

PSDE6019 Major Project Interim Report Dan Lee

by Daniel Lee

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BSc: Electrical and Electronic Engineering

PSDE6019: Major Project

Major Project Interim Report

Alkylation Unit Off Plot Flare Drum Logic
Upgrade Demonstration Rig

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1 – Introduction

Pembroke oil refinery has been operational since 1964 and is one of the largest and most complex refineries in Western Europe. Valero purchased Pembroke refinery, located in South West Wales, from Chevron in 2011 marking their entry into the European Refining sector. The refinery's products consist of kerosene, petrochemical feedstocks, diesel, liquefied petroleum gas (LPG) and gasoline. (Valero, 2018).

During the time in which the refinery has been in production, a vast number of control systems have been installed in order to ensure safe and efficient process functionality. As industrial technologies advance systems require upgrading and modernising.

Not clear

The major project report includes the selection of an out dated and unreliable control logic system currently in use at the refinery. Identification and discussion of possible solutions to the selected problem and justification of chosen solution. A project design specification, detailed description of the project process including an in-depth work breakdown structure. A project plan, in the form of a Gantt chart, highlighting tasks with allocated time and budgetary constraints alongside any contingency plans. All simulation, testing and implementation of the project product illustrated with thorough conclusions and recommendations stated.

The proposed project relates to a flare knockout vessel, 19-F-201, that is controlled by a self-contained pneumatic (air powered) unit. This system consistently causes reliability and operational issues which ultimately disables automatic level control of the vessel. The aim is to integrate the current plant instrumentation to a new effective control system.

Good introduction to the problem that the project will be based upon.

1.1 – Project Aim

The aim of this project is to develop the skills and knowledge in order to correctly and efficiently programme and install a control system to enable the product to be readily available for implementation to solve an industrial problem.

This will not be implemented onsite in this current year, due to other priority projects currently ongoing, however the control system will be incorporated into a demonstration rig mimicking the peripheral devices currently installed on a specific section of plant at Pembroke refinery.

1.2 – Project Objectives

In order to achieve the aim of the project the following objectives were chosen:

- Select a current industrial problem at Pembroke Refinery.
 - Research process.
 - Why has this problem been selected?
- Select three possible solutions to the selected problem.
 - Identify the advantages/disadvantages of the solutions.
 - Select and justify the chosen solution.
- Design demonstration rig.
 - Compile Product Design Specification (PDS).
 - How can the control system be demonstrated?
 - How can the rig be constructed?
- Design software/programme to control demonstration rig.
 - What type and number of I/O is required?
- Purchase components and materials.
 - What components and materials are required?
 - Can they be sourced at/through the refinery?
 - How much cost is the project going to implement to construct?
- Construct demonstration rig.
- Testing.
 - Simulate the PLC programme whilst connected to the relevant components.
 - Prove correct software and hardware operation.
 - Crosscheck results with PDS.
- Troubleshooting.
 - Were there any deviations between test results and the PDS?
 - If so, explain the causes and rectify accordingly.
- Produce Final Project Report.

Good breakdown of project objectives.

2 – Background Research and Literature Review

2.1 – 19-F-201 Process and Control System Overview

In reference to *Figure 1*, all excess and undesirable products of the Alkylation Unit flow into a 16-inch diameter line labelled "HEADER". This line connects various different process lines together before entering F-125 FLARE DRUM. In this vessel, any liquid present in the HEADER line condenses (knocks out) and settles in the bottom of the drum. All remaining vapour flows from F-125 out through the "OFF PLOT ACID FLARE" outlet line.

The purpose of F-125 is to provide the necessary residence time to enable effective knock out relief of vapours in addition to adequate surge capacities for liquid releases in the event of an emergency.

In reference to *Figure 2*, the OFF PLOT ACID FLARE line from *Figure 1* appears as, "FLARE HEADER" and enters F-201 FLARE KO DRUM. As described previously concerning F-125, any liquid still present in the FLARE HEADER line will be knocked out and settle in the bottom of the drum. All vapour exits this vessel and flows up and out of the FLARE TIP. Here it is ignited and burnt off before dispersing into the atmosphere. The purpose of a flare is identified by William L Leffler's statement, "tall flares so characteristic of refineries are used to take momentary surges in gas manufacture by burning the excess" (1985, p. 56). A flame is continuously burning on the FLARE TIP as there is a continuous gas flow from F-201.

The purpose of this vessel replicates F-125.

The liquid level in F-201 is monitored and controlled using a pneumatic logic panel located nearby F-201 as this drum is located in a remote location of the refinery (off plot).

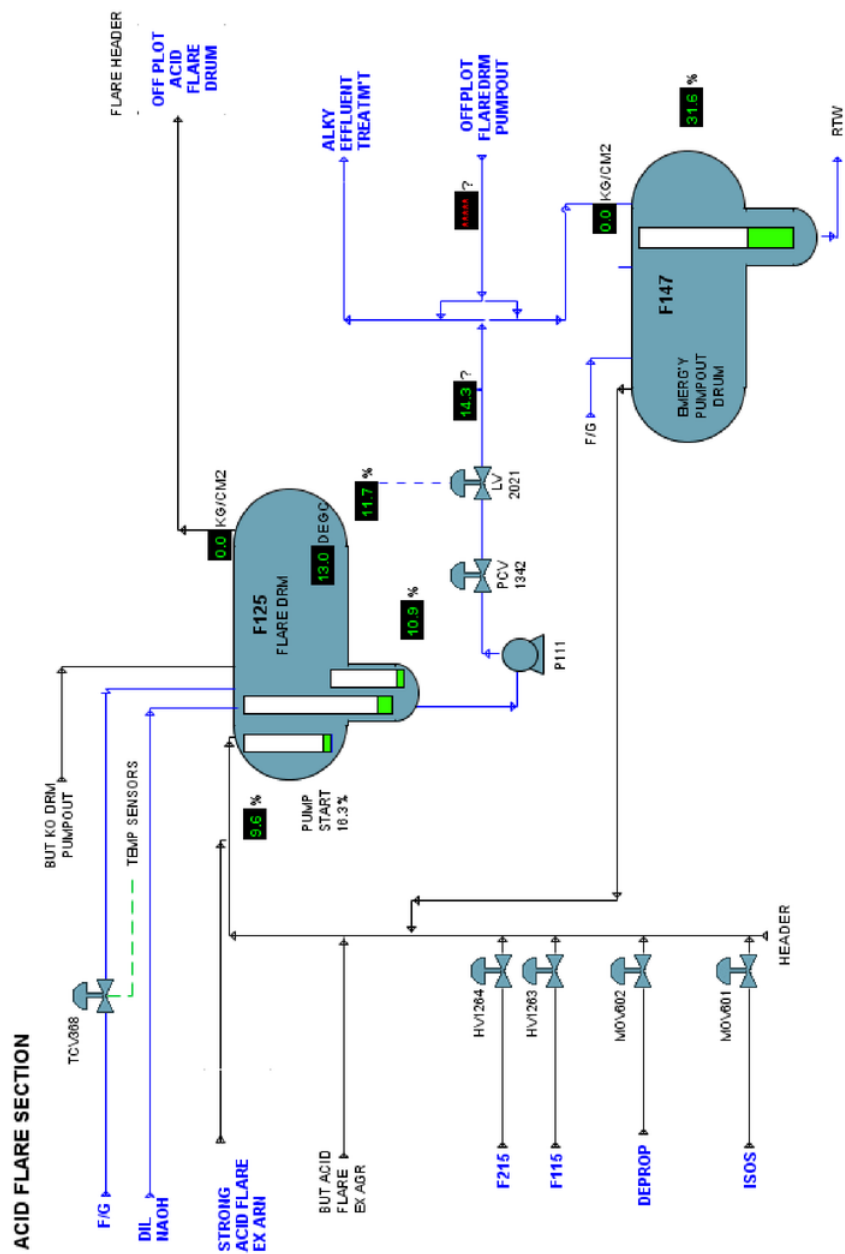


Figure 1: Pembroke refinery acid flare section graphical display

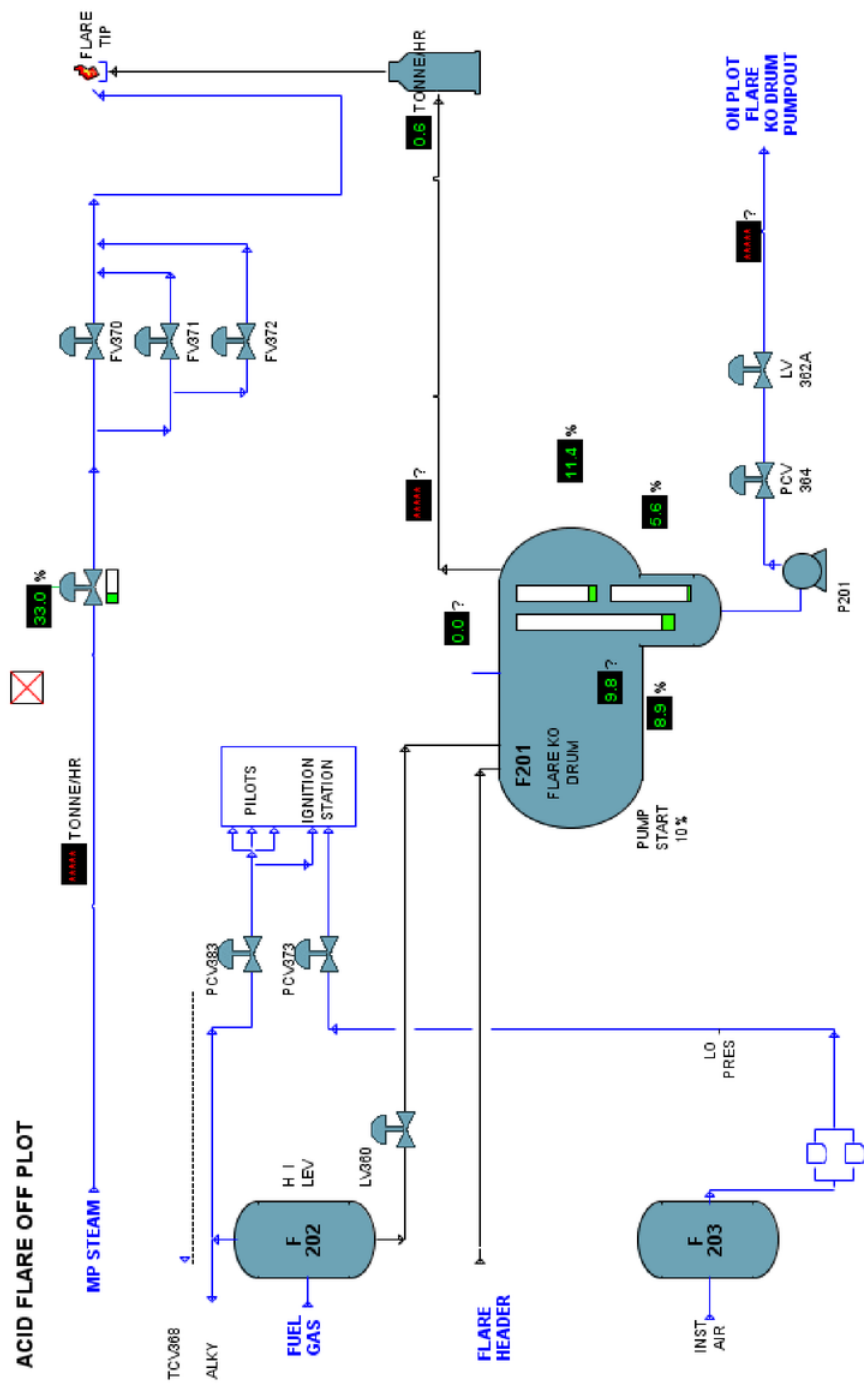


Figure 2: Pembroke refinery acid flare off plot graphical display

With reference to *Figures 3 and 4*, the level in the boot of F-201 contains a level of a product known as caustic, which is manually controlled by pump P-201. This is kept in the bottom of the vessel to aid with corrosion issues.

The drum level is controlled by two pumps, P-202 and 202S, and share a common discharge line with P-201 but they all have separate suction lines. P-202 and 202S take suction from the drum.

As illustrated in *Figure 3*, main pump 19-P-202 will start with a drum liquid level equal to 29.0%. A pneumatic level switch 19-LSH-533 produces this start signal and the main pump will stop once the liquid level is below 10.0%. Another pneumatic level switch 19-LSL-534 produces the stop signal.

A radar type level transmitter also monitors this drum level and will initiate an alarm to the operator if the liquid level reaches 30% to signify that the main pump is not sufficient in decreasing the drum level. If the liquid level were to reach 31% the standby pump will be instructed to start, this signal is governed by the radar transmitter 19-LT-362A.

An interlock is present in the control system that prevents both the main and standby pumps from running simultaneously. This is in place as the common discharge line is not designed to withstand two pumps running at the same time. A pneumatic pressure switch, 19-PSL-541, is connected to the discharge line that will disable the standby pump if the main pump is producing a healthy discharge pressure regardless if the internal liquid level is rising.

*Can both
pumps run
together, if
required, or
not?*

If the liquid level were continue to rise in F-201 a high-high level alarm is initiated at 35.5% of drum diameter. This is triggered by electronic level switch 19-LSHH-408. This is a safety critical alarm and if this level is reached operations must shutdown the Alkylation unit and a section of a neighbouring unit.

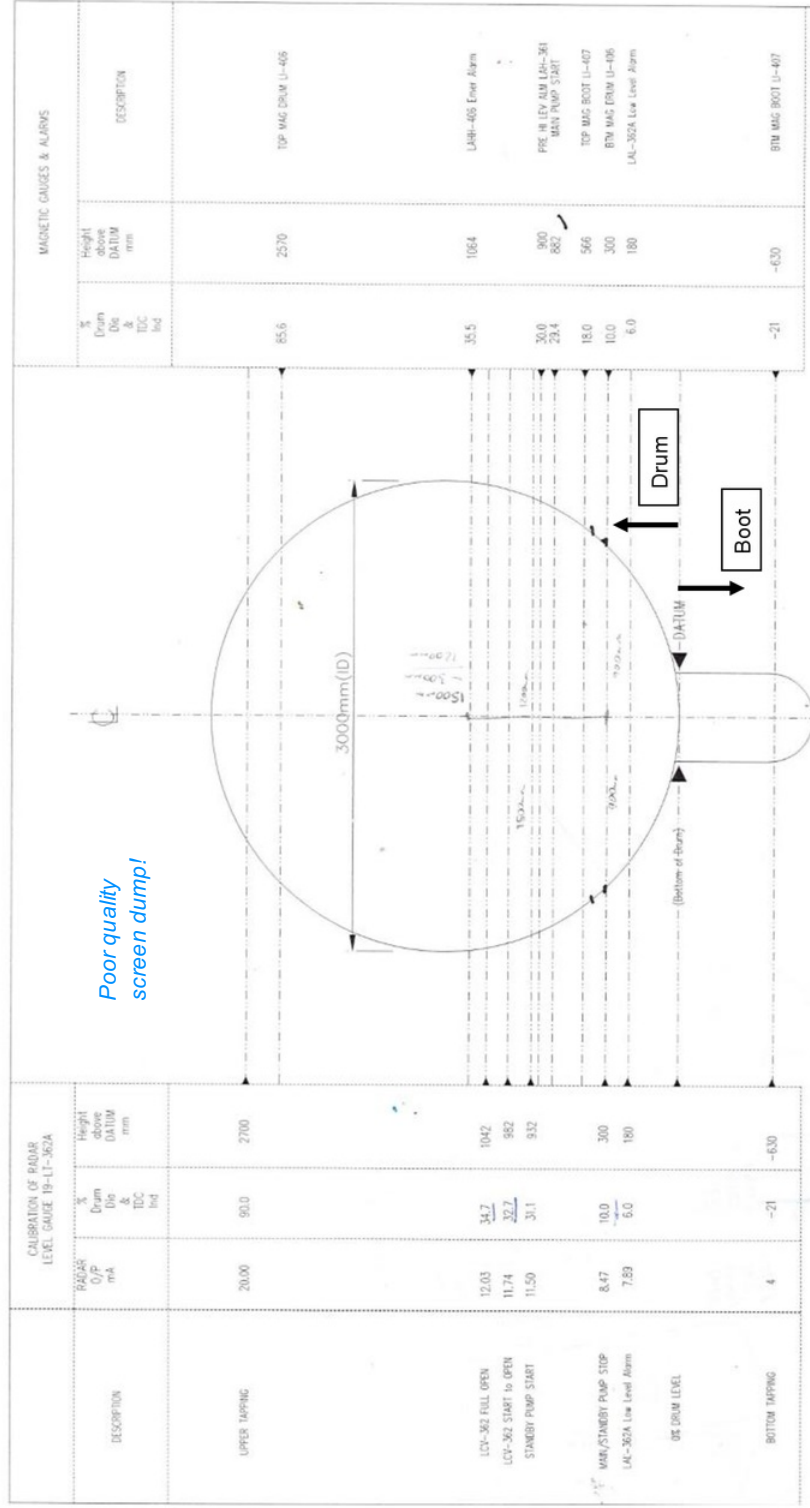


Figure 3: 19-F-201 instrument elevation and calibration details

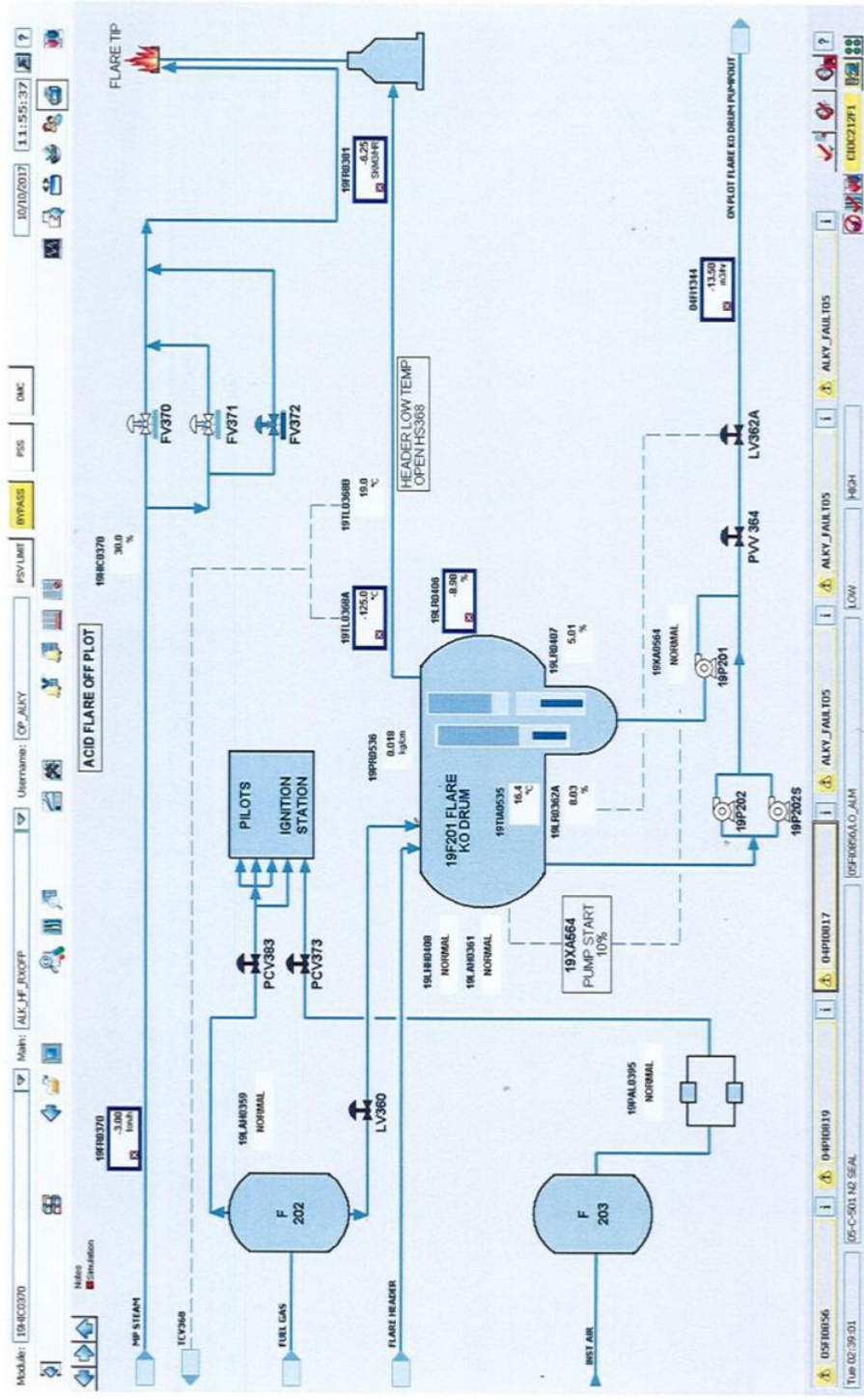


Figure 4: Alkylation unit operator's control panel screen

The overview of the existing system is clear and extensive

2.2 – Problem Description and Existing Technology

The existing system that controls the level within 19-F-201 is pneumatic and extremely unreliable. *Figure 5* depicts a document that was recently raised at the refinery to address the issue. The system is part of a planned maintenance schedule where every 3 months a function check of the system is conducted in reference to a procedure (see appendices for document).

The image shows a screenshot of a Valero Work Request form. At the top left is the Valero logo. The title 'Work Request' is centered at the top. The form is divided into several sections: 'Work Request #', 'Status', 'Work Category', 'Created By', 'Reported By', 'Changed By', and 'Changed On'. Below this is a 'Short Description' and a 'Detailed Description'. The 'Detailed Description' contains a paragraph about logic issues with the flare drum pump out system. Following this is an 'Asset Information' section with fields for Plant, Functional Location, Equipment, and Main Work Center. Below that is a 'Safety & Environmental' section with 'Safety Considerations' and 'Environmental Considerations'. The 'Reliability' section contains several yes/no questions about the rework, discovery during maintenance, and the creation of a preventive maintenance plan. The 'Finalization Information' section includes 'Priority', 'Suggested Start Date', and 'Reason'. The 'Reason' field contains the text: 'Flare system that has been faulty for sometime and requires attention.'

VALERO Work Request

Work Request #: 582781
Status: Ready for Approval
Work Category: Maintenance Repair

Created By: Kenniford, James
Reported By: Kenniford, James
Changed By: Kenniford, James
Changed On: 10/09/2017 04:45 PM

Short Description: 19-F-201 Logic Issues
Detailed Description:
Following PM checks on the cut in logic for the flare drum its been found there is still a logic fault with the system preventing correct operation of the pump out system. For 19-P-202 cut in via level switches the low and high switches both operate and valve operates ok, however logic is faulty as it will clear the high switch once initiated and close the valve were as it should wait until the low switch is cleared before stopping the pump (according to procedure). Tested numerous times and reset pneumatic logic in panel and checked components numerous times to no joy. 19-P-2025 cut in via SAAB checks during PM failed to cut in the turbine. Other elements of the logic operated correctly however valve wasn't called for an open. Manually checked valve operated, all ok. Tested numerous times whilst checking the pneumatic components for the logic and it wouldn't call for an open. Please verify logic and check components in the instrument panel as it would appear something has failed or been misplaced causing issues with the pump out system.

Asset Information *Very good*
Plant: PL25 - Pembroke
Functional Location: PL25-03-0050-12-19F201
Equipment: 10972088
19F201, Alky Flare KO Drum (Offsite) 19F201, Alky Flare KO Drum (Offsite)
Planner Group: IN Main Work Center: IN-COR

Safety & Environmental
Safety Considerations
Environmental Considerations

Reliability
Is this Rework?
No
Was this discovered during preventive or predictive maintenance?
Yes Work Order #: 5036784
Can the repair be made while the asset is online?
Yes
Is the asset currently operable?
No
Should a preventive or predictive maintenance plan be created for this task?
No

Finalization Information
Priority: Urgent
Suggested Start Date: 10/16/2017
Reason
Flare system that has been faulty for sometime and requires attention.

Figure 5: Valero work request raised by instrument technician relating to 19-F-201.

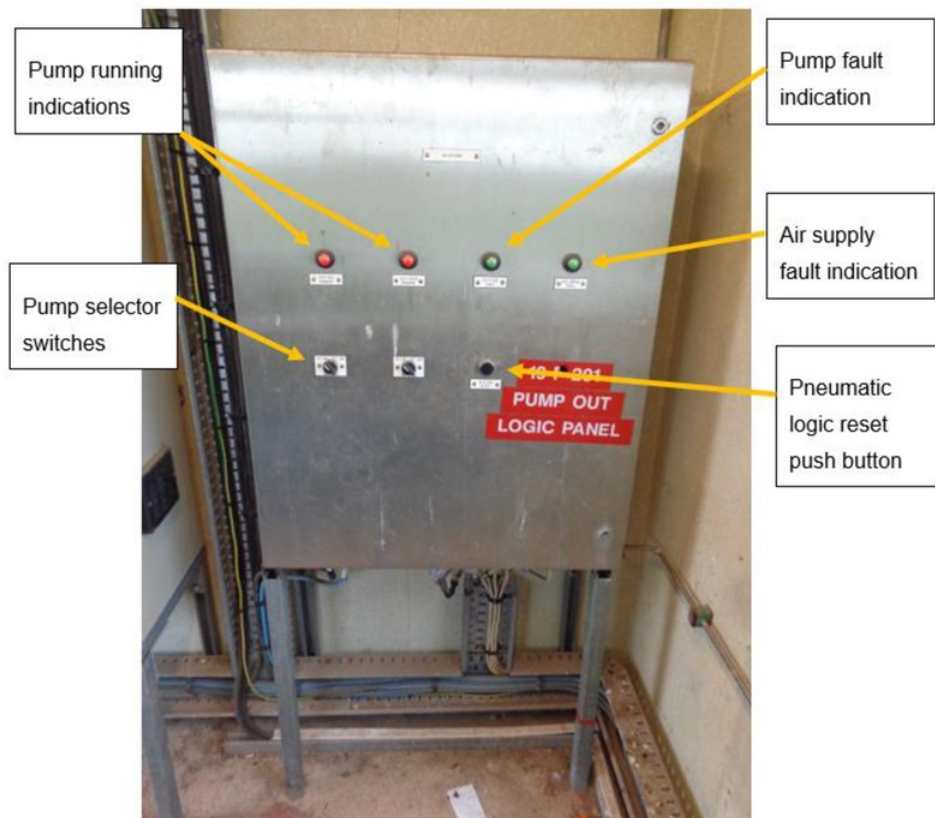


Figure 6: Front view of pneumatic logic cabinet.

Figure 6 illustrates the closed cabinet that houses the outdated pneumatic system. Figure 7 portrays this cabinet's internal components and as can be seen in Figure 7 the current state of the system is disorganised and causes difficulty when fault finding on the system.

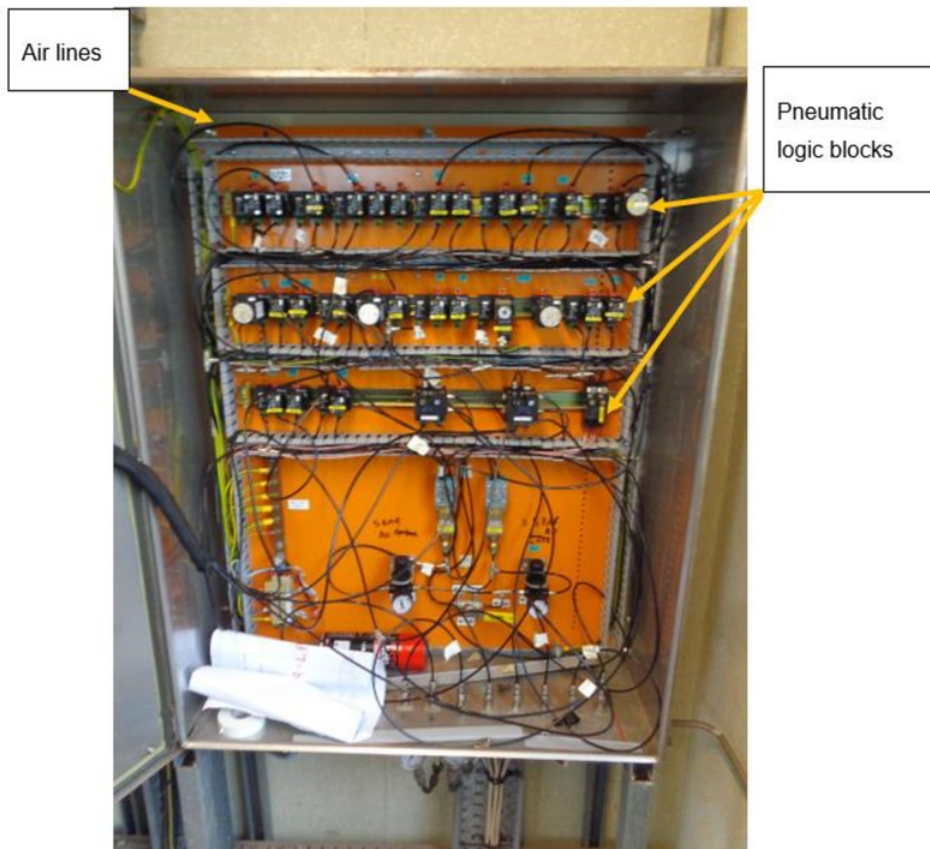


Figure 7: Internal view of pneumatic components currently installed

19-P-202 and 202S are both steam driven turbines that are coupled onto a centrifugal pump. These have a separate suction line connected to 19-F-201 drum and a common discharge line to push the liquid elsewhere. Each pump has an individual steam inlet valve, which is a Blakeborough sliding stem and diaphragm type. There are two individual pneumatic outputs connected to this panel and out to the valve diaphragms. This pressure acts on the underside of the diaphragm and slides the valve stem, and subsequently the valve plug, up and allows a steam flow through the turbine. See *Figures 8 and 9* for further details.

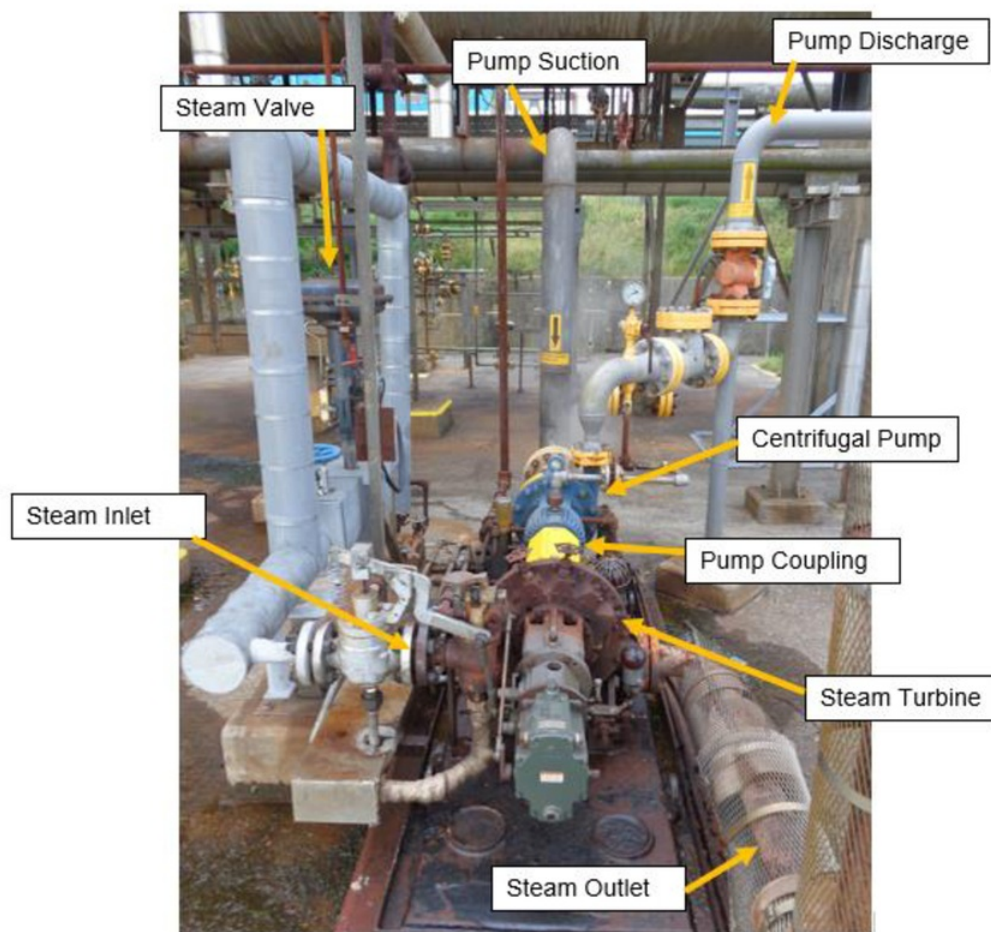


Figure 8: Photo of one of the two pumps

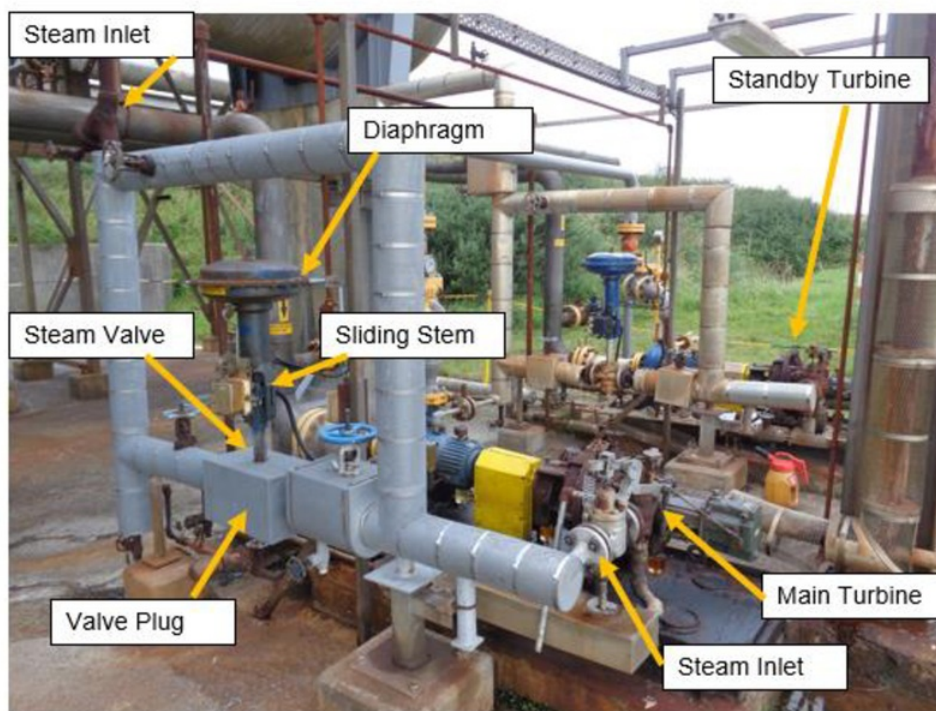


Figure 9: 19-P-202 and 202S on site

The control system shown in *Figure 7* consistently fails to start and stop the equipment shown in *Figure 9*. This is a Valero critical system and requires addressing as a matter of urgency.

Good photographic and documented evidence used to show clearly what the problem with the existing system is.

2.3 – Possible Problem Solution Research

Three possible solutions were identified and researched. These were subsequently compared and analysed to enable an effective selection. To minimise the possibilities available research was conducted into the refinery's policies relating to critical equipment and the following options were highlighted as acceptable:

2.3.1 – Allen Bradley ControlLogix PLC

A form of microprocessor-based controller, a programmable logic controller (PLC) utilises programmable memory to store instructions and subsequently implement functions including sequencing, counting, logic and arithmetic to control processes and machines (Bolton, 2009).

The Allen Bradley ControlLogix range is a chassis based modular control system. The fully customisable module composition consists of digital, analogue, motion control and speciality inputs/outputs (I/O) capabilities (Rockwell Automation, 2018).

Due to this products user configurability and versatility, dependant on system requirements, it makes it a prime candidate for the project as it can be tailored to the application in question. In addition, the PLC could connect with the operator's distributed control system (DCS) through serial communication to provide enhanced monitoring and control capabilities.



Figure 10: Allen Bradley ControlLogix Rack PLC. (Tierney, 2013).

2.3.1.1 – Advantages

- Maintenance requirements minimal.
- Versatile.
- Current instrumentation will integrate with system easily.
- Reliable.
- System has self-monitoring and diagnostics.
- Manufacturer accepted by Valero standards.
- Programme updates can be actioned quickly.

2.3.1.2 – Disadvantages

- Programming software is expensive.
- Expensive components and initial cost.
- Skilled personnel required to programme PLC.

Good detail well referenced, but no evidence of costing carried out.

2.3.2 – Electromechanical Control System (Relay Logic)

Electromechanical logic systems are tried and proven technology. As Béla G. Lipták identifies, “The function of a relay is to open or close an electrical contact or a group of contacts in consequence of a change in some electrical condition. These contact closures are used in the associated circuitry to select other circuits or functions and to turn on or off various operations” (1995, p. 757).

These systems consist of relays and trip amplifiers to carry out logic functions. The trip amplifiers are essential for interpreting analogue signals to produce digital outputs to integrate with the relays, as these are purely digital.



Figure 11: Example of a control panel consisting of relays (Small Panels, 2018).

2.3.2.1 – Advantages

- No programming software required.
- Specialist knowledge not required to rectify or modify system.
- Reliable and cheap to maintain.
- Provides physical electrical isolation between coil circuits and contact circuits.
- Small coil voltages can manipulate large contact voltages (interposing relays).
- Complexity dependant on the application.
- Fault diagnosis simple as components and wiring is simple.

2.3.2.2 – Disadvantages

- Modifications are not easy as physical wiring and components must be altered.
- Redundancy is not an option.
- When compared to a PLC system a relay logic system is much larger.
- This form of technology is similar to what is currently installed and would not be a technological enhancement.
- Purely digital system therefore trip amplifier would also be required to interpret analogue signals.

*Again good detail with clear Pros & Cons using this system
but no costing shown.*

2.3.3 – Pneumatic Control System

Physical corrective elements, such as valves, are frequently pneumatically operated, similar to what is currently installed, as these devices have a tendency to be cheaper and easier to cope with controlling process variables. In the current system, the logic functions are also driven by pneumatic components. However, the main drawback with pneumatic systems is the compressibility of air and the supply. A storage reservoir vessel is required to compensate for changes in pressure in relation with system demand (Bolton, 2004).

The difference being from a relay control system, the pneumatic system uses compressed air as opposed to electricity. For an example of such a system, refer back to *Figure 7*.

2.3.3.1 – Advantages

- Electricity supply not required.
- Simple design.
- Hazardous area safe and no safety implications in respect to combustible gases.
- Low maintenance and installation cost.
- Existing system is pneumatic so implementation would be simple.

2.3.3.2 – Disadvantages

- Existing system is unreliable.
- Would not be a technological enhancement.
- Noise.
- In comparison to PLC systems, the same level of reliability cannot be achieved.
- Air supply requires filtration and regulation.
- Regular maintenance would be recommended on system.
- When compared to a PLC system a relay logic system is much larger.

Again good detail noted in the possible use of this system but no costings shown.

2.4 – Problem Solution Decision Matrix

With the three possible solutions identified, a decision matrix was constructed where each of the solutions were scored, with a maximum mark of ten, against defined categories relevant to the problem.

	Allen Bradley	Electromechanical	Pneumatic
Reliability – (Level of system reliability)	7	6	3
Maintenance – (Ease of maintenance)	8	8	5
Modifications – (Ability for future modifications)	8	5	5
Programming – (Ease of logic building)	6	8	6
Integration – (Ease of integration)	7	7	9
Cost – (Estimate of installation cost)	6	7	7
Future Integration – (Capability of future component integration)	8	5	5
Ergonomics – (User friendliness)	7	6	4
Function – (Ability of the system to perform correctly/efficiently)	8	7	6
Total	65	59	50

'Key' for the numbers shown

Table 1: Possible problem solutions decision matrix.

In observation of *Table 1*, the Allen Bradley ControlLogix PLC was selected to develop further to solve the project problem. This is a direct result of this solution having the highest scores in reliability, future integration, function and overall total.

Good reasoning shown in making the best choice to take forward for project completion.

3 – Specification

The following section identifies the client's requested system functions, constraints, standards and all other data the supplier must adhere to in order to enable the end product to be successful.

3.1 – Product Design Specification (PDS)

3.1.1 – Performance

3.1.1.1 – An Allen Bradley ControlLogix PLC must be used.

3.1.1.2 – There must be two power supplies each with a 240VAC input and a 24VDC output.

3.1.1.3 – Two level switches must provide feedback to the logic panel and must be identified as 19-LSL-534 and 19-LSH-533.

3.1.1.4 – 19-LSL-534 and 19-LSH-533 must have local indicators displayed on a human machine interface (HMI) to show when both components change state.

3.1.1.5 – The outputs from 19-LSL-534 and 19-LSH-533 must start the duty pump.

3.1.1.6 – The output from 19-LSL-534 must stop the duty pump.

3.1.1.7 – Both the duty and standby pumps must be started by separate signals.

3.1.1.8 – Both the duty and standby pumps must have individual local HMI running indications.

3.1.1.9 – The running indications must be identified as 19-RL-522 and 19-RL-553.

3.1.1.10 – Pump running indications must show red if pump is stopped and green if pump is running.

3.1.1.11 – Local level indicators must show green when level is below switch and red when level is above.

3.1.1.12 – Duty and standby pumps must be selected from the local HMI.

3.1.1.13 – Duty and standby pumps must be identified as 19-P-202 and 19-P-202S.

3.1.1.14 – There must be an electrical supply fault indication on the local HMI that must be identified as 19-XA-563.

3.1.1.15 – 19-XA-563 must indicate red when there is a fault and green when the supply is healthy.

3.1.1.16 – 19-XA-563 must disable all operation of the system.

3.1.1.17 – There must be pump fault indication on the local HMI that must be identified as 19-XA-562.

3.1.1.18 – 19-XA-562 must indicate red when there is a fault and green when the pumps are healthy.

3.1.1.19 – 19-XA-562 must disable all operation of the system.

3.1.1.20 – There must be a START/RESET HMI button which must be identified as 19-HS-554.

3.1.1.21 – 19-HS-554 must be used to start the system initially and to start the system once all faults have been cleared. This input will reset 19-XA-563.

3.1.1.22 – There must be a FAULT/RESET HMI button which must be identified as 19-HS-553.

3.1.1.23 – 19-HS-553 must re-enable the duty pump to become operational. This input will reset 19-XA-562.

3.1.1.24 – There must be an input to provide feedback for pump operation and it must be identified as 19-PSL-541.

3.1.1.25 – 19-XA-562 must initiate if the following are not true:

3.1.1.26 – Once a start signal has been sent to the duty pump, 19-PSL-541 input must change state within 5 seconds.

3.1.1.27 – Once the duty or standby pump has been signalled to start, and 19-PSL-541 has confirmed that the pump has started, 19-PSL-541 must remain constant until 19-LSL-534 has signified a low level.

3.1.1.28 – Only one pump must operate at any one time.

3.1.1.29 – An analogue 4 – 20 mA current signal must be used to simulate the continuous level monitoring within 19-F-201 via existing instruments.

3.1.1.30 – This analogue signal must be identified as 19-LT-362A.

3.1.1.31 – Standby pump must start when 19-LT-362A output is ≥ 11.50 mA.

3.1.1.32 – Standby pump must stop when 19-LT-362A output is ≤ 8.47 mA.

3.1.1.33 – A low level alarm must initiate when 19-LT-362A output is ≤ 7.89 mA.

3.1.1.34 – The low level alarm must be identified as 19-LAL-362A.

3.1.1.35 – 19-LT-362A must provide a local indication on the HMI.

3.1.1.36 – 19-LT-362A local HMI indication must be identified as 19-LI-362A.

3.1.1.37 – 19-LI-362A must have a lower range value of -21% and an upper range value of 90% to correspond with 19-F-201.

3.1.1.38 – The system must produce an analogue 4 – 20 mA current output that is identified as 19-LY-362A.

3.1.1.39 – 19-LY-362A output must equal 4 mA when 19-LT-362A output ≤ 11.74 mA.

3.1.1.40 – 19-LY-362A output must equal 20 mA when 19-LT-362A output ≥ 12.03 mA.

3.1.1.41 – 19-LY-362A output will increase/decrease in a linear fashion between the 19-LT-362A threshold defined in sections 3.1.1.39 and 3.1.1.40.

3.1.2 – Environment

3.1.2.1 – Product must be used in a cool and dry area.

3.1.2.2 – Product must be stored in a cool and dry area.

3.1.2.3 – Product must be mainly used and kept in one area such as a workshop.

3.1.2.4 – Minimal noise must be generated from the product.

3.1.3 – Product Life Span

3.1.3.1 – This must be a one off product.

3.1.3.2 – Spare parts must be supplied when necessary.

3.1.4 – Life in Service

3.1.4.1 – Product must withstand any operating period of uninterrupted use.

3.1.5 – Shelf Life

3.1.5.1 – Product must have a shelf life of at least 10 years (if stored in cool, dry area).

3.1.6 – Target Costs

3.1.6.1 – In total, the Alkylation Unit Off Plot Flare Drum Logic Upgrade Demonstration Rig must cost no more than £50000.

3.1.7 – Quantity

3.1.7.1 – One unit must be produced.

3.1.8 – Maintenance

3.1.8.1 – Product must be maintenance free unless a component fails, in which case spares must be promptly available and easy to replace.

3.1.9 – Size and Weight Restrictions

3.1.9.1 – Weight must not exceed 40 Kg.

3.1.9.2 – Length must not exceed 2 metres.

3.1.9.3 – Width must not exceed 2 metres.

3.1.9.4 – Height must not exceed 2 metres.

3.1.10 – Aesthetics

3.1.10.1 – If costs allow, the product must look visually appealing to the user.

3.1.11 – Ergonomics

3.1.11.1 – Product must be intended to be placed onto a work surface whilst in operation.

3.1.12 – Quality and Reliability

3.1.12.1 – Quality must be such that the product must not fail within a period of 5 years. This must only stay true whilst the product is used and stored correctly.

3.1.13 – Safety

3.1.13.1 – No one person must be hurt whilst operating this product.

3.1.14 – Testing

3.1.14.1 – All circuits and components must be tested prior to product being used.

3.1.15 – Applicable Standards

3.1.15.1 – EN 60204-1: European code for control panels.

3.1.15.2 – ANSI/ISA 18.1: Annunciator Sequences and Specifications.

3.1.15.3 – BS 7671: IEE Wiring Regulations (17th Edition).

3.1.15.4 – IEC/EN 60529: Specification for Degrees of Protection Provided by Enclosures (IP Code).

3.1.15.5 – BS EN 65108: Functional Safety of Electrical/Electronic/Programmable Electronic Safety Related Systems.

3.1.15.6 – All equipment must be certified to European Union standards and be marked with “CE”.

Good detail shown in specification which will lead to a very detailed test procedure in commissioning the proposed system.

4 – Planning and Procedures

To enable the product to be completed successfully, and by the deadline date, thorough planning and procedures were required.

4.1 – Work Breakdown Structure

- Design Alkylolation Unit Off Plot Flare Drum Demonstration Rig.
 - Replicate the existing system as closely as practically possible (with improvements).
 - Select construction materials that will suit the application.
 - Determine how the Demonstration Rig will be assembled.
 - Design Demonstration Rig base and how the components will be mounted.
- Select Instrumentation.
 - Select components that will be required for use on the Demonstration Rig.
- Design Allen Bradley PLC programme.
 - Determine the input and output requirements.
 - Construct flow chart depicting Demonstration Rig operation.
 - Ensure PLC meets product design specification and I/O requirements.
 - Function check with hardware e.g. valves, components etc.
- Design Allen Bradley HMI
 - Link to PLC programme.
 - Construct Demonstration Rig on-screen schematic.
 - Programme HMI in adherence with the Product Design Specification.
 - Function check.
- Obtain Materials, Components and Instrumentation.
 - Determine the cost implications of the Demonstration Rig.
 - Order selected instrumentation if cannot be sourced elsewhere e.g. onsite.
- Construct Demonstration Rig.
 - Construct base.
 - Mount all associated components including the PLC and HMI onto base.
 - Run and secure cable trunking to Demonstration Rig base.
 - Install and connect all relevant wiring.

- Test Demonstration Rig.
 - Fully function check Demonstration Rig through several scenarios whilst monitoring the HMI.

4.2 – Health and Safety Planning, Risk Assessment and Professional Conduct

The student is an employee of Valero Energy Corporation and therefore has general duties that are enforced by the Health and Safety Executive (HSE). He must take reasonable care of the health and safety of himself and all other persons who could possibly be affected by his own acts or omission of his work (Parliament of the United Kingdom, Health and Safety at Work Act 1974).

A risk assessment and electronic management of change (EMOC) document will be required to be completed in adherence to Pembroke refinery policy as per checklist risk assessment document PP-PEM-FRM-0026 Rev 4.0.

A high level of professional conduct will be maintained at all times. This will include ensuring that a risk assessed permit to work document is created, checked by operations, issued by operations and accepted by project engineer once operations are satisfied that the equipment is safe to work on prior to any work taking place.

Pembroke refinery minimum personal protective equipment (PPE) will be worn at all times unless work is required within the Alkylation Unit yellow and black chain fence where PPE requirements instruct 04-OPS-POI-0004 must be adhered to.

4.3 – Project Plan Task/Time Breakdown (Gantt Chart)

Microsoft Project 2013 was used to construct a Gantt Chart in order to establish a project plan outlining tasks and identifying the duration of each task.

Please refer to *Figure 12* for the Major Project Gantt Chart.

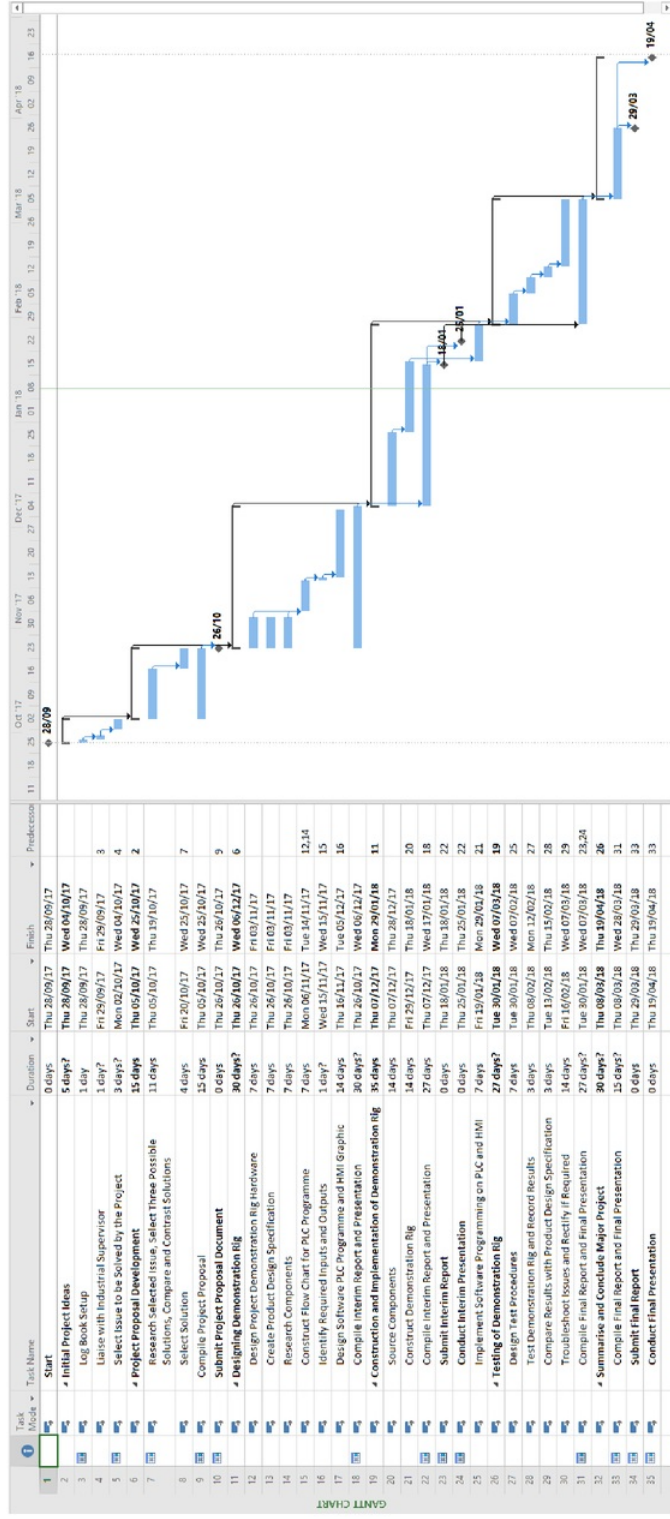


Figure 12: Microsoft Project 2013 major project Gantt chart.

4.4 – Contingency Plans

Throughout this Major Project process, unforeseen events and/or outcomes may present themselves at various stages that may be favourable or detrimental to the project aim.

The objectives highlighted previously in this report identify what needs to be completed and the Product Design Specification identifies the detailed requirements for this project to be a success.

In the event that an objective cannot be reached, the problem will be addressed and then mitigated as accurately and cost effectively as possible. This could also include the guidance and input from the supervisory personnel named previously.

In the event that the project is completed ahead of schedule (refer to Gantt Chart) then the possibility of improving the Demonstration Rig could be considered. This will include both hardware and software aspects.

The analysis of any issues and contingency actions taken will be fully discussed and solutions chosen with direct relation to the following:

- The stage in which the problem has presented itself e.g. Research, construction etc.
- Resources available.
- Time constraints.
- Cost.
- Detriment to the completion of the Individual Project.

Details of these occurrences will be recorded within the Individual Project Log Book.

Very good Gantt Chart with contingency plans noted.

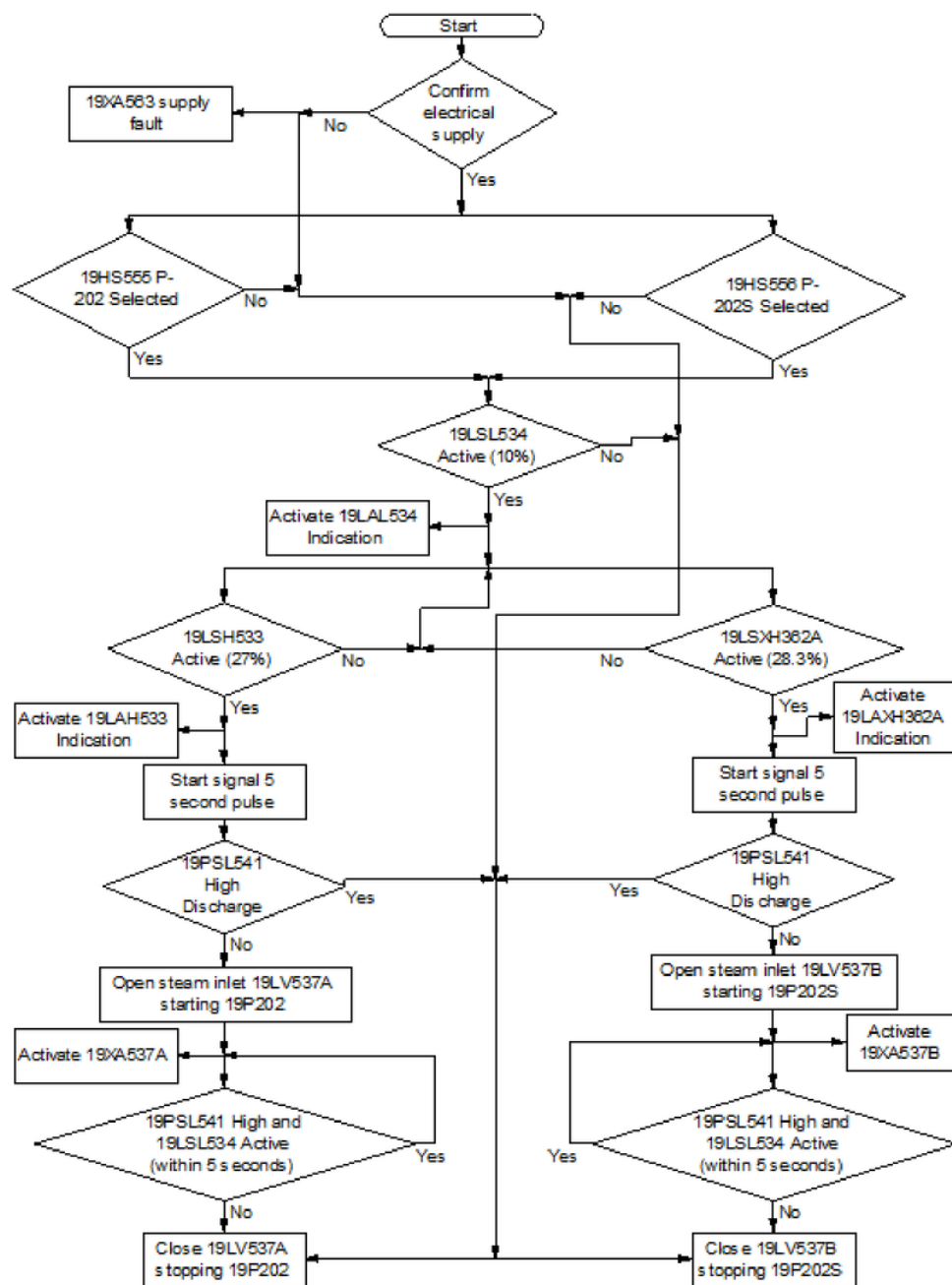
5 – Project Progress and Testing

As this is the Interim Report, the current progress of the project needs to be identified along with any/all test results.

5.1 – Current Design Progress

Following discussions with both industrial and academic supervisors, it was decided that the physical product would consist of a PLC and a HMI with all peripheral components being replicated in a sub-programme within the PLC software. This will enable the programme to be dynamically tested and the actual process simulated as accurately as practically possible. A further benefit of carrying out the project in this way is that cost will be minimised, as minimal components will be required apart from the PLC and HMI.

A flow chart has been constructed, in relation to 19-P-202 and 202S operation, to ensure the PLC programme will be designed and implemented efficiently and correctly.



Good detail shown in the flow chart

Figure 13: 19-P-202 and 202S operational flow chart

5.2 – Current Practical Progress

The Allen Bradley PLC has been sourced and mounted onto a board ready for programming. The PLC is part of the Allen Bradley ControlLogix brand and has a Logix5561 Processor module.



Figure 14: Allen Bradley ControlLogix PLC used for project

The processor has been configured in order for the module to acknowledge the different modules inserted into the 13-module rack. If this is not completed correctly, the programme will not function as per design. This was carried out using RSLogix 5000 software.

5.2.1 – Allen Bradley ControlLogix PLC Rack Configuration Settings

5.2.1.1 – Slot 0: Processor

- Type: 1756-L61 ControlLogix 5561 Controller
- Rev: 18
- Chassis Type: 1756-A13 13 Slot ControlLogix Chassis

5.2.1.2 – Slot 1: Ethernet Card

- IP Address: 10.10.4.111

5.2.1.3 – Slot 2: Prosoft Card

- Comm Format: Data-Int
- Input: 1, 248
- Output: 2, 230
- Configuration: 4, 0

5.2.1.4 – Slot 3: Digital Input Card

- 1756-1B32/B
- 32-Point 10V – 31.2 VDC Input

5.2.1.5 – Slot 4: Analogue Input Card

- 1756-1F16
- 16 Channel Non-Isolated Voltage/Current Analogue Input
- Comm Format: Float Data, Single-Ended, No Alarm

5.2.1.6 – Slot 5: Spare

5.2.1.7 – Slot 6: Digital Output Card

- 1756-OB32
- 32-Point 10V – 31.2 VDC DC Output

5.2.1.7 – Slot 7: Analogue Output Card

- 1756-OF8
- 8 Channel Non-Isolated Voltage/Current Analogue Output

5.3 – Test Results

There has been no testing conducted as the project is not yet at that stage.

6 – Conclusions and Recommendations

With reference to *Figure 12*, the project Gantt chart, the current status of the project concludes that the project is not on target.

There have been unforeseeable events presenting themselves, in regards to other work commitments within the company, which are accountable for the stalling of project progress.

After liaising with both industrial and academic supervisors, it has been made clear what is expected from this particular project outcome. The main components required to construct the Demonstration Rig, namely the PLC and HMI, have been sourced and are ready for programming once the designing phase is complete.

The following recommendations relate to a successful project completion:

1. Design and implement PLC main programme.
2. Design and implement HMI graphic and interfacing inputs to the PLC.
3. Design and implement PLC simulation sub programme.
4. Fully test system and analyse results in relation to the PDS.

In conclusion, currently the project is running behind schedule in relation to the Gantt chart time line. The plan to recover the lost time is dependent on modification of the remaining components of the Gantt chart. Specifically, the remaining tasks for completion will be re-scheduled to suit the remaining time to ensure the project aim is fulfilled within the initial deadline date.

*Good, honest conclusion given which does
show some reflection*

7 – Citation List

Bolton, W., 2004. *Instrumentation and Control Systems*. 1st ed. Oxford: Newnes.

Bolton, W., 2009. *Programmable Logic Controllers*. 5th ed. Burlington: Newnes.

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Tierney, S., 2013. *The Automation Blog*. [Online]

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Good, varied research carried out.

PSDE6019 Major Project Interim Report Dan Lee

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

58/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

Text Comment. Not clear

Text Comment. Good introduction to the problem that the project will be based upon.

PAGE 7

PAGE 8

Text Comment. Good breakdown of project objectives.

PAGE 9

PAGE 10

PAGE 11

PAGE 12

Text Comment. Can both pumps run together, if required, or not?

PAGE 13

Text Comment. Poor quality screen dump!

PAGE 14

Text Comment. The overview of the existing system is clear and extensive

PAGE 15

Text Comment. Very good

PAGE 16

PAGE 17

PAGE 18

PAGE 19

Text Comment. Good photographic and documented evidence used to show clearly what the problem with the existing system is.

PAGE 20

PAGE 21

Text Comment. Good detail well referenced, but no evidence of costing carried out.

PAGE 22

PAGE 23

Text Comment. Again good detail with clear Pros & Cons using this system but no costing shown.

PAGE 24

Text Comment. Again good detail noted in the possible use of this system but no costings shown.

PAGE 25

Text Comment. No costing exercise shown in the report!

Text Comment. 'Key' for the numbers shown please...

Text Comment. Good reasoning shown in making the best choice to take forward for project completion.

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

Text Comment. Good detail shown in specification which will lead to a very detailed test procedure in commissioning the proposed system.

PAGE 31

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PAGE 36

Text Comment. Very good Gantt Chart with contingency plans noted.

PAGE 37

PAGE 38

Text Comment. Good detail shown in the flow chart

PAGE 39

PAGE 40

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PAGE 42

Text Comment. Good, honest conclusion given which does show some reflection

PAGE 43

Text Comment. Good, varied research carried out.

GRADING FORM: CSG-RUBIC

DANIEL LEE

58

RESEARCH-INFORMED LITERATURE

	Introduction (4/5): Good, gives the context of the project, aims and outcomes. Background Research (3/4): : A good explanation of the problem has been given with helpful diagrams and photos. However, one issue remains unexplained. Harvard Referencing (3/4): Good range of sources listed and cited correctly. Literature Review (3/7): Three solutions briefly researched but no costs given. Selection matrix needs explanation.	13
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KNOWLEDGE AND UNDERSTANDING

	WBS (7/10): Good, detailed Work Breakdown Structure shown in the report. Specification (8/10): Good with lots of detail. However, will you be delivering it all since the project has become a demonstration rig? Gantt Chart (7/10): Good evidence of planning with contingencies but these could have been shown on the Gantt chart.	22
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ANALYSIS

	Analysis of test results (2/10): Good analysis of the flow chart design for the PLC program. No actual testing carried out. Conclusions (5/10): Honest conclusion given which lists problems encountered in keeping the project on track.	7
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PRACTICAL APPLICATION AND DEP.

	Progress to date (1/5): Some progress made including flow chart design and hardware sourcing.	3
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Presentation of test results (2/5): Flow chart produced for the PLC design for the system.

SKILLS FOR PROFESSIONAL PRAC.



Recommendations (6/10): Reflection shown in conclusion and work left to do to complete the project clearly noted. Report Quality (/710): Good report structure which clearly shows the work carried out to date.

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