Defect Elimination Report Summary

Defect	**Number**
Pump Coupling Failures	DE-0109

Plant	**Plant Area**
Flaxton Plant	Milling

Date Opened	**Date Closed**
12th July, 2018	12th January, 2019

Defect Elimination Team Leader	**Defect Elimination Team Members**
T. Christian	H. Zahlee (Operator) K. Nate (Mechanic) S. James (Engineer) H. Roy (Equipment Vendor/SME)

Executive Summary

Pump Coupling failures in the last 6 months have caused 113 hours of downtime for the Milling area of the Flaxton plant, resulting in a loss in plant availability and an increase in $180,000 in maintenance costs.

A DE Team worked to eliminate Pump Coupling failures for the Milling area of the Flaxton plant and prevent the further loss of value to the organization.

Solutions were identified and implemented to develop training and competency around shaft alignment, repair and maintenance shaft alignment tooling, and to prevent any further assets from being built that may inhibit shaft alignment.

The solutions since being implemented have eliminated any further Pump Coupling failures.

DE Program Sponsor Approval	**DE Program Owner Approval**
Albert Fisher	P. Lovering

DE Stakeholder Approval

Christena G Gray Alwyn Rice Lena Pradella Alcesta Barbi Margaret H Bender

Defect Identification

Due to a falling trend in the Flaxton Plant's availability and an increase in maintenance costs as seen in Figures 1 and 2, the downtime and maintenance data were reviewed as part of the Monthly Defect Elimination meeting to identify and prioritize defects.

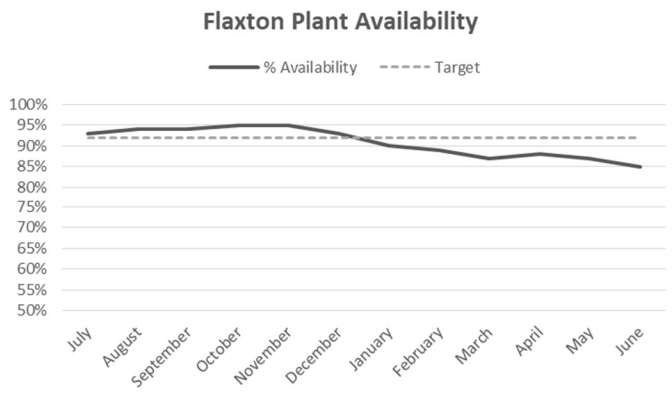


Figure 1

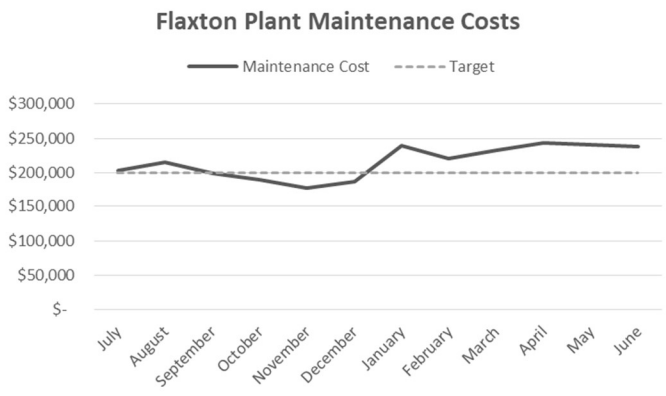


Figure 2

Pump Coupling Failures were identified as having the highest event count and are the second highest contributor to downtime for the last 6 months (see Figures 3 and 4). Upon further analysis of the work order history, it was identified that Pump Coupling failures are spread across a number of different pump assemblies (see Figure 5).

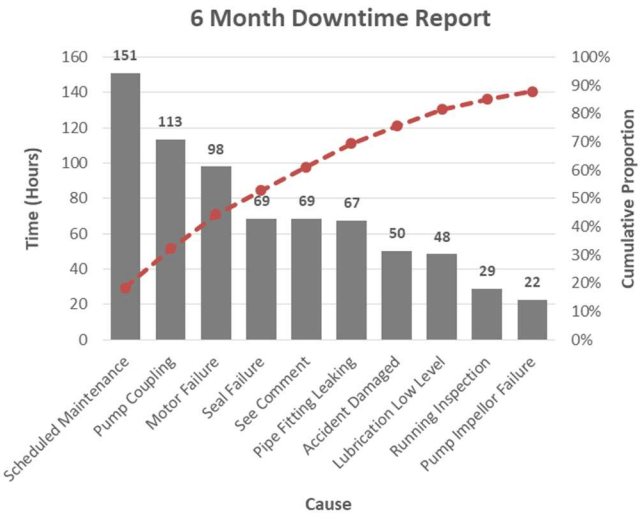


Figure 3

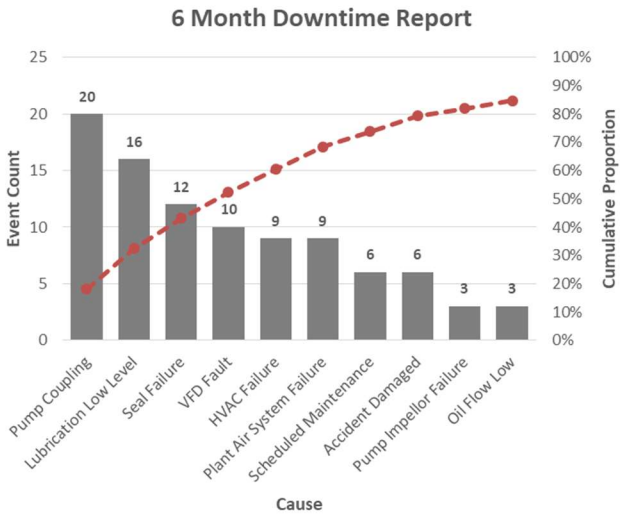


Figure 4

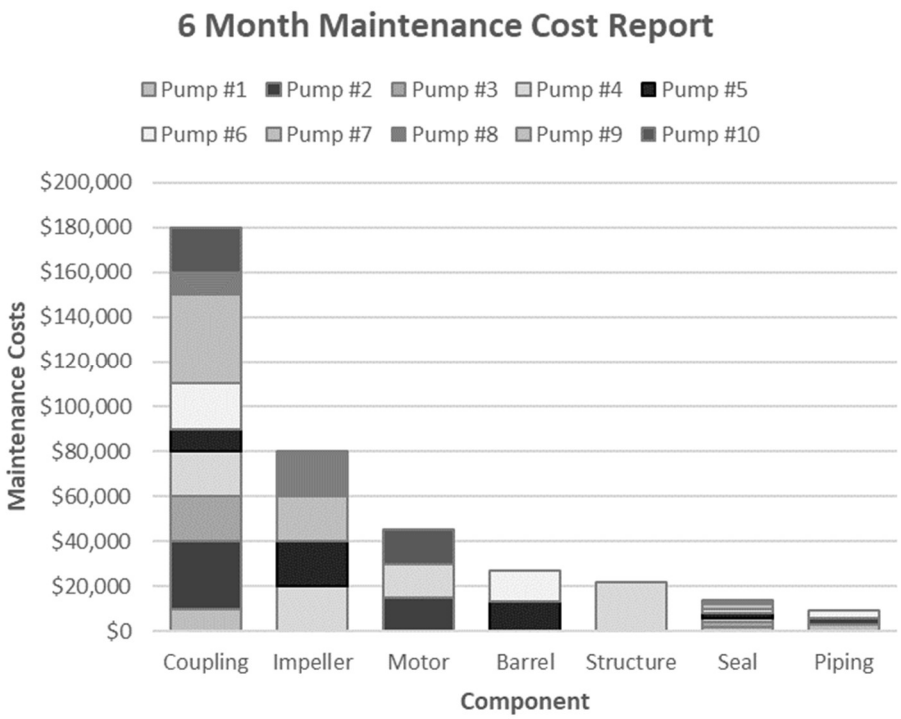

6 Month Maintenance Cost Report
Pump #1
Pump #2
Pump #3
Pump #4
Pump #5
Pump #6
Pump #7
Pump #8
Pump #9
Pump #10
$200,000
$180,000
$160,000
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
Maintenance Costs
Coupling
Impeller
Motor
Barrel
Structure
Seal
Piping
Component

Figure 5

Defect Prioritization

Based on the Defect Elimination Prioritization Matrix, which references the key value drivers for the business, the priority score of the Pump Coupling defect is 86. The calculation of this is shown in Figure 6.

		Operational and/or Maintenance Cost per year	Downtime and/or Delay Time per year	Frequency of Defect	HSE Risk	Estimated Cost to Eliminate Defect (either one-off cost or sustaining cost for 1 year)	Time Defect Has Been Present	Impact on Personnel	Impact on Location
Multiplier		5	2	2	2	1	3	4	1
Rank	1	<$10k	<5hrs	< Once per year	No potential for an injury or impact to the environment	>$1M	<1 week	Impacts 1 person	Impacts only 1 location in plant area
	2	$10-49k	5 to 20hrs	Once every 184 to 365 days	Potential for a single injury with no medical attention required; Short-term impact (multiple days) to the environment	$500K - $1M	1 month	Impacts up to 5 people	Impacts more than 1 location in plant area
	3	$50-99k	20 to 50hrs	Once every 31 to 183 days	Potential for a single injury requiring medical attention; Short-term impact (single week) to the environment	$100K - $500K	3 months	Impacts entire team	Impacts entire plant area
	4	$100-499k	50 to 100hrs	Once every 7 to 30 days	Potential for a single injury requiring leave from work; Medium-term impact (single month) to the environment	$50K - $100K	6 months	Impacts entire plant	Impacts entire plant
	5	$500k-1.9M	100 to 200hrs	Once every 1 to 6 days	Potential for a single fatality or serious injury; Medium-term impact (multiple months) to the environment	$25K - $50K	1 year	Impacts entire business	Impacts entire business
	6	>$2M	>200hrs	> Once per day	Potential for fatalities or serious injuries; Long-term impact with residual damage to the environment	<$25K	>1 year	Impacts entire industry	Impacts entire industry

Defect	Operational and/or Maintenance Cost per year	Downtime and/or Delay Time per year	Frequency of Defect	HSE Risk	Estimated Cost to Eliminate Defect (either one-off cost or sustaining cost for 1 year)	Time Defect Has Been Present	Impact on Personnel	Impact on Location	Priority Score
Pump Coupling Failures	4 x 5 = 20	5 x 2 = 10	4 x 2 = 8	3 x 2 = 6	6 x 1 = 6	4 x 3 = 12	5 x 4 = 20	4 x 1 = 4	86

Figure 6

Defect Analysis

Problem Statement

Pump coupling failures in the last 6 months have caused 113 hours of downtime for the Milling area of the Flaxton plant resulting in a loss in plant availability and an increase in $180,000 in maintenance costs.

Objective Statement

The DE Team will work toward eliminating Pump Coupling failures for the Milling area of the Flaxton plant for the next 6 months.

Business Case

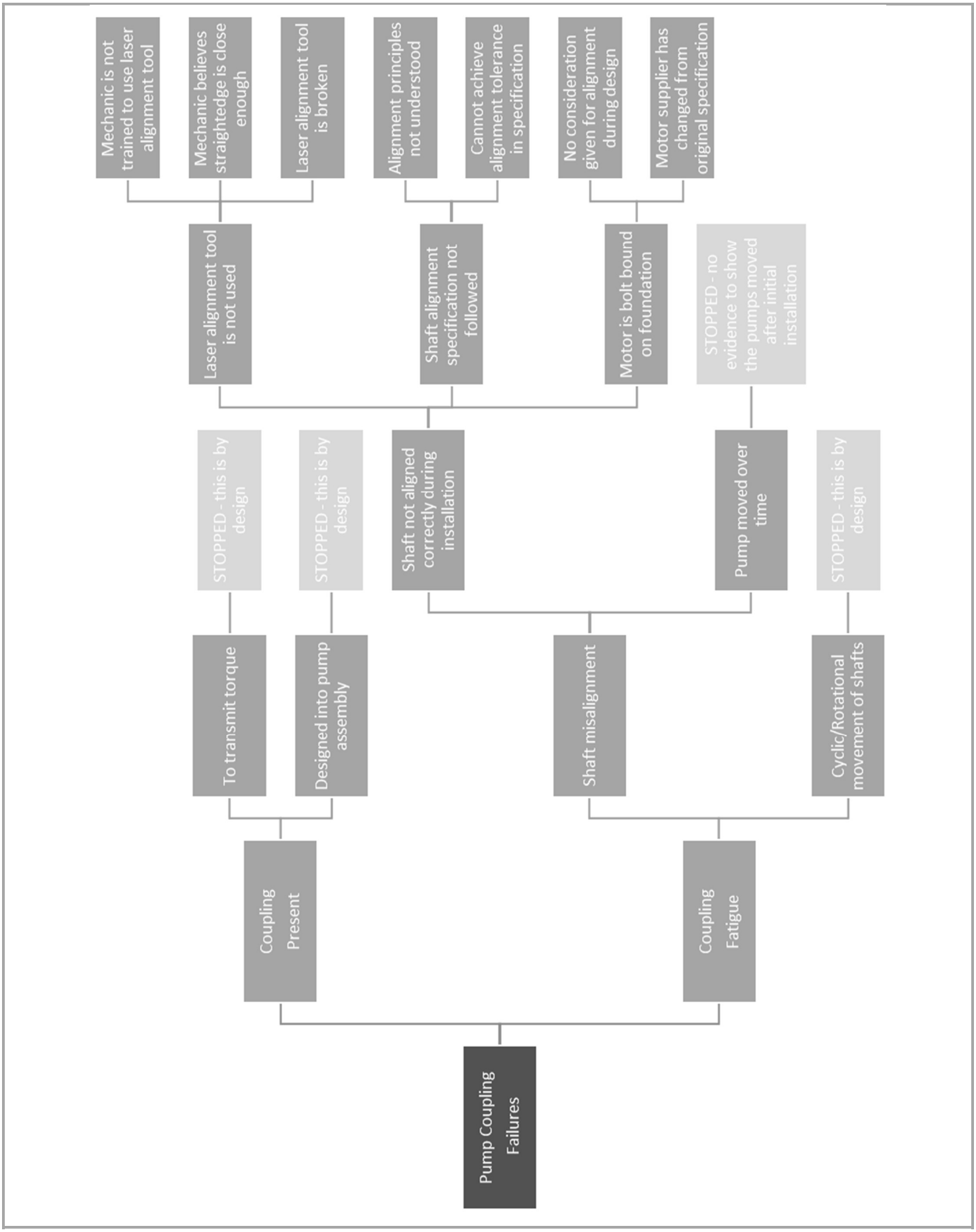
The direct value lost in the last 6 months from Pump Coupling failures is $180,000 in maintenance costs and $22.6 million in productivity due to the 113 hours of lost plant availability, all of which can be ended by the elimination of this defect.

Additionally, maintenance schedule compliance has decreased due to the reactive nature of the maintenance department, and an increase in frustration by the operations teams not being able to run the plant has resulted. It is expected that these can be eased by the elimination of the Pump Gland Seal failures.

Root Cause Analysis

A Root Cause Analysis (RCA) was conducted and the following identified as the root causes:

1. Mechanic is not trained to use laser alignment tool
2. Mechanic believes straightedge is close enough
3. Alignment principles not understood
4. Laser alignment tool is broken
5. No consideration given for alignment during design
6. Motor supplier has changed from original specification



Defect Solutions

From the analysis of the defect, a number of solutions have been identified and prioritized according to the ranking criteria in Figure 7.

		Operational and/or Maintenance Cost Decreased per year	Downtime and/or Delay Time Decreased per year	HSE Risk Reduction	Cost to Implement (either one-off cost or sustaining cost for 1 year)	Time to Implement	Time to Realize Benefit	Sustainability Potential - Hierarchy of Controls	Replication Potential
Multiplier		**5**	**2**	**2**	**1**	**3**	**3**	**5**	**1**
Rank	**1**	<$10k	<5hrs	Increases HSE Risk DO NOT PROCEED WITH THE SOLUTION	>$1M	More than 4 weeks to implement, with multiple resources	>1 year	-	Single Implementation - No Replication
	2	$10-49k	5 to 20hrs	HSE Risk Unaffected	$500K - $1M	More than 4 weeks to implement, with minimum resources	1 year	Protective System	Multiple Replications
	3	$50-99k	20 to 50hrs	Will Decrease by 1 HSE Risk Rank	$100K - $500K	Less than 4 weeks to implement, with multiple resources	6 months	Administrative Control	Department-wide Replication
	4	$100-499k	50 to 100hrs	Will Decrease by 2 HSE Risk Rank	$50K - $100K	Less than 2 weeks to implement, with multiple resources	3 months	Engineered Control	Site-/Plant-wide Replication
	5	$500k-1.9M	100 to 200 hrs	Will Decrease by 3 HSE Risk Rank	$25K - $50K	Less than 4 weeks to implement, with minimum resources	1 month	Substitution	Company-wide Replication
	6	>$2M	>200hrs	Will Eliminate all HSE Risks	<$25K	Less than 2 weeks to implement, with minimum resources	<1 week	Elimination	Industry Changing Initiative

Figure 7

The priority ranking of the solutions are listed in Figure 8. Using 132 as the highest possible priority ranking possible (all categories achieve a score of 6), the cutoff score is 66. Those that are greater than the cutoff score have been deemed priority and will be accepted for implementation.

Root Cause	Potential Solution	Operational and/or Maintenance Cost Decreased per year	Downtime and/or Delay Time Decreased per year	HSE Risk Reduction	Cost to Implement (either one-off cost or sustaining cost for 1 year)	Time to Implement	Time to Realize Benefit	Sustainability Potential - Hierarchy of Controls	Replication Potential	Priority Score
1, 2, 3	Develop a training and competency module that incorporates shaft alignment principles and uses laser alignment tools	4 x 5 = 20	4 x 2 = 8	2 x 2 = 4	6 x 1 = 6	5 x 3 = 15	5 x 3 = 15	3 x 5 = 15	5 x 1 = 5	88
4	Repair laser alignment tooling and develop a program for calibration and upgrades based on the manufacturer's recommendations	4 x 5 = 20	4 x 2 = 8	2 x 2 = 4	5 x 1 = 5	2 x 3 = 6	5 x 3 = 15	3 x 5 = 15	5 x 1 = 5	78
5	Review all projects currently in the design phase to ensure shaft alignment is considered to allow for movement of the component(s)	2 x 5 = 10	2 x 2 = 4	2 x 2 = 4	6 x 1 = 6	6 x 3 = 18	3 x 3 = 9	4 x 5 = 20	5 x 1 = 5	76
5	Identify all assemblies where shaft alignment is inhibited due to the design of the assembly	2 x 5 = 10	2 x 2 = 4	2 x 2 = 4	5 x 1 = 5	1 x 3 = 3	3 x 3 = 9	4 x 5 = 20	5 x 1 = 5	60
6	Revert back to the original motor supplier(s)	1 x 5 = 5	2 x 2 = 4	2 x 2 = 4	2 x 1 = 2	1 x 3 = 3	1 x 3 = 3	5 x 5 = 25	4 x 1 = 4	50

Figure 8

Solution Implementation

The solutions in Figure 9 have been approved and completed.

Root Cause	Action	Assigned To	Due Date	Status	MoC Number	Comments
1, 2, 3	Develop a training and competency module that incorporates shaft alignment principles and uses laser alignment tools	K. Bruce	8/9/2018	Complete	00256	Training and competency module completed with all mechanics now certified
4	Repair laser alignment tooling and develop a program for calibration and upgrades based on the manufacturer's recommendations	S. James	9/4/2018	Complete	00257	Laser alignment tooling repaired with maintenance program established
5	Review all projects currently in the design phase to ensure shaft alignment is considered to allow for movement of the component(s)	R. Gray	9/4/2018	Complete	Not Required	All projects reviewed - 1 project identified and modified to eliminate alignment restrictions

Figure 9

The measurement plan to determine if the solutions have been successful in eliminating the defect of Pump Coupling failures is in Figure 10.

ID	Measure	Data Source	Baseline	Target	Actual	Comments
1	Downtime hours attributed to pump coupling failures	Delay Accounting System	155hrs (6 month total)	0hrs	5hrs	Baseline data Jan to June; Solution verification starting Aug
2	Impact on the planned maintenance budget attributed to pump coupling failures	CMMS	$180,000 (6 month total)	$0	$1,000	Baseline data Jan to June; Solution verification starting Aug
3	Impact on the maintenance schedule compliance % attributed to pump coupling failures	CMMS	17% (6 month average)	0%	2%	Baseline data Jan to June; Solution verification starting Aug

Figure 10

Solution Verification & Sustainment

Once the solutions were completed in August and September, the defect was tracked. There were no events and subsequent impacts after August as shown in Figure 11 and Figure 12. The solutions are deemed to have been successful and the defect marked as eliminated.

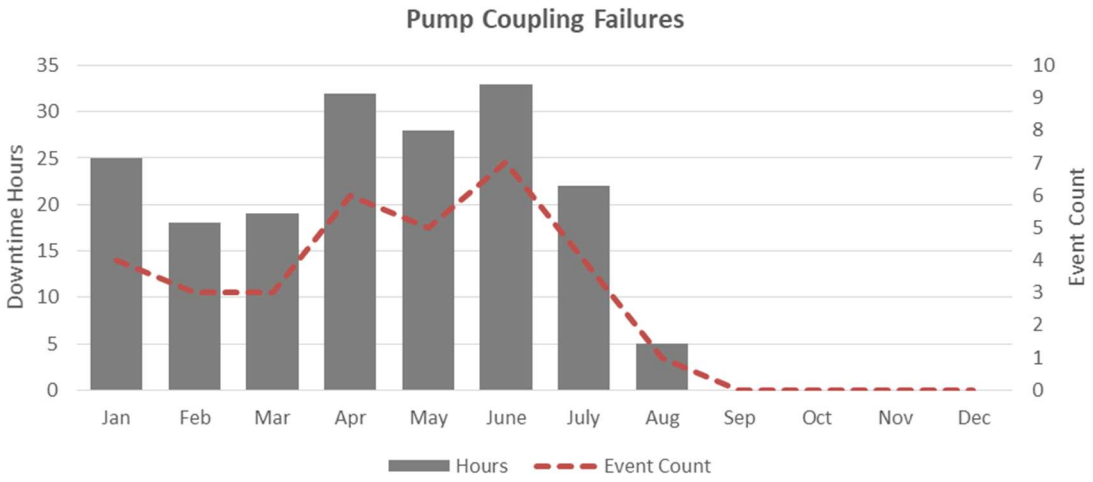


Figure 11

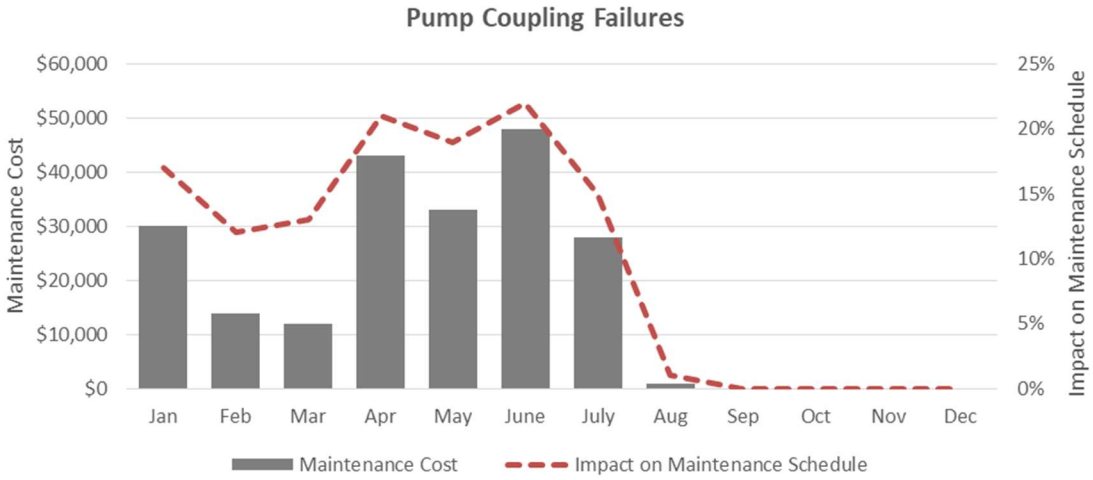


Figure 12