

1708174

by Jordan Gough

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Fired Heater Combustion Difficulty Monitoring

Jordan Gough

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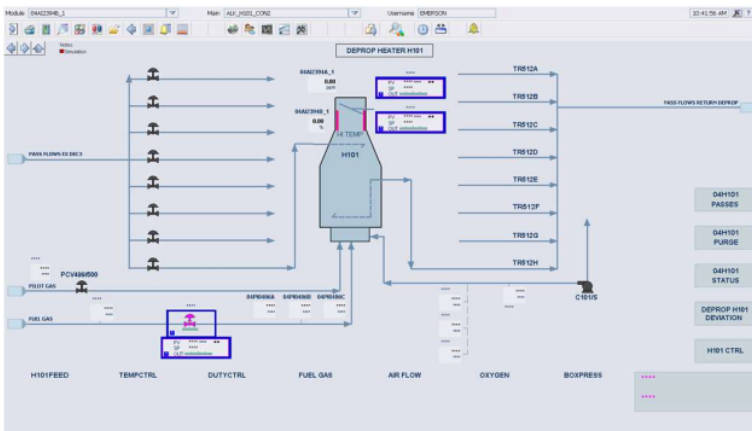
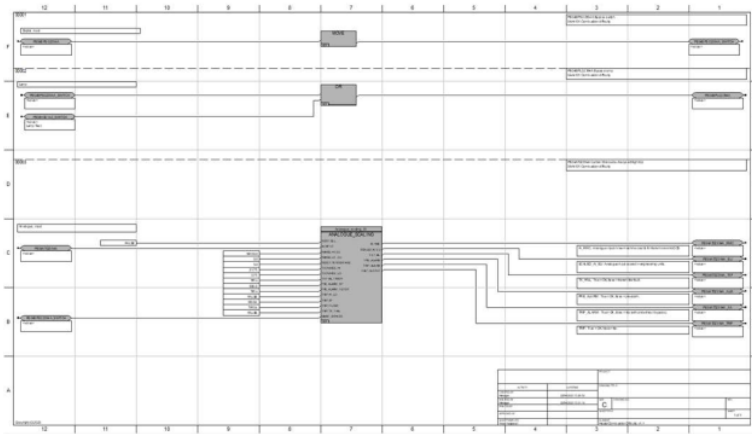
19/05/2023

Introduction



On detection of carbon monoxide greater than 1500 PPM within the Alky Unit heater, the fuel gas XVs will close and shut down the heater, whilst maintaining an air flow using the combustion air fans to purge carbon monoxide. On detection of methane greater than 3%, a high percentage methane alarm will activate.

- Production or modification of necessary drawings, documentation and procedures
- Installation of tuneable diode laser spectrometer, junction boxes, utility panel, cables and pipework
- Modification of existing temperature measurement loop and installation of temperature transmitter to interface with analyser
- Configuration of both tuneable diode laser spectrometer and temperature transmitter
- Modification of Alkylation Unit PLC program for heater shutdown
- Modification of Alky DCS control panel graphics
- Function testing



Functional Design Specification

Items were added to the FDS following the initial creation. These items were added due to new information being identified through further reading or because they were initially missed.

- Cost
- Completion Date
- Analyser Process Measurement and mA Output
- Analyser Mounting Location and Flange Standard
- Analyser Power Requirement (24VDC)
- NAMUR Output Standard
- Highway Addressable Remote Transducer (HART) Protocol Capability
- HMI Interfacing
- Utility Panel Air and Validation Gas Compatibility
- Utility Panel Swagelok Construction
- Utility Panel Location
- UPS Requirements
- Power Supply Location
- Power Supply Isolation
- Power Supply Redundancy
- Cable Installation
- ATEX Rating
- SIL Rating
- PLC Modifications
- PLC Output – Amended to include trip point
- DCS Modifications
- DCS Alarms
- Temperature Measurement – New addition
- Temperature Transmitter Configuration – New addition
- DCS Charm – New addition

Design Phase

Drawings and Documents

- Block Diagram
- P&ID
- Loop Diagrams
- Interconnection Diagrams
- Data Sheets
- Hook-up Diagrams
- Manufacturer's Diagrams
 - Junction Box Diagrams
 - Hook-up Diagrams
- Cause and Effect Diagrams
- Cable Schedule
- CHARM Schedule
- Triconex Schedule
- Range, Alarm and Trip Schedule
- PLC Flowchart
- PLC Request Form
- Location Plan

PLC Modifications

- Heater logic recreated due to restrictions
- Analogue scaling added for two analogue inputs
 - Analogue scaling for CO measurement has trip output
 - Analogue scaling for CH4 measurement doesn't have a trip output
- Trip output used within heater trip logic and purge logic
- Digital input and output added for shutdown bypass
- Flowchart created to assist with PLC modifications

Design Phase

Refer to 79-CSE-SPC-0008 Sht 21 & 79-EIN-ICD-0023 Sht 21 for Serial Link Data.

Cable Destruction			
Location	Gland	Gland Size	Gland Description
04-45	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-A7-2304	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-A7-2334 Signal B	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-A7-2334 Signal A	CG653MHC-H25	M25	Eis die bome kaagde/af (Dish cable)
04-A7-2334 Signal B	CG653MHC-H25	M25	Eis die bome kaagde/af (Dish cable)
04-17-000	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-17-000	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-A7-2334 Signal B	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-45-71	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)
04-A7-2334 Signal A	CG653MHC-H20	M20	Eis die bome kaagde/af (Dish cable)

[illegible][illegible]

Construction Phase

Installation

- Cables run between locations per cable schedule
- Cable glands fitted per cable schedule
- Cables put into enclosures where possible
- Cables without enclosures were covered to protect from weather
- Cable installation delayed by roughly 2 weeks

Configuration

- Rosemount 644 temperature transmitter obtained from site stores
- Selected because it is a SIL rated model
- Transmitter calibrated as per original installation data sheet
 - Range – 0 - 1300°C
 - Sensor Type - K



Modification

- DCS graphics created to show process variables and alarm states as per range, alarm and trip schedule
- Heater DCS screen modified to include process variables on complete overview
- DCS CHARM obtained for digital input associated with fault alarm
- PLC program modified to include one analogue reading for carbon monoxide with a shutdown function, one reading for methane and a bypass switch

Testing Phase

Simulation Tests

Completed

- Carried out function test of temperature transmitter, using a thermocouple calibrator as a source and using a multimeter to measure the output
- Carried out emulator testing of PLC program modifications
- Carried out emulator testing on DCS analogue inputs and function testing of digital input

Pending

- Analyser function checks
- Power supply checks
- Fault alarm checks
- HART compatibility check
- HMI function check
- Utility panel function check
- Practical PLC checks
- Practical DCS checks

Compliance Checks

Completed

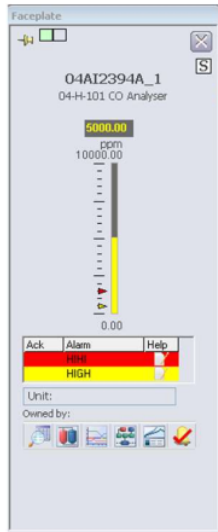
- Cost came in under budget
- Sensor SIL rating is SIL 2
- **End date yet to be met**

Pending

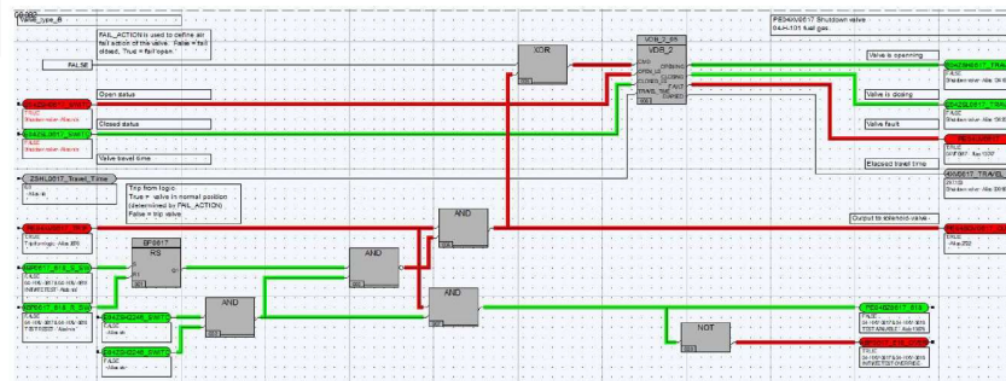
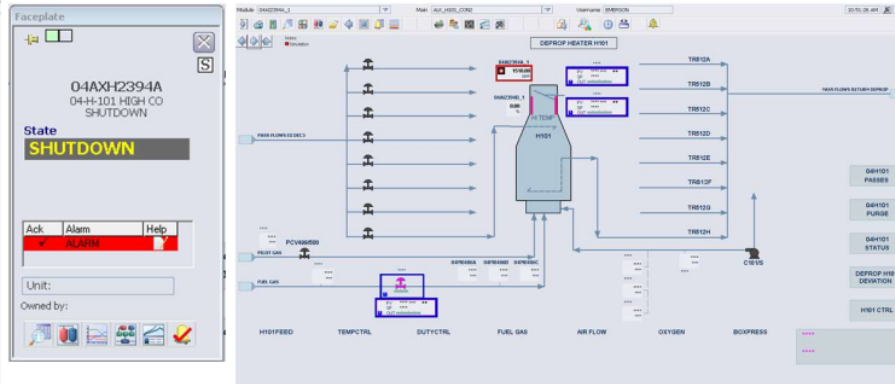
- ASME B16.5 flange standard
- BS 7671 electrical installation standard
- BS EN 60079 ATEX standard

Some function tests or compliance checks cannot be completed until final installation is completed

Testing Phase



Ack	Time In	Unit	Module	Description	Alarm	Help	Message	Priority
	21-Apr-23 10:58:43 AM		04A012394A	04-H-101 HIGH CO SHUTDOWN	ALARM		SHUTDOWN	EMERGENCY
	21-Apr-23 10:57:56 AM		04A012394A_1	04-H-101 CO Analyser	HIGH		High Alarm Value 1510 Limit 11	EMERGENCY
	21-Apr-23 10:57:56 AM		04A012394A_1	04-H-101 CO Analyser	HIGH		High Alarm Value 1510 Limit 500	HIGH
	21-Apr-23 10:58:11 AM		04A012394B_1	04-H-101 CH4 Analyser	HIGH		High Alarm Value 5 Limit 3	HIGH

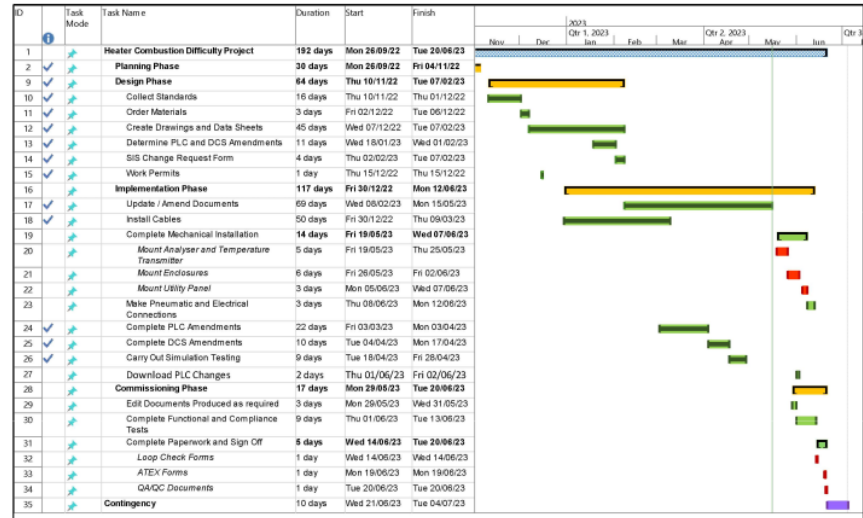
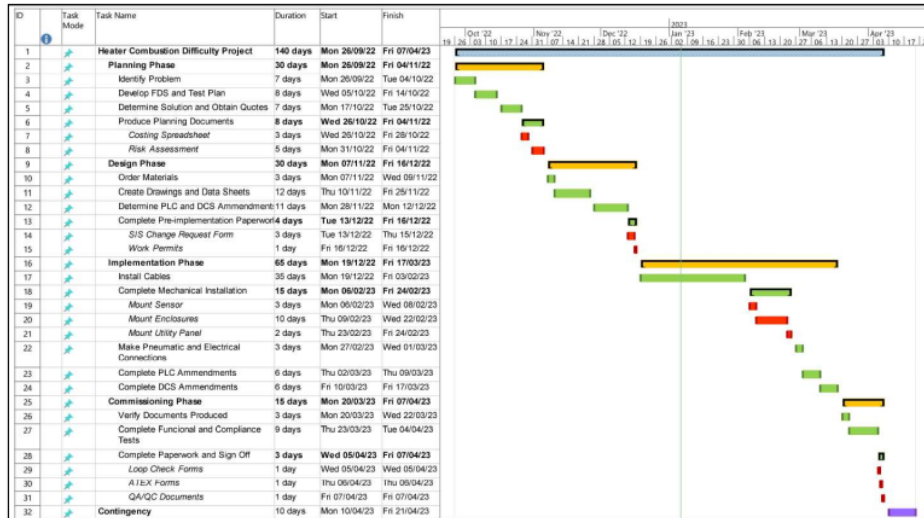


Project Management Review

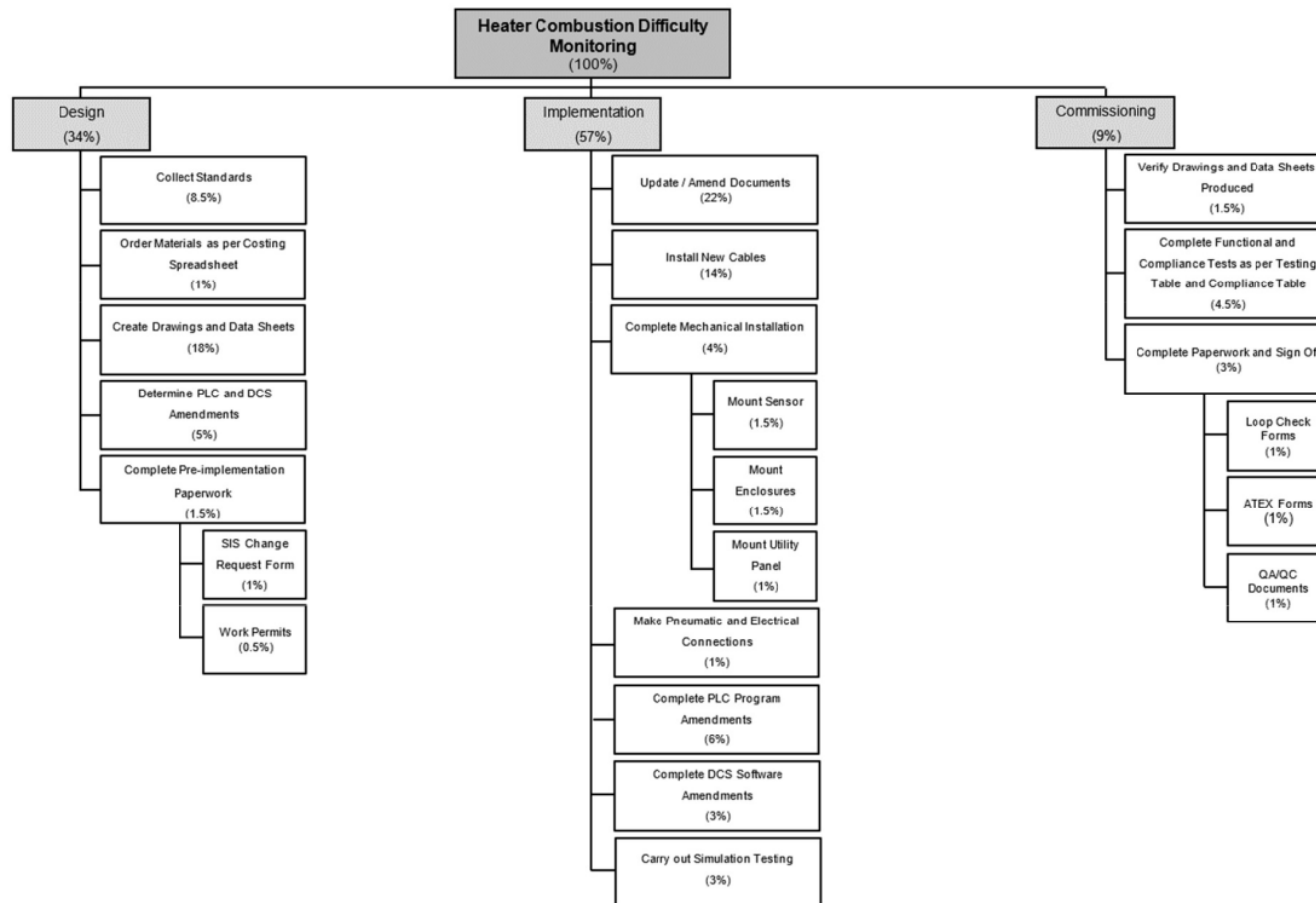
ID	Task Mode	Task Name	Duration	Start	Finish	2023												Name	Start	Finish	% Complete
						Nov	Dec	Qtr 1, 2023	Jan	Feb	Mar	Qtr 2, 2023	Apr	May	Jun	Qtr 3					
1		Heater Combustion Difficulty Project	192 days	Mon 26/09/22	Tue 20/06/23													Heater Combustion Difficulty Project	Mon 26/09/22	Tue 20/06/23	89%
2	✓	Planning Phase	30 days	Mon 26/09/22	Fri 04/11/22													Planning Phase	Mon 26/09/22	Fri 04/11/22	100%
9	✓	Design Phase	64 days	Thu 10/11/22	Tue 07/02/23													Identify Problem	Mon 26/09/22	Tue 04/10/22	100%
10	✓	Collect Standards	16 days	Thu 10/11/22	Thu 01/12/22													Develop FDS and Test Plan	Wed 05/10/22	Fri 14/10/22	100%
11	✓	Order Materials	3 days	Fri 02/12/22	Tue 06/12/22													Determine Solution and Obtain Quotes	Mon 17/10/22	Tue 25/10/22	100%
12	✓	Create Drawings and Data Sheets	45 days	Wed 07/12/22	Tue 07/02/23													Produce Planning Documents	Wed 26/10/22	Fri 04/11/22	100%
13	✓	Determine PLC and DCS Amendments	11 days	Wed 18/01/23	Wed 01/02/23													Costing Spreadsheet	Wed 26/10/22	Fri 28/10/22	100%
14	✓	SIS Change Request Form	4 days	Thu 02/02/23	Tue 07/02/23													Risk Assessment	Mon 31/10/22	Fri 04/11/22	100%
15	✓	Work Permits	1 day	Thu 15/12/22	Thu 15/12/22													Design Phase	Thu 10/11/22	Tue 07/02/23	100%
16	✓	Implementation Phase	117 days	Fri 30/12/22	Mon 12/06/23													Collect Standards	Thu 10/11/22	Thu 01/12/22	100%
17	✓	Update / Amend Documents	69 days	Wed 08/02/23	Mon 15/05/23													Order Materials	Fri 02/12/22	Tue 06/12/22	100%
18	✓	Install Cables	50 days	Fri 30/12/22	Thu 09/03/23													Create Drawings and Data Sheets	Wed 07/12/22	Tue 07/02/23	100%
19	✓	Complete Mechanical Installation	14 days	Fri 19/05/23	Wed 07/06/23													Determine PLC and DCS Amendments	Wed 18/01/23	Wed 01/02/23	100%
20	✓	Mount Analyser and Temperature Transmitter	5 days	Fri 19/05/23	Thu 25/05/23													SIS Change Request Form	Thu 02/02/23	Tue 07/02/23	100%
21	✓	Mount Enclosures	6 days	Fri 26/05/23	Fri 02/06/23													Work Permits	Thu 15/12/22	Thu 15/12/22	100%
22	✓	Mount Utility Panel	3 days	Mon 05/06/23	Wed 07/06/23													Implementation Phase	Fri 30/12/22	Mon 12/06/23	89%
23	✓	Make Pneumatic and Electrical Connections	3 days	Thu 08/06/23	Mon 12/06/23													Update / Amend Documents	Wed 08/02/23	Mon 15/05/23	100%
24	✓	Complete PLC Amendments	22 days	Fri 03/03/23	Mon 03/04/23													Install Cables	Fri 30/12/22	Thu 09/03/23	100%
25	✓	Complete DCS Amendments	10 days	Tue 04/04/23	Mon 17/04/23													Complete Mechanical Installation	Fri 19/05/23	Wed 07/06/23	0%
26	✓	Carry Out Simulation Testing	9 days	Tue 18/04/23	Fri 28/04/23													Mount Analyser and Temperature Transmitter	Fri 19/05/23	Thu 25/05/23	0%
27	✓	Download PLC Changes	2 days	Thu 01/06/23	Fri 02/06/23													Mount Enclosures	Fri 26/05/23	Fri 02/06/23	0%
28	✓	Commissioning Phase	17 days	Mon 29/05/23	Tue 20/06/23													Mount Utility Panel	Mon 05/06/23	Wed 07/06/23	0%
29	✓	Edit Documents Produced as required	3 days	Mon 29/05/23	Wed 31/05/23													Make Pneumatic and Electrical Connections	Thu 08/06/23	Mon 12/06/23	0%
30	✓	Complete Functional and Compliance Tests	9 days	Thu 01/06/23	Tue 13/06/23													Complete PLC Amendments	Fri 03/03/23	Mon 03/04/23	100%
31	✓	Complete Paperwork and Sign Off	5 days	Wed 14/06/23	Tue 20/06/23													Complete DCS Amendments	Tue 04/04/23	Mon 17/04/23	100%
32	✓	Loop Check Forms	1 day	Wed 14/06/23	Wed 14/06/23													Carry Out Simulation Testing	Tue 18/04/23	Fri 28/04/23	100%
33	✓	ATEX Forms	1 day	Mon 19/06/23	Mon 19/06/23													Download PLC Changes	Thu 01/06/23	Fri 02/06/23	0%
34	✓	QA/QC Documents	1 day	Tue 20/06/23	Tue 20/06/23													Commissioning Phase	Mon 29/05/23	Tue 20/06/23	0%
35	✓	Contingency	10 days	Wed 21/06/23	Tue 04/07/23													Edit Documents Produced as required	Mon 29/05/23	Wed 31/05/23	0%
																		Complete Functional and Compliance Tests	Thu 01/06/23	Tue 13/06/23	0%
																		Complete Paperwork and Sign Off	Wed 14/06/23	Tue 20/06/23	0%
																		Loop Check Forms	Wed 14/06/23	Wed 14/06/23	0%
																		ATEX Forms	Mon 19/06/23	Mon 19/06/23	0%
																		QA/QC Documents	Tue 20/06/23	Tue 20/06/23	0%
																		Contingency	Wed 21/06/23	Tue 04/07/23	0%

Project Management Review

Original Gantt Chart and Updated Gantt Chart: Side-by-side Comparison



Project Management Review



Project Management Review

	Quantity	Unit Type	Unit Price	Net Cost £	VAT £	Total Cost £
Probe Type Tunable Diode Laser Spectrome	1.00	EA	37,532.65	37,532.65	7,506.53	45,039.18
HMI Interface Unit H8000-S2-E-N/M/C/SC7	1.00	EA	3,845.44	3,845.44	769.09	4,614.53
Calibration Cell K9777ZA	1.00	EA	3,728.39	3,728.39	745.68	4,474.07
Utility Panel BOP107227	1.00	EA	21,686.32	21,686.32	4,337.26	26,023.58
Project Management & Engineering	1.00	EA	6,853.56	6,853.56	1,370.71	8,224.27
Packing BOP 107227	1.00	EA	606.37	606.37	121.27	727.64
SAT - 1 day at site	1.00	EA	1,500.00	1,500.00	300.00	1,800.00
Document Control	1.00	EA	3,990.00	3,990.00	798.00	4,788.00
PMI BOP107227	1.00	EA	670.00	670.00	134.00	804.00
Witnessing of Factory Acceptance Test (FAT)	1.00	EA	1,500.00	1,500.00	300.00	1,800.00
Delivery	1.00	EA	1,500.00	1,500.00	300.00	1,800.00
1x2x1.3mm Type KX PVC Cam PVC - Green	20.00	EA	8.00	160.00	32.00	192.00
1pr 1.5 Pas5308 Pt1 Tp2 Pe Overall Scree	60.00	EA	2.90	174.00	34.80	208.80
1pr 1.5 Pas5308 Pt1 Tp2 Pe Overall Scree	40.00	EA	2.90	116.00	23.20	139.20
2x2.5mm² Xpe Swa PVC 1kv Black Bs5467	60.00	EA	1.15	69.00	13.80	82.80
2pr 1.5 Pas5308 Pt1 Tp2 Pe Ind & Overall	200.00	EA	3.30	660.00	132.00	792.00
2pr (Quad) 1.5 Pas5308 Pt1 Tp2 Pe Overall	20.00	EA	2.50	50.00	10.00	60.00
5pr 0.75 Pas5308 Pt1 Tp2 Pe Overall Scree	40.00	EA	2.95	118.00	23.60	141.60
Hawke 501 453 Universal A-Gland Kit M20	8.00	EA	11.48	91.84	18.37	110.21
Hawke ICG 653 Universal Brass Gland, O, M20	26.00	EA	22.53	585.78	117.16	702.94
Hawke ICG 653 Universal Brass Gland, B, M25	4.00	EA	31.25	125.00	25.00	150.00
Mg221020-3 Weidmuller Ktb Mh 303020	2.00	EA	701.08	1,402.16	280.43	1,682.59
3x4mm² Xpe Swa Pvc 1kv Black Bs5467	720.00	EA	2.10	1,512.00	302.40	1,814.40
Hawke ICG653 Universal Os Gland	6.00	EA	21.78	130.68	26.14	156.82
402133177 4 Way Metal Easy9 Consumer Uni	2.00	EA	47.38	94.76	18.95	113.71
Easy9 Blank 402134312	8.00	EA	2.00	16.00	3.20	19.20
IC60h2 Rcbo 10a 30ma	2.00	EA	147.31	294.62	58.92	353.54
½" OD Union Straight 316stst Ss-810-6	8.00	EA	25.08	200.64	40.13	240.77
½" OD X 0.035" Wall Thickness 316stst	48.00	EA	6.39	306.72	61.34	368.06
½" OD X 0.035" Wall Thickness 316stst	48.00	EA	15.68	752.64	150.53	903.17
½" OD Union Straight 316stst Ss-400-6	8.00	EA	11.88	95.04	19.01	114.05
½" OD Union Tee Ss-400-3 Swagelok ~ M	3.00	EA	24.11	72.33	14.47	86.80
½" OD Union Tee Ss-810-3 Swagelok ~ M	2.00	EA	47.92	95.84	19.17	115.01
½" OD x ¼" Bspt Male Straight Connection	8.00	EA	7.69	61.52	12.30	73.82
½" OD x ¼" Bspt Male Straight Connection	8.00	EA	15.27	122.16	24.43	146.59
½" x 0.035" Avg Wall 316/316ss Seamlss	250.00	EA	8.93	2,232.50	446.50	2,679.00
Double End Shut Off Quick Disconnect 1/2	1.00	EA	58.09	58.09	11.62	69.71
Double End Shut Off Quick Disconnect 1/2	1.00	EA	58.09	58.09	11.62	69.71
½" OD x ½" OD Tube Adaptor Reducer 3	1.00	EA	11.58	11.58	2.32	13.90
½" OD Ss-62ts4 60 series Ball Valve, Rei	5.00	EA	190.84	954.20	190.84	1,145.04
½" OD Ss-63ts8 60 series Ball Valve, Rei	4.00	EA	230.83	923.32	184.66	1,107.98
Ss-Th8ta8ta8-62 T Series Pffe Hose, 316	1.00	EA	346.09	346.09	69.22	415.31
29-EIN-SOW-0061	1,237.00	HOURS	46.57	57,607.09	11,521.42	69,128.51
Drilling out Junction Boxes	34.00	HOURS	46.57	1,583.38	316.68	1,900.06
Materials				2,000.00	400.00	2,400.00
Rosemount 644 Temperature Transmitter	1	EA	498.25	498.25	99.65	597.90
Temperature Transmitter Head	1	EA	8.53	8.53	1.71	10.24
Delta V Digital Input Charn	1	EA	79.00	79.00	15.8	94.80
Total Cost				157,079.58	31,415.92	188,400.70

Budget – £250,000
Expenditure – £188,400.70
Remaining – £61,599.30
(Does not account for wages)

Project Evaluation

- Project cost was £61,599.30 lower than budget
- Estimated finish date delayed from April 7th to June 20th, not including contingency time
 - Delays included strike action, planned and unplanned maintenance events and shipping and factory acceptance test delays
 - Some items obtained from site stores or local suppliers reduced delivery times
 - Plans updated to reflect time scale changes
- Three items added to FDS and one change made since initial specification
- 5 of the 26 FDS items can currently be deemed successful and 1 unsuccessful
 - Remaining items are deemed pending until they can be resolved
- All documents and drawings were modified or created and put into correct format for the document management system
- Software changes were made but cannot be downloaded until installation is complete

Conclusions and Recommendations

Improve Safety and Reliability

- Installation of at least a second analyser would increase the overall SIL rating of the system from SIL 1 to SIL 2
- Installation of at least a second analyser would improve the reliability of the shutdown function by becoming 2-out-of-2 or 2-out-of-3 voting
- Spurious shutdowns should be prevented
- Allows for sensor failure
- Would require heater to be offline and made safe for new nozzle(s) to be added to allow for installation

Improve Accuracy

- Installation of a pressure transmitter would allow for pressure compensation, increasing the accuracy of the measurement
- No pressure measurement loops available for modification
- Would require heater to be offline and made safe for new nozzle(s) to be added to allow for installation

FINAL GRADE

GENERAL COMMENTS

Instructor

68/100

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GRADING FORM: NEW CSG-RUBRIC

JORDAN GOUGH

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1. ENGAGEMENT WITH LITERATURE



N/A

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2. KNOWLEDGE AND UNDERSTANDING



Project design
Good evidence presented. (7/10)
Project implementation

21

Good explanation given. (7/10)

Response to questions

Good but not always clear and fluent. (7/10)

3. COGNITIVE AND INTELLECTUAL



Deployment method, use of material, tools, equipment and techniques in the construction of the project.

21

Good explanation given of methods employed. (7/10)

Quality of the final product or system

Good quality of SCADA modifications (6/10)

Management of the design process including use of plans, costing spreadsheet

Good explanation given (6/10)

4. PRACTICAL APPLICATION



Deployment method, use of material, tools, equipment and techniques in the construction of the project.

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Good explanation given of methods employed. (7/10)

Quality of the final product or system

Good quality of SCADA modifications (6/10)

Management of the design process including use of plans, costing spreadsheet

Good explanation given (6/10)

5. TRANSFERABLE SKILLS



Quality of the presentation slides

Excellent slides (4/5)

Quality of the delivery style

Good but sometimes hesitant (3/5)

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