

Assignment 1

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Submission date: 09-Jan-2023 08:05PM (UTC+0000)

Submission ID: 194232428

File name: 13876_Gareth_Wilkins_Assignment_1_180854_807075064.pdf (1.54M)

Word count: 9677

Character count: 53787

Course: BSc (Hons) Electrical and Electronic Engineering
Module: SGEL6000 Independent Project
Assignment: 1. Project Definition, Research and Quality Planning
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University number: 1809804
Date submitted: 09/01/2023
Word count: 3931

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1. Executive Summary

A glue storage, mixing and supply machine was designed to meet the needs of a local tissue manufacturing company. The need for the project originated from health & safety and quality concerns. A proposal was produced that outlined the requirements and resource for the project and was agreed with industrial supervisor. The constraints being ethical, sustainability and legal requirement were observed to ensure conformity to company policy. The functional design specification (FSD) was produced to establish the limitations, functionality, and requirements of the machine. Conformity and functionality tests were conceived in line with the FDS to assure the project met the deliverables. Three solutions were established that would meet the requirements of the FDS. The best solution was chosen with a scoring system and visually displayed in a radar diagram. A work breakdown structure (WBS) of three levels was produced to ascertain work packages to capture all the requirements for the project. The WBS enabled the generation of a Gantt chart that divided the project into specified tasks that resulted in six milestones. A risk assessment for the implementation stage was produced with mitigation actions. Conclusions and recommendations were established for the design stage of the project.

You could have said more about the background, problem and solution.

2. Introduction

The report objective is to design a system that stores, mixes, and delivers glue to paper machines at a local tissue making company. The design will replace the labour intensive and hazardous operation of glue delivery to the line. The system will automate the process of obtainment and delivery of adhesive to the paper machine. A project plan is designed to implement the project.

3. Project Background and Problem Definition and Constraints

3.1 Background

a very good sub-section

The company manufactures and markets tissue paper for hygienic or domestic use. The production process at the plant starts at the paper mill and ends at the converting plant. The process begins with virgin pulp where bales are positioned on the loading conveyors and transported to the pulpers where the fibres are processed to produce varying specifications of paper. Kitchen towel is produced from long fibre pulp while soft tissue paper is produced from short fibre pulp. The pulp is formulated with hot water which is homogenised and conveyed to the paper machine. This concoction is propelled onto a screen and deposited on to felt which transports it to the Yankee cylinder which is heated to approximately 100°C (Sofidel, 2020). The Yankee cylinder is a large diameter drum which is pressurised with steam to provide a hot cylinder surface used for soft tissue products (S L Paper Machines LLP , 2022). The hoods then blow hot air at approximately 450°C and remove moisture from the sheet which is then revolved on a spool to produce a parent reel. The physical and technical parameters of the parent reels are inspected to ensure they are within specification. The reels are wrapped, labelled, transported, and stored in the parent reel warehouse pending the converting process (Sofidel, 2020).

The converting process produces the finished product from the parent reel. Different finished products are made by specific converting lines referred to as converting plants. In these plants the tissue paper is printed, glued, embossed, punched and wound onto cardboard cores. This produces the log which is then cut to the specified dimension. The product is then wrapped in single packages and then enclosed in multiple packaging for wholesale. Packages are positioned on pallets by robots and the wrapping and labelling stages complete the manufacturing process. The finished product is transported to the warehouse awaiting delivery to the customer (Sofidel, 2020).

This project involves the supply and mixing of different glues for a specific line. The project will be modifying the existing plant to provide the required glue for the specified production line. This line's product requires four gluing applications. The four gluing applications are: (1) Core glue, (2) Ply glue, (3) Pick up glue and (4) tail sealer glue.

- (1) Core glue is supplied to the core machine which produce the carboard core of paper rolls from coils of cardboard. Grocer's apostrophe
- (2) Ply glue is used to bind the ply's of paper together. Different products have different numbers of ply's. Grocer's apostrophe
- (3) The pick up glue is applied to the core to enable the paper to bind onto the cardboard core and wind.

- (4) The tail sealer glue is applied to the end of the paper to fasten the paper to not allow it to unravel.

The core and pickup glue do not require agitating. The line runs two different products requiring different ply glues. One requires a mixture of laminating glue (SL 53021, BXP 77294) and water and the other is premixed and only requires transportation from the glue room. The desired concentration level of laminating glue to water will be obtained from the quality department. From this a calculation will be performed on the PLC with consideration of number of ply's. The ply glue will be supplied from one tank therefore a method for altering agents is required.

3.2 Problem definition

clearly defined

The project is to be undertaken mainly due health and safety and quality concerns. At present intermediate bulk containers (IBCs) are located on the line to supply the glue for the gluing applications. The IBCs are positioned on stands and the glue is gravity fed into a bucket for the operate to transport to the applicator. This constitutes major risk factors due to the transportation, storing and manual handling of the glue. Removing the requirement of forklift truck operation for IBC transportation will reduce its operating time on the shop floor and reduce the likelihood of accidents. The storage of these IBC containers on the line also produces a risk of spillages which produces environmental and work area risks. Quality concerns have been highlighted where incorrect recipes have been produced. Currently chemicals are obtained from IBC containers and water is obtained from a valve on the line. A bucket is used to measure the recipe and this is susceptible to human error. Therefore, the quality department require an automated system that removes the likelihood of human error. The only method of monitoring usage currently is IBC level and replacement. A production data screen will be produced to monitor accumulative consumption of glue used.

3.3 Ethical engineering

Briefly explained

Engineers endeavour to improve the welfare and health & safety of society whilst considering effects on the environment and sustainability of resource. A statement of ethical principles has been produced by the Royal Academy of Engineering in association with leading professional engineering institutions which it believes all professional engineers should advocate. Four fundamental principles to guide engineers in attaining high paradigms of professional life include:

- 1) The highest level of professional conduct incorporating openness, fairness, honesty and integrity must be upheld by engineering professionals.
- 2) All pertinent laws and regulations must be observed with consideration to facts, standards and guidance and broader public awareness.

- 3) The understanding, knowledge and skills must be acquired to perform their role.
- 4) High standards of leadership and communication must be promoted including equality diversity and inclusion.

(Engineering Council, 2017).

3.4 Sustainability

Briefly explained

The solution must comply with the group's fundamental commitment to social responsibility and sustainability. The group seeks to control the ecological impact of its activities and systematically seeks to improve them in a consistent, effective, and sustainable manner observing the ISO 14001 standard (Sofidel, 2022). The ISO 45001 standard outlines minimum standards of good practice for worker health and safety. A framework is established for improving safety, reducing workplace hazards, and improving worker health and welfare. (ISO, 2015). The quality of suppliers is imperative for sustainable procurement. Suppliers must provide certification; guarantee an ethical approach to the market; and behave respectfully towards their employees. This is where the ISO 20400 standard ability to affect positively on the whole supply chain produces virtuous behaviour for everyone (Sofidel, 2018).

3.5 Legal/commercial

this is an excellent sub-section

The machinery Directive (2006/42/EC) aims to unify the regulations governing the trade of machines within the EU, while assuring the best achievable standard of safety for customers and workers (European Commission, 2022). The machinery directive puts sole responsibility for the design and manufacture of the machine on the manufacturer. The manufacturer takes responsibility for implementing and the administrative procedures for the plant. The machinery directive compels machine builders who manufacture for their own use to comply with the directives. As the machine is not to be traded the machinery directive is applied to guarantee that the safety level of the machine harmonises to that of machines obtainable on the market (Pilz, 2017).

ISO 12100:2010 – Safety of machinery – General principles for design

This standard stipulates the fundamental terminology, codes and a methodology for achieving safety in the design of machinery. Risk assessment (RA) and risk reduction principles are specified to aid designers in attaining this objective (ISO, 2010). The existing process RA can be found in Appendix 9.8. The risk assessment for the new system can be found in appendix 9.9.

ISO 13849-1:2015 – Safety-related parts of control system – Part 1 General principles of design

This standard concerns the safety standard for the design of safety related control systems for machinery. EN ISO 13849 is established on a probability approach to evaluate safety related control systems. (Pilz, 2017) . The PL categorisation of the machine is shown in appendix 9.10.

ISO 13949-2: 2012 – Safety related parts of control systems – Part 2 Validation

These standard details the methods and conditions to be performed for the validation by investigation and testing of the defined safety functions, the category achieved, and the performance level attained by the safety related parts of the control system as designed in accordance of ISO 13849-1.

BS EN 60204-1:2018 – Safety of Machinery – Electrical equipment of machines

This standard concerns the electrical, electronic and programmable electronic equipment and systems within stationary machines intended to function in conjunction with other machinery. This B-type harmonised standard for the Machinery Directive 2006/42/EC (Machine Building, 2018).

The solution to be produced is relatively simple and will not require any intellectual property protection. The project will be produced as part of authors work so the intellectual property will belong to the company.

4. Functional Design Specification and Test Plan

4.1 Functional design specification

a very good sub-section

A glue storage, mixing and supply station is required to improve the current system at the converting plant. The existing system utilises a labour-intensive process that incurs health and safety and quality concerns. The objective for the new system is to remove storage containers off the line, reduce the need of manual handling, and remove human error by automating the glue dosing process. The new system will fully automate the process for obtainment, storage, mixing and supply of glue to the paper machine applications.

The deliverables for this project are listed in table 1.

Table 1: Project deliverables

Reference	Criteria
1.1	The station must use Profibus communication protocol.
1.2	Automatic mode: Glue request, storage, mixing and supply.
1.2.1	Core glue Core glue must be requested when the tank is at low level. The tank must fill until it reaches its desired level. The glue must be supplied to the core machine
1.2.2	Ply/Blitz glue
1.2.2.1	There must be an operator selector for either neat or blitz and the number of ply's.(2-4)
1.2.2.2	Ply glue: Water must be supplied when the tank is at low level. Once the desired quantity of water is loaded laminating glue must be dosed. The consistency must be established with the support of the quality department.
1.2.2.3	Blitz: Blitz glue must be requested when the tank is low level. The tank must fill until it reaches the desired level. The ply/blitz glue must be supplied to the embosser of the paper machine and controlled via a remote operator panel.
1.2.3	Pickup glue Core glue must be requested when the tank is at low level. The tank must fill until it reaches its desired level. The pickup glue must be supplied to the rewinder section of the paper machine, and the pumping must be controlled via the paper machine.

1.2.4	Tail glue Water must be supplied when the tank is low level. Once the desired volume of water is loaded tail glue must be dosed. The consistency must be established with the support of the quality department. The tail glue must be supplied to the tail sealer of the paper machine and must be controlled via a remote operator panel.
1.3	Manual mode: Must only allow the operator to empty the tanks.
1.4	Automatic/Manual selection mode Mode selector must be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single control mode.
1.5	A human machine interface must be provided for user operation and data acquisition There must be a user-friendly screens for all application. The screens to be produced are
1.5.1	1) Main menu
1.5.2	2) Core glue application
1.5.3	3) Ply/Blitz glue application
1.5.4	4) Pickup glue application
1.5.5	5) Tail seal glue application
1.5.6	6) Production data
1.5.7	7) Production data Ply
1.5.8	8) Production data Blitz
1.5.9	9) Production data Tail
1.6	A beacon must be provided for each gluing applications to show its status.
1.6.1	1) Blue – Glue pumping from glue room
1.6.2	2) Red – System fault
1.7	The flow sensors must be manufactured by IFM and be suitable for the media as shown in appendix 9.11.
1.8	A single phase 230V supply must be provided with a method of isolation.
1.9	The equipment must be fixed and stable.
1.10	The tank must incorporate a method of overflow protection.
1.11	The enclosure must be a minimum of IP65 rated.
1.12	The PLr category must be category a.
1.13	Technical documentation must be compiled.

1.14	The machine must be accompanied by instructions in the official community language.
1.15	The total spend cannot exceed £20,000
1.16	The implementation and commissioning must be completed by April 2023.

A test procedure was produced to prove the implemented machine meets the deliverables of the project as specified in the FDS. The test procedure was divided into conformity (Table 2) and functional tests (Table 3).

4.2 Conformity test

Table 2: Conformity test table

Reference	FDS Reference	Description of test	Expected result	Actual result	Pass/fail
CT1	1.1	Profibus communication	In Simatic Manager software the I/O modules and HMI should be discoverable in the network.		
CT2	1.4	Automatic/manual mode selection	On the HMI the user selects manual operation. This in turn latches into position. The mode selection on the screen clearly shows manual operation. The operator selects automatic operation. The selector latches into automatic mode. The HMI clearly states automatic operation.		
CT3	1.7	Flow sensors manufacturer	All flow sensors are manufactured by IFM.		
CT4	1.8	Electrical supply and lockable isolation point	A voltmeter will measure the supply voltage. With the isolator in the ON position: The readings should be		

			Phase-Neutral $\approx 230V$ Phase-Earth $\approx 230V$ Neutral-Earth $\approx 0V$ With the isolator in the OFF position a lock must be applied. The isolator cannot be energised with the lock in position. The readings should be Phase-Neutral $\approx 0V$ Phase-Earth $\approx 0V$ Neutral – Earth $\approx 0V$		
CT5	1.9	Stability of machine	The machine is subject to moderate force and the integrity is not compromised.		
CT6	1.10	Performance level of machine	The risks associated with the machine as per the risk assessment and performance level classification match that of the physical machine.		
CT7	1.10	Technical documentation	CAD drawings of the system and schematic electrical drawings are available. The CAD drawing and schematic electrical drawings are accurate to the physical system.		
CT8	1.11	Enclosure IP rating	The closure IP rating and cable entry glands conform to IP65 rating.		

CT9	1.12	Machine operational instructions	The operational instruction provides a detailed instruction on the operation of the machine.		
CT10	1.13	Project costs	The total spend is below £20,000		

4.3 Functional test

excellent detail

Table 3: Functional test table

Reference	FDS Reference	Description of test	Expected result	Actual result	Pass/fail
FT1	1.2.1	Core glue automatic sequence	On the core glue screen automatic mode is selected on the selector. As the tank is low level core glue is requested solenoid valve actuated and the glue is pumped from the glue room. The tank fills up to until it reaches the desired level probe. The glue is then pumped to the core machine.		
FT2	1.2.2.1 1.2.2.3	Ply glue automatic sequence	On the Ply/Blitz screen automatic is selected then neat glue is selected and the number of plys entered as 3. As the tank is empty the tank will fill with the desired water level. Then the desired quantity of laminating glue will be		

			dosed. The desired consistency will be established with the support of the quality department. The remote operator request button will be pressed and the glue will be sent to the embosser.		
FT3	1.2.2.2 1.2.2.3	Ply/blitz automatic sequence	On the Ply/Blitz screen automatic is selected then blitz is selected. As the tank is empty the tank will fill with the desired quantity of Blitz. The remote operator request button will be pressed and the glue will be sent to the embosser.		
FT4	1.2.3	Pick up glue automatic sequence	On the pickup glue screen automatic mode is selected. As the tank is empty the tank fill up until it reaches the high level probe. The pickup glue is pumped over to the rewinder and controlled by the paper machine.		
FT5	1.2.4	Tail sealer glue automatic sequence	On the tail seal screen automatic mode is selected. As the tank is empty water is filled into the tank. Once the desired volume of water is filled into the tank the desired value of tail seal		

			glue is dosed into the tank. The request button on the remote panel on the tail sealer section of the paper machine is activated and the glue is supplied to the tail sealer.		
FT6	1.3	Manual mode	Manual modes are selected on each of the gluing applications. The glue in each tank is pumped till each tank is empty. The tank will not request glue from the glue room.		
FT7	1.5 1.5.1 1.5.1.1 1.5.1.2 1.5.1.3 1.5.1.4	HMI operation	The system loads to the root screen being the main menu. From the main menu navigated to the core glue screen back to the main menu. From the main menu navigated to the Ply/Blitz screen back to the main menu From the main menu navigated to the pick up glue screen back to the main menu From the main menu navigated to the tail seal glue screen back to the main menu		

	1.5.2.1		From the main menu navigated to the production data screen back to the main menu.		
	1.5.2.2		From the production data navigate to the production data ply and back to production data.		
	1.5.2.3		From the production data navigate to the production data Blitz and back to production data		
	1.5.2.4		From the production data navigate to the production data tail and back to production data.		
FT8	1.6	Machine beacon indicator			
	1.6.1		In automatic mode glue is requested from the glue room the blue beacon indicator will illuminate. Once the request is complete the indicator will switch off.		
	1.6.2		In automatic mode core glue the glue tanks are filled up to the emergency level probe. The red beacon will illuminate and only clear when the tank level is lowered and reset cycle is pressed on the screen		

5. Literature Review

5.1 Instrumentation

A flow meter measures the flow of material through a pipe. The volume and flow rate of the fluid is provided by an electrical signal. Subject to application and metering requirement there may be numerous meter options or a solitary option for the specific application. Confounding selection further external factors also determines if the meter satisfies its intended purpose (Sousek, 2020).

The process fluid type is significant to ensure the flow meter matches the application. Fluid types are categorised into four types being gas, liquid, slurry and vapour which constitute their own unique characteristics. Fluid density, temperature, viscosity, and corrosiveness are properties that must be established. Failure to correctly select a flow meter for the application can lead to incompatibility (Sousek, 2020).

Certain flow meter technologies can be affected by temperature and operating pressure. If temperature affects the accuracy of a flow meter temperature compensation must be implemented. Flow meters with moving parts are not designed for high pressure operation. Some flow meters perform well with regular flow others will outperform in high turndown applications (Davis, 2010).

The flow range and pipeline diameter are significant considerations in the selection of flow meters. Some flow meters do not respond to sudden variations in flow rate while others function well over a wide turndown rate (Davis, 2010).

An application-specific comparative flow meter evaluation tool is a method to ensure the flow meter is appropriate for the application (Davis, 2010). A flow meter selection matrix is shown in table 4 and 5 for water and adhesives. The data sheet for the substance is shown in appendix 9.11.

Water dosing meter requirements

What about the other parts of the solution?

Table 4: Water meter evaluation tool

Evaluation criteria	Requirement
Fluid type	Liquid
Viscosity	1mpa
Fluid temperature	20
Flow range	50-80l/m
Pipe internal diameter (I.D)	25mm

Installation considerations	Stainless steel pipework
Accuracy	<10%
IP rating	IP65
Material	Stainless steel
Expected installation life	>20 years
Meter life expectancy	Min 10 years

Table 5: Adhesive meter evaluation tool

Evaluation criteria	Requirement
Fluid type	Fluid
Viscosity	25,000mpa-30,000mpa
Fluid temperature	15-30
Flow range	25-40 l/m
Pipe internal diameter (I.D)	25mm
Installation considerations	Stainless steel pipework
Accuracy	<10%
Installation Considerations	Stainless steel pipework
Expected installation life	>20 years
Meter life expectancy	Min 10 years

The flow sensors for the application have been chosen as the IFM SM8100 magnetic inductive flow meter (IFM , 2021) for water and IFM SU7000 ultrasonic flow meter (IFM, 2022) for the adhesives. These were selected as both meet the requirement of the flow evaluation tables shown in tables 4 and 5. The data sheets for the sensors are shown in *datasheets are not required in the appendix, you should cite informatin from them instead* appendix 9.12 and 9.13. These IFM sensors can be configured in three ways being analogue signal, pulse signal or IO-Link. The benefits and limitations of these configurations will be discussed.

5.2 Solution 1 – Flow sensors using pulse signal

Solution one uses the IFM magnetic flow meter in digital pulse output configuration (IFM, 2021). For this solution the flow sensor would be configured in pulse signal and the digital signal would be transferred to the Siemens 6ES7 131-4BD01-0AA0 digital input card. This digital input card has four digital inputs (Siemens, 2021). The card is simply added to the ET200 rack and added to the project from the library. The cost of the digital output card is £39.80 and readily available from leading suppliers (RS Components, 2022). These cards are a stock item in the factory and in the unlikely event of failure a spare is on the shelf. Siemens is a trusted brand, and these cards are used extensively across all machines and are proven.

Would the input card need to be setup up for high speed counting?

What is the relationship between frequency and flowrate?

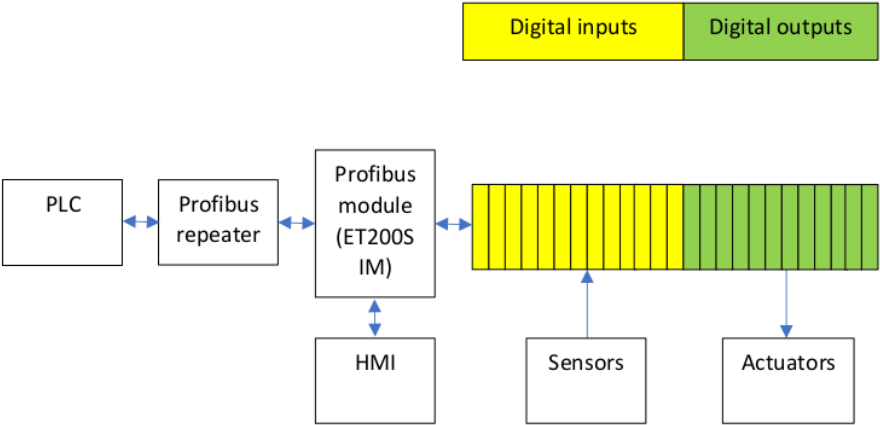
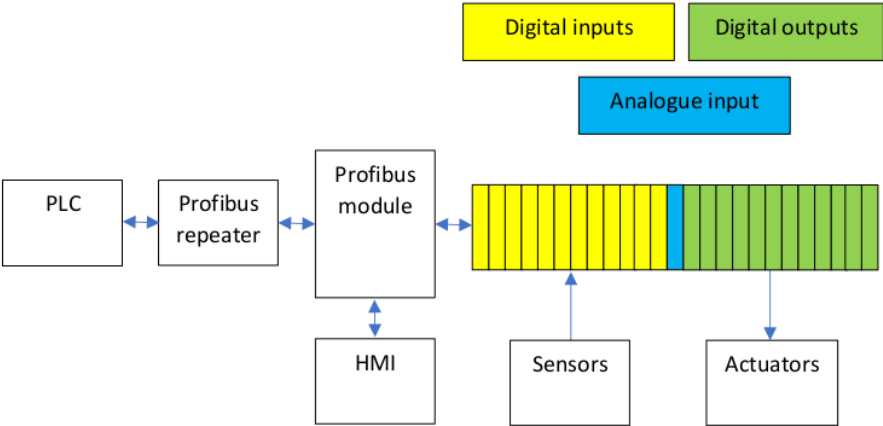


Figure 1: Solution 1 block diagram

5.3 Solution 2 – Flow sensor using analogue signal

Solution two uses the IFM magnetic flow meter in analogue output configuration (IFM, 2021). The analogue signal would be supplied to the Siemens analogue input card. The 4-20mA signal would be scaled to provide a representation of the flow rate. The analogue input card has 4 analogue inputs (Siemens, 2021). The card is simply added to the ET200 rack and the card is added to the project from the library. The module costs £279.60 with a lead time of 4 weeks (RS Components, 2023). As with solution one Siemens is a trusted brand.



shouldn't the sensor be connected to the blue card?

Figure 2: Solution 2 block diagram

5.4 Solution 3 – Flow sensor using IO Link signal

Solution three uses the IFM flow meter in IO Link configuration. To interface the IO Link sensor to the project an IO-Link PROFIBUS interface would be required. IFM offer the AL1010 PROFIBUS interface requiring a 24VDC supply and a Profibus connection. The interface is field mountable and rated up to IP67. The PROFIBUS module has 8 IO Link inputs. The interface module would be added to the project via a GSD file provided by IFM. The GSD file however is only compatible with TIA portal and the existing system is Simatic Manager (IFM, 2022). There is a possibility of upgrading the existing system to TIA portal, but the upgrade is not feasible due to time and it's not within scope of this project. The interface module costs £453.80 with a lead time of 2 weeks.

Your project solutions seem to be concerned only with the selection of a sensing and conditioning method

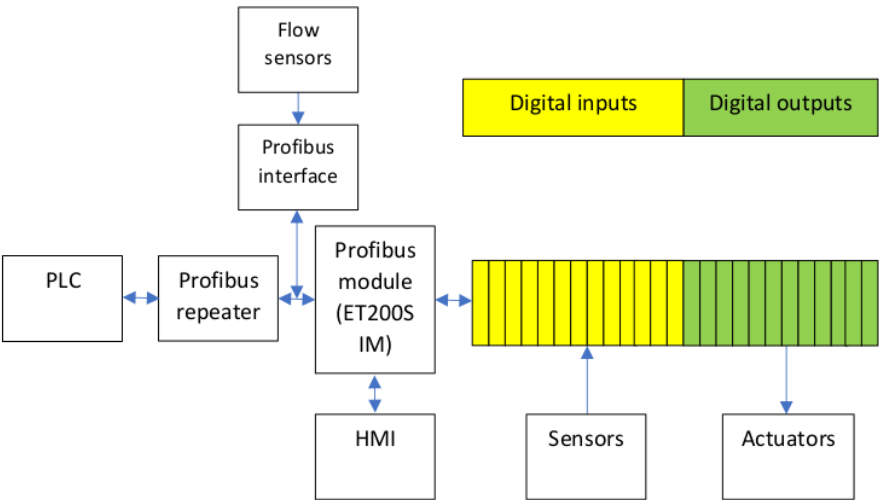


Figure 3: Solution 3 block diagram

5.5 Chosen solution

The radar diagram shown in figure 4 was produced from the scoring matrix shown in appendix 9.3. It is evident solution 1 is the chosen solution scoring highest in five out of the six criteria. Solution 2 was comparable with solution 1 on two criterion but the cost, availability, complexity and feasibility was its demise. Solution 3 scored the lowest in all criteria apart from availability.

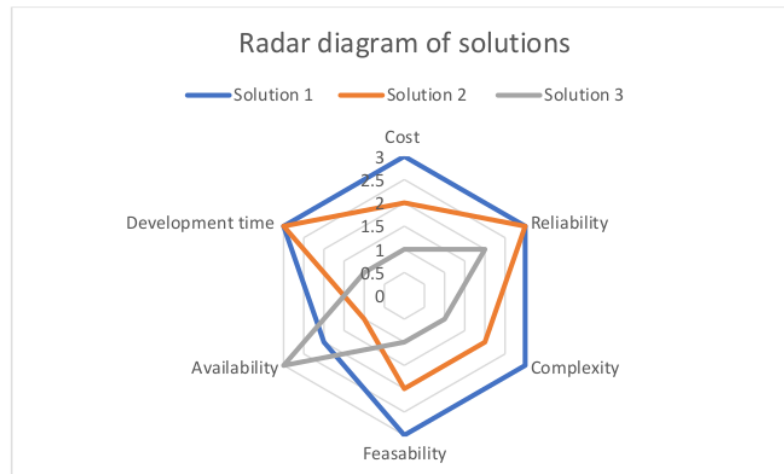


Figure 4: Radar diagram of solutions

The machine inputs and output are shown in appendix

This is a surprising choice as IO-Link is future proof

There must be more to your design than a sensor. What else are you designing?

5 Project Planning, Work breakdown and Management Techniques

The WBS subdivides the project into smaller elements. Its purpose is to divide the project into pieces of work termed packages. Allotting work packages for the project simplifies the process of scheduling and budgets and to assign management and budgets task responsibilities (John M. Nicholas, 2012).

The WBS diagram can be found in Appendix 9.4. The WBS was divided into three levels and the forecast workload percentage was established. The WBS enabled the construction of the Gantt chart as shown in Appendix 9.5.

The Gantt chart was divided into six milestones and further subdivided to activities to achieve the milestones. The design and implementation stages are forecast to take 14 weeks. The six milestones are as follows:

- 1) Electrical and software design
- 2) Source and obtain components
- 3) Hardware assembly
- 4) Machine installation
- 5) Testing and commissioning
- 6) Handover

The forecast total cost for the project is £13,225. The breakdown costing spreadsheet can be found in appendix 9.6.

The quality management of the project will be subject to company change control procedures. As the project alters the current method of glue delivery a period of validation will be in place to ensure the system provides the deliverables as defined in the FDS. Once the quality team accept the functionality of the system the system factory accepted and integrated into the work process documentation.

The risk assessment for the implementation phase of the project is shown in appendix 9.2.

6 Conclusion and Recommendations

6.1 Conclusion

There were no signatures or dates in the proposal?

A project proposal was produced and agreed with the industrial supervisor. The logbook described week by week progress and the accumulative hours are 100 hours so far. The project background and problem definition provided valuable data for the deliverables of the project. The ethical, sustainability and legal constraints specified company and legislative conformity for the project. The FDS provided the deliverables and clear limitation, features, and conformity requirements of the machine. A clear and detailed FDS shows the customer the limitations and deliverables of the machine. An itemised test plan ensured conformity to directives and functionality of machine.

It is not clear how the selection of a flow meter meets the requirements of the FDS

Instrumentation research enabled the provision of a flow meter evaluation tool. The corroboration of this table and the obtainment of adhesive datasheet enabled the selection of the appropriate flow meter. The selection of flow meter permitted the selection of signal processing modules to communicate with the PLC. Three solutions were designed, and a block diagram was produced to show the interconnection of components. The solutions were compared in a scoring matrix and visually represented in a radar diagram. The radar diagram clearly showed the best solution.

A WBS was produced and divided the project into smaller elements. The WBS depicted the allocation of the sub projects and work packages for the project. A Gantt chart was produced to allocate and schedule tasks for the implementation stage of the project. Six milestones were established that can track progress and provide stakeholders information on progress. The cost breakdown structure calculated the costs for the project. A risk assessment for the implementation phase of the project shows potential hazards and the mitigation actions in place.

6.2 Recommendations

To ensure the project completion date is met the tasks as stipulated in the Gantt chart must be completed on time to achieve the milestones. The logbook must be kept up to date to track activities and accumulative hours. The budget for the project must be followed to prevent spiralling costs. The FDS must be always referred to prevent deviation from scope.

7 Citation List

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8 Appendix

9.1 Project Proposal

SGEE6000 Independent Project

Student Name: Gareth Wilkins
Project title: Glue mixing station
Date: 07/10/2022
Budget: £20,000

The project will be based in a local tissue manufacturing company. The Production department have requested an automated system for the delivery of glue to the paper machines. This request has arisen from quality and health and safety concerns. The current method of supplying glue to the lines is labour intensive and requires an operator to leave the line and retrieve the glue from the glue storage area. This is time consuming, and the manual loading imposes manual handling risks. This method also incurs quality concerns as operators are relied upon to obtain the correct glue recipe for the application. The Quality department have requested a process that automates the system where the recipe is selected, and the glue is provided with the correct consistency.

The design, construction and commissioning will be performed in house. The management, electrical design, build, software design and commissioning will be undertaken by author with the support of the automation engineer. All pipework and mechanical fixtures will be produced by fabricators on site. The budget for the project is £20,000. The project must be commissioned, and factory accepted by April 2023.

Signatures and dates of approval are missing

9.2 Risk Assessment for implementation phase

ID	Risk Description	Likelihood of the risk occurring	Impact if the risk occurs	Severity	Owner	Mitigating action	Contingent	action
1	Project specification and deliverables not clearly established	1	4	4	Project manager	Project proposal and functional design specification agreed with supervisor.	Escalate to management including assessment of unremitting costs	
2	Project schedule not outlined or established	2	5	10	Project manager	Schedule regular meetings with project team so the project plan is understood and the likelihood of tasks being missed is reduced	Work plan shared and upcoming tasks to be discussed at regular review meetings.	
3	Work priorities	3	4	12	Project manager	Project manager to brief supervisor on the importance of project. Project manager to define staff roles	Escalate to Engineering manager	

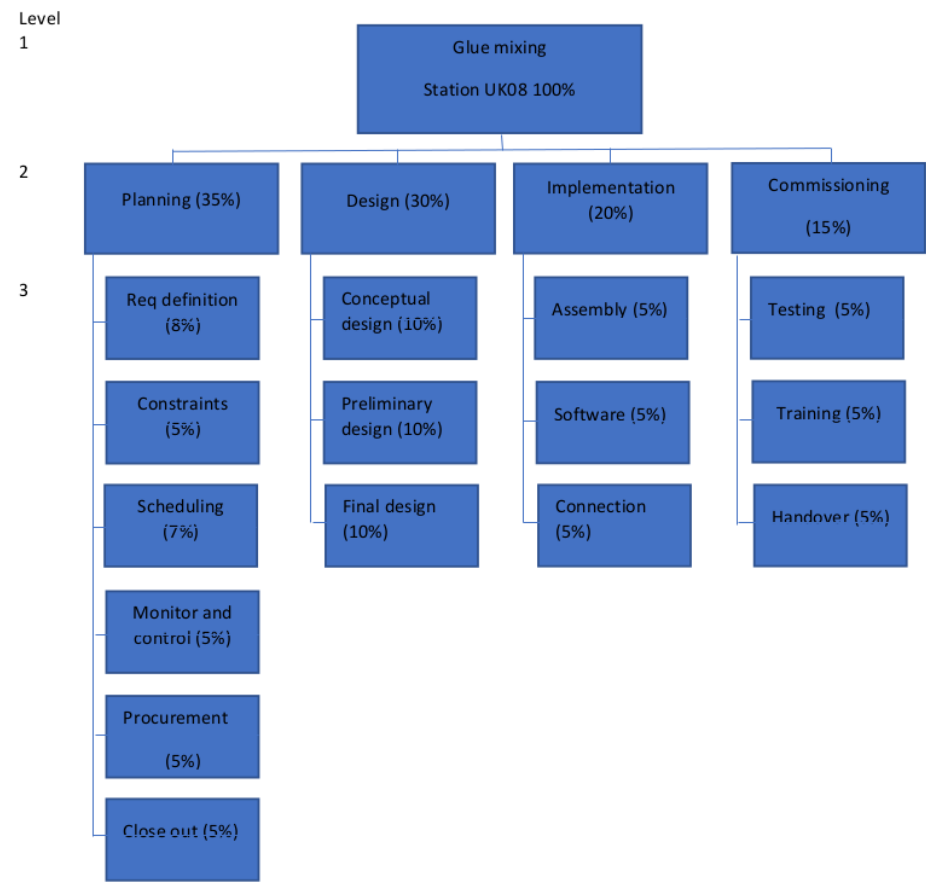
4	Cost Estimating errors	3	5	15	Project manager	Track costs carefully and forecast cost at completion adjusting as necessary. Allow 10% contingency on costs.	Escalate to engineering manager. Raise change request for budget.
5	Scheduling errors	3	5	15	Project manager	Monitor schedules daily and include schedule review in every project team meeting. Highlight forecast inaccuracies or delays at the earliest opportunity to the project team. Project envisaged to be completed by end of April.	Escalate to engineering manager. Raise change request for change in scheduling.
6	Inadequate communication causing misunderstanding and misinterpretation.	3	3	9	Project manager	Ascertain clear lines of communication with personnel involved in project. Regular review meetings to be conducted and any issues to be highlighted	Resolve any misunderstandings early. Clarify any areas that are not clearly understood.
7	Scope creep	3	3	9	Project manager	The project scope is documented in the FDS and agreed between the project manager and engineering manager.	Any scope creep must be documented and authorised by project manager.

8	Project concerns not escalated in timely manner	3	4	12	Project manager	Regular project team meetings to be held and any concerns to be highlighted.	Concerns to be escalated to engineering manager to resolve.
9	Delays in component deliveries risking implementation date of project	2	5	10	Project manager/ Procurement	Ensure project plan is as precise as possible utilising scheduling workshops and work breakdown structure.	Escalate to engineering manager any delays.

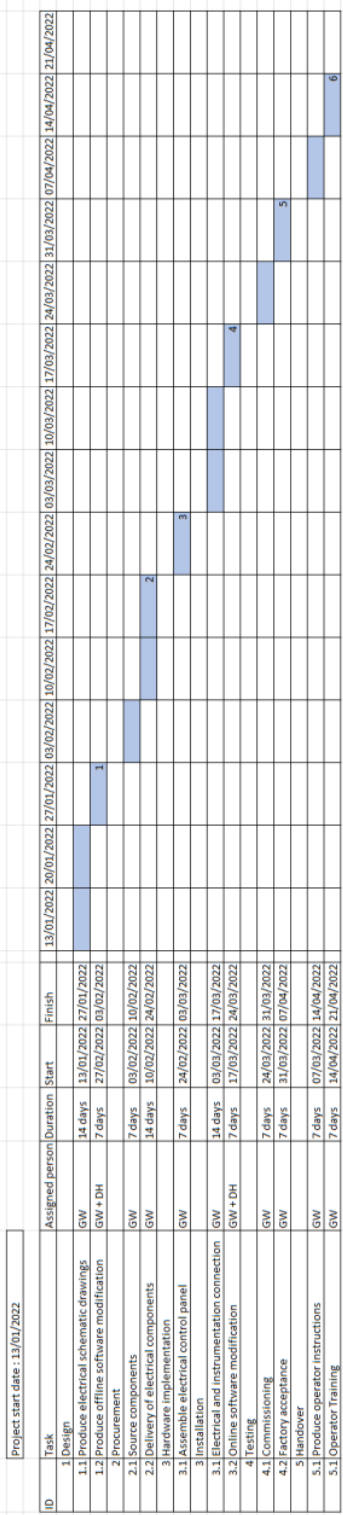
9.3 Scoring matrix for Solutions

Criteria	Solution 1	Solution 2	Solution 3
Cost	3	2	1
Reliability	3	3	2
Complexity	3	2	1
Feasibility	3	2	1
Availability	2	1	3
Development time	3	3	1

9.4 WBS chart



9.5 Gantt chart



9.6 Costing Spreadsheet

Quantity	Part Number	Description	Quote	Each	Total
1	6EP1332-2BA20	SITOP PSU100S 24V/2.5A	Web	£102	£102
1	6AV6642-0AA11-0AX1	SIMATIC Touch panel TP 177A	Web	£1,942	£1,942
10	61F-GPN-BT/-BC	Conductive Level Controller	Web	£114.90	£1,149
2	SU7000	Ultrasonic volumetric flow sensor	Web	£775.94	£1,552
1	SM8100	Magnetic-Inductive flow meter	Web	£761.42	£761
1	NSYS3D10625	Control Panel 1000 x 600	Web	£197.50	£198
4	GVAG-3VK1	Level probe	Web	£450.78	£1,803
2	STM UK MN56B/4 SIM 14	Motor 0.09KW	Web	£466.66	£933
1	6SE7 151-1AA02-0AB0	ET200S IM 151 I/F Module Profibus	Web	£995.44	£995
1	6SE7 138-4CA01-0AA0	Power module	Web	£21	£21
5	6ES7-193-4CB30	Simatic ET200SP (Pack of 5)	Web	£25	£125
13	6ES7 131-4BD01-0AA0	DI module	Web	£39.80	£517
12	6ES7 132-4BD32-0AA0	DO module	Web	£104.60	£1,255
9	NA54N15-02	Solenoid valve	Web	£100.12	£901
		Miscellaneous - Cabling, glands etc	Web	£1,000	£1,000

Total	£13,255
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SGEL6000
Independent Project
Log Book

Gareth Wilkins
Glue mixing station
2022-2023

Summary of Entries

Log Entry	Date	Brief Description of Activity	Duration (hrs)	Accumulated time (hrs)
1	23/09/22	Logbook template produced and project ideas	4	4
2	30/09/22	Possible projects investigated	4	8
3	07/10/22	Project proposal agreed – Glue mixing station	4	12
4	14/10/22	Project background and defining problem to be solved	8	20
5	21/10/22	Investigation into existing system and evaluation of integration with new mixing station	8	28
6	28/10/22	Substance Investigation, risk assessment and PL categorisation	8	36
7	04/11/22	Functional design specification (FDS) outlined and agreed	8	44
8	11/11/22	Test plan produced in line with FDS	8	52
9	18/11/22	Solutions evaluated to meet FDS requirements	8	60
10	25/11/22	Solution chosen	8	68
11	02/12/22	Work breakdown structure produced	8	76
12	09/12/22	Gantt chart produced	8	84
13	16/12/22	Conclusion and recommendations	8	92
14	23/12/22	Compiling report	8	100

Log Entry Sheet

Log Number	1
Date	23/09/22
Duration (hrs)	4
Accumulated time (hrs)	4

Record of activities and achievements

Received course introduction specifying the requirements of the individual project. Log entry template was produced which will detail the activities performed each week and the plan for the following week. The project will take place in the workplace. Discussed with supervisor production and safety concerns that require addressing.

Plans for next week

A project will be agreed upon and a project proposal will be drafted.

Log Entry Sheet

Log Number	2
Date	30/09/22
Duration (hrs)	4
Accumulated time (hrs)	8

Record of activities and achievements

The project to be undertaken was decided to be a glue delivery, storage and mixing station. The current labour-intensive method was assessed, and the requirement of the automated system was observed. A project proposal was drafted including where the project is based and why the project is needed. The project will be based in the converting plant. The project is required due to health & safety and quality concerns.

Plans for next week

Further project proposal information will be obtained including who will be involved in the project, budget and completion date.

Log Entry Sheet

Log Number	3
Date	07/10/22
Duration (hrs)	4
Accumulated time (hrs)	12

Record of activities and achievements

The persons involved in the project will be author and support from the automation engineer will be provided for software modifications. The budget for the project is £20,000 as agreed by the maintenance manager. The completed project proposal was agreed upon by industrial supervisor, tutor and author.

Plans for next week

The background of the project and the defining the problem to be solved will be detailed.

Log Entry Sheet

Log Number	4
Date	14/10/22
Duration (hrs)	8
Accumulated time (hrs)	20

Record of activities and achievements

The company background and process of the paper manufacturing company was produced. The gluing application for the specific line was detailed. The problem definition being the health and safety and quality concerns was described. The constraint of the project including ethics, sustainability and legal codes of practice was discussed.

Plans for next week

The existing system and evaluation of integration with the new system will be investigated.

Log Entry Sheet

Log Number	5
Date	21/10/22
Duration (hrs)	8
Accumulated time (hrs)	28

Record of activities and achievements

The existing system was investigated where the PLC is a CPU317-2 DP using profibus communications. To interface with the existing glue system a remote I/O profibus module will be required. Due to the distance from the glue room to the line profibus repeaters will be required. The single phase supply will be fed to the line from the glue room supply.

Plans for next week

The substances involved in the project will be investigated, a risk assessment for the existing system and the new system will be produced. From the risk assessment the performance level (PLr) will be determined.

Log Entry Sheet

Log Number	6
Date	28/10/22
Duration (hrs)	8
Accumulated time (hrs)	36

Record of activities and achievements

The data sheets for the glue was obtained: BIM DL 63007, BIM SL 53021, Aquence Seal EO104, Aquence E7205 were obtained from the environmental department. A risk assessment for the existing system was conducted listing the hazards and the risk reduction methods. A risk assessment was conducted for the new system and any new hazards were noted and risk reduction methods noted. From the risk assessment the PLr category was determined being class a.

Plans for next week

The function design specification (FSD) will be produced and agreed by industrial supervisor.

Log Entry Sheet

Log Number	7
Date	04/11/22
Duration (hrs)	8
Accumulated time (hrs)	44

Record of activities and achievements

The general machine features and function were outlined. The FSD was produced in a table with a reference number and criteria. The FSD criteria are established of the functions and features of the machine and conformity to standards as per the machinery directives. The industrial supervisor and tutor agreed to the FSD.

Plans for next week

The test plan will be produced and divided into two segments being conformity and functionality tests.

Log Entry Sheet

Log Number	8
Date	11/11/22
Duration (hrs)	8
Accumulated time (hrs)	52

Record of activities and achievements

A test plan was produced in line with the FSD criteria. One test plan was produced to ensure conformity and the other was produced to ensure machine functionality. The expected result was described and a pass or fail box was added. The test plan was discussed and agreed with industrial supervisor.

Plans for next week

Three solutions to meet the FSD will be produced.

Log Entry Sheet

Log Number	9
Date	18/11/22
Duration (hrs)	8
Accumulated time (hrs)	60

Record of activities and achievements

Investigation into flow meters was conducted. As stipulated in the FDS the flow sensor must be manufactured by IFM so two sensors being the SU7000 ultra sonic and SM8100 magnetic flow sensors were selected for the project. To interface the flow sensors three solutions were investigated being a Siemens 6ES7 131-4BD01-0AA0 digital input card, Siemens 6ES7 134-4GB11-0AB0 analogue input card and the IFM AL1010 profibus interface. Block diagrams for each solution was produced to show feasibility.

Plans for next week

The best solution will be chosen through a scoring matrix.

Log Entry Sheet

Log Number	10
Date	25/11/22
Duration (hrs)	8
Accumulated time (hrs)	68

Record of activities and achievements

The scoring matrix enabled the creation of a radar diagram to visually depict the best solution. It was obvious that solution 1 - Siemens 6ES7 131-4BD01-0AA0 digital input card was the best solution and would be put into implementation. The solution scored best in five out of the six selection criteria.

Plans for next week

The work breakdown structure will be produced.

Log Entry Sheet

Log Number	12
Date	02/12/22
Duration (hrs)	8
Accumulated time (hrs)	76

Record of activities and achievements

The WBS produced was a three level and divided into percentages for scheduling. The project was 100% and level 1. Level 2 being the sub project all accumulated to 100% being the whole project. Level 3 activities were responsible for the sub projects at level 2 success.

Plans for next week

The Gantt chart will be produced and responsibility allocated.

Log Entry Sheet

Log Number	6
Date	09/12/22
Duration (hrs)	8
Accumulated time (hrs)	84

Record of activities and achievements

The WBS enabled the scheduling and allocation of tasks. The Gantt chart was produced over a 14 week period and started on the 13/01/2023. Six milestones were compiled being:

- 1) Electrical and software design
- 2) Source and obtain components
- 3) Hardware assembly
- 4) Machine installation
- 5) Testing and commissioning
- 6) Handover

Plans for next week

The conclusion and recommendations for the project will be outlined.

Log Entry Sheet

Log Number	14
Date	16/12/22
Duration (hrs)	8
Accumulated time (hrs)	92

Record of activities and achievements

The project as it stands is on track and all requirements have been achieved.

Plans for next week

The report for the project will be compiled and all relevant documentation will be included.

Log Entry Sheet

Log Number	14
Date	23/12/22
Duration (hrs)	8
Accumulated time (hrs)	100

Record of activities and achievements

The report was compiled, and layout out is the required manner.

Plans for next week

The project will be put on hold during the Christmas break. The project restart on 13/01/2023 and the tasks will be performed as outlined in the Gantt chart.

9.7 Existing Risk assessment

Title: Transporting ink to line						
Risk assessment number	RA - 014	Version: 1	Location: Converting	Assessment date	01/09/2022	Assessor name G. Wilkins
Department	Converting					
Activity	Handling and transporting of glue to lines - Buckets are filled with glue in the glue room then manually moved onto a trolley. The operator then uses the trolley to transport the ink to the lines. The buckets cannot hold more than 15kg of glue. The buckets are then lifted and manually emptied into the glue tanks					Overall Risk rating Medium

Hazard Identification				Risk level		Method of reducing the risk	By whom	Final Risk Level		
Hazard number	Hazard (What could cause harm)	Risk (How is could cause harm)	Whom maybe Harmed / Affected Parties (Employees , Contractors & Visitors)	Likelihood of impact/injury	Severity of injury	Risk level	Control measures to be applied	Likelihood of impact injury	Severity of impact	Hazard control
1	Manual Handling	The buckets used to transport the ink when full weigh a maximum of 15kg. If not lifted correctly and trolleys used incorrectly, this could cause musculoskeletal injury.	Employees	4	3	12	Operators must adhere to correct manual handling procedures as per their training at all times both when lifting the buckets to the tanks and when manoeuvring the	2	3	AC

2	FLT Movement	Operators must cross the path in which FLT's operate, this could result in a collision and/or serious injury	Employees	4	4	16	trolley from the ink room to the lines No more than three buckets to be manoeuvred on the trolley at any one time Pre-user checks to be carried out on the trolley before use to ensure it is in full working order with no defects	Operators	1	3	3	AC
3		Liquid spillages, discarded wrapping materials on the floor cause an operator to slip, trip or fall	Employees, contractors and visitors	3	3	9	All spills are to be cleaned immediately using the spill kits located around the department. Spills must be reported to the Environmental department. Strict cleaning regimes are in place to limit the amount of dust, debris on the floor. These	Operators	1	3	3	AC

Hierarchy of risk control		
Elimination - E	Redesign or remove the hazard completely	
Substitution - S	Replace the material or process that causes the hazard to become less hazardous	
Engineering Controls - EC	Introduce engineering controls, engineering controls do not eliminate hazards but protect employees from hazard	
Administrative Controls - AC	Administrative controls are improvements to the way employees carry out their activities in a safer manner. Develop and implement procedures / SSOW for the employees to work safely	
Personal Protective Equipment - PPE	PPE should be used as a last resort, employees must be trained in the use of PPE	

9.9 Glue mixing station risk assessment

Title:	Transporting ink to line							
Risk assessment number	RA - 15	Version:	1	Location: Converting	Assessment date	10/11/2022	Assessor name	G. Wilkins
Department	Converting							
Activity	Operation and maintenance of glue mixings station							
							Overall Risk rating	Low

Hazard Identification					By whom	Method of reducing the risk	Final Risk Level			
Hazard number	Hazard (What could cause harm)	Risk (How is could cause harm)	Whom maybe Harmed / Affected Parties (Employees, Contractors & Visitors)	Risk level		Control measures to be applied	Likelihood of impact injury	Severity of impact	Risk level	Hazard control
1	Slips, Trips and Falls	Liquid spillages cause an operator to slip, trip or fall	Employees, contractors and visitors	3	3	The tanks will have high level controls to prevent tank from overflowing	1	3	3	EC
						Any leaks are to be cleaned immediately using the spill kits located around the department. Leaks must be reported to the	1	3	3	AC

no need to include datasheets in the appendix

9.10 Performance level categorisation

The PL category for the machine in PLa.

This was established following the selection criteria below.

► 3.4 Standards

Determination of the required performance level PL_r

Just three parameters need to be examined to assess the performance level (PL):

Severity of injury	S
Slight (normally reversible injury)	S ₁
Serious (normally irreversible injury including death)	S ₂

Frequency and/or duration of exposure to a hazard	F
Seldom to less often and/or exposure time is short	F ₁
Frequent to continuous and/or the exposure time is long	F ₂

Possibility of avoiding the hazard	P
Possible under specific conditions	P ₁
Scarcely possible	P ₂

The required performance level PL_r is calculated using the following graph and the classification of the individual parameters. Assessment of the risk begins at the starting point on the graph and then follows the corresponding path, depending on the risk classification. The required performance level PL_r a, b, c, d or e is determined once all the parameters have been assessed.

A new addition in the latest version of the standard is the option of assessing the probability of occurrence of a hazard. With the conclusion that this probability is too low, the previously determined PL_r can be reduced by one level. The devil is in the details in this case: namely, that comparable machinery should be used to assess this question. This comparable machinery is equipped with sufficient safety measures, however, as otherwise it would not be available on the market. A low occurrence of accidents on comparable machines is thus not sufficient justification for classifying the associated hazards as low. Instead this would prove that the implemented safety measures were appropriate (and a reduction of these would be misguided).

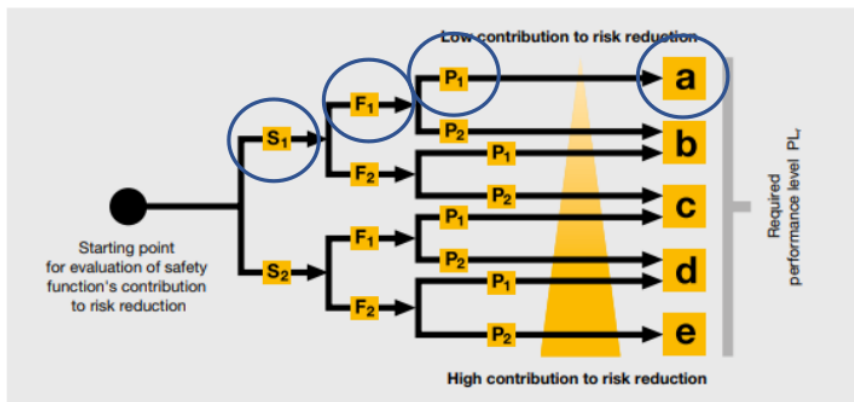


Figure 5: Performance level categorisation (Pilz, 2017)

BIM SL 53021

Tissue plybonding adhesive



BIM SL 53021 is an aqueous based concentrated adhesive based on water soluble polymers.

Physical properties

<i>Appearance:</i>	Hazy Liquid
<i>Viscosity:</i>	25,000-30,000 mPa.s
<i>pH:</i>	4.0-6.0

Benefits

The main benefits of using BIM SL 53021 are:

- Supplied in concentrate form and requires to be diluted before use;
- Suitable for high speed lamination of kitchen towel and toilet tissue;
- Exhibits high wet tack and fast setting speed;
- Gives economical mileage figures and clean running characteristics;

Application techniques

BIM SL 53021 should be pre-diluted with 3-5 parts of water prior to use. Advice regarding dilution ratios is available from BIM personnel.

The diluted product can be applied by usual methods, including embossing roller (e.g. point-to-point etc).

Storage/handling

Maximum product storage time is 6 months at ambient temperature (ideally 15-30°C) in unopened containers.

BIM SL 53021 can be irreversibly damaged by low temperature, especially frost.

Safety precautions and approvals

A Material Safety Data Sheet containing detailed information is available upon request.

BIM SL 53021 is not hazardous but should be used under conditions of good industrial hygiene.

BIM SL 53021 contains ingredients conforming to FDA 21 CFR 175.105 and BfR XXXVI Regulations.

Edition 1 TI/JS/2019-09-06

AQUENCE SEAL E0104

Known as Adhesin TS 0104
January 2017

PRODUCT DESCRIPTION

AQUENCE SEAL E0104 provides the following product characteristics:

Technology	Water-based Adhesive
Product Type	Colloidal solution
Application	Tissue Converting

Application Areas

Tail tie of high quality toilet- and tissue paper rolls.

Product Properties

AQUENCE SEAL E0104 provides a safe sealing of the last layer on the roll.

Film Properties

The dried adhesive film does not leave any traces and assures a very good release without paper tear.

Technical Data

AQUENCE SEAL E0104:

Viscosity, Brookfield - RVT, 6/20/23, mPas	16,000 to 24,000
ISO 2555	
pH value	6.5 to 8.5
ISO 976	

Handling Information

Due to the variety of different materials available on the markets pre-tests should be carried out.

Cleaning

Uncured adhesive residues as well as dried adhesive films can easily be removed with hot water. Wetting agents accelerate the cleaning process.

STORAGE

Protect from freezing.
Close containers thoroughly after use.

Shelf life:

Shelf-life (in unopened original packaging), months	6
Frost-Sensitive	Yes
Recommended Storage Temperature, °C	5 to 35

Classification:

Please refer to the corresponding **safety data sheets** for details on:

Hazardous Information
Transport Regulations
Safety Regulations

DIRECTIONS OF USE

Preliminary Statement

Prior to application it is necessary to read the Safety Data Sheet for information about precautionary measures and safety recommendations. Also, for chemical products exempt from compulsory labeling, the relevant precautions should always be observed. Please also refer to the local safety instructions and contact Henkel for analytical support.

Application

Application method:

- roller
- segment
- nozzle
- over flowing system

Dilution

AQUENCE SEAL E0104 is normally diluted 1:1 up to 1:3 with water.

BIM DL 63007

Ink for tissue plybonding adhesive



BIM DL 63007 is an aqueous based blue ink suitable for incorporating into plybonding adhesives for tissue decolam applications.

Physical properties

Appearance: Blue Liquid
Colour: Pantone Blue 292U
Viscosity: 20-90 mPa.s
pH: 5.0 -9.0



Application techniques

BIM DL 63007 should be stirred before adding to deco-laminating adhesive in ready-to-use form. The addition must be done SLOWLY WITH VIGOROUS MECHANICAL STIRRING.



The coloured adhesive can be applied by usual methods, including embossing roller (e.g. point-to-point etc).

Storage/handling

Maximum product storage time is 4 months at ambient temperature (ideally 15-30°C) in unopened containers.

BIM DL 63007 can be irreversibly damaged by low temperature, especially frost.

BIM DL 63007 must be stirred to raise any sediment prior to use.

Safety precautions and approvals

A Material Safety Data Sheet containing detailed information is available upon request.

BIM DL 63007 is not hazardous but should be used under conditions of good industrial hygiene.

BIM DL 63007 contains ingredients conforming to BfR XXXVI Regulations.

Edition 1 TI/JS/2022-11-16

(Documentation obtained from company database)

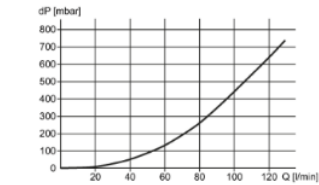
9.12 IFM SM8100 datasheet

Technical details	Accessories	Downloads	Further information
Product characteristics			
Number of inputs and outputs	Number of digital outputs: 2; Number of analogue outputs: 1		
Measuring range	0.2...100 l/min	0.01...6 m³/h	
Process connection	threaded connection G 1 DN25 flat seal		
Application			
Special feature	Gold-plated contacts		
Application	totaliser function; for industrial applications		
Installation	connection to pipe by means of an adapter		
Media	conductive liquids; water; hydrous media		
Note on media	conductivity: ≥ 20 µS/cm		
	viscosity: < 70 mm²/s (40 °C)		
Medium temperature [°C]	-10...70		
Pressure rating [bar]	16		
Pressure rating [Mpa]	1.6		
MAWP (for applications according to CRN) [bar]	11.2		
Electrical data			
Operating voltage [V]	18...30 DC; (to SELV/PELV)		
Current consumption [mA]	95; (24 V)		
Protection class	III		
Reverse polarity protection	yes		
Power-on delay time [s]	5		
Inputs / outputs			
Number of inputs and outputs	Number of digital outputs: 2; Number of analogue outputs: 1		
Inputs			
Inputs	counter reset		
Outputs			
Total number of outputs	2		
Output signal	switching signal; analogue signal; pulse signal; IO-Link; (configurable)		
Electrical design	PNP/NPN		
Number of digital outputs	2		
Output function	normally open / normally closed; (parameterisable)		
Max. voltage drop switching output DC [V]	2		
Permanent current rating of switching output DC [mA]	200		
Number of analogue outputs	1		
Analogue current output [mA]	4...20; (scalable)		
Max. load [Ω]	500		
Analogue voltage output [V]	0...10; (scalable)		
Min. load resistance [Ω]	2000		
Pulse output	flow rate meter		
Short-circuit protection	yes		
Type of short-circuit protection	pulsed		
Overload protection	yes		
Measuring/setting range			
Measuring range	0.2...100 l/min	0.01...6 m³/h	
Display range	-120...120 l/min	-7.2...7.2 m³/h	
Resolution	0.1 l/min	0.005 m³/h	
Set point SP	0.7...100 l/min	0.04...6 m³/h	
Reset point rP	0.2...99.5 l/min	0.01...5.97 m³/h	
Analogue start point ASP	0...80 l/min	0...4.8 m³/h	
Analogue end point AEP	20...100 l/min	1.2...6 m³/h	
In steps of	0.1 l/min	0.005 m³/h	

Volumetric flow quantity monitoring		
Pulse value	0.00001...100 000 m³	
Pulse length [s]	0,0025...2	
Temperature monitoring		
Measuring range [°C]	-20...80	
Resolution [°C]	0.2	
Set point SP [°C]	-19.2...80	
Reset point rP [°C]	-19.6...79.6	
Analogue start point [°C]	-20...60	
Analogue end point [°C]	0...80	
In steps of [°C]	0.2	
Accuracy / deviations		
Flow monitoring		
Accuracy (in the measuring range)	± (0,8 % MW + 0,5 % MEW)	
Repeatability	± 0,2% MEW	
Temperature monitoring		
Accuracy [K]	± 2,5 (Q > 5 l/min)	
Response times		
Flow monitoring		
Response time [s]	0.15; (dAP = 0, T19)	
Delay time programmable dS, dr [s]	0...50	
Damping process value dAP [s]	0...5	
Temperature monitoring		
Dynamic response T05 / T09 [s]	T09 = 20 (Q > 5 l/min)	
Software / programming		
Parameter setting options	Flow monitoring; quantity meter; Preset counter; Temperature monitoring; hysteresis / window; normally open / normally closed; switching logic; current/voltage/pulse output; start-up delay; display can be deactivated; Display unit	
Interfaces		
Communication interface	IO-Link	
Transmission type	COM2 (38,4 kBaud)	
IO-Link revision	1.1	
SDCI standard	IEC 61131-9	
Profiles	Smart Sensor; Process Data Variable; Device Identification; Device Diagnosis	
SIO mode	yes	
Required master port type	A	
Process data analogue	3	
Process data binary	2	
Min. process cycle time [ms]	5	
Supported DeviceIDs	Type of operation	DeviceID
	Default	575
Operating conditions		
Ambient temperature [°C]	-10...60	
Storage temperature [°C]	-25...80	
Protection	IP 67	
Tests / approvals		
EMC	DIN EN 60947-5-9	
CPA approval	model number	002MI
	accuracy class	-
	maximum allowable error	± 1,5 % FS
	Q (min)	0,01 m³/h
	Q (l)	-
	Q (max)	6 m³/h
Shock resistance	DIN IEC 68-2-27	20 g (11 ms)
Vibration resistance	DIN IEC 68-2-6	5 g (10...2000 Hz)
MTTF [years]	145	
Pressure Equipment Directive	Sound engineering practice; can be used for group 2 fluids; group 1 fluids on request	

Mechanical data		
Weight [g]	640	
Materials	stainless steel (1.4404 / 316L); PBT-GF20; PC; FKM; TPE	
Materials (wetted parts)	stainless steel (1.4404 / 316L); PEEK; EPDM	
Process connection	threaded connection G 1 DN25 flat seal	
Displays / operating elements		
Display	Display unit	6 x LED, green (l/min, m³/h, l, m³, 10°, °C)
	switching status	2 x LED, yellow
	measured values	alphanumeric display, 4-digit
	programming	alphanumeric display, 4-digit
Remarks		
Remarks	MW = measured value	
	MEW = Final value of the measuring range	
Pack quantity	1 pcs.	
Electrical connection		
Connection	Connector: 1 x M12, coding: A; Contacts: gold-plated	
Diagrams and graphs		

Pressure loss



d
P
Pressure loss

Q
volumetric flow quantity

9.13 IFM SU7000 datasheet

Technical details

Accessories

Downloads

Further information

Select language

PDF data sheet

Scale drawing

Wiring

CE

UK

PA

UL

Product characteristics

Number of inputs and outputs

Number of digital outputs: 2; Number of analogue outputs: 1

Measuring range

0...50 l/min0...3 m³/h

Process connection

threaded connection G 3/4 flat seal

Application

Special feature

Gold-plated contacts

Application

totaliser function; for industrial applications

Installation

connection to pipe by means of an adapter

Media

water, glycol solutions; coolants; oils

Note on media

low-viscosity oils with viscosity: 7...40 mm²/s (40 °C)

high-viscosity oils with viscosity: 30...68 mm²/s (40 °C)

Medium temperature [°C]

-10...80

Pressure rating

16 bar1.6 Mpa

Electrical data

Operating voltage [V]

19...30 DC; (to SELV/PELV)

Current consumption [mA]

100

Min. insulation resistance [MΩ]

100; (500 V DC)

Protection class

III

Reverse polarity protection

yes

Power-on delay time [s]

10

Inputs / outputs

Number of inputs and outputs

Number of digital outputs: 2; Number of analogue outputs: 1

Inputs

Inputs

counter reset

Outputs

Total number of outputs

2

Output signal

switching signal; analogue signal; pulse signal; (configurable)

Electrical design

PNP/NPN

Number of digital outputs

2

Output function

normally open / normally closed; (parameterisable)

Max. voltage drop switching output DC [V]

2

Permanent current rating of switching output DC [mA]

250; (per output)

Number of analogue outputs

1

Analogue current output [mA]

4...20; (scalable)

Max. load [Ω]

500

Analogue voltage output [V]

0...10; (scalable)

Min. load resistance [Ω]

2000

Pulse output

flow rate meter

Short-circuit protection

yes

Type of short-circuit protection

pulsed

Overload protection

yes

Measuring/setting range

Measuring range

0...50 l/min0...3 m³/h

Display range

0...60 l/min0...3.6 m³/h

Resolution

0.1 l/min0.005 m³/h

Set point SP

0.1...50 l/min0.005...3 m³/h

Reset point rP

0...49.9 l/min0...2.995 m³/h

Analogue start point ASP

0...40 l/min0...2.4 m³/h

Analogue end point AEP

10...50 l/min0.6...3 m³/h

Max. flow rate

60 l/min3.6 m³/h

In steps of

0.1 l/min0.005 m³/h

Volumetric flow quantity monitoring

Pulse value

0.1 L...1 000 000 m³

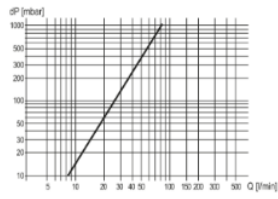
Pulse length [s]

0.05...2

Temperature monitoring		
Measuring range [°C]	-10...80	
Resolution [°C]	0.2	
Set point SP [°C]	-9.8...80	
Reset point rP [°C]	-10...79.8	
Analogue start point [°C]	-10...62	
Analogue end point [°C]	8...80	
In steps of [°C]	0.2	
Accuracy / deviations		
Flow monitoring		
Accuracy (in the measuring range)	water: < ± (3 % MW + 0.2 % MEW); glycol (35 %), oil (viscosity 68 mm²/s at 40 °C): < ± (5 % MW + 0.5 % MEW)	
Repeatability	0.1 l/min; 6 l/h; 0.006 m³/h	
Temperature monitoring		
Accuracy [K]	± 3 (Q > 1 l/min)	
Response times		
Flow monitoring		
Response time [s]	0.25; (dAP = 0)	
Delay time programmable dS, dr [s]	0...50	
Damping process value dAP [s]	0...1	
Temperature monitoring		
Dynamic response T05 / T09 [s]	T09 = 70 (Q > 5 l/min); (water)	
Software / programming		
Parameter setting options	Flow monitoring; quantity meter; Preset counter; Temperature monitoring	
Operating conditions		
Ambient temperature [°C]	-10...60	
Storage temperature [°C]	-25...80	
Protection	IP 67	
Tests / approvals		
EMC	EN 61000-4-2 ESD	4 kV CD / 8 kV AD
	EN 61000-4-3 HF radiated	10 V/m
	EN 61000-4-4 Burst	2 kV
	EN 61000-4-5 Surge	0.5 kV
	EN 61000-4-6 HF conducted	10 V
CPA approval	model number	001US
	accuracy class	3
	maximum allowable error	-
	Q (min)	0.5 m³/h
	Q (l)	-
	Q (max)	3 m³/h
Shock resistance	DIN IEC 68-2-27	20 g (11 ms)
Vibration resistance	DIN IEC 68-2-6	5 g (10...2000 Hz)
MTTF [years]	175	
Pressure Equipment Directive	Sound engineering practice; can be used for group 2 fluids; group 1 fluids on request	
Mechanical data		
Weight [g]	1551.5	
Materials	housing: AlMgSi0.5 anodised; Sealing: FKM; PA 6.6; cover film: PA	
Materials (wetted parts)	stainless steel (1.4404 / 316L); FKM; PES; Centellen 200	
Process connection	threaded connection G 3/4 flat seal	
Displays / operating elements		
Display	Display unit	6 x LED, green (l/min, m³/h, l, m³, 10°, °C)
	switching status	2 x LED, yellow
	measured values	alphanumeric display, 4-digit
	programming	alphanumeric display, 4-digit
Accessories		
Items supplied	sealings: 2, Centellen	
Accessories (optional)	adapter for pipe: 1 x R1/2, stainless steel, E40178	
	adapter for pipe: 1 x R1/2, brass, E40151	
Remarks		
Remarks	MW = measured value	
	MEW = Final value of the measuring range	
	sealing: only with supplied Centellen seals	
Pack quantity	1 pcs.	
Electrical connection		
Connection	Connector: 1 x M12, coding: A-  guided body: brass, Optalloy-plated; Contacts: gold-plated	

Diagrams and graphs

Pressure loss



dP Pressure loss
 P
 Q volumetric flow quantity

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9.14 Glue mixing station input and outputs

Description	I/O
Core glue low tank level probe	Input
Core glue tank max level	Input
Core glue tank emergency level	Input
Ply glue tank low level	Input
Ply glue tank emergency level	Input
Pickup glue low level probe	Input
Pick up glue tank max level	Input
Pickup glue tank emergency level	Input
Tail tank low level	Input
Tail tank emergency level	Input
Ply - Remote push button, pump out from tank to remove tank	Input
Ply – remote push button stop pump out from tank to remote tank	Input
Ply glue - Flow meter	Input
Tail – remote push button pump out from tank to remote tank	Input
Tail – Remote push button stop pump out from tank to remote tank	Input
Water – Flow meter	Input
Tail glue – Flow meter	Input

Description	I/O
Core glue lamp on running	Output
Ply glue blue tower light	Output
Pickup glue lamp on running	Output
Ply Water valve	Output
Ply glue valve	Output
Tail water valve	Output
Tail glue	Output
Ply - neat glue selected	Output
Ply – blitz glue selected	Output
Ply agitator	Output
Ply pump out valve	Output
Ply Pump out green LED on remote push button	Output
Ply – Anti syphon solenoid valve	Output
Ply – Red tower light	Output
Tail – Water valve	Output
Tail – Glue valve	Output
Tail - Mixer	Output
Tail – Pump out valve	Output
Tail – Pump out green LED on remote push button	Output
Tail – Anti syphon solenoid valve	Output
Tail – Red tower light	Output

Assignment 1

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

67 /100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

Text Comment. You could have said more about the background, problem and solution.

PAGE 6

PAGE 7

Text Comment. a very good sub-section

QM

Grocer's apostrophe

If you meant this as a plural word, don't use an apostrophe. This also applies to acronyms and initialisms such as PLCs

QM

Grocer's apostrophe

If you meant this as a plural word, don't use an apostrophe. This also applies to acronyms and initialisms such as PLCs

PAGE 8

Text Comment. clearly defined

Text Comment. Briefly explained

PAGE 9

Text Comment. Briefly explained

Text Comment. this is an excellent sub-section

PAGE 10

PAGE 11

Text Comment. a very good sub-section

PAGE 12

PAGE 13

PAGE 14

PAGE 15

Text Comment. excellent detail

PAGE 16

PAGE 17

PAGE 18

PAGE 19

Text Comment. What about the other parts of the solution?

PAGE 20

Text Comment. datasheets are not required in the appendix, you should cite informatin from them instead

PAGE 21

Text Comment. Would the input card ned to be setup up for high speed counting?

Text Comment. What is the relationship between frequency and flowrate?

PAGE 22

Text Comment. shouldn't the sensor be connected to the blue card?

PAGE 23

Text Comment. Your project solutions seem to be concerned only with the selection of a sensing and conditioning method

PAGE 24

Text Comment. This is a surprising choice as IO-Link is future proof

Text Comment. There must be more to your design than a sensor. What else are you designing?

PAGE 25

PAGE 26

Text Comment. There were no signatures or dates in the proposal?

Text Comment. It is not clear how the selection of a flow meter meets the requirements of the FDS

PAGE 27

PAGE 28

PAGE 29

Text Comment. Signatures and dates of approval are missing

PAGE 30

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Text Comment. no need to include datasheets in the appendix

PAGE 61

GRADING FORM: NEW CSG-RUBRIC

GARETH WILKINS

67

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 Since the literature review was mainly about choosing a sensor, there is limited cope for citations in this section. However, there is evidence in the others sections of engagement with research. (5/10)
Sections 3, 5 and 8: Extent of reading, use of credible sources, use of Harvard method for listing and citing A good range of sources cited and listed correctly. (6/10) Total = 11/20

11

2. KNOWLEDGE AND UNDERSTANDING

 Section 3: Project background and problem definition An excellent background section with clear problem definition. (4/5) Section 3: Project constraints: Ethical. Briefly explained with reference to the Royal Academy of Engineers (2/5) Section 3: Project constraints: Sustainability Brief explanation given (2/5) Section 3: Project constraints: Legal/Commercial A thoroughly detailed section with good citations (4/5) Total = 12/20

12

3. COGNITIVE AND INTELLECTUAL

 Section 4: Functional Design Specification A very detailed FDS (5/5) Section 4: Test planning Excellent plans for testing (5/5) Section 5: Evaluation of solutions and justification of final solution A simple choice of a sensor hardly gives enough scope to score well in this section. However, a good method was used to choose the component yet not much has been said about the other components. (2/5) Section 7: Conclusions and Recommendations A reasonable set of conclusions but it is not clear how the selection of a flow meter meets all the requirements of the FDS. (3/5) Total = 14/20

14

4. PRACTICAL APPLICATION

 Section 6: Project Plan A brief plan included in the appendix for implementation (2/5) Section 6:

12

Working breakdown structure, costing exercise and management techniques A good WBS diagram provided and costing spreadsheet (2/5) Appendix: Risk assessment for implementation phase An excellent good risk assessment provided for the implementation phase and PL rating chart (5/5) Appendix: Planning phase log-book entries. A good series of log entries (3/5) Total = 12/20

5. TRANSFERABLE SKILLS



Section 1: Executive summary A good summary that covers most of the project. However, you could have said more about the background, problem and solution. (3/5) All Sections: Presentation quality of the report, diagrams, charts, tables, figure numbering, page, and section numbering etc A well presented report (5/5) All Sections: Quality of the writing style, use of punctuation and grammar Excellent writing style (5/5) Word count limit not exceeded Limit not exceeded (5/5) Total = 18/20

18