

# Christopher James project proposal

*by Chris James*

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# PROJECT PROPOSAL

PLC and panel upgrade from Mitsubishi to Siemens  
S1200 on the Leak tester line 2

## Abstract

Upgrade the panel components and create a new PLC program and HMI in TIA portal while  
reducing the cycle time of the machine

Presented by: Christopher James

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## **Leak tester line 2 upgrade project proposal.**

### **Introduction**

Energys continuously look at ways to improve production, safety and efficiency while keeping costs low. One effective way of achieving this is to upgrade outdated machinery. My proposal focuses on upgrading the Line 2 leak tester to ensure that it is capable of operating more efficiently and reliably

My project focuses on upgrading the leak testing machine to increase efficiency and reliability while bringing it up to date with current technology.

This project aims to modernise the leak tester, replacing the obsolete Mitsubishi FX PLC with a Siemens S1214, introducing a HMI, finally allowing access to Energys' ignition network. These upgrades will help increase the maximum line capacity by up to 15000 batteries annually whilst reducing downtime and improving data retrieval capabilities.

### **Company Background**

Energys are global leaders in battery manufacturing. We are experiencing an increased demand which requires increasingly efficient machinery to ensure goals are met. It is essential to meet customer demands to maintain competitiveness whilst producing quality product.

### **Machine Background**

The leak tester is designed to ensure the integrity between the lid and the box. A sealed battery once passed will proceed to charging and then shipping. The machinery uses air pressure to detect leaks, monitoring drops of air pressure over time.

### **Current machine specs**

Due to its age, the leak testers components are mostly obsolete and almost no electrical documentation exists. It currently uses a Mitsubishi FX PLC with 110v outputs which was common for its time. My proposal is to upgrade this to a Siemens S1214 PLC using 24vDC outputs allowing for improved maintenance and overall safety.

The current machine is over 35 years old and the majority of its components are now obsolete. We also have minimal electrical drawings for the current unit.

It uses a Mitsubishi fx plc which is no longer the standard for site. My aim is to upgrade this to a siemens 1200 plc. The Mitsubishi plc uses 110v outputs which matches all of the components within the current panel. I aim to replace all of these with 24vdc components. This will make it safer for future maintenance to work on the machinery.

There are multiple benefits to reducing the voltage from 110vac to 24vdc

- Electric shock 24vDC is considered SELV (safe extra low voltage), this means largely reducing the risk of electric shock (**Niceic, 2018**)
- Lower risk of fire – 24VDC produces less heat in components. This risk of fire and improves efficiency.
- Availability – 24VDC control components are much more widely available compared to 110vDC. This aligns with more modern engineering standards

Currently, operators cannot see key information such as quantity of pass or fail, or sensor positions/limits. Adding a Siemens HMI will allow access to this information along with a greater manual control.

Due to its age, the current leak tester cannot connect to a network. Connecting to the companies ignition software will allow real time monitoring of the machines status and performance. The upgrade will allow connection to this network, aligning with the company requirements.

## Literature review

Upgrading out of date machinery in the industrial environment is an ideal way to improve productivity, safety and also to reduce overheads and costs. PLC's have improved greatly over the past 30 years, allowing for faster processing speeds and improved control features, including network connectivity.

An article by D.O supply shows the issues with outdated control modules, such as obsolescence which can cause large amounts of downtime if you are trying to source a replacement for something which is no longer available. **(Supply, 2023)** As an example, An obsolete allenbradley SLC 5/05 can cost upwards of £3000 where as its replacement, the newer 5069-L310ER, can be purchased for approximately £2000 (<https://route.co.uk/en-gb/shop/programmable-controllers/compactlogix/5069-l310ers2>). This shows a large financial benefit to upgrading a PLC.

**(Smith, 2022)** states that upgrading a plc can offer modular expansion and a faster processing speed of the machine. This may offer benefits such as an increased manufacturing speed and greater output.

The transition of lowering the control voltage from 110vAC to 24vDC is highly recommended. This is due to the potential of electric shock and other hazards such as fire.

In an article by Alaa Alqeisy, she shows that 24vdc systems generate lower heat output in relays and other components, which reduces the power outputs, reducing the potential of electrical fires **(AlQeisy, 2023)**. This will keep in line of one of the companies current goals of reducing power output across site while also improving safety and minimising downtime.

Incorporating a HMI (Human machine interface) into the system can greatly improve the operational efficiency of the leak tester. Research shows that a HMI can provide a real time insight into the machines performance which will allow the operator to monitor the process and stop or make adjustments if and when required. This can help to minimise issues such as human error or unexpected downtime. **(Rango, 2024)**. A HMI will also allow you to put many different functions on the screen, where as If you were to use physical switches then you would be limited to the amount of space that you have available.

## Literature review conclusion

The reviewed literature shows just some of the many benefits to upgrading outdated machinery. This includes improving efficiency, safety, communication and minimising downtime. Upgrading the PLC, lowering the control voltage, adding a HMI and allowing for networking, I am following the companies overall goals of upgrading machinery to improve efficiency, safety and control.

## Objectives:

The below graph shows the overall objectives, highlighting the current standard compared to the expected upgrades:

| Objectives                 |                       |                                           |                                                                                                                                                                                                     |
|----------------------------|-----------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Component                  | Current Machine specs | Planned upgrades                          | Comments                                                                                                                                                                                            |
| PLC                        | Mitsubishi Fx3g-40M   | Siemens s1214 with expansion module       | • New PLC – Replacing the original Mitsubishi PLC with a new Siemens S1200 plc                                                                                                                      |
| Electrical control voltage | 110v                  | 24vDC                                     | • 110vac to 24vdc conversion – Where possible, all of the new components will be 24vdc                                                                                                              |
| HMI                        | Does not exist        | Siemens mp277                             | • HMI – A HMI display will allow operators to carry out manual functions and observe values such as pass and fail rates. User login levels may be included to allow maintenance/engineering access. |
| Networking                 | Does not exist        | Ethernet connectivity to ignition network | • Ethernet compatibility to allow connection to the ignition 'SCADA' network                                                                                                                        |
| Create electrical drawings | Does not exist        | Complete system electrical drawings       | • Electrical drawings to be created for new electrical system                                                                                                                                       |
| Create plc program         | Does not exist        | New siemens plc program                   | • Create a siemens s1214 and HMI program using TIA portal V19                                                                                                                                       |

### Tools and Software requirements.

The following equipment will be required to carry out the project:

|          | Component            | QTY                  | Supplier           | Cost per unit | Overall cost     |
|----------|----------------------|----------------------|--------------------|---------------|------------------|
| Hardware | Electrical panel     | 1 RS                 |                    | £169.00       | £169.00          |
|          | Power supply         | 1 RS                 |                    | £194.00       | £194.00          |
|          | 24v relay            | 4 RS                 |                    | £8.27         | £33.08           |
|          | relay base           | 4 RS                 |                    | £7.09         | £28.36           |
|          | safety relay         | 1 RS                 |                    | £212.93       | £212.93          |
|          | mcb 1p               | 3 RS                 |                    | £77.70        | £233.10          |
|          | mcb 3p               | 1 RS                 |                    | £101.84       | £101.84          |
|          | Isolator             | 1 RS                 |                    | £29.66        | £29.66           |
|          | PLC S1214            | 1 Parmley and graham |                    | £340.00       | £340.00          |
|          | PLC expansion module | 1 Parmley and graham |                    | £161.00       | £161.00          |
|          | Contactactor         | 1 RS                 |                    | £57.98        | £57.98           |
|          | HMI                  | 1 RS                 |                    | £768.00       | £768.00          |
|          |                      |                      |                    |               |                  |
| Software |                      |                      |                    |               |                  |
|          | TIA Portal V19       | N/A                  | Parmley and Graham | N/A           |                  |
|          |                      |                      |                    |               |                  |
|          |                      |                      |                    | <b>Total</b>  | <b>£2,328.95</b> |

## **Analysis**

To evaluate the feasibility of the project, I have looked at the potential benefits and risks of the project. I have also considered the impact that the upgrade will have on the process as a whole.

### **Cost-Benefit Analysis:**

My budget will include the cost to buy the hardware and all of the components required. The overall project should be less than £2500

An improvement to the machine will allow a saving of approximately 2 seconds per battery. This will allow the maximum capacity to increase from 500 batteries per shift to 520 batteries per shift. Based on a 5-day week and a 50 week year (shut downs over Christmas and easter), this increases the potential output by 15000 blocks per year. This does not consider changeovers and other unexpected downtime of the line.

Upgrading this machine will also align with the overall company strategy of upgrading and improving the machinery within the department (Cell 2). We are working towards improving the amount of control that we have on all machines within Cell 2. By upgrading the machine, we will have more manual features while having an up to date processor that will be capable of handling all of the machine requirements with the potential of further expansion in the future if required.

Currently the Mitsubishi FX Plc is considered a fixed PLC which only has a set amount of inputs and outputs whereas the Siemens S1200 that I plan to use is considered modular. This means that if required I can add multiple expansions to it in the future to increase the amount of inputs and outputs. This will offer me more flexibility.

## Risks:

There are potential risks to the project. These must be minimised to ensure that the project runs smoothly. These risks are tabulated below:

| ID                                 | Risk                       | Caused by                              | Consequence                                                                                               | Probability | Impact | Risk rating | Control                                                                                                                                 | Probability (after controls) | Impact (after control) | Risk rating (after control) |
|------------------------------------|----------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------|--------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------------------------|-----------------------------|
| 1                                  | Delays in delivery         | External supplier issues               | Overall delay to project                                                                                  | 4           | 5      | 20          | Ensure that all parts are purchased from verified sources. E.g. EnerSys has an account with RS components offering next day delivery.   | 2                            | 3                      | 6                           |
| 2                                  | Installation delays        | Production demands                     | less time to carry out installation                                                                       | 3           | 4      | 12          | Allow a buffer time for installation to ensure impact is minimised. Discuss with all departments including planning and production.     | 1                            | 2                      | 2                           |
| 3                                  | Going overbudget           | Unforeseen costs                       | Going overbudget may result in being unable to complete the project                                       | 2           | 5      | 10          | Allow extra in the budget in case of unexpected costs - if this is used then it should be noted and accounted for                       | 1                            | 2                      | 2                           |
| 4                                  | Testing issues             | Faults in program or wiring            | This may cause delays in testing phase, resulting in production being delayed                             | 3           | 4      | 12          | Ensure project is fully tested before installation - Have others also test before installing. Allow a buffer time in case of any issues | 1                            | 1                      | 1                           |
| 5                                  | Injury during installation | Inadequate safety precautions in place | This can result in large delays to the installation and even potential fines and law suits to the company | 3           | 5      | 15          | Company safety policy followed at all times. First aid kit available at all times in case of emergency                                  | 1                            | 3                      | 3                           |
| Key                                | 0-5 = Low                  |                                        |                                                                                                           |             |        |             |                                                                                                                                         |                              |                        |                             |
|                                    | 6-10 = Med                 |                                        |                                                                                                           |             |        |             |                                                                                                                                         |                              |                        |                             |
|                                    | 11-15 = High               |                                        |                                                                                                           |             |        |             |                                                                                                                                         |                              |                        |                             |
|                                    | 16-20 = Very High          |                                        |                                                                                                           |             |        |             |                                                                                                                                         |                              |                        |                             |
| Risk rating = Probability x impact |                            |                                        |                                                                                                           |             |        |             |                                                                                                                                         |                              |                        |                             |

## Expected outcome

This project ensures multiple benefits. While upgrading the PLC allows machine networking for real time monitoring, redesigning the program can allow the processing time to reduce by a minimum of 2 seconds, achieved by modifying the entrance and exit sequences of the program. The HMI will make operations smoother and also display all important information.

Creating counters and tags in my program will track the pass and fail quantities of the process, showing areas of potential improvement. The network connection will support this monitoring. The information gathered from this will be vital for quality control and future improvements.

## Timeline

I intend to complete all of my goals within 5 months of the start date. I will use a Gantt chart to keep track of all of my objectives. This will help to ensure that I do not fall behind. Other techniques such as a critical path can also be used to help ensure that I complete on time. I aim to have had the panel and plc programs all created and built by the end of December with the installation to begin shortly after. This will then allow enough time to ensure that the operators are comfortable with the new controls.

## **Conclusion**

My project will aim to provide improvements to the efficiency reliability overall control of the Leak tester on Line 2. Upgrading the outdated machine with a more modern PLC (the S1200), a HMI and 24VDC control will have multiple benefits to the lines production and control capabilities.

Some of the key benefits include:

Increased product efficiency – The proposed project will aim to reduce the processing time of each battery by 2 seconds. This can result in a maximum product capacity of this machine by up to 15000 batteries per year without incurring greater costs or increased manning.

Improved safety and maintenance – Converting control systems from 110VAC to 24VDC will reduce risks of electric shock allowing for a safer working area for maintenance and production.

Up to date electrical drawings will make fault finding easier for maintenance, reducing the amount of downtime while a HMI will give the maintenance staff access to information such as sensor/contactors positions. IT will also offer staff greater visibility over the machines performance.

Allowing networking – Integrating the Leak tester into the ignition system will provide real time monitoring capabilities. This will allow us to view a real time machine performance while comparing it to previous data when required.

The value of this project will continue to extend further than the immediate benefits. The upgrades will allow for future improvements and expansion due to the greater capacity of the PLC and the greater data retrieval potential.

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# Christopher James project proposal

GRADEMARK REPORT

FINAL GRADE

/100

GENERAL COMMENTS

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