

1809810

by David Thomas

Submission date: 27-Jan-2023 11:20AM (UTC+0000)

Submission ID: 196269949

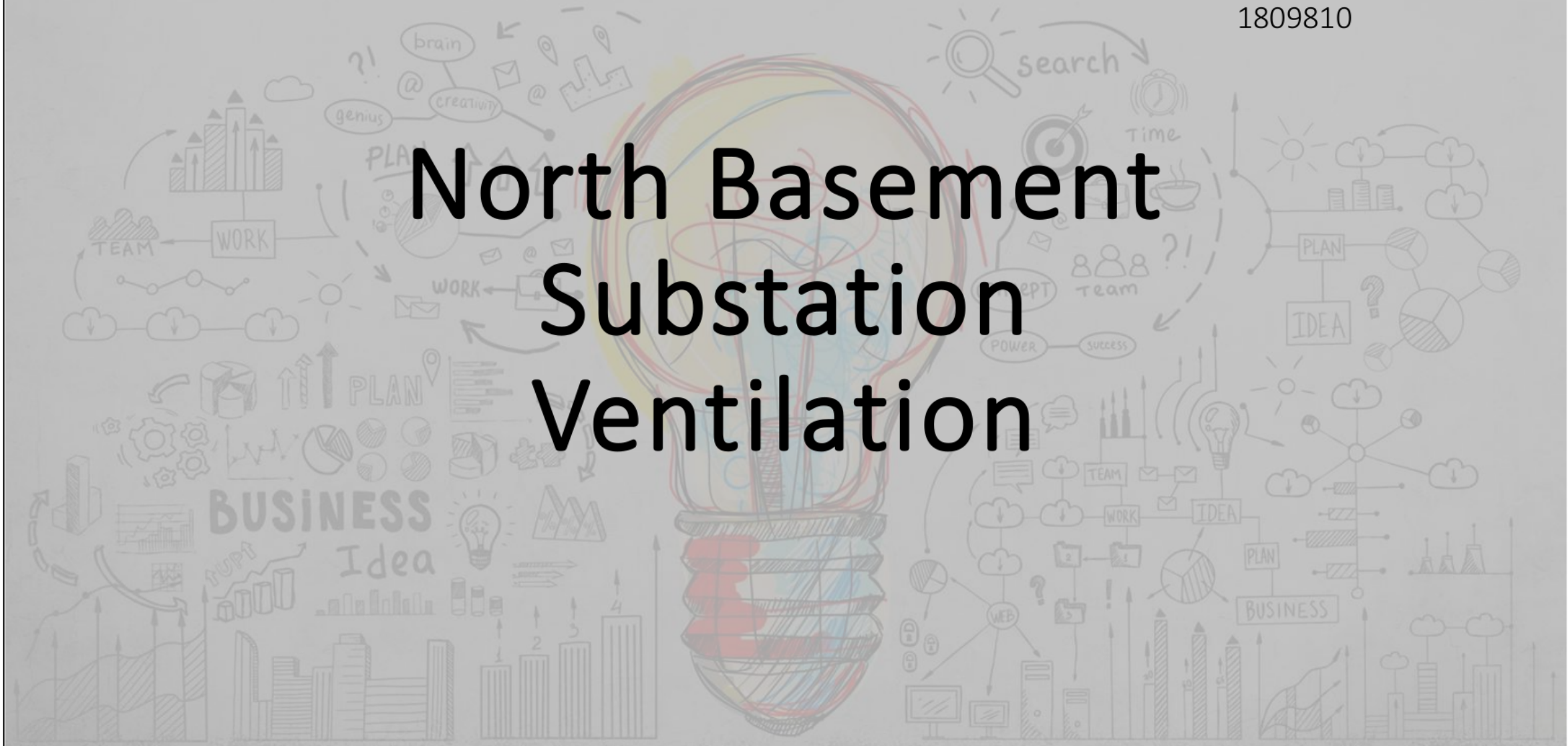
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David Mathew Thomas
1809810

North Basement Substation Ventilation



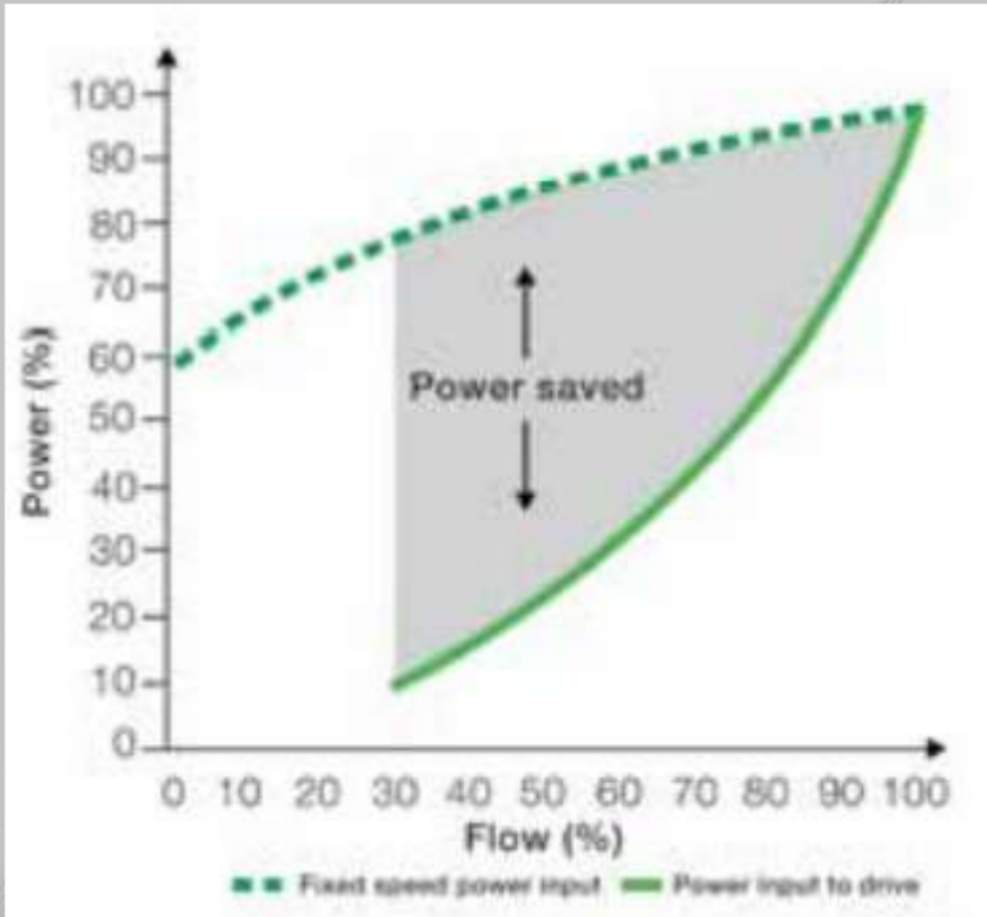
Project Background



Current ventilation system:

- Required to force cool distribution transformers
- Consists of two ventilation fans that are each driven by 3-phase inductive motors.
- Both motors operate via a DOL starter and are in continuous operation, regardless of substation ambient temperature.

Problem Definition



- *Current* calculated operation costs:
£76.32 daily
£27,856.80 annually
- With control, *projected* calculated operational costs
£50.88 daily (Saving - £25.44 Daily)
£18,571.20 annually (Saving £9285.60 Annually)
- Budget - £15,000, with 25% contingency.
- Projected Payback – Up to 2 years

Constraints

Legal & Commercial



- BS EN 60204-1:2018 Safety of Machinery Electrical - Equipment of machines
- BS EN 13849 Safety of Machinery - Safety related parts of control systems
- Company Management of Change procedure

Constraints

Sustainability & Ethical Engineering



- Project aims to reduce energy consumption
- Equipment to be sourced from reputable approved vendors
- Where required, approved local contractors to be used
- Installation to be relatively maintenance free, excluding filter replacement

Functional Design Specification

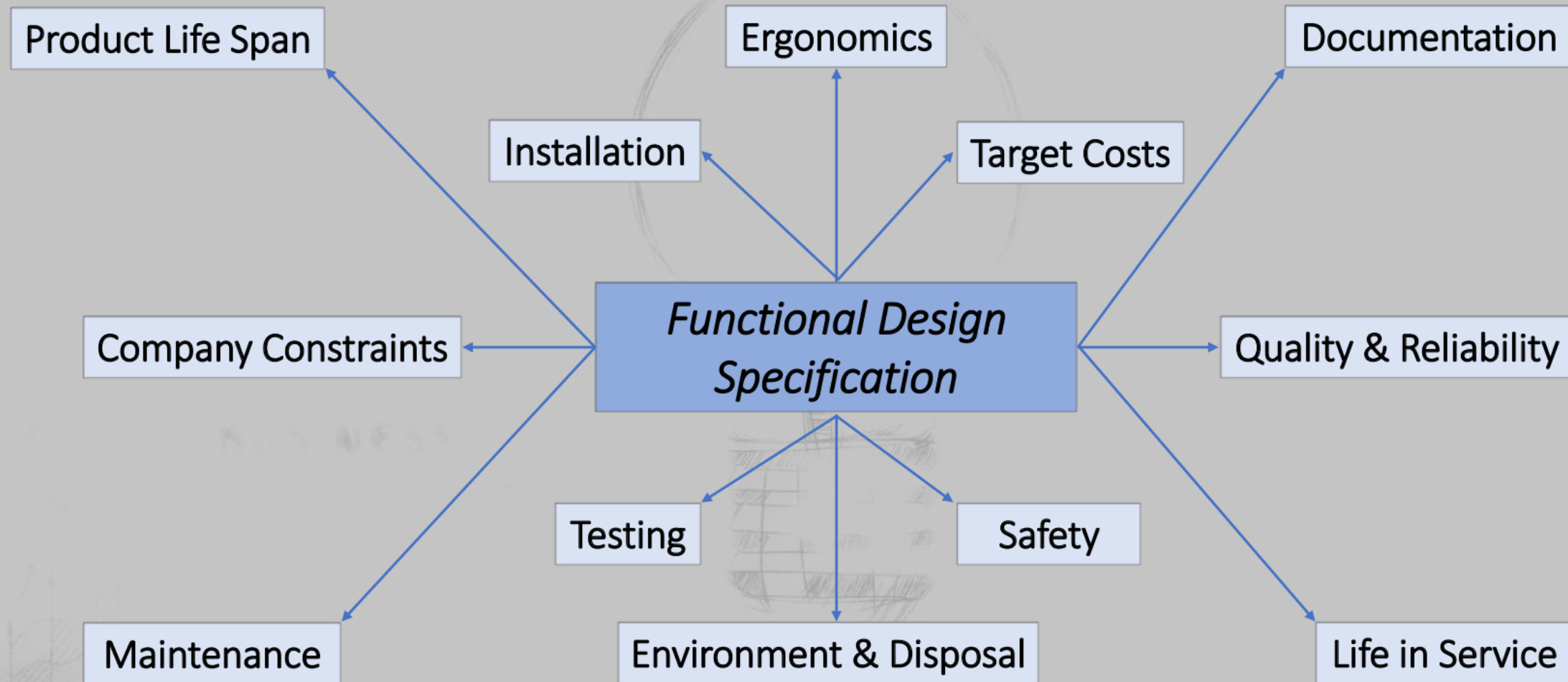
Performance & Functionality

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

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

- Make use of existing infrastructure (Motors/Fans/Ducting)
- Motors must be variable speed controlled
- Automatic system operation according to ambient temperature set points
- Filter replacement indication for reduced air speed
- Belt replacement indication for zero air speed

Functional Design Specification



Test Planning

System Operation					
2.0	System Run - Fans On	Are electric motors and associated fans operating with the correct rotation (Clockwise)			
2.1	System Run - Fans On	Display for current operation of motors and ambient temperature			
2.2	System Run - Simulate temp > 20°C	Fans operate at 100% capacity			
2.3	System Run - Simulate temp > 20°C	Display for current operation of motors and ambient temperature			
2.4	System Run - Simulate temp between < 20°C	Fans operate at 50% capacity			
2.5	System Run - Simulate temp between <20°C	Display for current operation of motors and ambient temperature			
2.6	System Run - Simulate temp < 10°C	Fans stop			
2.7	System Run - Simulate temp < 10°C	Display for current operation of motors and ambient temperature			
2.8	System Run - Simulate air flow reduction <70% for Intake 1	Indication requiring for intake 1 filter change			
2.9	System Run - Simulate nominal air flow for intake 1	Indication for intake 1 filter change reset			

System Operation					
2.10	System Run - Simulate no air flow for Intake 1	Indication for belt failure for motor 1			
2.11	System Run - Simulate nominal air flow for intake 1	Indication for motor 1 belt failure reset			
2.12	System Run - Simulate air flow reduction <70% for Intake 2	Indication requiring for intake 2 filter change			
2.13	System Run - Simulate nominal air flow for intake 2	Indication for intake 2 filter change reset			
2.14	System Run - Simulate no air flow for Intake 2	Indication for belt failure for motor 2			
2.15	System Run - Simulate nominal air flow for intake 1	Indication for motor 1 belt failure reset			
2.16	System Run - Fans on. Press Emergency Stop	System shutdown. No restart whilst E-Stop is active. E-Stop indication			
2.17	Operation - Energy Consumption	Monitor operation to calculate energy average consumption. Compare with previous energy usage			

- Test plan divided into two parts: General and Operational

Solutions

Solution 1

Siemens 6SL3220-3YE24-0UF0



Solution 2

ABB ACS380-040S-17A0-4



Solution 3

Danfoss FC-101P7K5T4E5AH2XA



Company Required Equipment for Each Solution



- Company requirements have restricted PLC and HMI manufacturer to Siemens.



Required Equipment for Each Solution

The following components are required for each solution:

- Rittal enclosure
- Emergency stop
- Fused isolator with switching handle
- 24VDC power supply
- Ethernet switch
- Motor MCBs



Pressure Sensor



Pilz Safety Relay

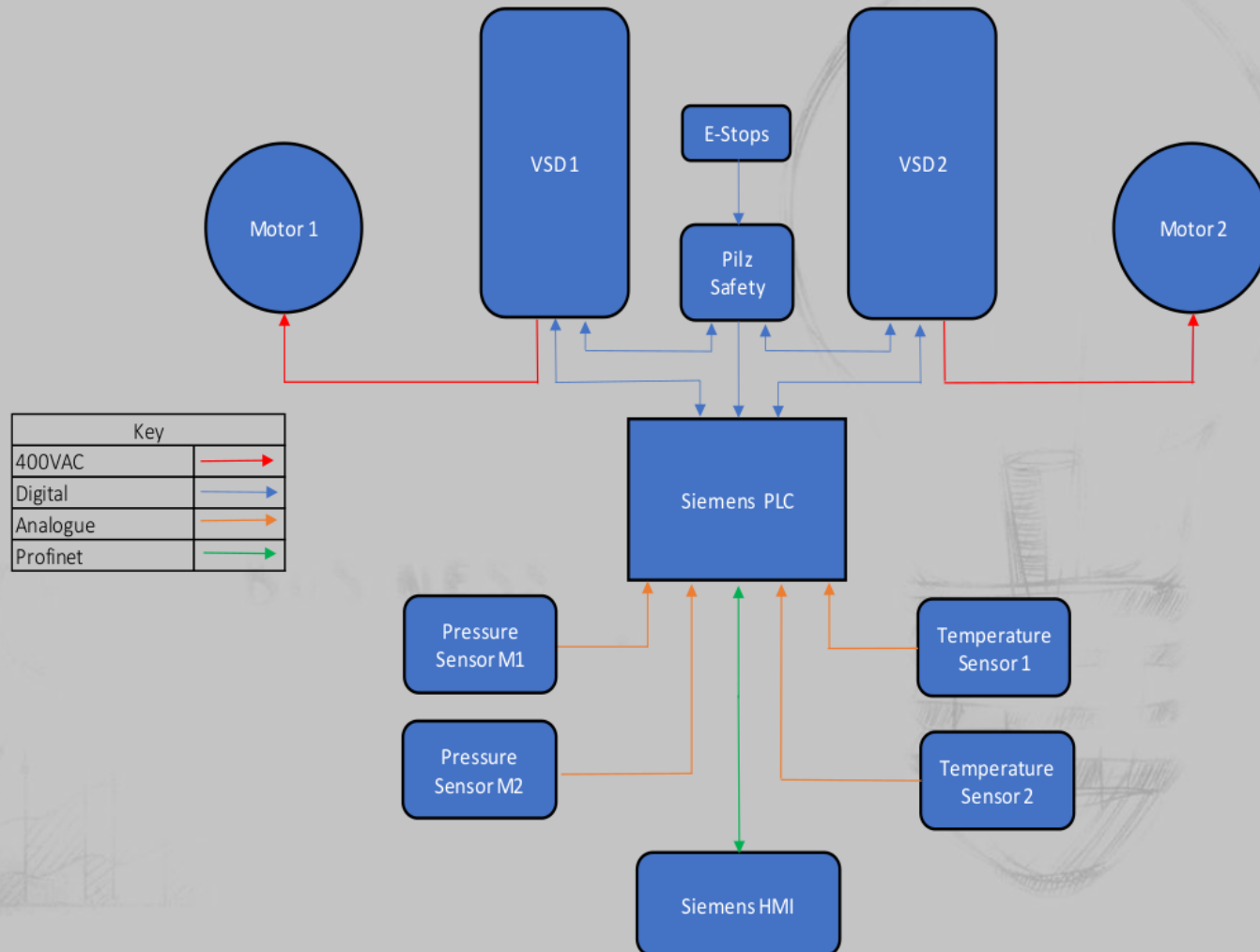


RTD Sensor



RTD Analogue Input

Solution Review



- Little to no differences between each of the solutions
- Each is suitable to be used for the VSD shown in the block diagram.
- ABB solution is the only VSD that isn't a HVAC VSD. ABB is a more capable VSD for the price.
- Programming - ABB and Danfoss solutions will be seen as outputs in TIA Portal.

Solution Choice & Justification

Solution 2



Solution Scoring Comparison

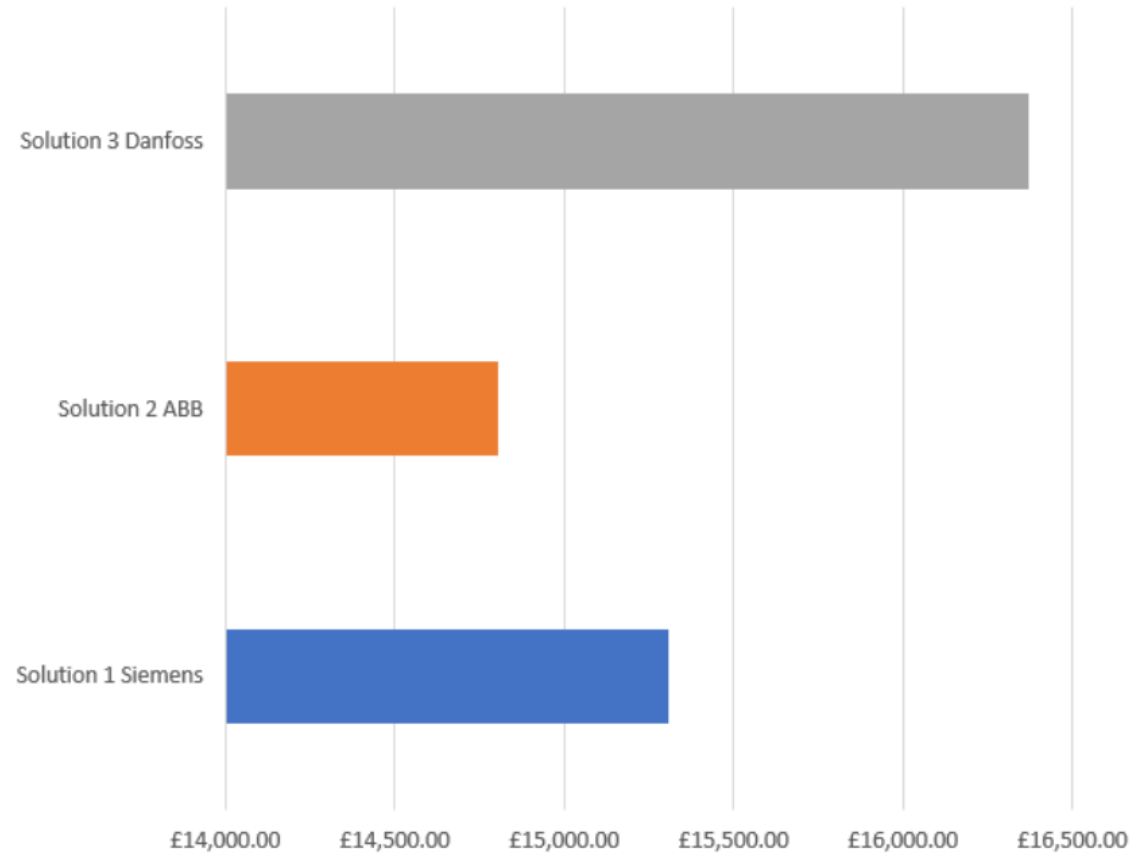


Solution Choice & Justification

Solution 2



Solution Costing Comparison



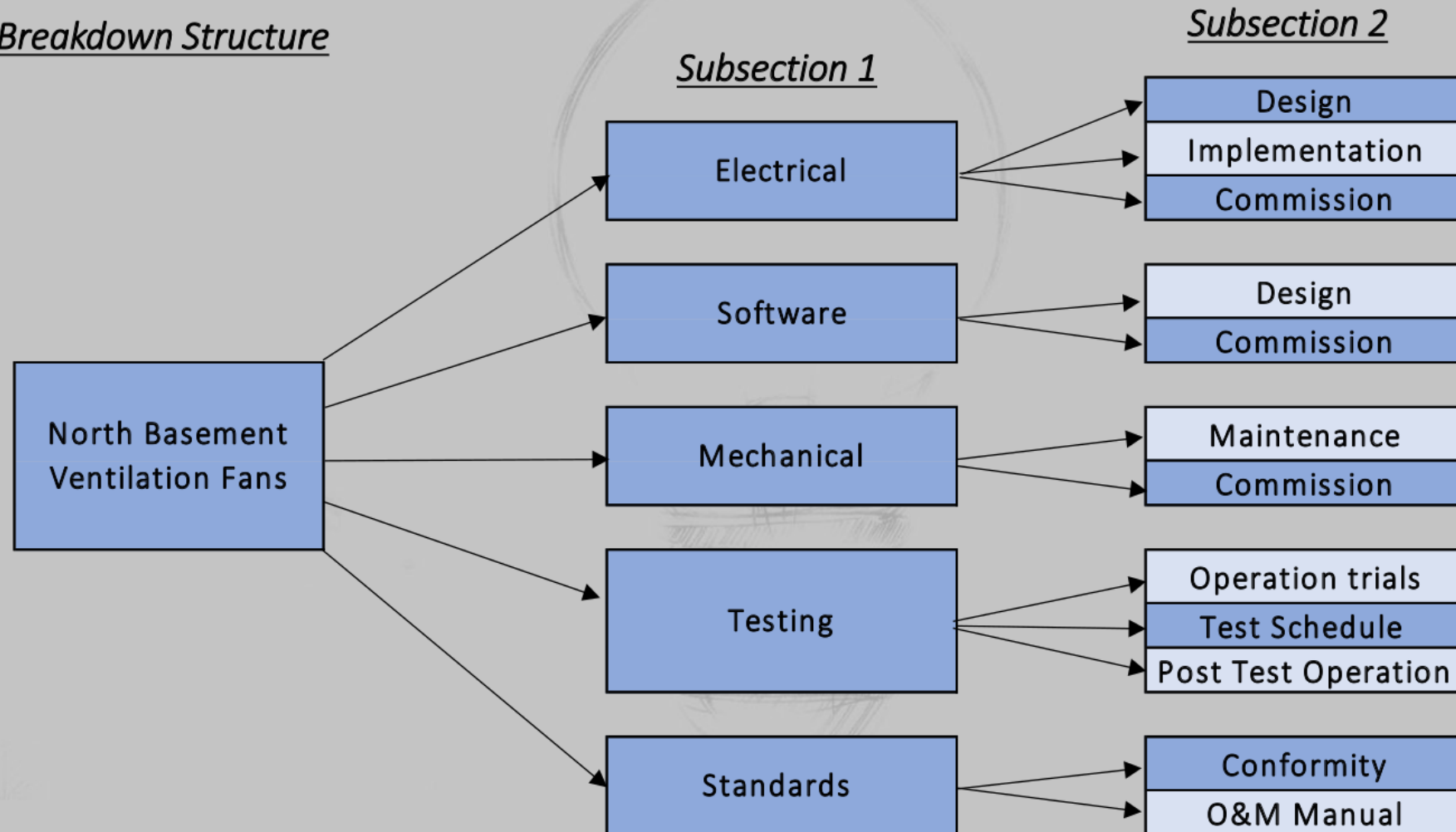
Project Planning

- Adaptive management technique
- Current economic climate and component availability.



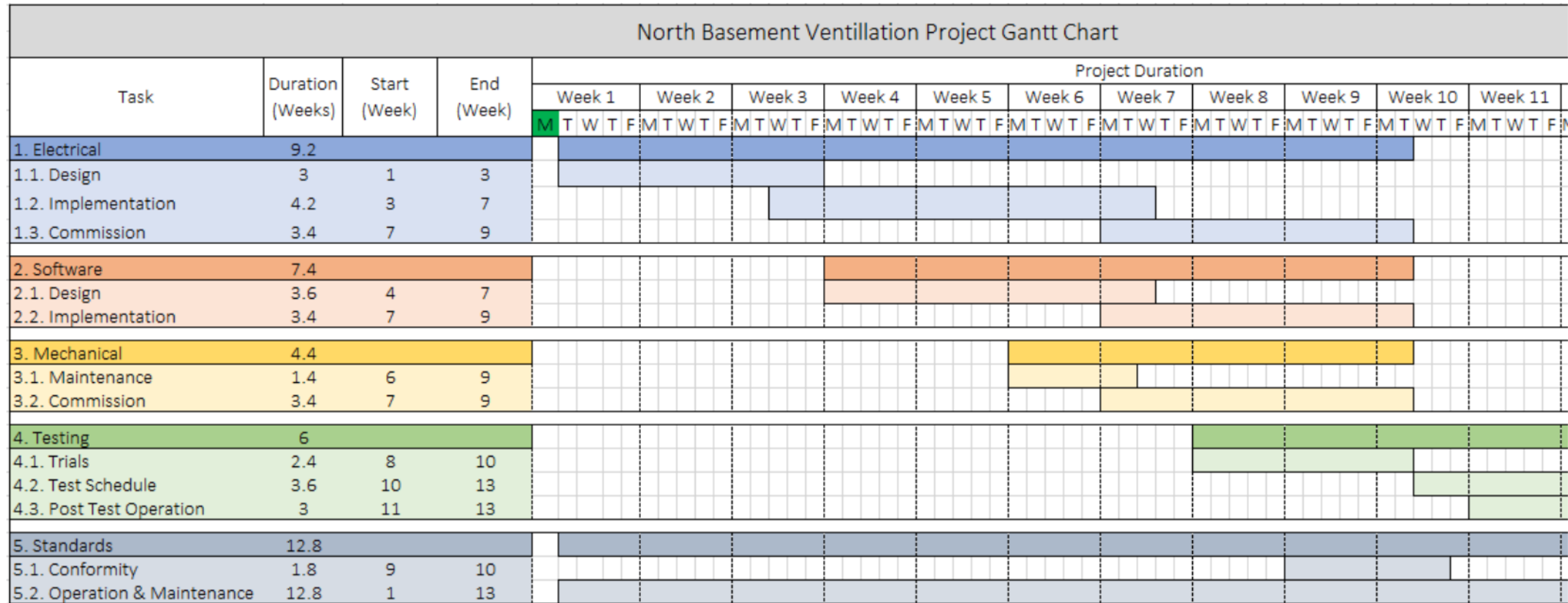
Project Planning

Work Breakdown Structure



Project Planning

Gantt Chart – Proposed Schedule



Progress to Date

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FINAL GRADE

GENERAL COMMENTS

Instructor

70/100

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GRADING FORM: NEW CSG-RUBRIC

DAVID THOMAS

70

1. ENGAGEMENT WITH LITERATURE

2. KNOWLEDGE AND UNDERSTANDING

 Project background and problem definition (6/10) Project constraints, risks, health and safety (7/10)
Response to questions (6/10) Total = 19/20

19

3. COGNITIVE AND INTELLECTUAL

 Functional Design Specification (8/10) Test planning (8/10) Project Planning and management
methods (8/10) Total = 24/30

24

4. PRACTICAL APPLICATION

 Review of Solutions (5/10) Justification of final solution (7/10) Total = 12/20

12

5. TRANSFERABLE SKILLS

 Quality of the presentation slides (8/10) Quality of the delivery style (7/10) Total = 15/20

15