



RCA Name Slurry pump seal leakage
 Report Number 2012-B201
 Report Date 12/3/2012
 RCA Owner C. Eckert

Root Cause Analysis Report

Problem Statement

Focal Point 20 hours of production outage (Pump seal replacement)

When

Start Date 11/21/2012 End Date 11/22/2012
 Start Time 14:00 End Time 10:00
 Unique Timing 2 weeks after pump was installed as part of capital project

Where

Business Unit Performance products
 Location Crump, Michigan, USA
 System Reaction step
 Component P-105

Actual Impact

		Cost
Safety	None	\$0.00
Environmental	500 lbs of methyl bad-stuff leaked into dike; contained	\$0.00
Revenue	Lost profit due to 20 hours downtime (Plant is sold out). Delays in getting product to market	\$100,000.00
Cost	Pump repair; labor & parts	\$15,000.00
Cost	Clean up	\$1,500.00
Environmental	Disposal of spilled methyl bad-stuff	\$3,000.00
Actual Impact Total:		\$119,500.00

Frequency 1 times per week

Frequency Notes Pump has been replaced twice in last 2 weeks, so total cost so far is ~\$240k.

Potential Impact

Safety	Potential exposure to skin irritant from leaking seal	\$0.00
Revenue	Annualized loss at current rate. Losses could grow if demand grows per expected market projections	\$5,200,000.00
Potential Impact Total:		\$5,200,000.00

Report Summaries

Executive Summary

The repeat failure of the new P-105 slurry pump has caused repeat, unplanned shutdowns resulting in lost profit and excessive expenditures due to seal leaks. The slurry contains 50% methyl bad stuff which is an environmentally regulated chemical and requires the pump to be shut down upon detection of a leak greater than 2kg/hr causing production losses amounting to \$240,000 thus far. These losses will increase as product demand grows. The project team was under cost- and timing- pressure, and specified a seal that was not suitable for this service.

In order to prevent repeat seal failures, the corrective action is to install a new type of seal and stuffing box capable of handling the solids. The preventive actions are to integrate a reliability review with all new capital projects and to require the area reliability engineer to provide design criteria to the project teams for special, known process and equipment requirements.

Cause and Effect Summary

The unplanned shutdown was caused by a seal leak of slurry pump P-105. The seal leak was the result of a single mechanical seal being installed in slurry service. Single mechanical seals with discharge recirc flushes in slurry service fail due to solids depositing on the seal faces. Deposits open the seal faces as the pumped liquid evaporates across the seal faces, leaving solids behind. This opens the seal faces creating increasingly worse seal leakage. The single mechanical seal was installed because the project team didn't know it was not the best choice, and because it was inexpensive. The team didn't know it wasn't the best choice because they didn't seek reliability input and because no one gave them input upfront as to the most effective design criteria for the process and equipment requirements. The missing input was caused by no step, or requirement, in the capital project guidelines to integrate reliability input. The project team also went with the single seal because they were looking to cut costs due to budget constraints imposed on them by the business and because they were projected to be over budget. They were also in a rush to complete the project in order to get the product to market more quickly.

Solutions

ID	Label	Description		
1	Solution	Replace single seal with double mechanical seal		
	Cause	Single mechanical seal on pump		
	Note			
	Assigned	Bill Wilson	Criteria	Pass
	Due	12/26/2012	Status	Approved
	Term	Short	Cost	\$10,000.00
2	Solution	Modify capital project steps to include R&M review		
	Cause	New pump did not receive reliability review		
	Note			
	Assigned	Sue Young	Criteria	Pass
	Due	2/3/2013	Status	Approved
	Term	Medium	Cost	\$800.00
3	Solution	Modify capital project steps to have reliability engineer provide list of key design criteria for new equipment		
	Cause	Design choice by capital project team		
	Note			
	Assigned	Bill Wilson	Criteria	Pass
	Due	2/3/2013	Status	Approved
	Term	Medium	Cost	\$0.00
4	Solution	Install seal-less pump		
	Cause	Single mechanical seal on pump		
	Note	Not confident that seal-less pump would be able to handle the large solids present		
	Assigned	Choose	Criteria	Fail
	Due		Status	Identified
	Term	Choose	Cost	\$0.00
5	Solution	Replace conventional stuffing box with taper bore stuffing box		
	Cause	Conventional stuffing box installed		

Note			
Assigned	Choose	Criteria	Pass
Due	12/26/2012	Status	Selected
Term	Short	Cost	\$2,000.00

Team

ID	Label	Description	Label	Description
1	First Name	Bill	Last Name	Wilson
	Phone (1)		Phone (2)	
	Role	Rel eng	Group	
	Email	bw@stuff.com		
2	First Name	Sue	Last Name	Young
	Phone (1)		Phone (2)	
	Role	Proj eng	Group	
	Email	sy@stuff.com		
3	First Name	Dan	Last Name	Valerio
	Phone (1)		Phone (2)	
	Role	Machinist	Group	
	Email	dv@stuff.com		
4	First Name	Chris	Last Name	Eckert
	Phone (1)		Phone (2)	
	Role		Group	
	Email	chris.eckert@sologic.com		

Evidence

ID	Label	Description
1	Evidence Cause(s)	visual observation Single seal ordered with new pump Single mechanical seal on pump Pump was running Pump P-105 seal leaking excessively Solids stick to faces Inexperienced project team No clean, external seal flush Pump not upgraded after installation Solids in fluid accumulate on seal faces Accumulated solids opens faces Conventional stuffing box installed Solids not flushed away Face materials are the same One face is stationary Total turnaround time = 20 hours 1 hour to LOTO 1 hour to flush and drain 1 hr for LEO and disconnection 3 hours to reinstall 2 hours to de-LEO and recommission 12 hours to replace seal in shop
	Location	
	Link	
	Contributor	Bill Wilson
	Type	Direct Observation
	Quality	★★★★☆
2	Evidence Cause(s)	EH&S Manager statement Desire to be in compliance with all environmental regulations Pump handles regulated chemical Desire to be good environmental stewards Decision not to exceed allowable emissions Pumped fluid is skin irritant Leaking seal is safety hazard
	Location	
	Link	

Contributor Choose
Type Direct Statement
Quality ★★★★★

3 **Evidence** Project engineer statement

Cause(s) Reliability group never provided feedback
No reliability personnel assigned to project team
Single seal is relatively inexpensive
Project team needed to save money
Project team over-ran budget
Design choice by capital project team
Fast track Project
Inexperienced project team
No one recognized the need
Capital projects group never asked
Reliability input not required in project guidelines
New pump did not receive reliability review
No design standards for this application
No information or knowledge to spec anything different
Single seal ordered with new pump

Location

Link

Contributor Choose
Type Direct Statement
Quality ★★★★★

4 **Evidence** Seal mfg literature

Cause(s) Single mechanical seals unable to tolerate solids
Accumulated solids opens faces
Liquid vaporizes
Small amount of pumped fluid leaks across seal faces
Conventional stuffing boxes unable to effectively purge solids
Seal faces run hotter than liquid boiling point
Heat generated by seal face friction
Inability to cool faces
High friction coefficient
One face is stationary
One face rotates

Location

Link <http://www.flowserve.com/Products/Seals>

Contributor Chris Eckert
Type Document
Quality ★★★★★

5 **Evidence** Machinist statement
Cause(s) Single seal is relatively inexpensive
Single mechanical seal on pump
Accumulated solids opens faces
Pumped fluid contains solids
Capital projects group never asked
Pump not upgraded after installation
No clean, external seal flush
Solids stick to faces
Conventional stuffing boxes unable to effectively purge solids

Location
Link

Contributor Choose
Type Direct Statement
Quality ★★★★★

6 **Evidence** Operations Supv statement
Cause(s) System under pressure
Choose not to run with leaking seal
Decision to repair pump P-105

Location
Link

Contributor Choose
Type Direct Statement
Quality ★★★★★

Actions & Chart Quality

Custom Actions - 1

ID	Label	Description		
149	Action	Determine type of stuffing box		
	Cause	Conventional stuffing box installed		
	Assigned	Choose		Due Date
	Completed	no		

Evidence - 1

Termination Points - 6

Cause Types - 0

Unconnected Causes - 0

Empty Cause Boxes - 0

Notes

ID	Label	Description
1	Note	Machinists checked clearances and tolerances, and all looked in accordance with spec
	Cause	Seal Improperly installed?
2	Note	Speed to market was key to successful product launch
	Cause	Fast track Project
3	Note	Verified steps
	Cause	Seal Improperly installed?

Chart Type Legend

- ▶ Transitory
- Non-transitory
- ⏸ Omission - Transitory
- Omission - Non-transitory
- ★ Focal Point
- ⊙ Solution Implemented

