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New Mexico State University
Klipsch School of Electrical and Computer
Engineering

Cement Fixation – Control System Upgrade

System Concept Review

Jessica Nadine Rivas

Friday, September 13th, 2013
Capstone Design

Introduction

- **Project Overview**
 - Statement
 - Description
 - Objectives
 - Measures for Success
- **System Overview**
 - Requirements
 - Sub-Systems
 - Risks
 - Agenda
 - Budget
 - Summary

Problem Statement

- The current Cement Fixation (CF) process was built in 1989 and employs aging and perhaps obsolete equipment.
- For the most part, the control scheme is undocumented which makes it difficult to troubleshoot problems.

Cement Fixation Process

Figure 1.

Feed storage tank in the CF Process

Figure 2.

Project Description

- **Develop and deploy a new control system and necessary hardware upgrades for the cement fixation system in order to:**
 - **Improve reliability of controls related hardware,**
 - **Ensure drop-in, 'like-for-like' replacement parts are available,**
 - **Create documentation and back-up software compatible with modern computers to eliminate the need to reverse-engineer documentation or software in the event of a failure.**

Objectives

1. Replace current relay logic with a PLC equipped with touchscreen HMI.
2. Upgrade is directed at control system, not delivery equipment which cannot be easily integrated with new control hardware.
3. Eliminate bulky control cabinet that must currently be pushed out of the way to remove drums.
4. This project doesn't plan to add functionality that has never before existed, but does aim to regain lost functionality.
5. A maintenance mode so that components such as vibrators and individual valves can be run manually.
6. Relocate motor starters near the system to facilitate troubleshooting in a central location.

Project Success Criteria

- Finalize the Functional & Operational Requirements (F&OR), define a schedule, start and complete a Design Change Form (DCF) with a Design Agency Representative(s) (DAR) signature for 'approval to proceed.'
- Specification and procurement of hardware and software.
- Completed prototype of the Supervisory Control and Data Acquisition (SCADA). Send software to the Software Quality Assurance (SQA) department. Start Maintenance Plan Binders. Send DCF to the Unresolved Safety Questionnaire (USQ) department.

Control System Description

- The existing control system consists of five components:
 - Cement Storage and Delivery Module
 - Waste Storage and Transfer Module
 - Stirrer Control Module
 - Weigh Scale Module
 - Emergency Stop Module

Control System Block Diagram

Project Sub-Systems

System Requirements (Testability)

- The Cement Storage and Delivery will perform each stage consecutively.
- The Waste Storage and Transfer valves shall open and close in accordance to transfer and discharge processes.
- The Stirrer Control shall be lowered into and raised out of the waste drum to the required height and depth.
- After mixing has started, the Stirrer Control shall remain on until shut-off.
- To eliminate a single point failure, a secondary weight sensor is being implemented to the Weigh Scale Module.
- The Emergency Stop shall terminate the CF process.

Risk Assessment

	PLC	HMI	Computer	Sensors	Valves	Motors	Power Relays	Overall
Performance								
Schedule								
Cost								
Safety								
Testing								
Manpower								
Facilities								
Overall								

Parts:

Schedule

	August	September	October	November	December
SCR	Phase 1				
PDR		Phase 2			
CDR			R&D/troubleshooting		
Final				Phase 3	
Phase 1: F&OR finalized & schedule defined					
Phase 2: Specification and procurement of hardware & software					
Phase 3: Complete prototype of the Supervisory Control and Data Acquisition					

Conclusion

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Questions

Appendix:

Appendix:

Acronyms

- CF - Cement Fixation
- DAR - Design Agency Representative
- DCF - Design Change Form
- F&OR - Functional & Operational Requirements
- FT – Feed Storage Tank
- GB – Glovebox
- SCADA - Supervisory Control and Data Acquisition
- SQA - Software Quality Assurance
- USQ - Unresolved Safety Questionnaire
- TK – Evaporator Storage Tank

Appendix:

System Description

- **Cement Storage and Delivery System**
 - The Cement Storage and Delivery System consists of 2 stages and is represented in Figure 1. Stage 1 is from the bulk silo to the dayhopper, and Stage 2 is from the dayhopper to the waste drum attached to the glovebox (GB).
 - The need for 2 stages is to prevent the occurrence of a continuous open pathway from the glovebox to the outside environment through which back contamination can occur.
 - While Stage 1 is open and operating to deliver cement, Stage 2 is closed and disabled; and vice versa.
 - Low-level detectors are located in the silo, dayhopper and glovebox screw feeder to keep the cement pathway full of cement as a precaution against back contamination.

Appendix:

System Description

- **Waste Storage and Transfer Module**
 - The valves associated with the feed storage tank (FT) farm are pneumatically-actuated, remotely-operated ball valves.
 - The five (5) FT tanks have a common feed manifold through which solution is transferred from the evaporator storage tanks (TK) in the evaporator salt box.
 - Likewise, the tank farm has a common discharge manifold through which solution is transferred to the CF glovebox and the waste drum.
 - The pneumatic actuations are powered from a reservoir air tank that is supplied by the facility air system to contain enough compressed air to actuate the valves if facility air is interrupted.
 - Figure 2 shows a schematic representation of the FT tank system in the cement fixation process.

Appendix:

System Description

- **Stirrer Control Module**
 - The stirrer system controls the mixers used for stirring the contents of the drum during pH adjustment and cement addition.
 - There are two mixers, one for each of the two drum stations in the glovebox. The mixers are electrically lowered into and raised out of the drum.
 - Finally, each mixer has an amp meter to indicate current during operation. The mixers have an internal trip mechanism to stop rotation if a torque amperage is reached that can damage the mixer.

Appendix:

System Description

- **Weigh Scale Module**
 - The drums are positioned on top of weigh scales during their attachment to the glovebox.
 - The scales are used to monitor cement addition and the final weight of the drum to make sure it does not exceed the DOT weight limit for shipping.
 - The scales rest on a portable platform that allows the scale to be brought out from under the glovebox by 18 inches in order to facilitate accessing the drum with the drum handler forklift.
 - Each platform is moved via a screw-jack run by a motor.

Appendix:

System Description

- **Emergency Stop**
 - This button is used to put the cement fixation system in 'safe mode', if workers must quickly evacuate during the process.
 - When pushed in, it stops cement delivery to the glovebox by stopping and closing the Stage 2 equipment and stopping and raising the mixers.

Appendix:

Budget

Notes: 1 FTE = 1750 hrs 0.01 FTE = 17.5 hrs 40 hrs = 0.023 FTE 1750 hrs / 50 wk = 35 hrs/wk 35 hrs = 0.02 FTE 1750 hrs / 40 hrs = 43.75 wks						FY2013 Budget	
Resource	MET-1 CF	MET-1 Furnaces	MET-1 EV	MET-1 Other	FTE / Qty	Extd Cost	
Induction Heating Team							
James Jurney	0.06				0.06		
Ray Krause	0.02				0.02		
Laura Cartelli	0.01				0.01		
Craig Ross	0.08				0.08		
Andres Gomez	0.02				0.02		
Jessica Rivas	0.16				0.16		
Tom Jachimowski	0.01				0.01		
Labor Total:							76,229
MET-2 Procurements:	\$20,000						20,000
Project Total:							96,229

Notes: 1 FTE = 1750 hrs 0.01 FTE = 17.5 hrs 40 hrs = 0.023 FTE 1750 hrs / 50 wk = 35 hrs/wk 35 hrs = 0.02 FTE 1750 hrs / 40 hrs = 43.75 wks						FY2014 Budget	
Resource	MET-1 CF	MET-1 Furnaces	MET-1 EV	MET-1 Other	FTE / Qty	Extd Cost	
Induction Heating Team							
James Jurney	0.40				0.40		
Ray Krause	0.10				0.10		
Laura Cartelli	0.10				0.10		
Craig Ross	0.80				0.80		
Andres Gomez	0.40				0.40		
Jessica Rivas	1.00				1.00		
Tom Jachimowski	0.02				0.02		
Labor Total:							639,611
MET-2 Procurements:	\$20,000						20,000
Project Total:							659,611