measure	Risk value
Installation availability	Ventilation fans not operating/not working	Room over heating, Transformers overheating	10 Financial	System to be designed appropriately. .	10 Financial

Back to overview

Save as Draft

Submit for authorisation

Figure 10 - MOC Risk Analysis

RA Team Risk Analysis Assurance Planning & Scheduling Person To Inform

Subject	Action	
Maintenance procedures	Review current maintenance procedures. Review DR and CAPL vent fan procedures. Update SAP	
Education and training plan	Knowledge update on new equipment, electrical craft and shifts	
Modifying drawings	Drawing to be uploaded to Cabinet, Old drawings to removed/marked up accordingly	
Adjustment: maintenance/inspection plan	Updates to SAP	

Back to overview Save as Draft Submit for authorisation

Figure 11 - MOC Assurance

RA Team Risk Analysis Assurance Planning & Scheduling Person To Inform

Risk Area/ Category	Measure/ Task	Action Holder	End Date
Installation availability	System to be designed appropriately .	David Thomas 	28-02-2023
Maintenance procedures	Review current maintenance procedures. Review DR and CAPL vent fan procedures. Update SAP	David Thomas 	28-02-2023
Education and training plan	Knowledge update on new equipment, electrical craft and shifts	David Thomas 	30-04-2023
Modifying drawings	Drawing to be uploaded to Cabinet, Old drawings to removed/marked up accordingly	David Thomas 	30-04-2023
Adjustment: maintenance/inspection plan	Updates to SAP	David Thomas 	30-04-2023
Permanent change	Change has been implemented	David Thomas 	31-03-2023
Evaluation	An evaluation of this change needs to be conducted	Mr Mathew Thomas	31-05-2023

Back to overview Save as Draft Submit for authorisation

Figure 12 - MOC Planning & Scheduling

Risk Area/ Category	Measure/ Task	Action Holder	End Date	Status	
Maintenance procedures	Review current maintenance procedures. Review DR and CAPL vent fan procedures. Update SAP	David Thomas	28-02-2023	Task Released	
Education and training plan	Knowledge update on new equipment, electrical craft and shifts	David Thomas	30-04-2023	Task Released	
Modifying drawings	Drawing to be uploaded to Cabinet, Old drawings to removed/marked up accordingly	David Thomas	30-04-2023	Task Released	
Adjustment: maintenance/inspection plan	Updates to SAP	David Thomas	30-04-2023	Task Released	
Installation availability	System to be designed appropriately .	David Thomas	28-02-2023	Task Released	
Permanent change	Change has been implemented	David Thomas	31-03-2023	Task Released	

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File size should be less than 6MB

Figure 13 - MOC Action Overview

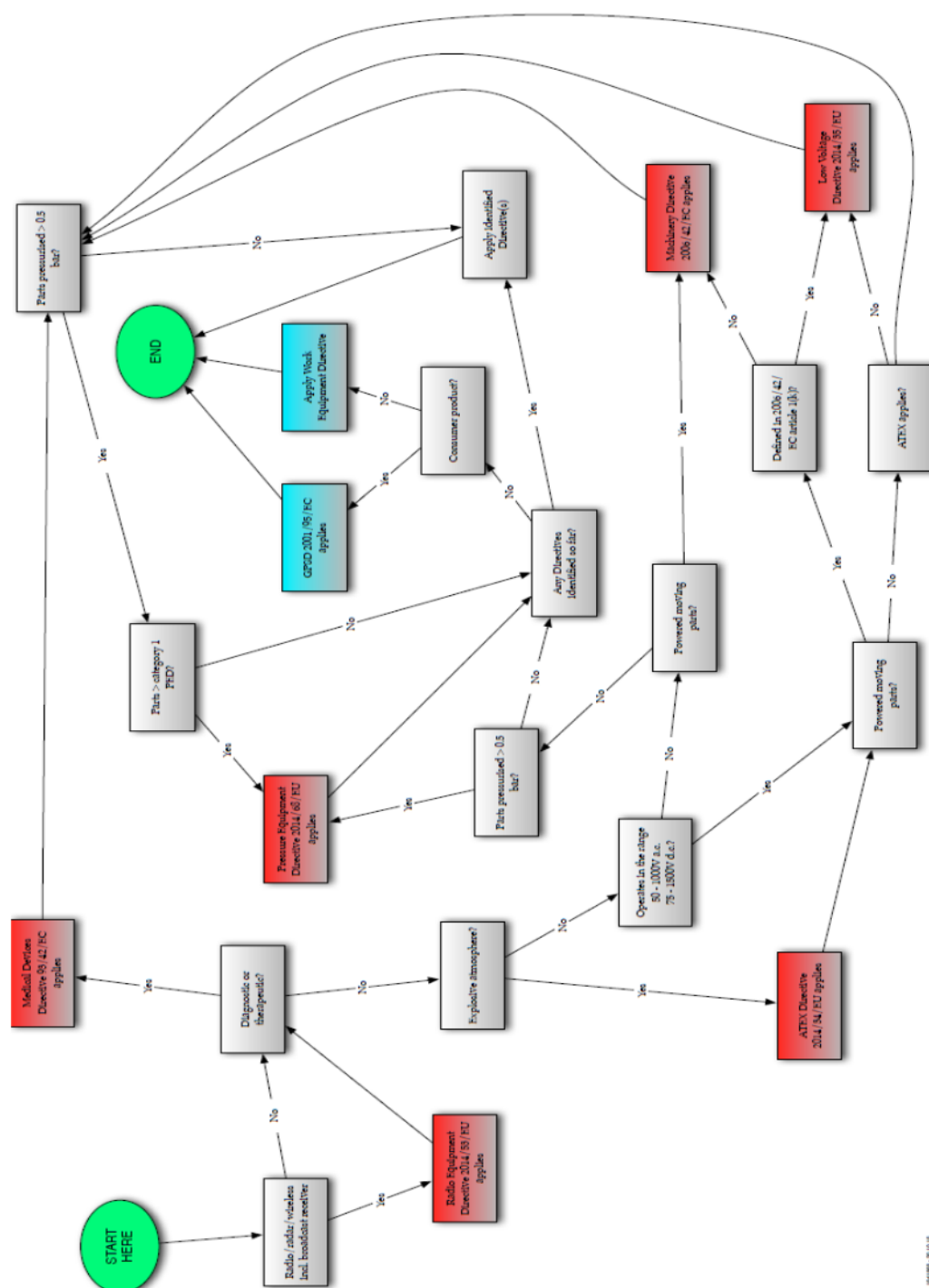


Figure 14 - Safety Directive Identification Flowchart

(Conformance CE, 2021)

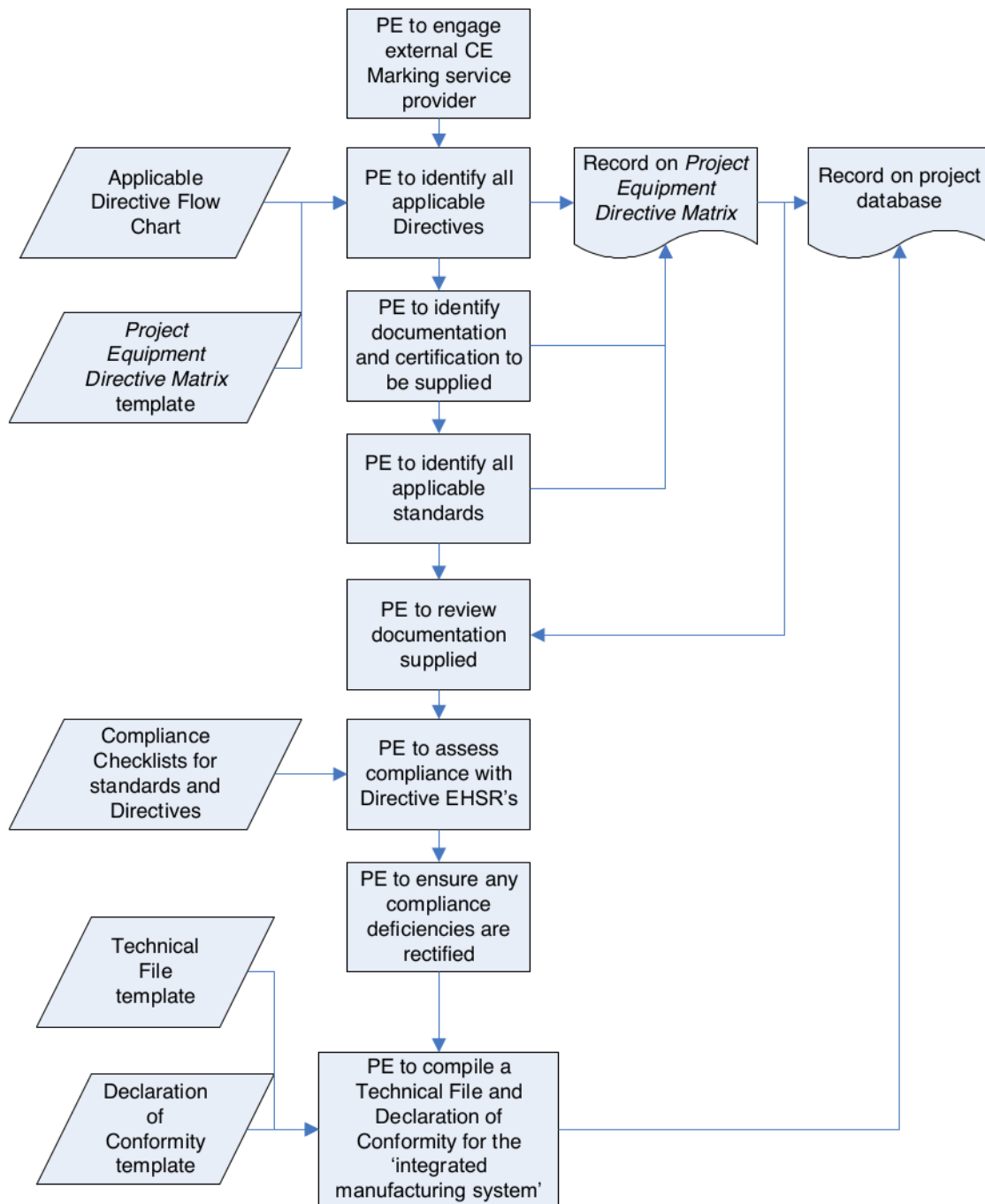


Figure 15 - CE Marking Flow Chart

(CE Marking, 2014)

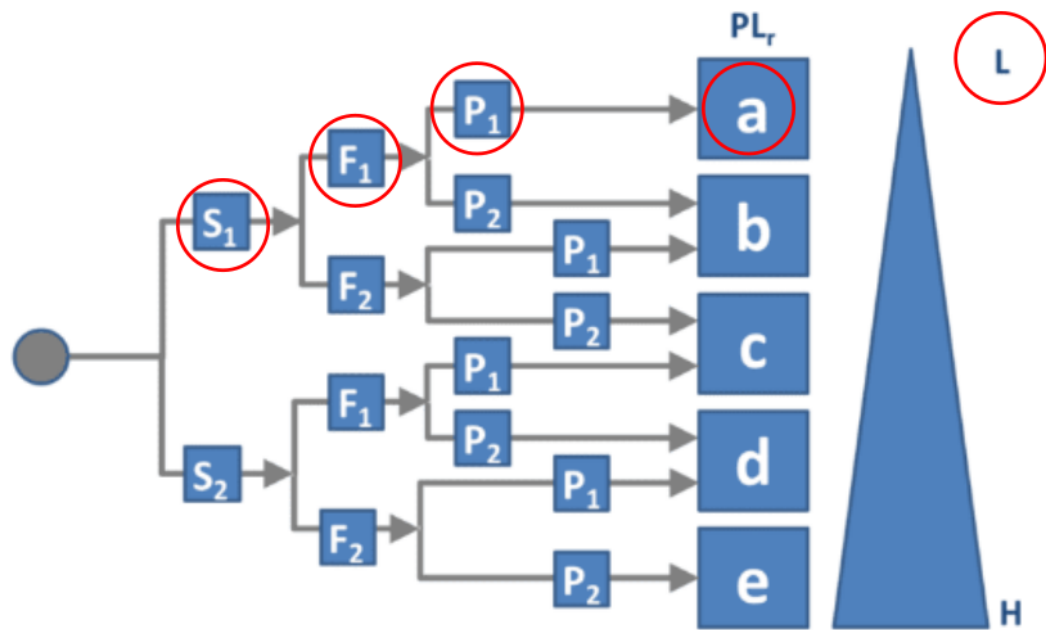


Figure 16 - PL Rating Graph

(Collins, 2019)

Risk Parameters	
S	Severity of Injury
S1	Slight (Usually reversible)
S2	Serious (Usually irreversible injury or death)
F	Frequency/Exposure
F1	Seldom to less often exposure
F2	Frequent to continuous exposure
P	Possibility of avoiding harm
P1	Possible under specific conditions
P2	Scarcely possible

Table 7 - PL Risk Rating Parameters

(Nix, 2015)

9.6. Solution Block Diagram

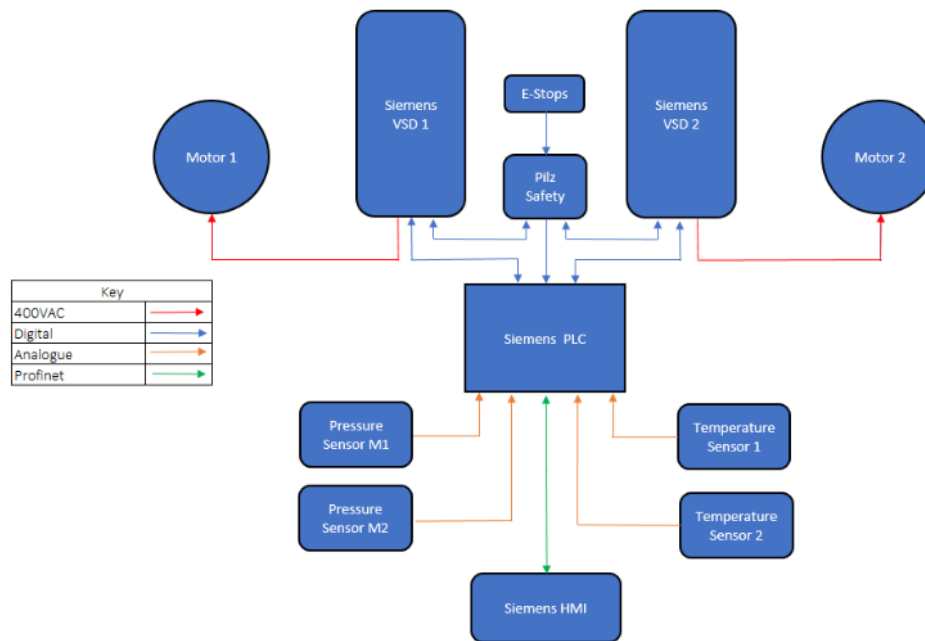


Figure 17 - Solution 1 - Siemens

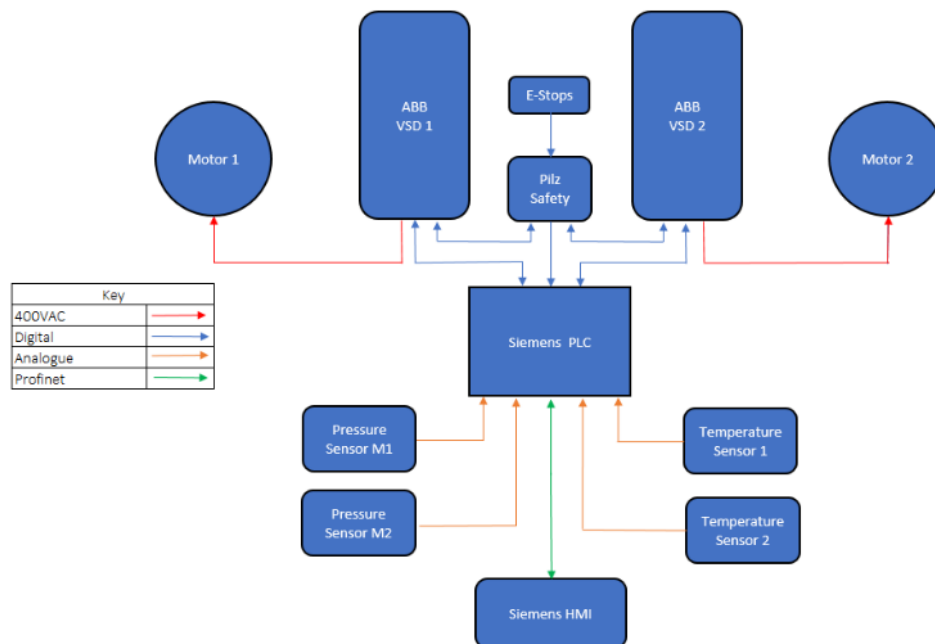


Figure 18 - Solution 2 - ABB

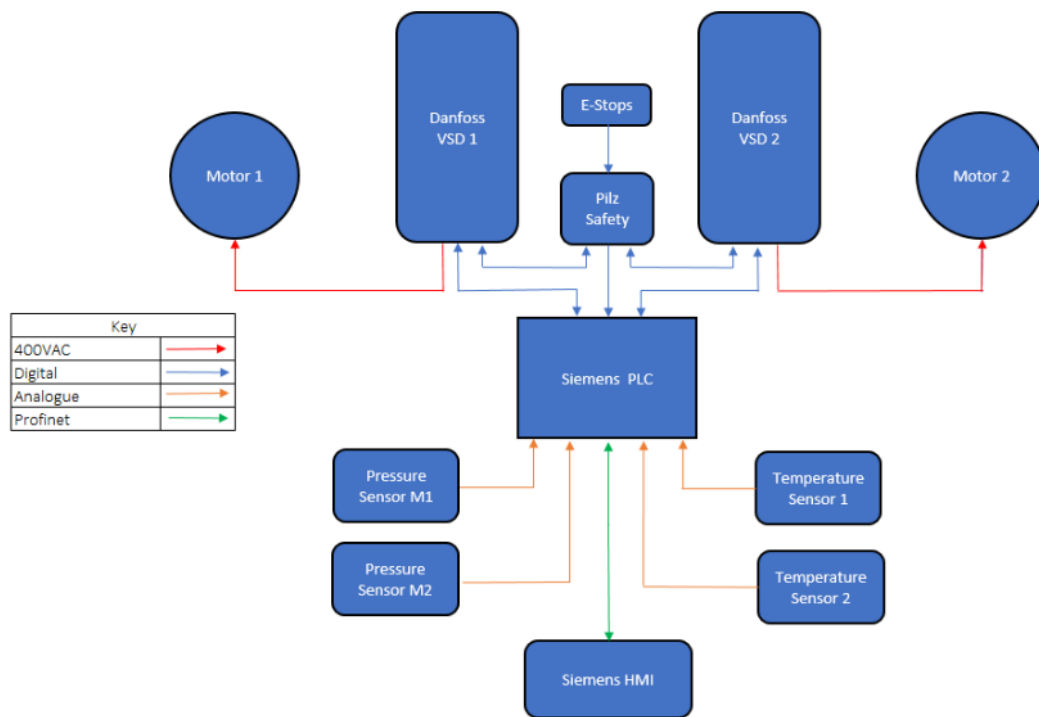


Figure 19 - Solution 3 - Danfoss

9.7. Scoring Matrix for Solutions

Solution Scoring Matrix			
Comparison Categories	Solution 1 Siemens	Solution 2 ABB	Solution 3 Danfoss
Reliability	4	4	4
Cost	4.5	5	2
Availability	3.5	4	1.5
Complexity	3.5	4.5	2
Manufacturer Support	4	4.5	3.5
Company Knowledge	3.5	5	2
Development	3	4.5	2.5
Feasibility	4	4	1
Risk	3.5	4	2
Total score (Max Score 45)	33.5	39.5	20.5

Table 8 - Solution Scoring Matrix

No	Product	Quantity	Solution 1 Siemens	Solution 2 ABB	Solution 3 Danfoss
1	VSD	2	£2,280.50	£1,778.14	£3,343.87
2	Siemens S7 PLC - 1214C	1	£512.40	£512.40	£512.40
3	Siemens KTP700 HMI	1	£877.20	£877.20	£877.20
4	Siemens Ethernet Switch	1	£103.92	£103.92	£103.92
5	Siemens 4x Analogue Input RTD	1	£426.00	£426.00	£426.00
6	24VDC Power Supply	1	£304.80	£304.80	£304.80
7	Pilz Safety Relay	1	£217.51	£217.51	£217.51
8	Temperature Sensor	2	£130.13	£130.13	£130.13
9	Pressure Sensors	2	£195.46	£195.46	£195.46
10	Cabinet - 1200x1200x400	1	£708.24	£708.24	£708.24
11	63A Switch Fuse with Shaft	1	£136.94	£136.94	£136.94
12	32A 15KW Manual Starter	2	£387.94	£387.94	£387.94
13	E Stop	3	£277.99	£277.99	£277.99
14	Cables, Containment & Miscellaneous	1	£1,500.00	£1,500.00	£1,500.00
Total Materials Cost			£6,559.03	£6,056.67	£7,622.40
Labour		250	£8,750.00	£8,750.00	£8,750.00
Total Cost			£15,309.03	£14,806.67	£16,372.40

Table 9 - Solution Costing Comparison

9.8. WBS Chart

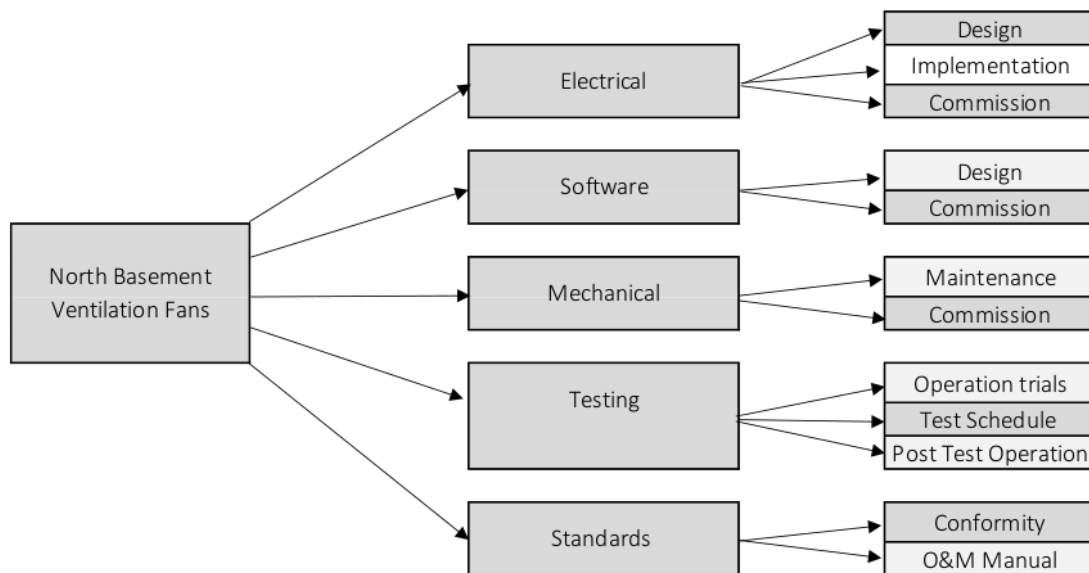


Figure 20 - Work Breakdown Structure

	WBS Element	WBS Requirement
1	Electrical - Design	Electrical design conducted; all components purchased.
2	Electrical - Implementation	Electrical panel to be constructed and installed. Associated wiring to be installed and terminated.
3	Electrical - Commission	Power of system. Implementation of safety circuits.
4	Software - Design	System logic design, functional design specification to be followed for required operation of system
5	Software - Commission	Program is installed on system, operation of system requirements/logic to be tested
6	Mechanical - Maintenance	Maintenance of mechanical components. Oil/grease moving parts, replace any damaged or worn belts. Torque check fixings and bolts
7	Mechanical - Commission	Align all mechanical components, motors and guarding
8	Testing - Trials	System is operated under all proposed conditions, testing all functions
9	Testing - Test Schedule	System tested to functional design specification. Test plan implemented. Safety functions tested.
10	Testing - Post Test Operation	Monitor operation to calculate energy average consumption. Compare with previous energy usage
11	Standards - Conformity	Conformity checks are conducted, ensuring that system conforms to standards
12	Standards - O&M Manual	Operation and Maintenance manual is compiled.

Table 10 - Work Breakdown Structure Requirement

9.9. Gantt Chart

This chart should have dates not just week numbers

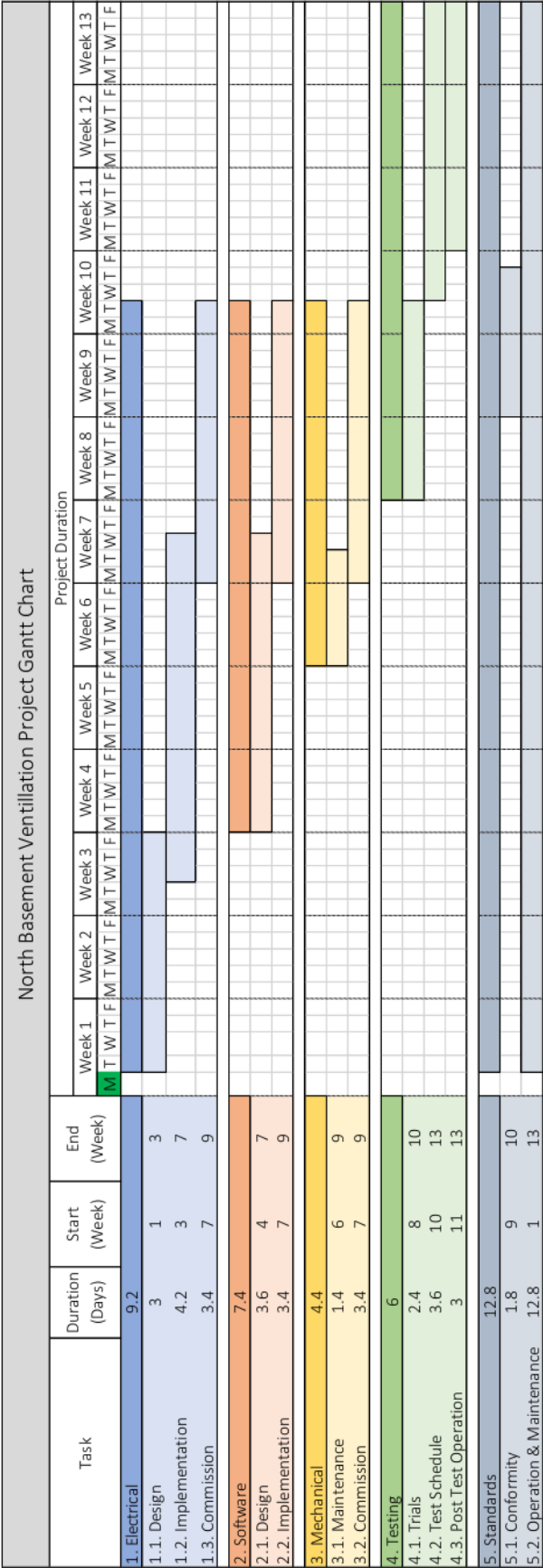


Figure 21 - Gantt Chart

9.10. Costing Spreadsheet

No	Product	Part Supplier	Quantity	Proposed Cost	Date Purchased	Date Delivered	Actual Spend
1	ABB ACS380 VSD	ABB	2	£1,778.14			
2	Siemens S7 PLC - 1214C	Parmley Graham	1	£512.40			
3	Siemens KTP700 HMI	Parmley Graham	1	£877.20			
4	Siemens Ethernet Switch	Parmley Graham	1	£103.92			
5	Siemens 4x Analogue Input RTD	Parmley Graham	1	£426.00			
6	24VDC Power Supply	Parmley Graham	1	£304.80			
7	Pilz Safety Relay	Kempston Controls	1	£217.51			
8	Temperature Sensor	RS - Online	2	£130.13			
9	Pressure Sensors	Rubix	2	£195.46			
10	Cabinet - 1200x1200x400	RS - Online	1	£708.24			
11	63A Switch Fuse with Shaft	ilecsys	1	£136.94			
12	32A 15KW Manual Starter	RS - Online	2	£387.94			
13	E Stop	Automation 24	3	£277.99			
14	Cables, Containment & Miscellaneous	Rexel	1	£1,500.00			
Total Materials Cost				£6,056.67			
Proposed Labour				£8,750.00	Actual Labour		
Proposed Total Cost				£14,806.67	Actual Cost		

Table 11 - Solution Costing Spreadsheet

SGEL6000
Independent Project
Logbook

David Mathew Thomas
North Basement Ventilation Fans
2022-2023

Summary of Entries

Log Entry	Date	Brief Description of Activity	Duration (hrs)	Accumulated time (hrs)
1	01-08-22	Project Research	4 hours	4 hours
2	15-08-22	Continue Project Research	3 hours	7 hours
3	30-08-22	Continue Project Research & Feasibility	2 hours	9 hours
4	06-09-22	Research Plant Requirements to Identify Possible Projects	3 hours	12 hours
5	09-09-22	Double Reduction Mill Drive Upgrade Feasibility	2 hours	14 hours
6	19-09-22	Project Research and Identification	4 hours	18 hours
7	28-09-22	Project Identified & Employer Approval	2 hours	20 hours
8	07-10-22	Project Proposal & Academic Approval	2 hours	22 hours
9	21-10-22	Project Background, Problem Definition & Constraints	3 hours	25 hours
10	28-10-22	Project Functional design & Specification	4 hours	29 hours
11	04-11-22	Project Functional design & Specification	5 hours	34 hours
12	11-11-22	Project Literature review	2 hours	36 hours
13	18-11-22	Project Literature review	4 hours	40 hours
14	25-11-22	Project Literature review	2 hours	42 hours
15	02-12-22	Project Literature review	7 hours	49 hours
16	09-12-22	Project Planning, Work breakdown	16 hours	65 hours
17	16-12-22	Finalise Assignment	8 hours	73 hours
18	23-12-22	Finalise Assignment	7 hours	80 hours
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				

Log Entry Sheet

Log Number	1
Date	01-08-22
Duration (hrs)	4 hours
Accumulated time (hrs)	4 hours

Record of activities and achievements

Researching plant requirements to identify a suitable project.

A number of potential projects have been identified.

1. Crane 4 upgrade to remote control operation.
Remote operation is required from a safety perspective as the crane operates intricate manoeuvres and lifts during maintenance activities. Remote operation would allow the crane operator to stand at the point of work, rather than the current cab driven position.
2. DMO switchgear upgrade. (Dependant manual operation)
With a number of legacy equipment within Tata steel's plant, Capital Expenditure investment has been allocated to replace a number of the sites LV distribution boards across the site.
3. Crane 9 Hoist upgrade.
Investment has been allocated to replace the hoist control for crane 9 from DC contractors and resistors to a DC drive. Providing modern technology and a solution to equipment that is discontinued and no longer supported.

Plans for next week

Continue with project research and feasibility of completing the projects within the required academic timescale.

Signed _____

Signed _____

Log Entry Sheet

Log Number	2
Date	15-08-22
Duration (hrs)	3 hours
Accumulated time (hrs)	7 hours

Record of activities and achievements

Continue with project research and feasibility.

Crane 4 remote operation and crane 9 hoist upgrade have had to be ruled out as feasible projects.

Due to a number of issues including, time, financial and contractor requirements, involvement and availability, both of these projects have had to be ruled out as feasible projects.

Plans for next week

Continue with DMO switchgear upgrade research.

Research possibilities of other projects.

Signed _____

Signed _____

Log Entry Sheet

Log Number	3
Date	30-08-22
Duration (hrs)	2 hours
Accumulated time (hrs)	9 hours

Record of activities and achievements

Continue with project research and feasibility.

DMO switchgear upgrade also had to be ruled out. Although the project will go ahead, the time scale and the 'hands on' requirement is not suitable for the academic year. The project planning is currently underway and the installation period for the switchgear is being planned for the annual maintenance period of Christmas 2022.

Plans for next week

Speak with manager to discuss plant requirements for possible projects.

Signed _____

Signed _____

Log Entry Sheet

Log Number	4
Date	06-09-22
Duration (hrs)	3 hours
Accumulated time (hrs)	12 hours

Record of activities and achievements

Research plant requirements to identify possible projects.

Had a discussion with my manager; it was suggested that I speak with the Projects department. Held a meeting with personnel in the Projects department in the hope of identifying a possible project that would be suitable for myself to complete whilst also meeting academic requirements.

It was suggested that I could be a part of the secondary rolling department's drive upgrade project for the Double Reduction Mill (DR Mill).

Plans for next week

Have discussions with secondary rolling department regarding the drive upgrade project.

Signed _____

Signed _____

Log Entry Sheet

Log Number	5
Date	09-09-22
Duration (hrs)	2 hours
Accumulated time (hrs)	14 hours

Record of activities and achievements

Double Reduction Mill drive upgrade.

Held discussions with the secondary rolling department regarding the drive upgrade project.

The project is the second phase of a previous project that had been completed in 2018. This phase of the project would see the replacement of the entry and exit drives of the DR Mill.

Although the project is more than substantial to meet the academic requirements, the timeline for the project does not suit the academic calendar. The project is planned to coincide with the plant's annual shutdown for Christmas 2022.

Plans for next week

Continue with project research.

Hold further discussions with project department and manager.

Signed _____

Signed _____

Log Entry Sheet

Log Number	6
Date	19-09-22
tion (hrs)	4 hours
Accumulated time (hrs)	18 hours

Record of activities and achievements

Project research and identification.

Due to the plant's production schedule, major projects take place during the annual maintenance, scheduled for Christmas shutdowns of each calendar year. The Projects department were not able to assist with identifying a required project that would meet with the academic schedule. A cost saving/energy saving approach to a project identification was suggested.

Whilst carrying out maintenance activities in North Basement substation, with a different approach to the project mind, the ventilation fans for the transformer cooling was identified as a possible suitable project. The fans are currently on a direct online starter, with no control. They operate 24 hours a day 365 days a year, regardless of the ambient temperature.

Plans for next week

Hold discussions with line manager for project approval.

Signed _____

Signed _____

Log Entry Sheet

Log Number	7
Date	28-09-22
Duration (hrs)	2 hours
Accumulated time (hrs)	20 hours

Record of activities and achievements

Project Identified: Employer Approval.

Held discussions with manager regarding identified project.

It was proposed to replace each DOL start/stop unit with a variable speed drive (VSD), a computer for logic programming, and a thermostat for a temperature control allowing a temperature setpoint to be set for an adequate ambient temperature. This would provide control of the motor, allowing speeds to be reduced when the ambient temperature is at a suitable level, thus providing cost savings and greater efficiency from the motors.

It was recommended by my manager that vibration monitors could also be installed to monitor the fans' mechanical components, detecting equipment failure and therefore minimising downtime. In addition, the vibration monitors could be used to detect any possible resonance within installation, as the use of a VSD to provide motor control is likely to cause the legacy equipment to resonate as a result of motor speed and frequency changes

Plans for next week

Write project proposal to be submitted for academic approval.

Signed _____

Signed _____

Log Entry Sheet

Log Number	8
Date	07-10-22
Duration (hrs)	2 hours
Accumulated time (hrs)	22 hours

Record of activities and achievements

Project Proposal & Academic Approval.

Draft project proposal for academic approval.

Slight alterations made for the proposal to be more generic to satisfy academic requirements.

Project approved academically and by employer.

Plans for next week

Continue with Project Background and Problem Definition and Constraints

Signed _____

Signed _____

Log Entry Sheet

Log Number	9
Date	21-10-22
Duration (hrs)	3 hours
Accumulated time (hrs)	25 hours

Record of activities and achievements

Project Background, Problem Definition & Constraints

Held meeting with Graham Mathias (Projects department) to discuss project requirements.
Topics included, VSD models, monitoring techniques for air pressure and temperature.

Write Project Background, Problem Definition & Constraints for assignment.

Plans for next week

Continue with Project Background, Problem Definition & Constraints.
Begin Function Design Specification.

Signed _____

Signed _____

Log Entry Sheet

Log Number	10
Date	28-10-22
Duration (hrs)	4 hours
Accumulated time (hrs)	29 hours

Record of activities and achievements

Project Functional design & Specification.

Begin function design specification.

Gather information from relevant sources to assist with compiling functional design specification.

Plans for next week

Continue with functional design specification

Signed _____

Signed _____

Log Entry Sheet

Log Number	11
Date	4-11-22
Duration (hrs)	5 hours
Accumulated time (hrs)	34 hours

Record of activities and achievements

Project Functional design & Specification.

Continue with functional design specification.

Make required changes to Project Functional design & Specification.

Changes are required to made, allowing for products to be available for literature review and possible solutions

Plans for next week

Begin literature review

Signed _____

Signed _____

Log Entry Sheet

Log Number	12
Date	11-11-22
Duration (hrs)	2 hours
Accumulated time (hrs)	36 hours

Record of activities and achievements

Project Literature review

Begin project literature review.

Gather information for three viable project solutions

Plans for next week

Continue with Project Literature review and associated tasks

Signed _____

Signed _____

Log Entry Sheet

Log Number	13
Date	18-11-25
Duration (hrs)	4 hours
Accumulated time (hrs)	40 hours

Record of activities and achievements

Project Literature review

Make further amendments to project literature review.
Continue with literature review.

Plans for next week

Continue with Project Literature review and associated tasks.

Signed _____

Signed _____

Log Entry Sheet

Log Number	14
Date	25-11-22
Duration (hrs)	2 hours
Accumulated time (hrs)	42 hours

Record of activities and achievements

Project Literature review

Continue with literature review.

Plans for next week

Continue with Project Literature review and associated tasks.

Signed _____

Signed _____

Log Entry Sheet

Log Number	15
Date	02-12-22
Duration (hrs)	7 hours
Accumulated time (hrs)	49 hours

Record of activities and achievements

Project Literature review

Continue with literature review.

Plans for next week

Continue with Project Literature review and associated tasks.

Begin work for project planning.

Signed _____

Signed _____

Log Entry Sheet

Log Number	16
Date	09-12-22
Duration (hrs)	16 hours
Accumulated time (hrs)	65 hours

Record of activities and achievements

Project Planning, Work breakdown

Research project planning techniques.

Create work breakdown structure and Gantt chart

Plans for next week

Project planning, Management Techniques.

Finalise assignment

Signed _____

Signed _____

Log Entry Sheet

Log Number	17
Date	16-12-22
Duration (hrs)	8 hours
Accumulated time (hrs)	73 hours

Record of activities and achievements

Finalise Assignment

Finalise assignment for submission.

Plans for next week

Continue with finalising assignment

Signed _____

Signed _____

Log Entry Sheet

Log Number	18
Date	23-12-22
Duration (hrs)	7 hours
Accumulated time (hrs)	80 hours

Record of activities and achievements

Finalise Assignment

Finalise assignment for submission.

Plans for next week

Begin work for Assignment presentation

Signed _____

Signed _____

1809810

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

70/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

Text Comment. what does the company produce?

Text Comment. what was the budget?

Text Comment. what were they?

Text Comment. which one did you choose?

Text Comment. a short summary but doesn't contain enough information

PAGE 8

PAGE 9

QM

Punctuation Error

Punctuation error

Text Comment. You could have said more about the background

Text Comment. is

PAGE 10

Text Comment. You have not referred to figure 1 in your report and have provided no explanation of this graph

Text Comment. poor image, some text cannot be read

Text Comment. This part reads like an FDS whereas you should be only focusing on the problem

PAGE 11

Text Comment. This sub-section was worth 5 marks.

Text Comment. This sub-section was worth 5 marks.

PAGE 12

PAGE 13

Text Comment. You may be able to save more money by making the fan speed proportional to the temperature error which could be calculated as the difference between ambient and 10 degrees.

Text Comment. You could even use PID. A process model might help you decide the PID parameters. The drive may even have the ability to do this for you.

Text Comment. How will you determine what the airflow should be at reduced fan speeds?

PAGE 14

Text Comment. What if the motor has stopped, it may not be the belt.

Text Comment. What is the correct IP rating?

PAGE 15

Text Comment. How do you define adequate ventilation?

Text Comment. What are the voltage and current ratings?

Text Comment. It would have been better to have read through these regs and cited specifically relevant material for your project rather than just listing them here.

Text Comment. However, your appendix does contain some explanations in table form

PAGE 16

PAGE 17

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PAGE 22

Text Comment. You could have considered doing the safety through the PLC using the Siemens F series as another solution

PAGE 23

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PAGE 32

PAGE 33

Text Comment. why does this photo not appear in the main report?

Text Comment. This is an excellent table but it belongs in the main report

Text Comment. This chart should have dates not just week numbers

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PAGE 72

GRADING FORM: NEW CSG-RUBRIC

DAVID THOMAS

70

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 There is excellent evidence of reading with some critical evaluation of material presented. (8/10) Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing Sources are credible and very widely ranging, correctly cited and listed. (8/10) total = 16/20

16

2. KNOWLEDGE AND UNDERSTANDING



Section 3: Project background and problem definition The background is very brief but the problem is clearly defined and explained. However, a few photos may have helped visualise the background to the problem. Also, figure 1 should have been explained. (3/5) Section 3: Project constraints: Ethical. A short brief explanation given. (2/5) Section 3: Project constraints: Sustainability A very short explanation given (1/5) Section 3: Project constraints: Legal/Commercial A good explanation provided. (3/5) Total = 9/20

9

3. COGNITIVE AND INTELLECTUAL



Section 4: Functional Design Specification Generally good but some aspects are not fully specified though table in the appendix helps with the relevant standards (3/5) Section 4: Test planning A good clear test plan found in the appendix (3/5) Section 5: Evaluation of solutions and justification of final solution Solutions are clearly presented although this section involves

13

mainly selection of one of the components with only one block diagram to cover all three solutions. You could have considered other ways of implementing safety. (3/5) Section 7: Conclusions and Recommendations Good sections showing a clear way forward. (4/5) Total = 13/20

4. PRACTICAL APPLICATION



Section 6: Project Plan A good Gantt chart presented although dates should be given not just week numbers. (3/5) Section 6: Working breakdown structure, costing exercise and management techniques Excellent evidence presented (5/5) Appendix: Risk assessment for implementation phase Some evidence though presented from the MOC system (2/5) Appendix: Planning phase log-book entries. A good detailed log book to date (5/5) Total = 15/20

15

5. TRANSFERABLE SKILLS



Section 1: Executive summary Generally good but lacking in detail (2/5) All Sections: Presentation quality of the report, diagrams, charts, tables, figure numbering, page, and section numbering etc Excellent quality of presentation (5/5) All Sections: Quality of the writing style, use of punctuation and grammar Generally, well written (5/5) Word count limit not exceeded Kept within limit (5/5) Total = 17/20

17