

**L5 – ENGINEERING & PROJECT MANAGEMENT
PROJECT PROPOSAL**

PAGE: 1 OF 19

ASSIGNMENT TITLE : PROJECT PROPOSAL

MODULE : L5 - ENGINEERING & PROJECT MANAGEMENT

MODULE CODE : ACDA5025A

PROGRAMME : BENG ELECTRICAL & ELECTRONIC ENGINEERING

STUDENT NAME : FREDDIE WILSON

STUDENT NO : 2413880

**L5 – ENGINEERING & PROJECT MANAGEMENT
PROJECT PROPOSAL**

PAGE: 2 OF 19

TABLE OF CONTENTS

1. INTRODUCTION	4
1.1. PROJECT DESCRIPTION	4
2. AIMS & OBJECTIVES	4
2.1. GENERAL	4
3. BACKGROUND RESEARCH	4
3.1. SCENARIO	4
4. PROJECT DESIGN	4
4.1. GENERAL	4
4.2. COMPRESSOR SPECIFICATION	5
4.3. CAPTIVE TRANSFORMER	5
4.4. VARIABLE FREQUENCY DRIVE	5
5. RESOURCES	5
6. PLANNING	7
6.1. ENGINEERING PHASE	7
6.2. CONSTRUCTION PHASE	8
6.3. SUPPORT	9
6.4. CRITICAL PATH ANALYSIS	10
7. EXPECTED OUTCOMES/DELIVERABLES	11
7.1. PROJECT OUTCOME	11
7.2. PROJECT DELIVERABLES	11
7.3. PROJECT MILESTONES	13
8. RISKS & MITIGATION	13
8.1. RISKS	13
8.2. QA/QC DOCUMENTATION	14

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 3 OF 19

8.3.	TESTING & COMMISSIONING	14
8.4.	SCHEDULING & SLACK	14
8.5.	CONTRACTORS	15
8.6.	COMPLIANCE WITH STANDARDS	15
9.	ETHICAL CONSIDERATIONS	15
9.1.	EQUIPMENT REPLACEMENT	15
9.2.	EQUIPMENT DISPOSAL	15
9.3.	EQUIPMENT MISUSE OR FAILURE	15
9.4.	EMPLOYING STAFF & CONTRACTORS	16
10.	ENVIRONMENTAL & SOCIETAL IMPACT	16
10.1.	ENVIRONMENTAL	16
10.2.	SOCIETAL	16
11.	CONCLUSION	16
12.	REFERENCES	17
13.	APPENDIX A – EQUALITY, DIVERSITY & INCLUSION CERTIFICATE	18
14.	APPENDIX B – PREVENT CERTIFICATE	19

TABLE OF FIGURES

Figure 1: Engineering Gantt Chart.....	7
Figure 2: Construction Gantt Chart.....	8
Figure 3: Project Support Gantt Chart.....	9
Figure 4: Engineering Activities Critical Path.....	10
Figure 5: Construction Activities Critical Path.....	10
Figure 6: Project Support Critical Path	11
Figure 7: Electrical Block Diagram	12
Figure 8: Cable Routing & Layout	12
Figure 9: Project Risk Matrix	14

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 4 OF 19

1. INTRODUCTION

1.1. Project description

- 1.1.1. This proposal aims to replace an outdated 750kW compressor motor, variable frequency drive (VFD), and transformer with efficient new components that meet current supply demands.

2. AIMS & OBJECTIVES

2.1. General

- 2.1.1. Engineer and construct the new equipment within 10 weeks of the start date $\pm$ 10%.
- 2.1.2. Replace existing equipment while minimising process disruption.
- 2.1.3. Where suitable, re-use existing infrastructure, power and control cables, and earthing arrangements to reduce cost and waste.
- 2.1.4. Produce drawing deliverables, a materials list, and man-hour estimates for installation purposes within 5 weeks.
- 2.1.5. Evaluate and mitigate potential societal, environmental, and ethical impacts.

3. BACKGROUND RESEARCH

3.1. Scenario

- 3.1.1. This project is required because the previous compressor and system experienced numerous faults and maintenance issues, as well as multiple cable failures following recent testing. This has resulted in the compressor motor no longer being fit for the process, and a replacement is required. In addition to replacing the system, the business aims to reduce its environmental impact and carbon footprint.

4. PROJECT DESIGN

4.1. General

- 4.1.1. The new motor will transport hydrogen from electrolysis to storage tanks, facilitating its use for vehicles and industries while promoting sustainability.
- 4.1.2. The new compressor motor will have an equivalent power consumption of 750kW. However, an improved design will provide a higher output flow rate than the original, resulting in much better efficiency with lower parasitic losses. This means an increase in the movement of product, allowing for future demand increases and business scaling.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 5 OF 19

4.2. Compressor Specification

- 4.2.1. The selected compressor will feature a 600V, 3-phase induction motor system with a maximum power output of 750kW or 1005hp. At peak capacity, it will operate at 50 Hz, achieve a flow rate of approximately 1000 kg/hr, and utilise a soft-start method. Additionally, it will be air-cooled and include an oil-free lubrication system to minimise potential environmental impact. This compressor has been selected based on its high performance, affordability, and sustainability. Furthermore, according to ABAC [1], who manufacture compressor motors, oil-free compressors are more cost-effective to operate than oil-cooled ones due to the absence of oil changes and reduced maintenance.

4.3. Captive Transformer

- 4.3.1. The captive transformer used for the compressor motor will be in a transformer pen outside of the substation. It will have a primary and secondary voltage rating of 11kV/0.6kV and a power rating of 1MVA. This will ensure the transformer can power the compressor and the associated VFD, considering the power factor of the motor. It will be fed via the existing 11kV switchboard located inside the substation. The transformer will also be a resin-filled, air-cooled transformer, as opposed to an oil-filled one. According to the Schneider Electric Blog [2], resin-filled transformers have a higher purchase cost compared to oil-filled options. However, they incur reduced maintenance costs and present significantly reduced fire risks, complying with IEC 60076-11:2018 [3].

4.4. Variable Frequency Drive

- 4.4.1. The variable frequency drive used to power the compressor will also have a power rating of 750 kVA and will be implemented to control the compressor's speed. According to the Harristian Electric Company [4], use of a VFD in the system will result in an increase in the compressor's lifespan due to a reduction in mechanical stress, as it can gradually ramp its speed up and down as required. Additionally, there will be noticeable energy savings, as the motor speed can be reduced during periods of low hydrogen output and adjusted to match fluctuations in demand.

5. RESOURCES

The total estimated cost for the project is £323,860 ± 5%. Costs will be broken down by discipline and equipment, as shown in the detailed man-hour table (Table I) and the bill of materials table (Table II).

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 6 OF 19

Table I: Man-hour Estimates

Activities	Discipline	Position	Hours	Rate (£)
Engineering	Electrical	Designer	80	25
		Engineer	96	60
		Principal Engineer	20	85
Cable Containment		Electrical Technician	32	50
		Senior Electrical Technician	32	65
Captive Transformer Removal & Install		Electrical Technician	8	50
		Senior Electrical Technician	8	65
Compressor Motor Removal & Install		Electrical Technician	8	50
		Senior Electrical Technician	8	65
Variable Frequency Drive Removal & Installation		Electrical Technician	24	50
		Electrical Technician	24	50
		Senior Electrical Technician	24	65
Cable Installation & Cable Termination		Electrical Technician	56	50
		Senior Electrical Technician	56	65
Testing & Commissioning		Electrical Technician	12	50
		Senior Electrical Technician	12	65
Support	PM	Principal Project Manager	40	85
	Management	Construction Manager	16	100
	Management	Engineering Manager	16	100
			572	33,360

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 7 OF 19

Table II: Bill of Materials

Bill of Materials - EEL-BOM-0001		
<u>Description</u>	<u>Quantity (Units)</u>	<u>Cost (£)</u>
750kW Compressor Motor	1	150,000
1MVA 11/0.6kV Captive Transformer	1	30,000
750kVA Variable Frequency Drive	1	75,000
Electrical Cables	355m	35,500
		290,500

6. PLANNING

6.1. Engineering Phase

6.1.1. Fig. 1, shown below, displays the Gantt chart for the engineering aspect of the project, outlining its activities, which are expected to take approximately 4.5 weeks to complete.

ACDA5025A - Engineering & Project Management
Freddie Wilson

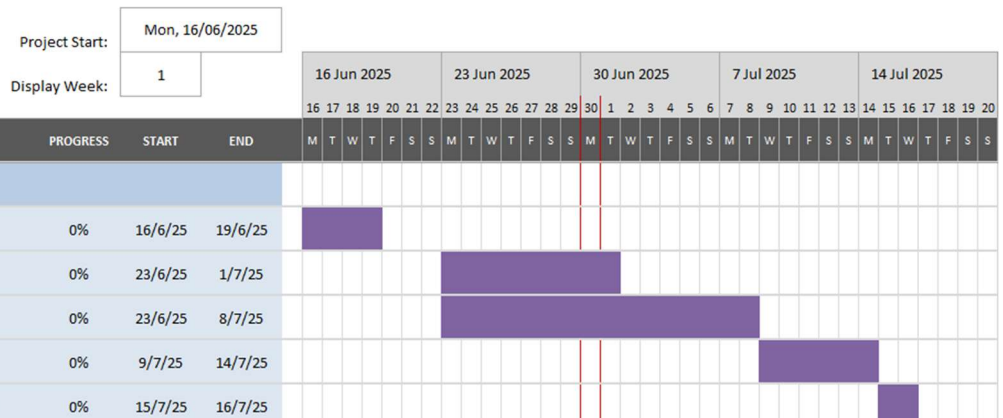


Figure 1: Engineering Gantt Chart

6.1.2. For the first activity of the engineering phase, a site survey will be required before any design work can take place. This is anticipated to take 4 days and will involve scoping out equipment locations and potential cable routes. Once this is completed, design deliverables will be created.

6.1.3. The electrical engineer on the project can begin working in parallel with the designer. The pair will work together and utilise each other's documentation and ideas to ensure alignment, taking approximately 2.5 weeks in total.

6.2.4. The next stage is cable installation and termination, which is the longest and most complex construction phase. It includes running new replacement cables between equipment and using joints to connect to the suitable existing cables, which will then be terminated at each section, following the engineer's

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 9 OF 19

interconnection diagram. This exercise will take two technicians seven days to perform.

- 6.2.5. The final stage of construction involves testing and commissioning the device and associated equipment. This will ensure the quality and functionality of the process before it is properly deployed and operational. This will take around 24 man-hours to complete and diagnose any issues.

6.3. Support

- 6.3.1. Fig. 3 below is the Gantt chart for general project support, including project, engineering, and construction managers.

750kW Hydrogen Compressor Motor Replacement

ACDA5025A - Engineering & Project Management
Freddie Wilson

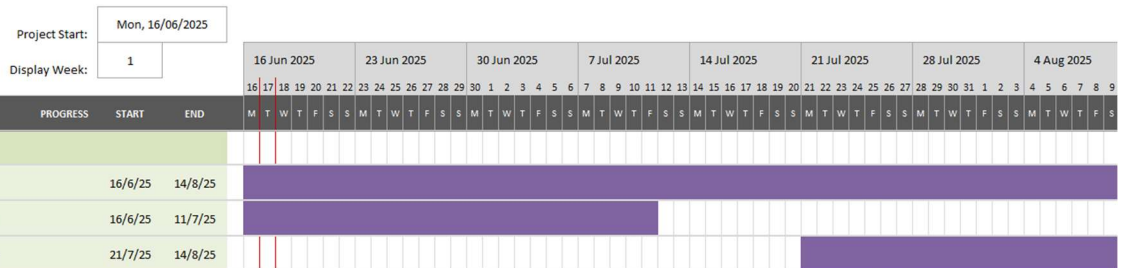


Figure 3: Project Support Gantt Chart

- 6.3.2. The project manager will be sporadically involved throughout the entire 9-week project lifecycle, from the site survey to the end of construction. Coordinating the engineering and construction process, tracking progress and expenditure to ensure work is completed on schedule and within budget.
- 6.3.3. Furthermore, the engineering manager will be involved throughout the entire engineering process, from the beginning to the commencement of construction, including approving documents and assisting the team with technical queries and problems.
- 6.3.4. The construction manager will become involved in the project once engineering has ended. They will oversee the construction phase of the project, have extensive site experience, and be able to assist with complications that may arise.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 10 OF 19

6.4. Critical Path Analysis

6.4.1. Fig. 4 below shows the critical path analysis for the engineering phase of this project.

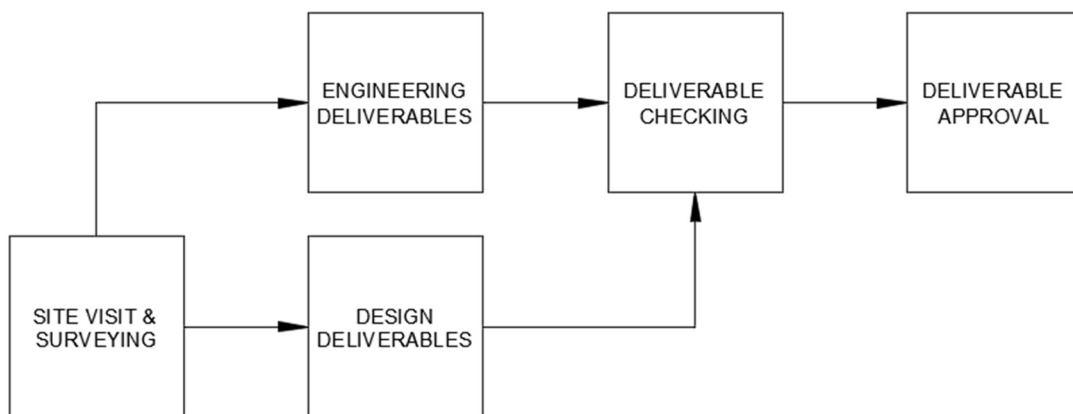


Figure 4: Engineering Activities Critical Path

6.4.2. Fig. 5 below shows the critical path analysis for the construction phase of this project.

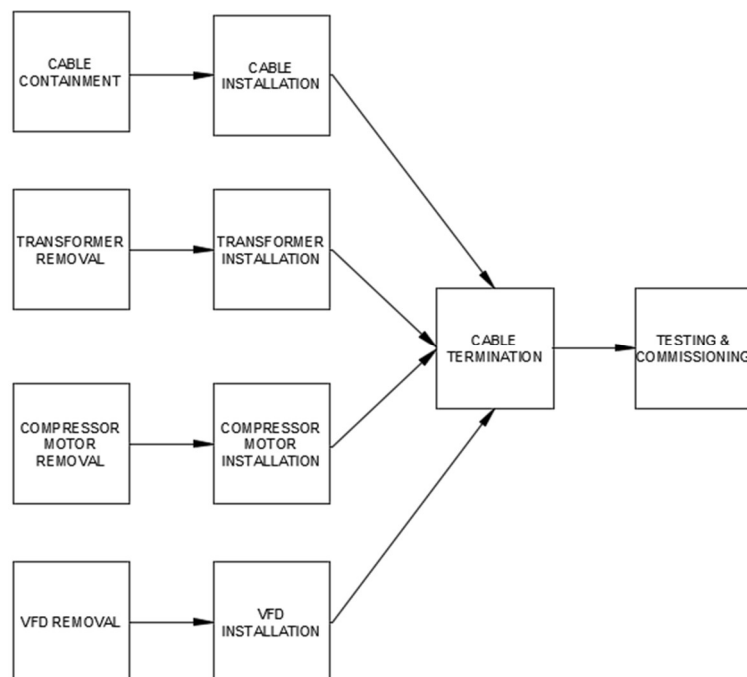


Figure 5: Construction Activities Critical Path

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 11 OF 19

6.4.3. Fig. 6 below illustrates the critical path analysis for the activities supporting this project.

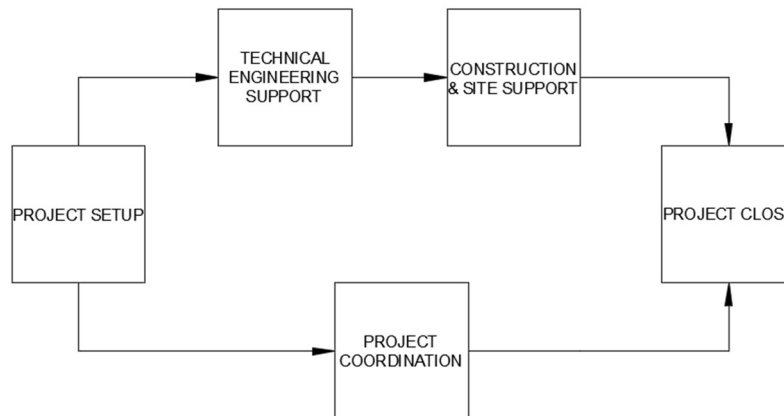


Figure 6: Project Support Critical Path

7. EXPECTED OUTCOMES/DELIVERABLES

7.1. Project Outcome

7.1.1. Completion of the project will yield a fully functional hydrogen compressor system, adhering to necessary health and environmental standards.

7.2. Project Deliverables

7.2.1. Table 7.2 provides a list of deliverables and documents that will be issued as part of the project's engineering activities.

<u>Ref.</u>	<u>Document No.</u>	<u>Title</u>
1	EEL-BLD-0001	Electrical Block Diagram
2	EEL-LAY-0001	Electrical Routing & Layout Drawing
3	EEL-BOM-0001	Electrical Bill of Materials
4	EEL-ICD-0001	Electrical Interconnection Diagram
5	EEL-DBS-0001	11kV Distribution Board Schedule
6	EEL-CSC-0001	Project Cable Schedule
7	EEL-SOW-0001	Electrical Scope of Work

Table 7.2.1: Reference documents

7.2.2. These deliverables will verify system functionality from supply to motor before installation, while providing technicians with essential reference documents. They define equipment requirements, support legal and team coordination, help minimise errors and variations, saving time and money.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 12 OF 19

Fig. 7 shows the block diagram EEL-BLD-0001 for the new hydrogen compressor system.

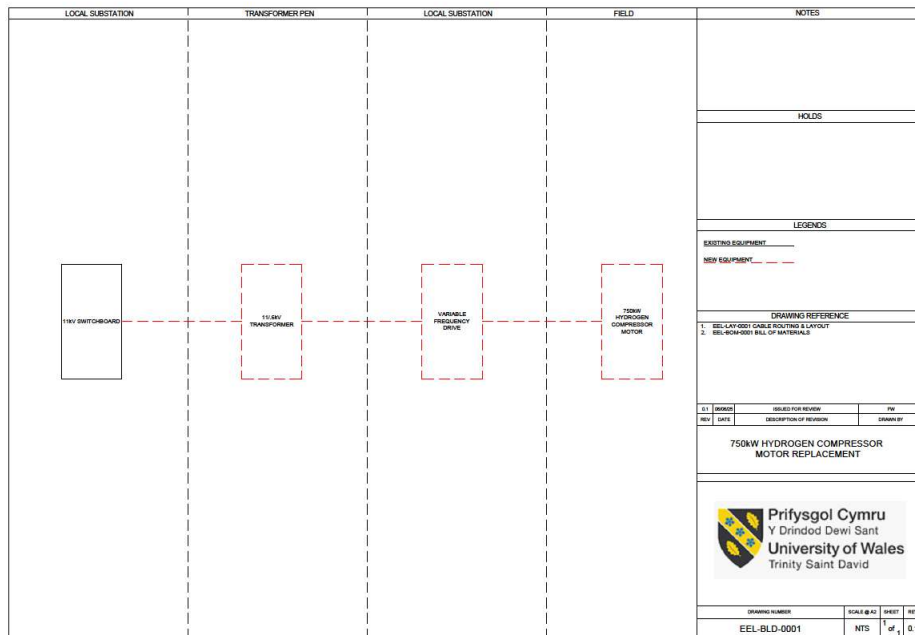


Figure 7: Electrical Block Diagram

Fig. 8 shows the electrical cable routing and equipment layout EEL-LAY-0001 for the new hydrogen compressor system.

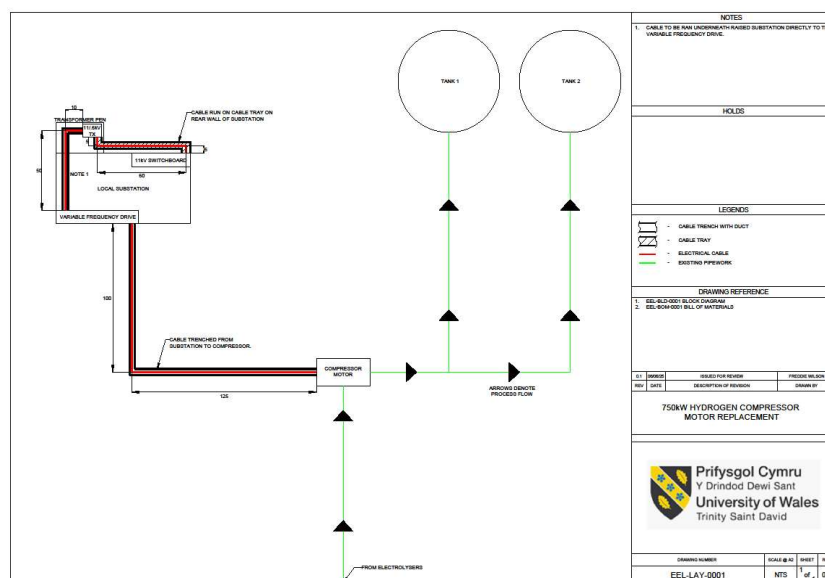


Figure 8: Cable Routing & Layout

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 13 OF 19

7.3. Project Milestones

- 7.3.1. The first project milestone is the creation of design deliverables such as the overall project block diagram, interconnection diagram and cable routing and layout.
- 7.3.2. The second milestone is the completion of the engineering deliverables, which includes the scope of work for the installation activities, cable schedule, bill of materials, and the 11kV distribution board schedule.
- 7.3.3. The third milestone is for the construction phase, which involves the removal of existing equipment on site and preparation for the new replacements to be installed.
- 7.3.4. The installation of the new motor, transformer and VFD is the penultimate milestone.
- 7.3.5. The final milestone for this project is confirming the functionality and compliance during testing after installation and cable termination.

8. RISKS & MITIGATION

8.1. Risks

- 8.1.1. Due to the nature of the project, delays are likely. The reason for this is that the electrical technicians must complete one task before beginning the next. This means work can't take place in parallel, and any delays will have a knock-on effect, which may compound over the project's lifecycle.
- 8.1.2. Once the project has been engineered and installed, there is a possibility that it does not operate as desired. For example, issues with the motor startup or varying speed.
- 8.1.3. Worker injury or sickness during engineering and construction could potentially prolong the project timeline.
- 8.1.4. During the engineering and design phase of the project, mistakes can occur, which could impact on the installation and ultimately lead to non-compliance or even severe system failure and equipment damage.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 14 OF 19

		Negligible	Marginal	Critical	Catastrophic
Probability Range	Certain				
	Likely		Project Delays		
	Possible		Employee Sickness		
	Unlikely			Operational Issues	Engineering Mistakes
	Rare				
		Consequence Range			

Figure 9: Project Risk Matrix

8.2. QA/QC Documentation

- 8.2.1. To ensure that the highest quality engineering deliverables are produced and the chances of errors are minimised, a meticulous checking and approval process will be implemented. This will include a designated checklist for each type of document produced by the designer and engineer on the project, which will be checked by the principal engineer and approved by the engineering manager.

8.3. Testing & Commissioning

- 8.3.1. To ensure construction quality and functionality, it is vital that all the relevant testing is performed before the equipment is switched on and used in the process. This is to detect and rectify any issues in any part of the system that could result in equipment failure, damage, or non-compliance with specified operating conditions. After that, the equipment should be tested and monitored again under load and in normal day-to-day operations to confirm its final performance.

8.4. Scheduling & Slack

- 8.4.1. When scheduling the activities for this project, some slack will be included to allow for any minor delays without affecting the final project deadline. This could occur due to accidents, project meetings, sickness, equipment issues, or supplier delays. In addition to interruptions from contractors or any rejections during the QA/QC, testing, and commissioning phases.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 15 OF 19

8.5. Contractors

- 8.5.1. To minimise the impact of delays during construction resulting from having only a single team of electrical technicians, additional contractors can be deployed to the project to assist in keeping the overall schedule on time if certain maintenance activities cause issues. However, this may impact the project cost and potentially become problematic for the budget, so it should be avoided unless necessary.

8.6. Compliance with Standards

- 8.6.1. Any electrical work undertaken for this project on a hydrogen production site shall comply with the following standards:
- BS 7671:2018 [5]
 - BS EN 60079-14:2014 [6]
 - BS EN 61511-1:2017 [7]
 - ISO9001 [8].
 - IEC 60076-11:2018 [3].

9. ETHICAL CONSIDERATIONS

9.1. Equipment Replacement

- 9.1.1. When selecting and specifying equipment for the new system, it should be operationally safer, more efficient and environmentally friendly than the previous system.

9.2. Equipment Disposal

- 9.2.1. Due to the outdated nature of the old equipment, it is essential to dispose of it correctly. The original transformer shall be drained of oil, and any metals or reusable parts recovered and recycled for all pieces of equipment. For parts that must be disposed of, a third-party local provider who are on the Environment Agency's public register [9] will be contracted. The contracted party will be required to provide evidence of environmental compliance and ISO certifications.

9.3. Equipment Misuse or Failure

- 9.3.1. When designing and installing the new system, numerous instruments will be installed to trip equipment and prevent accidental or malicious damage or issues, as well as send alarms to the control room to inform operators of the equipment's status. Furthermore, functional safety is used to prevent accidents

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 16 OF 19

and utilise fail-safes so a catastrophic incident won't occur or cause any damage to the site, employees or the surrounding area. Finally, the site itself is secure, with high fencing, CCTV, and security measures in place to prevent unauthorised access to equipment.

9.4. Employing Staff & Contractors

- 9.4.1. From undertaking and completing the PREVENT and DEI courses, there is a clear benefit of ensuring these are achieved when employing staff and contractors to work on the project. For example, varied perspectives and solutions, a wider talent pool and improved social responsibility. This will be ensured by tendering for contractors, who will be evaluated based on both their cost and the quality of their work. Additionally, it's the responsibility of the managers involved on the project to create an inclusive work environment and promote equal opportunities for all staff.

10. ENVIRONMENTAL & SOCIETAL IMPACT

10.1. Environmental

- 10.1.1. This project is designed to minimise environmental damage through the selection of equipment and responsible disposal practices. Additionally, the nature of the site being a hydrogen production plant and the new system allowing greater exports will overall contribute to better sustainability and reduced emissions for downstream clients.

10.2. Societal

- 10.2.1. This project overall will have a positive impact on society and the local community. Firstly, adding capacity for expansion and additional exports will result in higher revenues, ultimately leading to improved local infrastructure to support shipping and transportation. Furthermore, generating employment for local contractors and existing staff will improve the livelihoods of the surrounding areas. However, one societal drawback is that the temporary construction activities of the project have the potential to add noise and disruption to the community.

11. CONCLUSION

To conclude, the project aims to achieve a positive environmental impact alongside efficient resource use, thereby enhancing operational capabilities and enabling future advancements in hydrogen production. A dedicated focus on safety, quality assurance, and project management will ensure its success.

L5 – ENGINEERING & PROJECT MANAGEMENT PROJECT PROPOSAL

PAGE: 17 OF 19

12. REFERENCES

- [1] “Cost Breakdown: Oil-Free vs Oil-Lubricated Piston Compressors,” ABAC, 2025. <https://www.abacaircompressors.com/en-uk/blog/how-much-does-an-air-compressor-cost/cost-breakdown-oil-free-vs-oil-lubricated-piston-compressors> (accessed Jul. 04, 2025).
- [2] M. Sacotte, “Fire-Resistant Cast-Resin Transformers Offer Multiple Safety Benefits,” *Schneider Electric Blog*, Jul. 31, 2018. <https://blog.se.com/buildings/building-management/2018/07/31/fire-resistant-cast-resin-transformers-offer-multiple-safety-benefits/> (accessed Jul. 04, 2025).
- [3] IEC, IEC 60076-11: Power Transformers – Part 11: Dry-type Transformers, 2nd ed., International Electrotechnical Commission, Geneva, Switzerland, 2018.
- [4] 徐炜凡, “Optimizing Air Compressor Performance Using Variable Frequency Drive Technology: A Case-Based Analysis,” *Harristian Electric Co., Ltd*, May 30, 2025. <https://www.harristian.com/blogs/solution/impact-of-variable-frequency-drives-on-the-energy-efficiency-and-operational-stability-of-industrial-air-compressors?> (accessed Jul. 10, 2025).
- [5] British Standards Institution, *BS 7671:2018 Requirements for Electrical Installations – IET Wiring Regulations, 18th Edition*, London, UK: BSI, 2018.
- [6] British Standards Institution, *BS EN 60079-14:2014 Explosive Atmospheres – Part 14: Electrical Installations Design, Selection and Erection*, London, UK: BSI, 2014.
- [7] British Standards Institution, *BS EN 61511-1:2017 Functional Safety – Safety Instrumented Systems for the Process Industry Sector – Part 1: Framework, Definitions, System, Hardware and Software Requirements*, London, UK: BSI, 2017.
- [8] International Organization for Standardization, *ISO 9001:2015 Quality Management Systems – Requirements*, Geneva, Switzerland: ISO, 2015.
- [9] “Waste carriers, brokers and dealers,” [environment.data.gov.uk](https://environment.data.gov.uk/public-register/view/search-waste-carriers-brokers). <https://environment.data.gov.uk/public-register/view/search-waste-carriers-brokers>

13. APPENDIX A – EQUALITY, DIVERSITY & INCLUSION CERTIFICATE





14. APPENDIX B – PREVENT CERTIFICATE



AN INTRODUCTION TO
THE PREVENT DUTY
AS IT AFFECTS
HIGHER EDUCATION

CERTIFICATE OF COMPLETION

THIS ACKNOWLEDGES THAT

Name: Freddie Wilson

HAS SUCCESSFULLY COMPLETED THE INTRODUCTION TO PREVENT E-LEARNING

Date: 30/05/2025