Texas City Steam Trap Improvement Project

Black Belt

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Team Members

Angel Echevarria, Roger Light, Bill Wilkins

Ad- Hoc Team Members

Rex Gentry and Doris Wu

Master Black Belt	*Finance*	*Local Champion*	*Process Owner*
Beth Ballard	Darryl Rogers	Mike Clothier	Jay Crochet

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Project Scope

Optimizing the steam delivery in Energy Systems by reducing steam loss through steam traps

Project Business

Hydrocarbons and Energy

Benefits

- Lower cost of steam to customer
- Acceleration of integration/institutionalization of Dow work process into legacy UCC site
- Leverage In and Out capabilities
- EBIT of savings
- Quick wins in blocking steam traps with large leaks
- Maintenance program implemented

Project Status

1 year Realization

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Project Definition

Project Team

Angel Echevarria
Roger Light
Bill Wilkins
Rex Gentry
Doris Wu

Project Drivers:

- Energy Business be the low cost supplier of utilities to all of Dow's businesses.
- Eliminating lost asset utilization
- Reduce energy cost to serve the customer

Opportunity:

- Improve reliability of the entire plant steam system
- Reduce the total steam loss in Energy Systems distribution system due to defective steam traps.
- Reduction of the amount of steam purchased from Calpine.

CTC Requirements:

- Water-free steam
- Improve delivery of steam
- Steam at lower cost

Deliverables:

- Reduce the total steam loss by at least 70%

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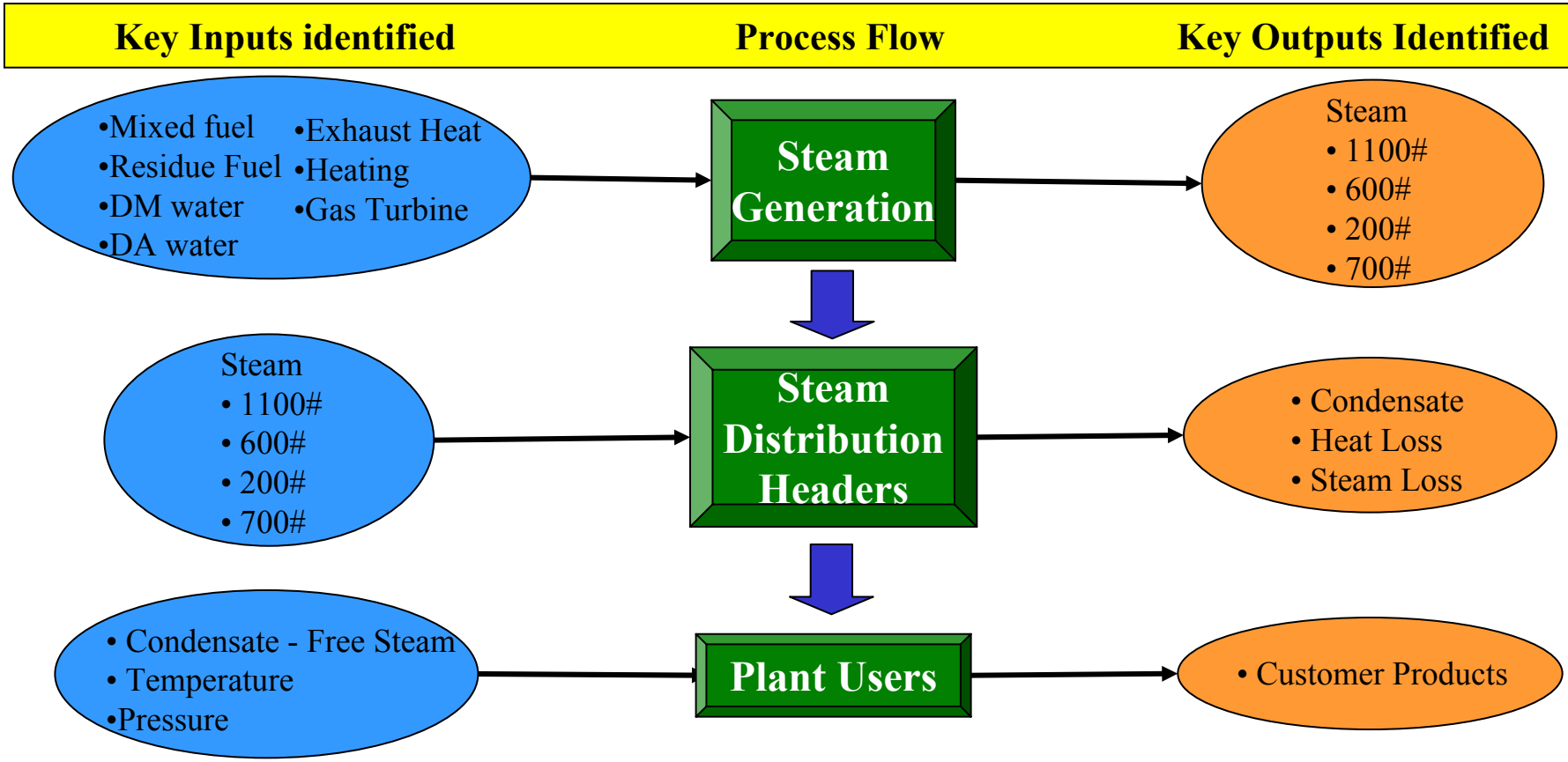
WHAT DO WE GET WHEN WE LOOK AT THE PROCESS MAP?

To gain understanding of measurement points leading to elimination of defects…



Critical to Quality Parameters:
- **Deliver water-free steam**
- **No steam loss during distribution of steam**

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Data Collection Methodology

Performance Measure	Operational Definition	Data Source and Location	Sample Size	Who will Collect the Data?	When Will the Data Be Collected?	How Will the Data Be Collected?	Other Data That Should Be Collected at the Same Time
% of Traps Blowing Through	Number of traps failed open, passing live steam, divided by the total number of in-service traps tested.	Texas Steam Company Steam Trap Survey Report	2001 Steam Trap Surveys for Energy Systems in Texas City	Texas Steam Survey Technicians	August - September 2001	Visual observation of trap discharge, portable listening devices / sound meters, temperature sensors	Manufacturer, model, type, inlet pressure, outlet pressure, strainer, location, misc. observations
% of Traps Leaking	Number of traps leaking live steam divided by the total number of in-service traps tested.	Texas Steam Company Steam Trap Survey Report	2001 Steam Trap Surveys	Texas Steam Survey Technicians	August - September 2001	Visual observation of trap discharge, portable listening devices / sound meters, temperature sensors	Manufacturer, model, type, inlet pressure, outlet pressure, strainer, location, misc. observations
% of Traps Cold Plugged	Number of traps failed closed, backing up condensate, divided by the total number of in-service traps tested.	Texas Steam Company Steam Trap Survey Report	2001 Steam Trap Surveys	Texas Steam Survey Technicians		Visual o ation f tra ge	facturer, model, e, inlet pressure, outlet pressure, ainer, location, misc. ons
% of Traps Flooded	Number of traps backing up condensate due to inadequate capacity divided by the total number of in-service traps tested.	Texas Steam Company Steam Trap Survey Report	2001 Steam Trap Surveys	Texas Steam Survey Techni			model, tlet pressure, r, location, misc. servations
% of Traps Rapid Cycling	Number of traps cycling excessively (pre-failure mode)	Texas Steam Company Steam Trap Survey Report	2001 Steam Trap Surveys	Texas Steam Survey Technicians	August - September 2001	al o tion trap dis rge, portable listening devices / sound meters, temperature sensors	nufacturer, model, e, inlet pressure, outlet pressure, strainer, location, misc. observations

Time Reduction with Leverage In: Used pre-approved vendor with survey requirements and steam loss calculations.

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TO DETERMINE THE SPECIFIC IMPROVEMENT YOU NEED
TO DEFINE THE DEFECT …...

Defect is the amount of steam loss from the the defective steam traps and visible leaks associated with the steam trap

CUSTOMER REQUIREMENT	MEASUREMENT TECHNIQUE	% OF TOTAL STEAM LOSS
Defective Steam Traps	Steam Trap Survey	49.4%
Visible Steam Leaks related to steam trap piping	Steam Trap Survey	50.7%

Sigma of 2.28 for Steam Traps

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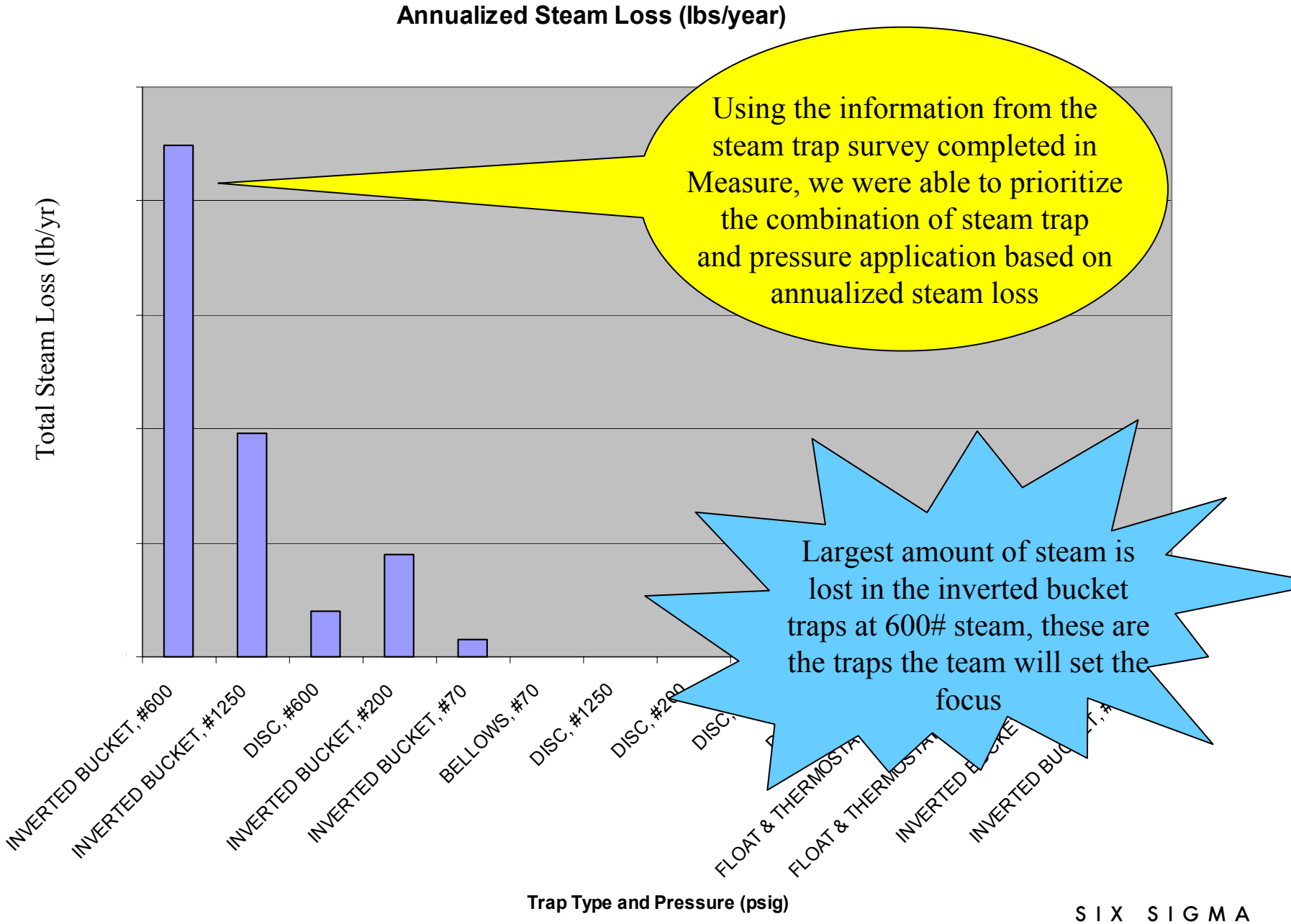
Annualized Steam Loss (lbs/year)
Total Steam Loss (lb/yr)
Using the information from the steam trap survey completed in Measure, we were able to prioritize the combination of steam trap and pressure application based on annualized steam loss
Largest amount of steam is lost in the inverted bucket traps at 600# steam, these are the traps the team will set the focus
INVERTED BUCKET, #600
INVERTED BUCKET, #1250
DISC, #600
INVERTED BUCKET, #200
INVERTED BUCKET, #70
BELLOWS, #70
DISC, #1250
FLOAT & THERMOSTA
FLOAT & THERMOSTA
Trap Type and Pressure (psig)

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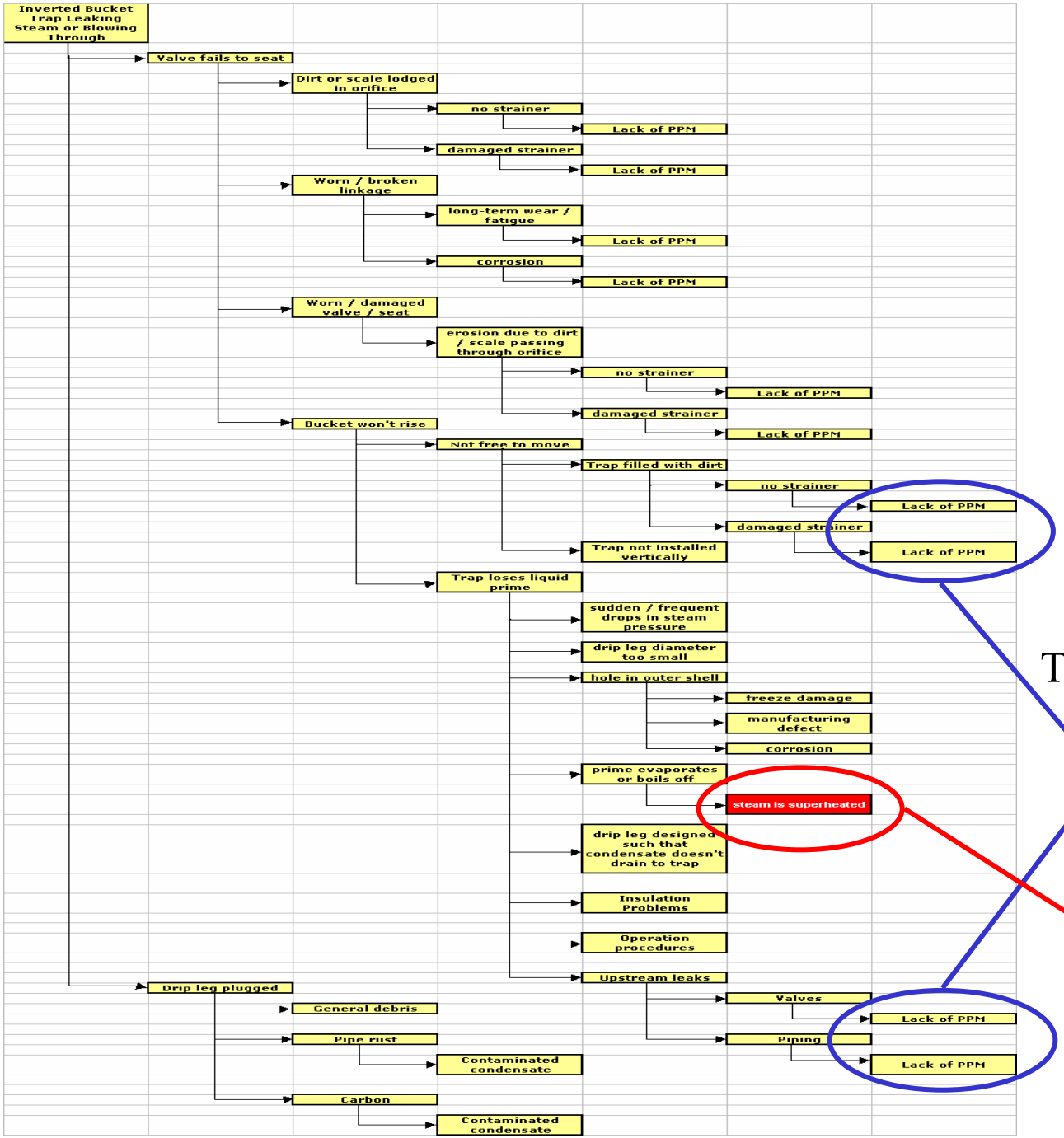

The Why-Why Analysis yielded two main potential root causes for failure of the inverted bucket trap, lack of PPM and superheated steam. The lack of PPM will be addressed in CONTROL and we felt that the most likely cause was the superheated steam.

Two Potential Root causes:

Lack of PPM

Steam is superheated

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Leveraging …

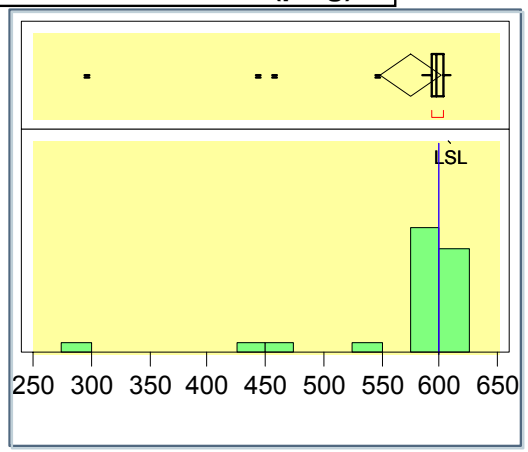
Leveraging information from other Six Sigma projects, it is determined that inverted bucket traps are not suitable for superheated steam.

Inverted bucket traps operate on the difference in density between steam and water. They require the retention of a water "prime" so that the bucket will float upward and close the valve to prevent the release of live steam. Without the prime, the bucket falls and the valve remains open allowing steam to escape. Because superheated steam applications have very low condensate loads and high temperatures, the prime tends to boil off resulting in a failed-open condition. This root cause was the easiest to validate with temperature and pressure information from the plants contributing to the 600# steam header.

To ensure that the root cause is the true root cause of the defects, validation is necessary ...

Is the steam really 600#? An hypothesis test will tell us if the mean is significantly different than 600#

Pressure of Steam (psig)



Quantiles

100.0%	maximum	610.00
99.5%		610.00
97.5%		610.00
90.0%		608.10
75.0%	quartile	604.00
50.0%	median	597.00
25.0%	quartile	593.00
10.0%		458.40
2.5%		298.00
0.5%		298.00
0.0%	minimum	298.00

Moments

Mean	576.03571
Std Dev	67.4556
Std Err Mean	12.74791
upper 95% Mean	602.19227
lower 95% Mean	549.87916
N	28

Test Mean=value

Hypothesized Value	600
Actual Estimate	576.036
df	27
Std Dev	67.4556

t Test

Test Statistic	-1.8799
Prob > |t|	0.0710
Prob > t	0.9645
Prob < t	0.0355

Tested with a different hypothesis and can not prove that the mean is different. We will use the saturation temperature of steam at 585# to validate that the steam is superheated.

P-value is small which indicates that the data suggests that the mean is different then 600

Test Mean=value

Hypothesized Value	585.3
Actual Estimate	576.036
df	27
Std Dev	67.4556

t Test

Test Statistic	-0.7267
Prob > |t|	0.4736
Prob > t	0.7632
Prob < t	0.2368

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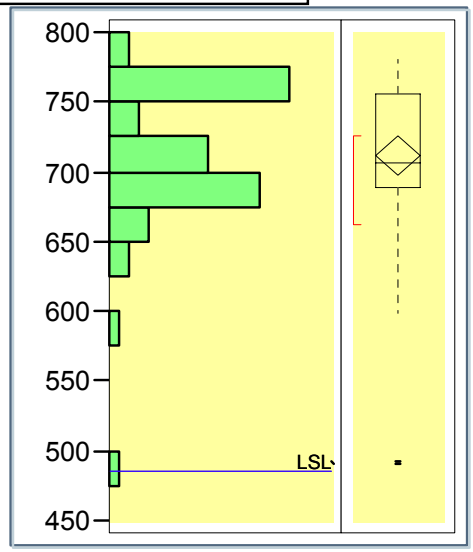
Temperature (oF)



Temperature data that was available from all the 600# steam producers was collected.

Quantiles

100.0%	maximum	780.00
99.5%		780.00
97.5%		779.15
90.0%		766.60
75.0%	quartile	756.50
50.0%	median	707.00
25.0%	quartile	688.50
10.0%		660.60
2.5%		536.48
0.5%		491.00
0.0%	minimum	491.00

Moments

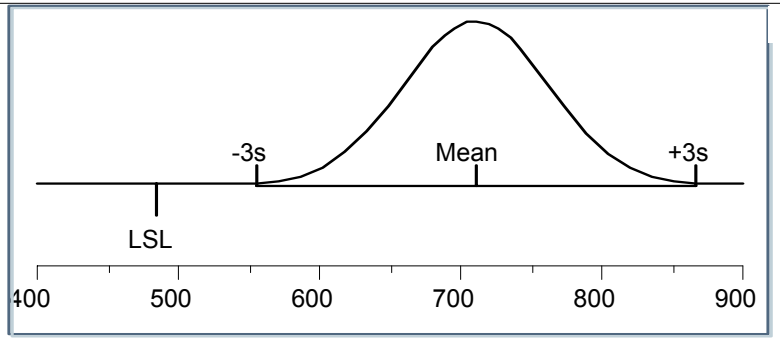
Mean	712.17857
Std Dev	51.830881
Std Err Mean	6.9261929
upper 95% Mean	726.05897
lower 95% Mean	698.29817
N	56

The temperatures were consistently above 486°F, thus the steam is superheated and our root cause is **validated!**

Capability Analysis

Specification	Value	Portion	% Actual
Lower Spec Limit	486	Below LSL	0.0000
Upper Spec Limit	.	Above USL	.
Spec Target	.	Total Outside	0.0000

Overall, Sigma = 51.8309



Capability	Index	Lower CI	Upper CI
CP	.	.	.
CPK	1.455	.	.
CPM	.	.	.
CPL	1.455		
CPU	.		

Portion	Percent	PPM
Below LSL	0.0006	6.3917
Above USL	.	.
Total Outside	0.0006	6.3917

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With the root cause validated, improvements were able to be made to the steam traps. The team followed MET to complete the steam trap repairs.

After repairs are complete, 87.3% of the steam lost due to failed traps and leaks will be recovered

87.3% Defect Reduction

Sigma shift from 2.28 to 3.02

Custom… Requ… …t …t Vari…	Measurement Technique	Cpk	Sample Size (In-service Traps)	D…
	Steam trap survey …med by Armstrong …rvice	> 2.0	345	11/05/01
	Steam trap survey …rformed by Armstrong …ervice	0.5506	345	11/05/01
	Steam trap survey …erformed by Armstrong …rvice	0.7279	345	11/05/01
…% … …erv… traps rap… …cling.	Steam trap survey performed by Armstrong Service	> 2.0	345	11/05/01
% of in-service traps defective (BT, LK, PL, RC)	Steam trap survey performed by Armstrong Service	**0.5080 63,770 DPO 3.02 SIGMA**	345	11/05/01

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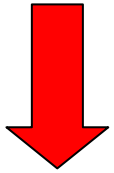
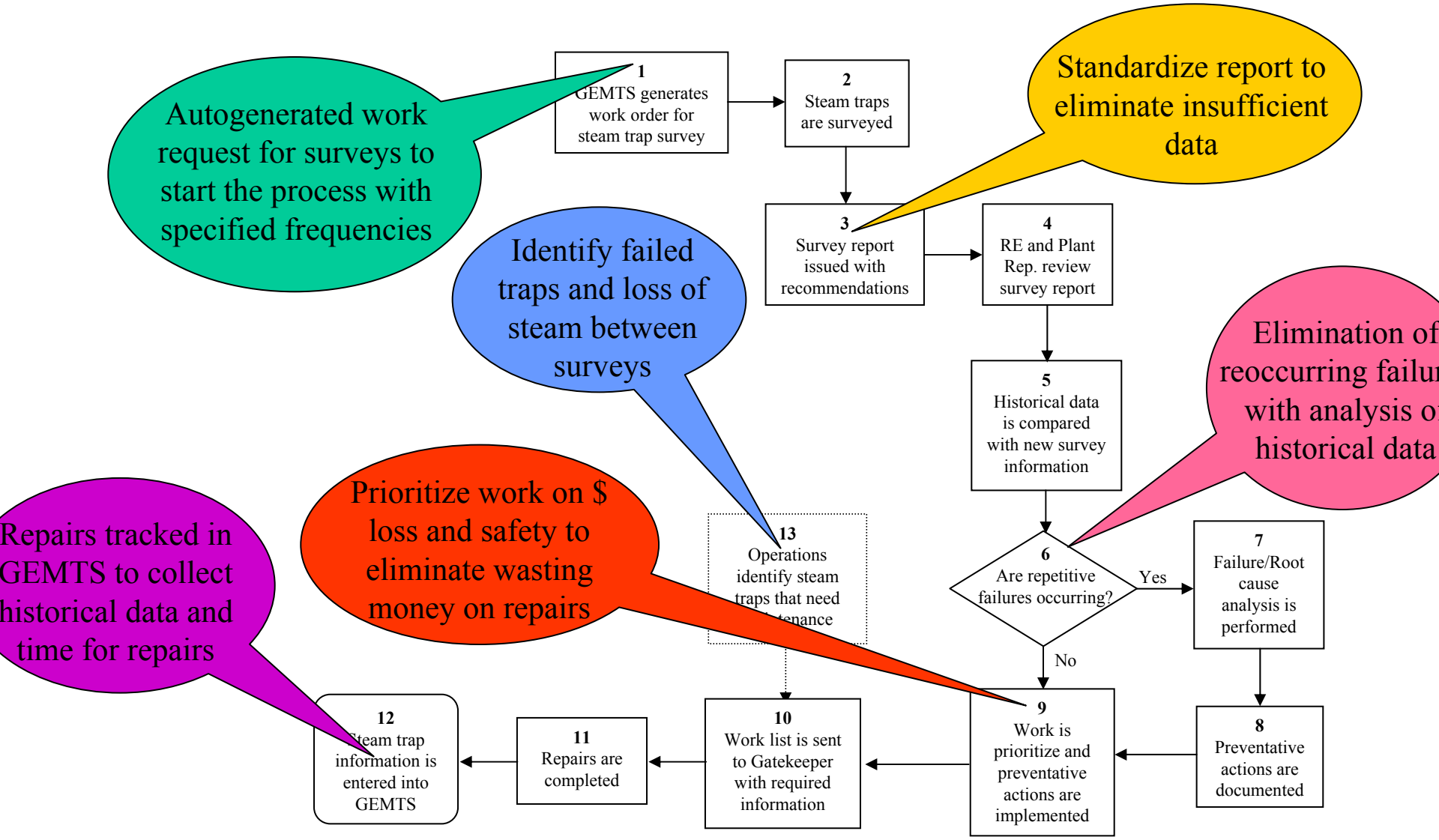
How do we sustain the gains?



Lack of P/PM was a potential root cause

- Create a P/PM (predictive preventative maintenance) program for steam trap maintenance.
- The objectives of the program:
  - To reduce the possibility of unplanned failures due to steam trap malfunctions.
  - To identify equipment problems and assist in preventing recurrence.
  - To reduce the amount of energy lost through steam traps.
  - To maximize the life expectancy of the equipment.

General Process Flow Diagram of the P/PM Program



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Final Project Statistics

Measurement	Initial Baseline	After Improvement
Number of Opportunities	345 In-service Traps	345 In-service traps
Number of Defects	75 Failed Traps	22 Failed Traps
% Defective	21.7%	6.37%
Sigma level	2.28	3.02
Visible Steam Leaks	45	10
% Steam Recovered		**87.3%**

Original Sigma Level
2.28

New Sigma Level
3.02

87.3% Defect Reduction of Steam Loss

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Hard Work is the Key to Success

- This project has completed great strides in upgrading the current state of the steam traps in Texas City Operations Energy System facility.

- With the repairs and improvements that have been made on the steam traps, the team reached their 1.7 X goal on the steam loss recovered in the system.

It is the responsibility of the department to sustain the gains.

Thanks to the Six Sigma Team for all their hard work!! The project would not have been a success without their involvement.

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