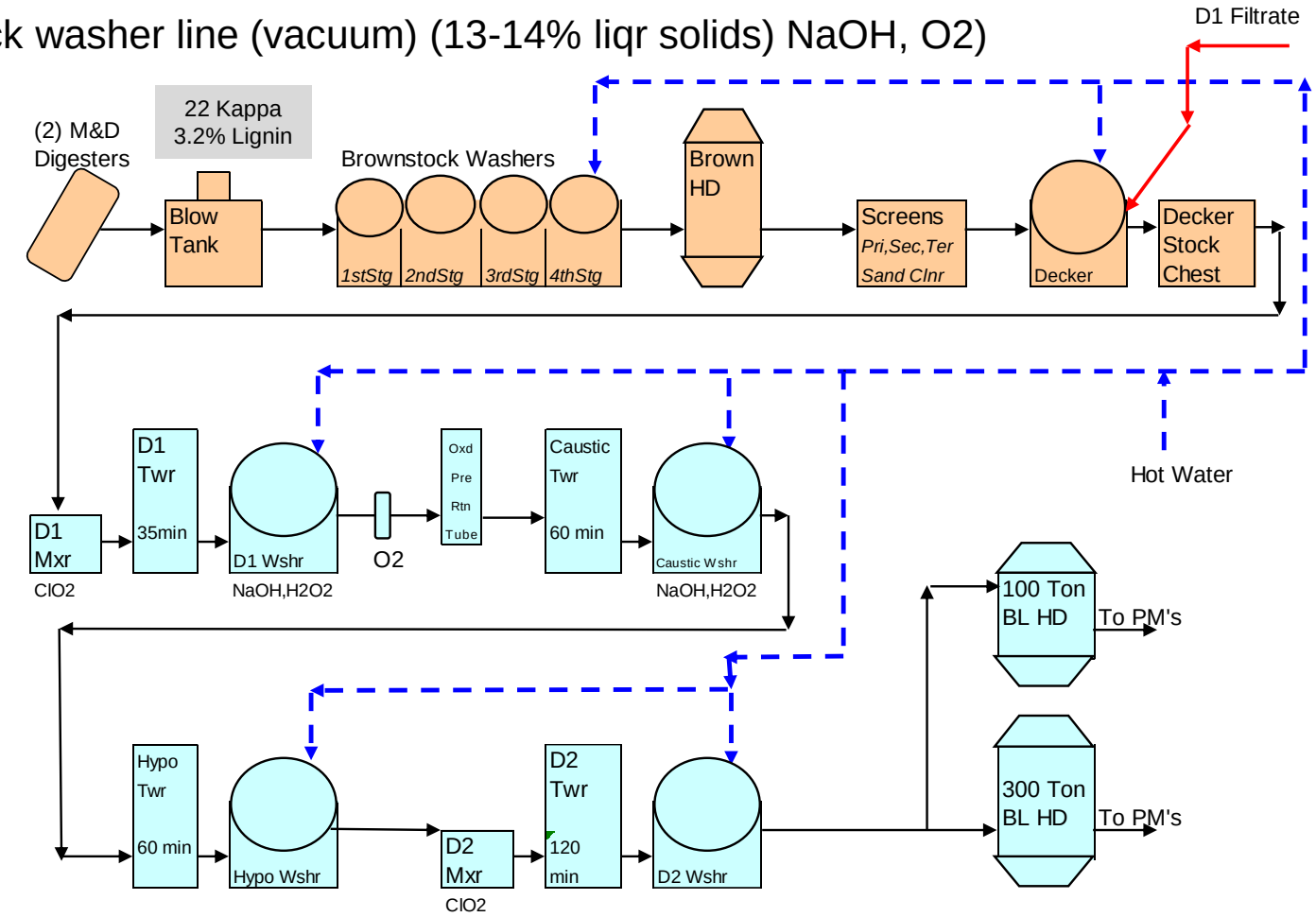
Reduce ClO_2 Usage in Sawdust Bleach

Greenbelt Project 5-11-2017

Sawdust Pulping Summary

- Two continuous feed M&D Sawdust digesters produce up to 500 tpd total bleached pulp (Kappa number = 20-22 (3.2% lignin); 160 psi; Cooking temp = 375 degF; Time=20-22 min)
- 4-stage brownstock washer line (vacuum) (13-14% liqr solids) NaOH, O2)
  - Primary, Secondary & Tertiary screening (0.006” slots) (also sand cleaners)
  - 5th Stage vacuum Decker washer for consistency control to bleach plant
  - 4-stage bleach plant (DEopPD); 87 brightness, (bleach chem: ClO2, H2O2, NaOH, O2)



2 M&D Digesters, 5-stages brownstock washing, 4-stage bleach plant

DMAIC - DEFINE

Why?

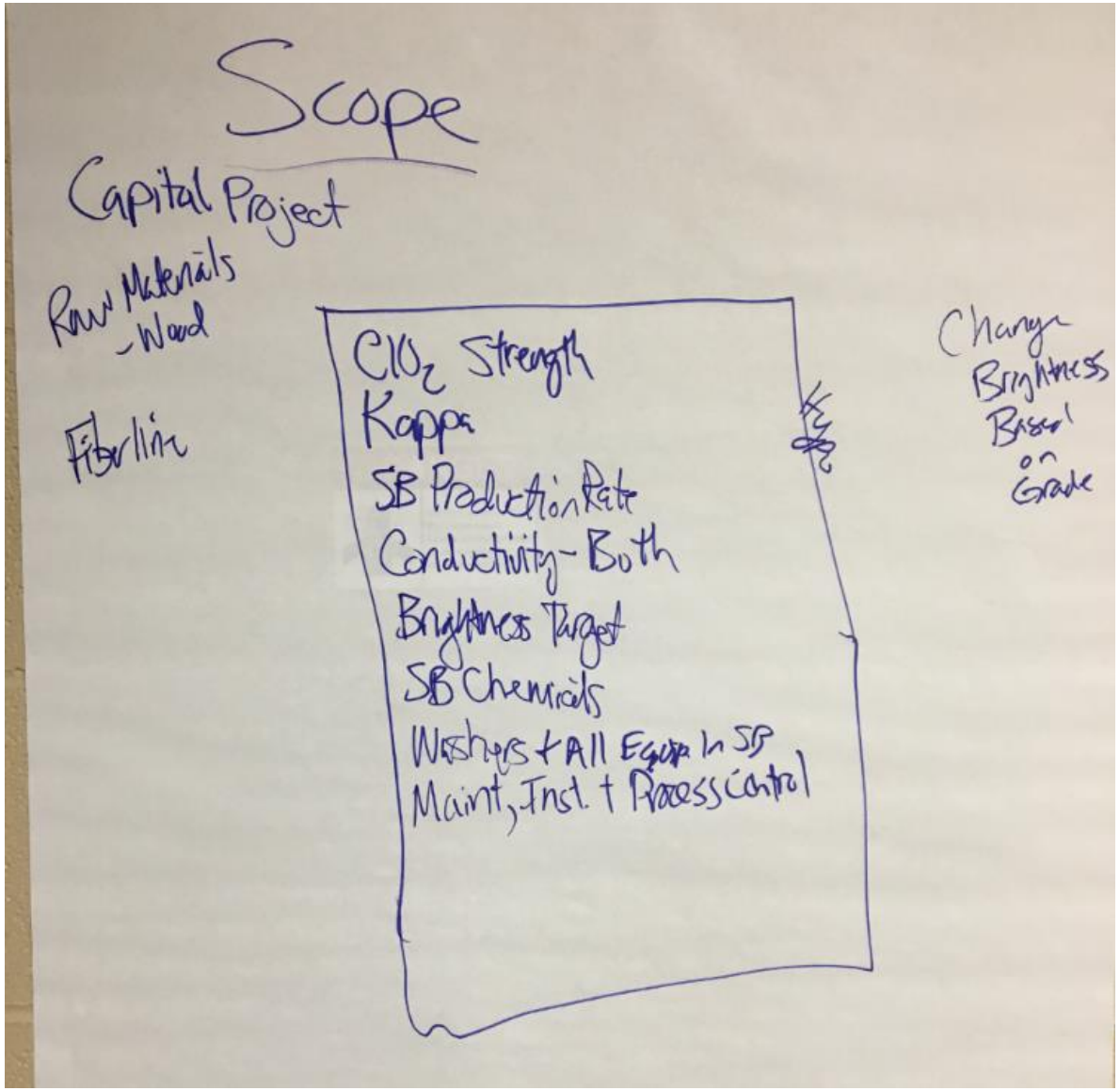
8	What is the Financial/Business **Impact** of this Problem?	Use words to describe the business reasons to do this project now.				
		Need to reduce the CLO2 usage to support the projected production increase used to justify the LPO Digester Project.				
		What is the Estimated Business Impact?				
		HARD Impact? (reduce waste, defects or $/unit)	Time to Realize Hard Impact?	SOFT Impact? (open capacity, reduce DT)	Time to Realize Soft Impact?	What is the likelihood of Soft Impact becoming Hard
		High (>$100k)	Immediately	High (>$100k)	Medium Lag (3~6Mo.)	High
	What must happen before "Soft" impact **becomes** "Hard" savings	**The Digester needs to come up on schedule, and the Pulp Dryer reliability and efficiency increases.**				

Who?

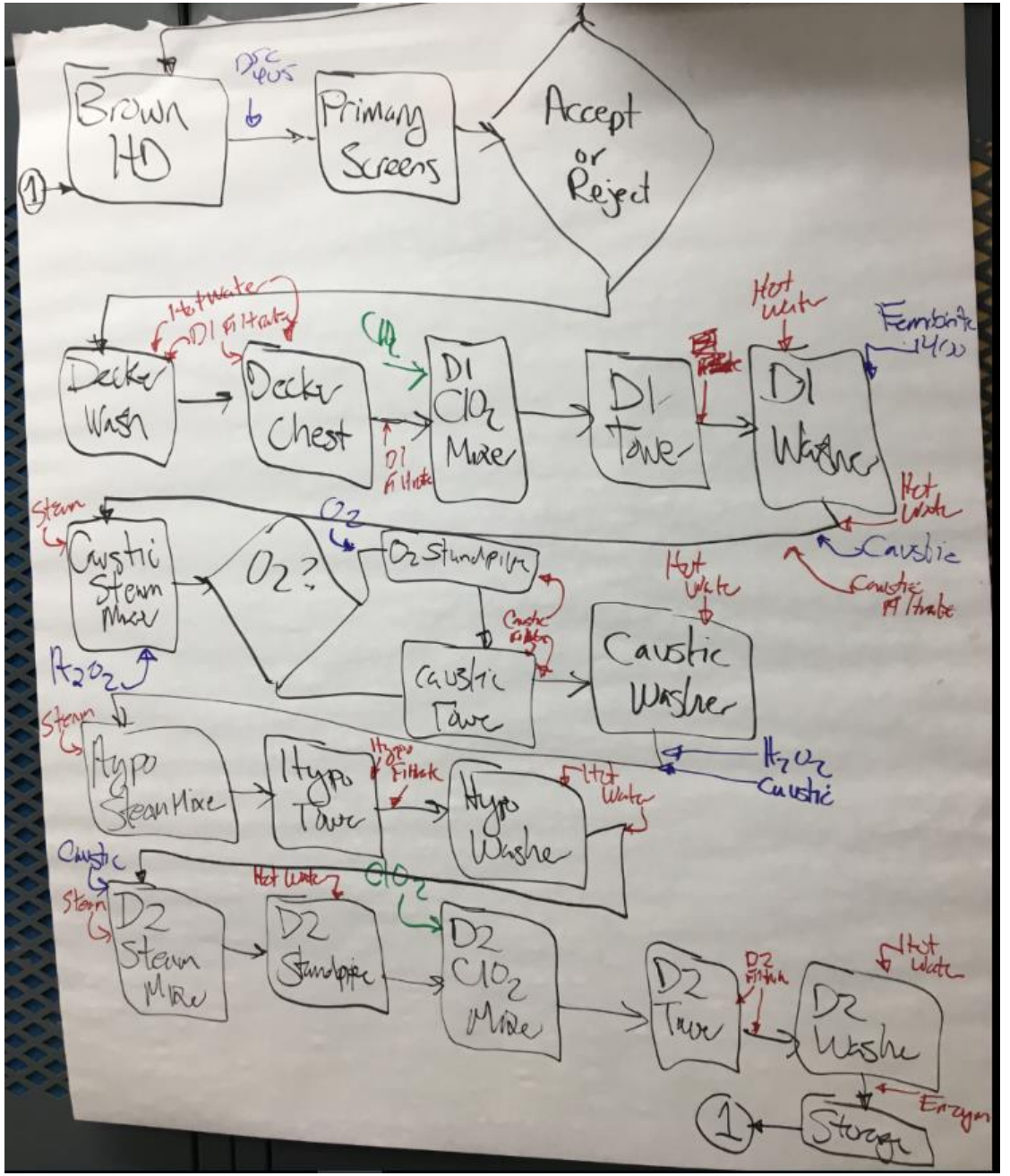
Team Members

Name	Email	Role	Department	Job Title
David Trzil	David.Trzil@clearwaterpaper.com	Project Leader	Pulp Mill	Senior Process Engineer
John Jacobs	John.Jacobs@clearwaterpaper.com	Champion	Pulp Mill, P&R	Operations Manager
Monte Visser	mvisser@mv-international.com	Mentor/Coach	MV-International	Six-Sigma Consultant
Nathan Smith	Nathan.Smith@clearwaterpaper.com	Financial Analyst	Finance	Manager
Ronald O Jones	RonaldO Jones <Ronald.Jones@clearwaterpaper.com>	Process Owner	Pulp Mill	Assistant Superintendent
Danielle Dotson	Danielle Dotson <Danielle.Dotson@clearwaterpaper.com>	Process Engineer	Pulp Mill	Process Engineer
Dareld Lookabill	Dareld Lookabill <Dareld.Lookabill@clearwaterpaper.com>	Sawdust Bleach Operator	Pulp Mill	Sawdust Bleach Operator
Tracy Hansel	Tracy Hansel <Tracy.Hansel@clearwaterpaper.com>	Bleach Assistant	Pulp Mill	Bleach Assistant

Scope

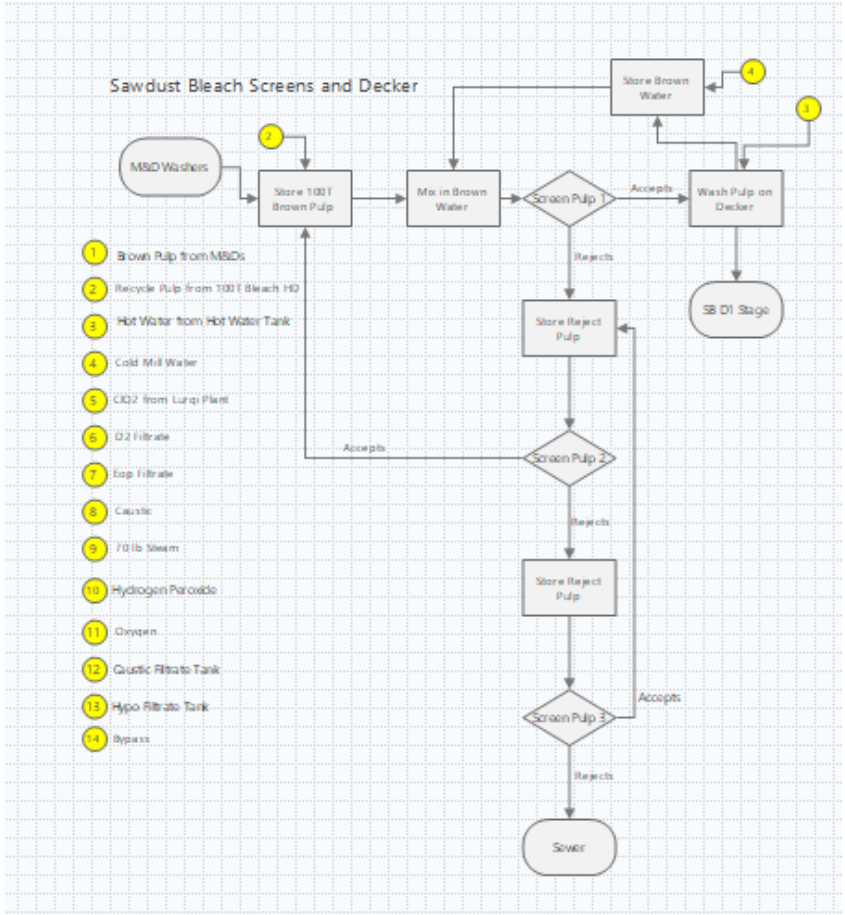

Scope
Capital Project
Raw Materials
- Wood
Fiberline
ClO2 Strength
Kappa
SB Production Rate
Conductivity - Both
Brightness Target
SB Chemicals
Washers + All Equip in SB
Maint, Inst. + Process Control
Change
Brightness
Based
on
Grade

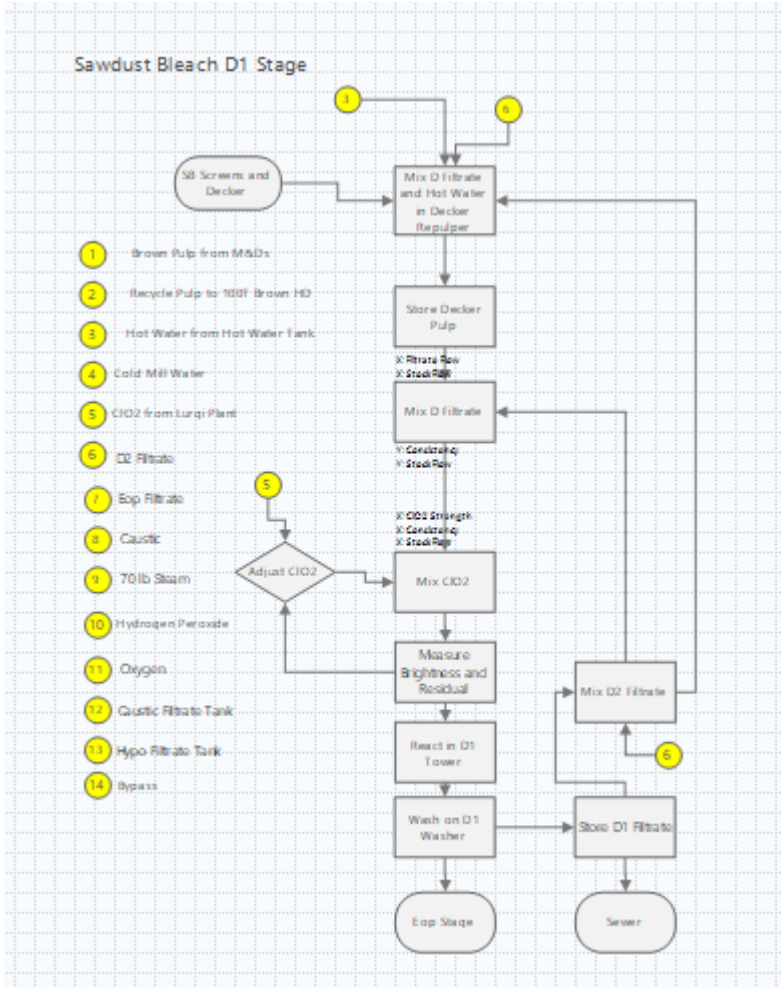
Process Map


Brown HD
Primary Screens
Accept or Reject
Decker Wash
Decker Chest
D1 ClO2 Mixer
D1 Tower
D1 Washer
Caustic Steam Mixer
O2?
O2 Standpipe
Caustic Tower
Caustic Washer
Hypo Steam Mixe
Hypo Tower
Hypo Washer
D2 Steam Mixe
D2 Standpipe
D2 ClO2 Mixe
D2 Tower
D2 Washe
Storage
Caustic
Hot Water
Enzym

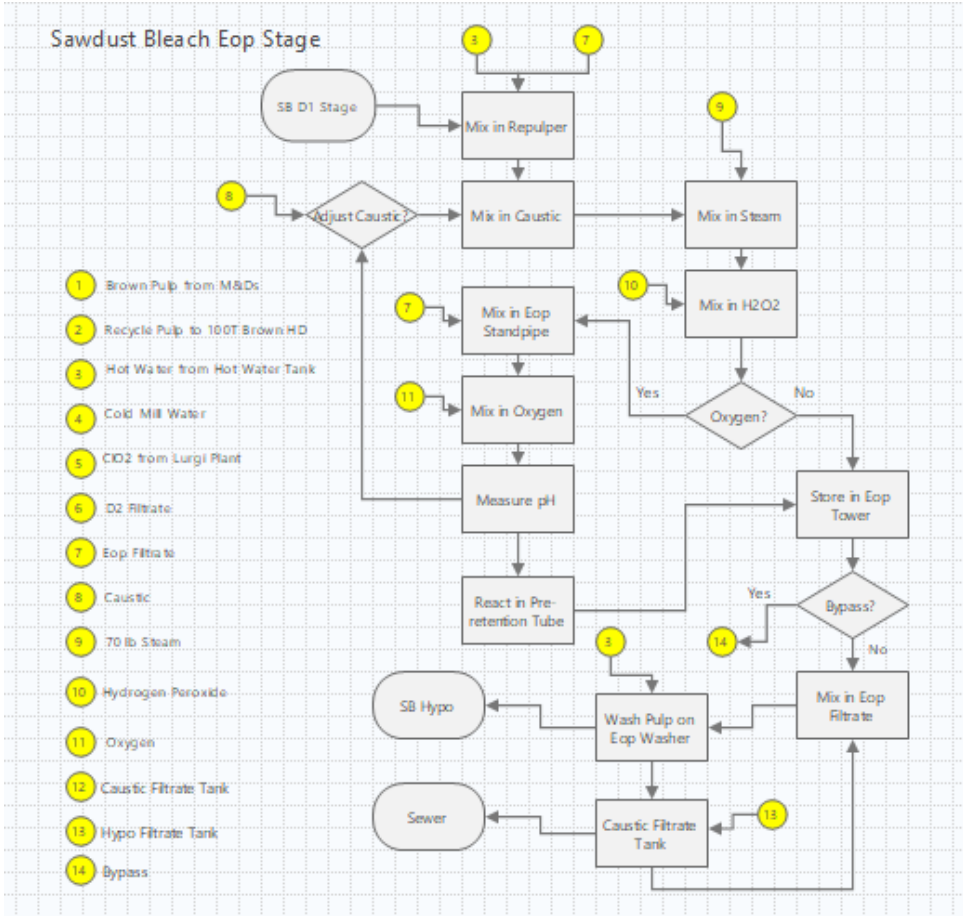
DMAIC - MEASURE

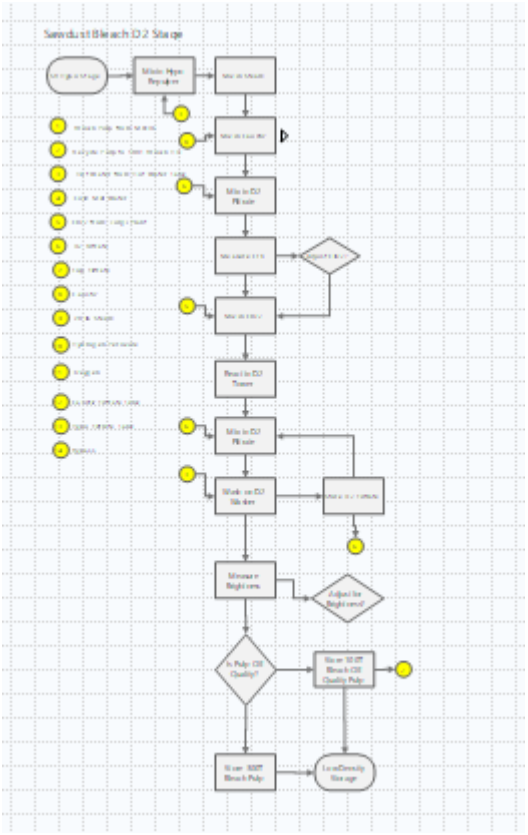
Process Map - refined



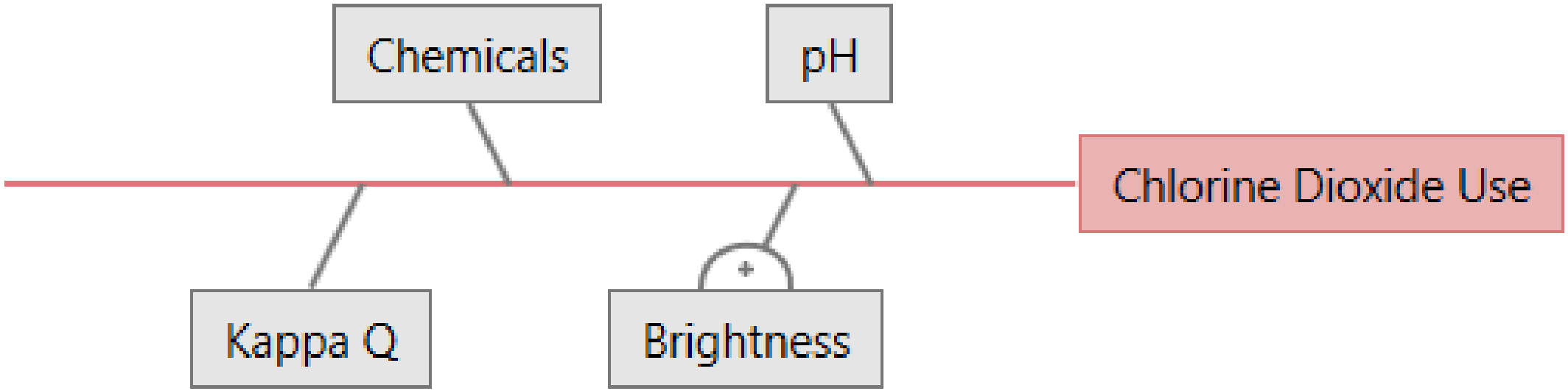


Process Map – refined (continued)



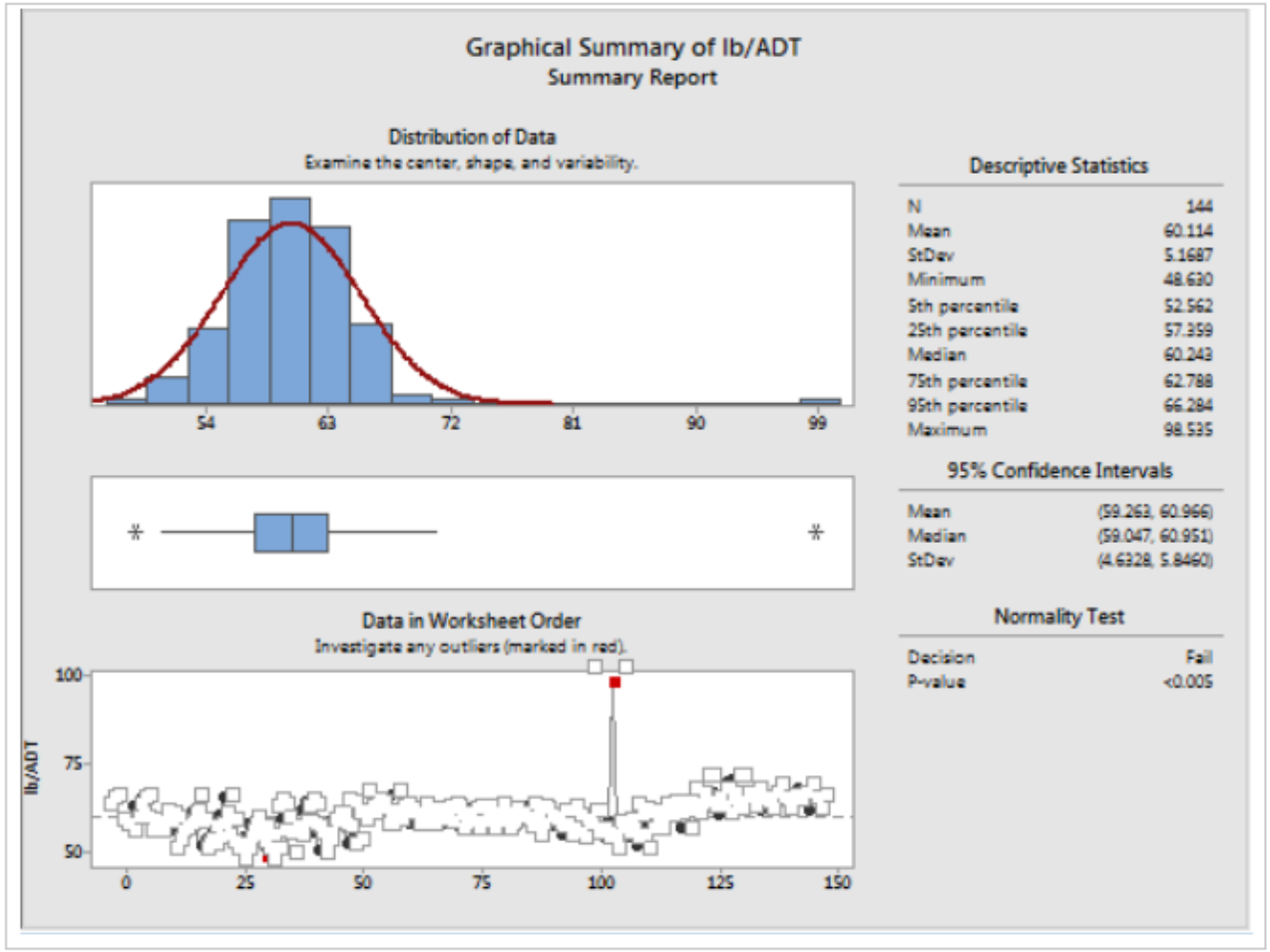


Fishbone Diagram



Primary Metric with outlier

Graphical Output:



Results

Observations:

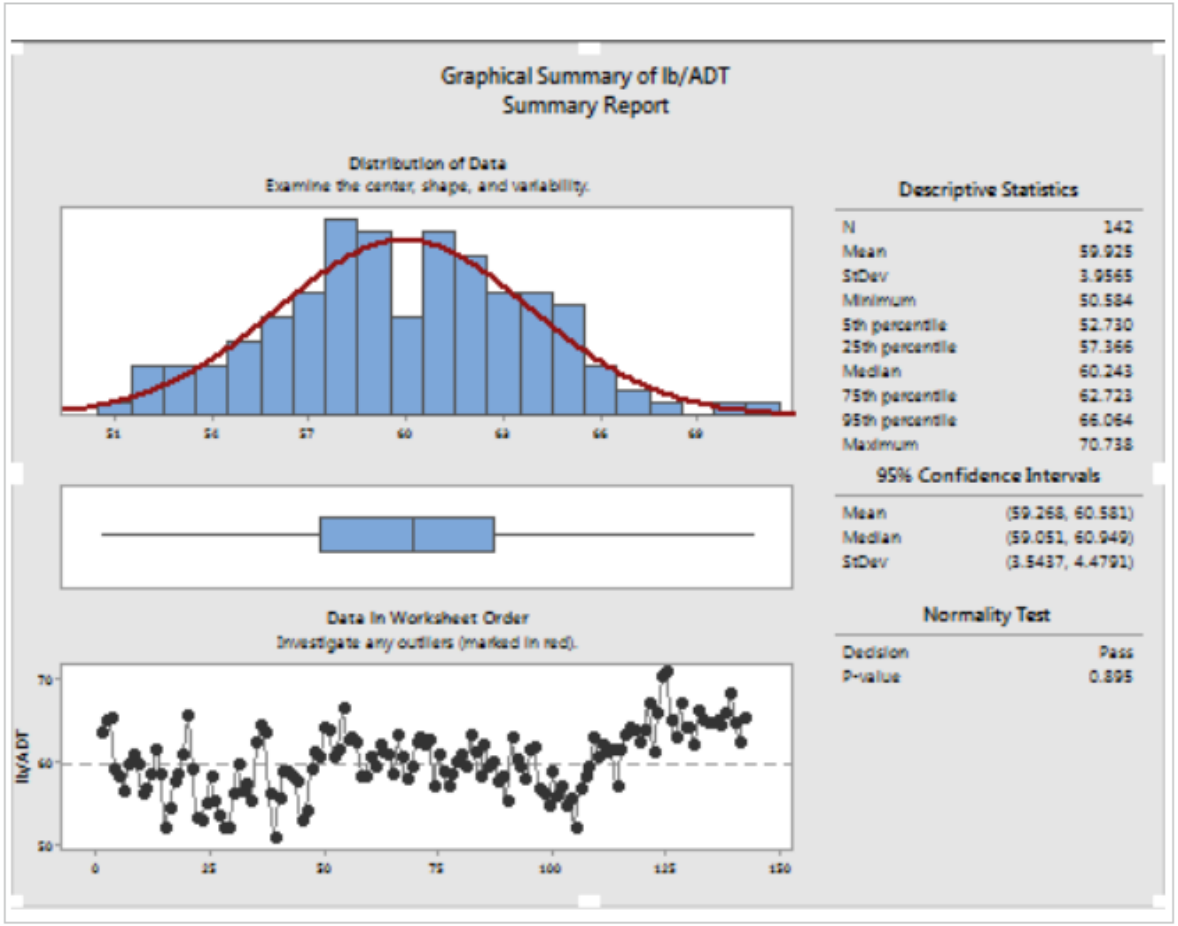
Outlier on 1-29 unknown cause but brightness is also low. Outlier on 4-12 due to down day, low production.

Next Steps:

Remove outlier and re-graph.

Primary Metric outlier removed

Graphical Output:



Results

Observations:

After sub-setting data to exclude 1-29, 4-12 outliers, normality test is a pass. Mean 59.9, SD 3.96

Next Steps:

Examine 1-29 outlier at team meeting and attempt to identify special cause.

DMAIC - ANALYZE

Could not show variation amongst crews

One-Way ANOVA for lb/ADT by Shift
Summary Report

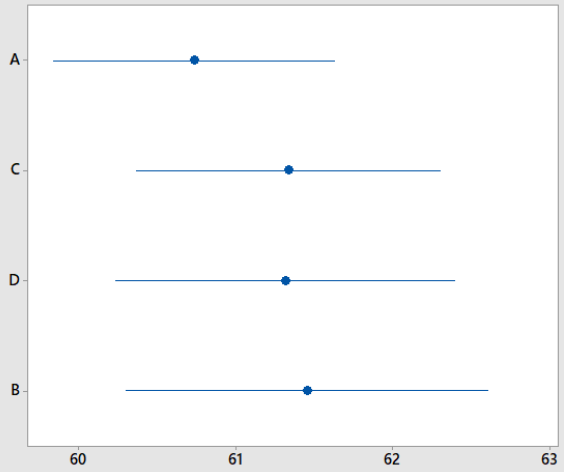
Do the means differ?

Differences among the means are not significant (p > 0.05).

Which means differ?

Sample	Differs from
A	
C	
D	None Identified
B	

Means Comparison Chart
Blue indicates there are no significant differences.

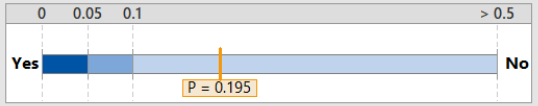


Comments

- Test: There is not enough evidence to conclude that there are differences among the means at the 0.05 level of significance.
- Comparison Chart: Blue intervals indicate that the means do not differ significantly.

Standard Deviations Test for lb/ADT by Shift
Summary Report

Do the standard deviations differ?

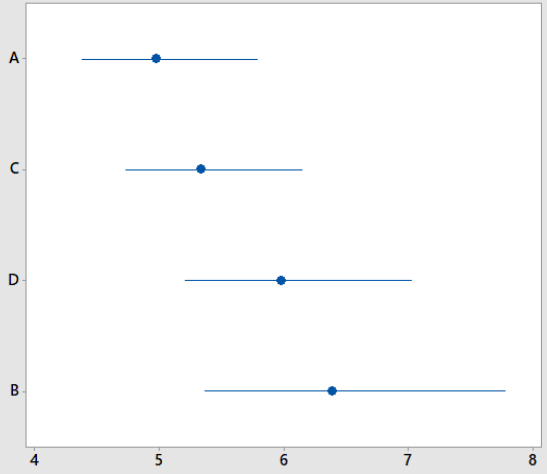


Differences among the standard deviations are not significant (p > 0.05).

Which standard deviations differ?

Shift	Differs from
A	
C	
D	None Identified
B	

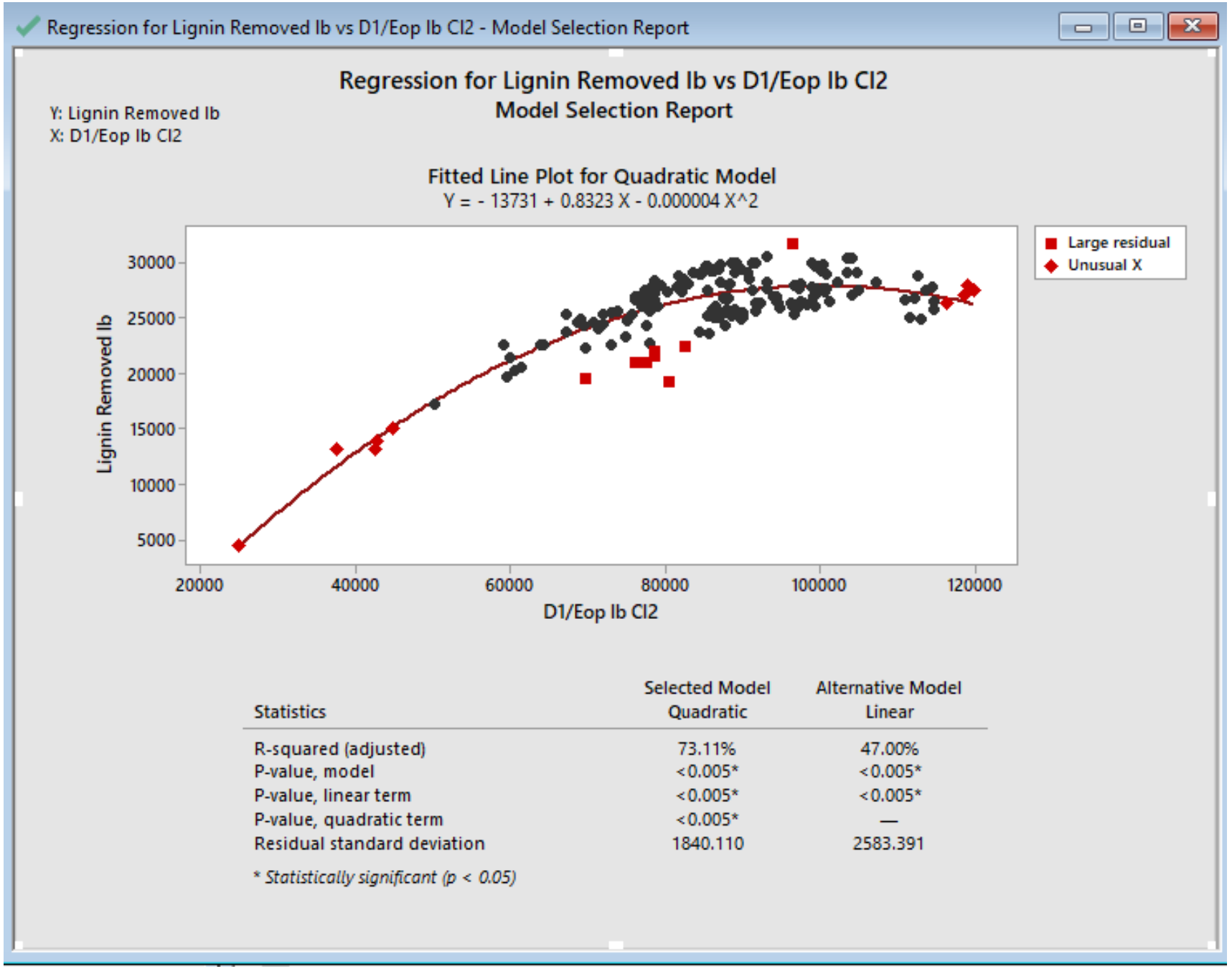
Standard Deviations Comparison Chart
Blue indicates there are no significant differences.



Comments

- Test: There is not enough evidence to conclude that there are differences among the standard deviations at the 0.05 level of significance.
- Comparison Chart: Blue intervals indicate that the standard deviations do not differ significantly.

Model Lignin Removal



Model D2

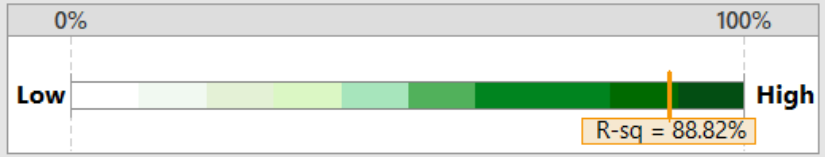
Regression for Lignin Remaining lb vs D2 ClO2 lb Cl2
Summary Report

Y: Lignin Remaining lb
X: D2 ClO2 lb Cl2

Is there a relationship between Y and X?

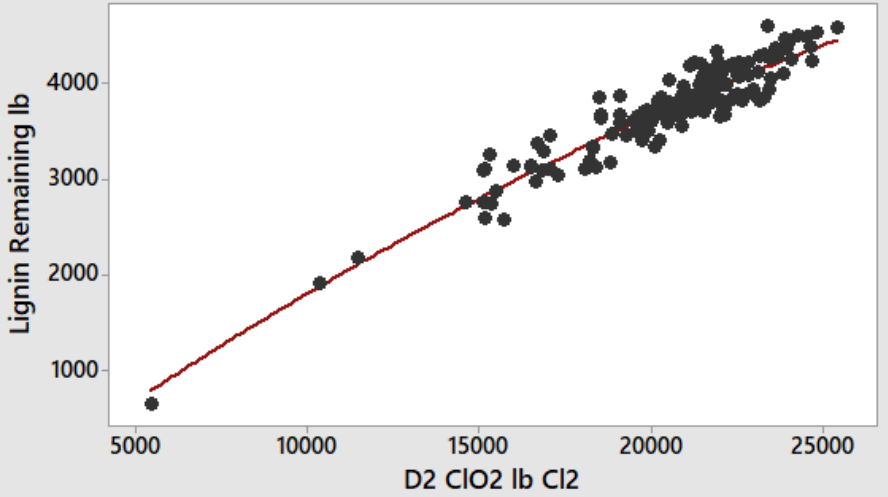
The relationship between Lignin Remaining lb and D2 ClO2 lb Cl2 is statistically significant (p < 0.05).

% of variation explained by the model



88.82% of the variation in Lignin Remaining lb can be explained by the regression model.

Fitted Line Plot for Quadratic Model
Y = - 553.6 + 0.2624 X - 0.000003 X^2



Comments

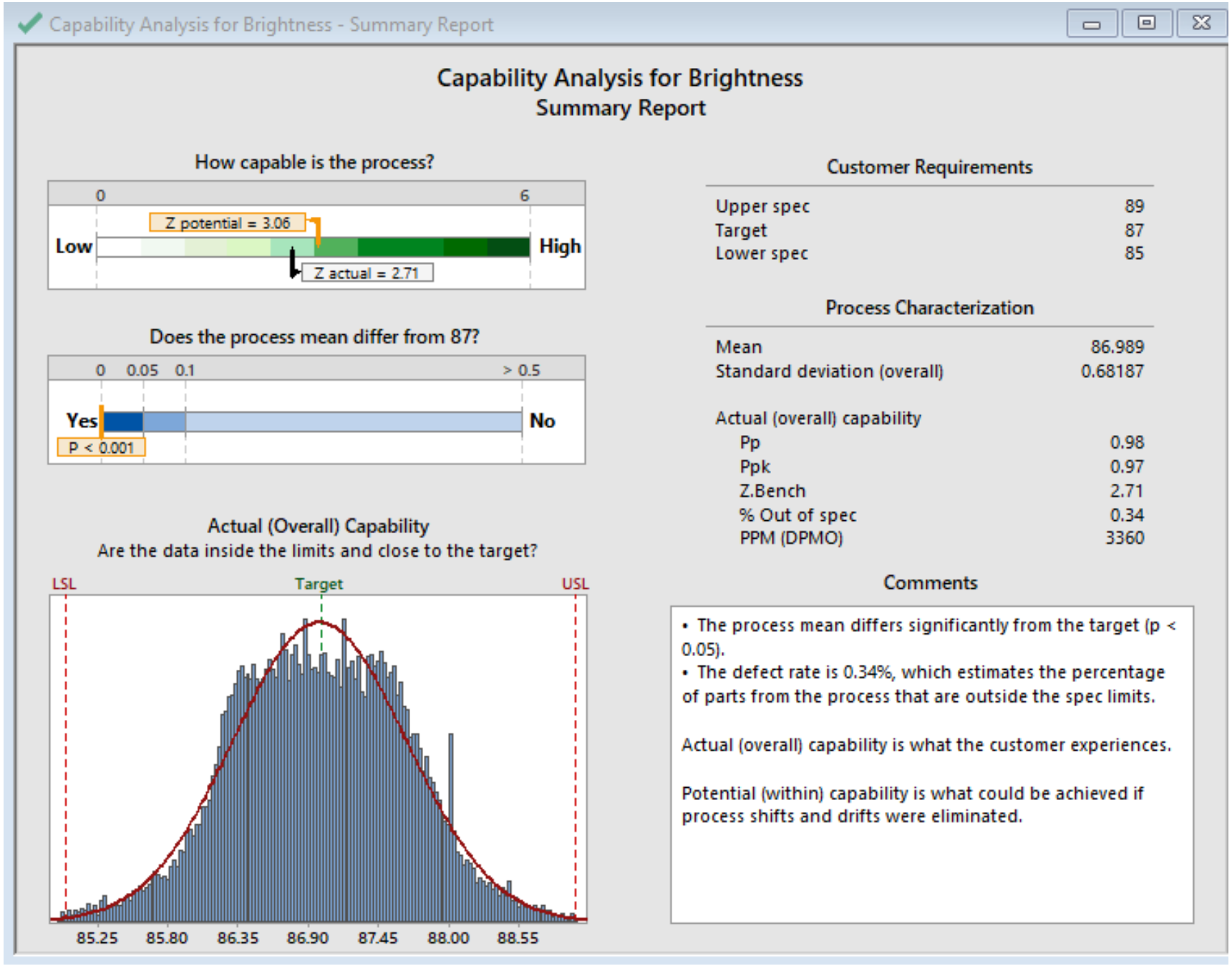
The fitted equation for the quadratic model that describes the relationship between Y and X is:

Y = - 553.6 + 0.2624 X - 0.000003 X^2

If the model fits the data well, this equation can be used to predict Lignin Remaining lb for a value of D2 ClO2 lb Cl2, or find the settings for D2 ClO2 lb Cl2 that correspond to a desired value or range of values for Lignin Remaining lb.

A statistically significant relationship does not imply that X causes Y.

Brightness Capability



DMAIC - IMPROVE

Greenbelt ClO_2 Reduction
TEMPORARY WORK INSTRUCTION

Print Copies on blue paper

Reason for Change: Greenbelt Team Goal to Reduce ClO_2 for New Digester

Department: Pulp Mill **Scope (Work Area): 70465**

Starting Date: 06-29-17 **Ending Date: 08-01-17**
(Typically no more than 90 days)

WI to be changed: NA **Approved by: David Trzil**

Approval Date: 06-29-17

With the new G2 digester coming on-line later this Fall, there is some concern that we will be short ClO_2 with the extra tonnage. A six-sigma greenbelt team was formed to see if we can reduce the ClO_2 usage. A "quick win" that the team came up with was to swap or adjust chemicals. In this case H_2O_2 for ClO_2. The table below takes us slowly down in D1 ClO_2 while raising Eop H_2O_2 by equal bleaching amounts. Please start working your way down the table to lower levels of ClO_2 usage. When we get to a kappa factor of 0.20 we will be running at 7.6 lb/ton less ClO_2 than we are today which is a big deal! Thanks!

D1 Kappa Factor	% H_2O_2	GPM H_2O_2	D1 lb/ton ClO_2
0.245	0.80	1.18	41.2
0.240	0.85	1.25	40.3
0.235	0.90	1.33	39.5
0.230	0.95	1.40	38.7
0.225	1.01	1.49	37.8
0.220	1.07	1.58	37.0
0.215	1.12	1.65	36.1
0.210	1.17	1.73	35.3
0.205	1.22	1.80	34.4
0.200	1.27	1.87	33.6

D1 and Eop O_2, H_2O_2 and ClO_2 Calculator

	Now	Future	
	Condition 1	Condition 2	Change
Kappa Factor	0.250	0.230	-0.02
Kappa	12.7	12.7	0.0
ClO_2 Strength	8.4	8.4	0.0
Production Rate	900	900	0
GPM ClO_2	215	198	-17
lb/min ClO_2	15.1	13.9	-1.2
O_2 lb/ton	12.2	12.2	
H_2O_2 lb/ton	19.5	21.0	
% H_2O_2	0.98%	1.05%	0.08%
lb/min O_2	7.6	7.6	
lb/min H_2O_2	12.2	13.1	0.9
lb/min O_2 as Cl_2	33.8	33.8	
lb/min H_2O_2 as Cl_2	25.4	27.3	2.0
lb/min ClO_2 as Cl_2	39.7	36.5	-3.2
lb/ton O_2 as Cl_2	54.1	54.1	
lb/ton H_2O_2 as Cl_2	40.6	43.7	
lb/ton ClO_2 as Cl_2	63.5	58.4	
Total H_2O_2 and ClO_2 as Cl_2	**104.1**	**102.1**	-2.0
Total O_2, H_2O_2 and ClO_2 as Cl_2	**158.2**	**156.2**	
D1 Kappa Factor - ClO_2/Kappa	**0.25**	**0.23**	
DEp Kappa Factor - (ClO_2 & H_2O_2)/Kappa	**0.41**	**0.40**	
DEop Kappa Factor - (ClO_2, H_2O_2 & O_2)/Kappa	**0.62**	**0.62**	

Green Belt ClO_2 Focus Items

1. Continue to Work with M&D Operators to hit D1 Feed Kappa = 21.0
2. Continue to Work to Hit D2 Brightness Target of 87.0
3. Continue to use Hydrogen Peroxide to Replace ClO_2
4. Kappa Q Controls are being tuned this week. We will give them a try…

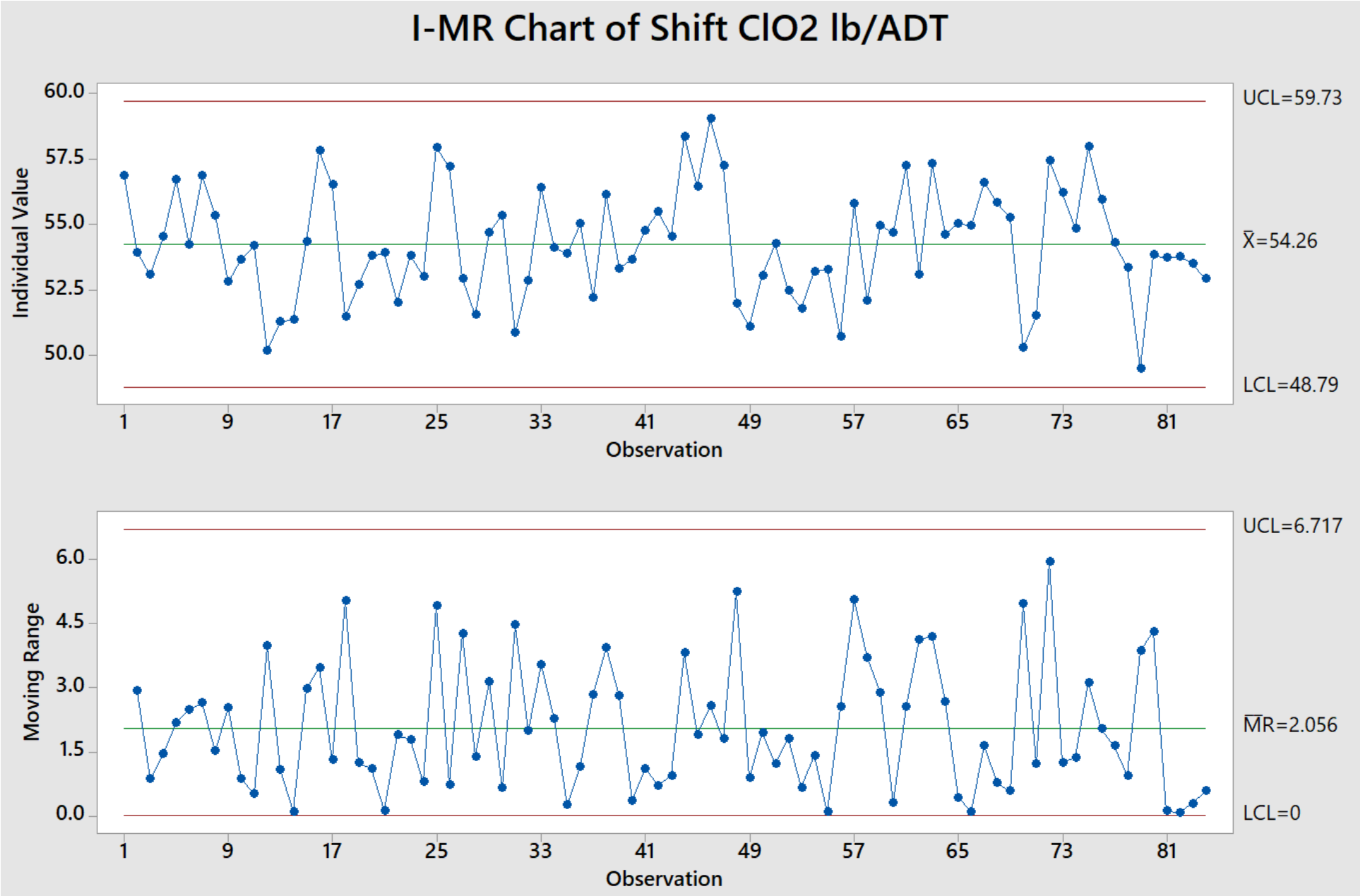
We have been at or below the Project Target recently – NICE WORK!!

DMAIC - CONTROL

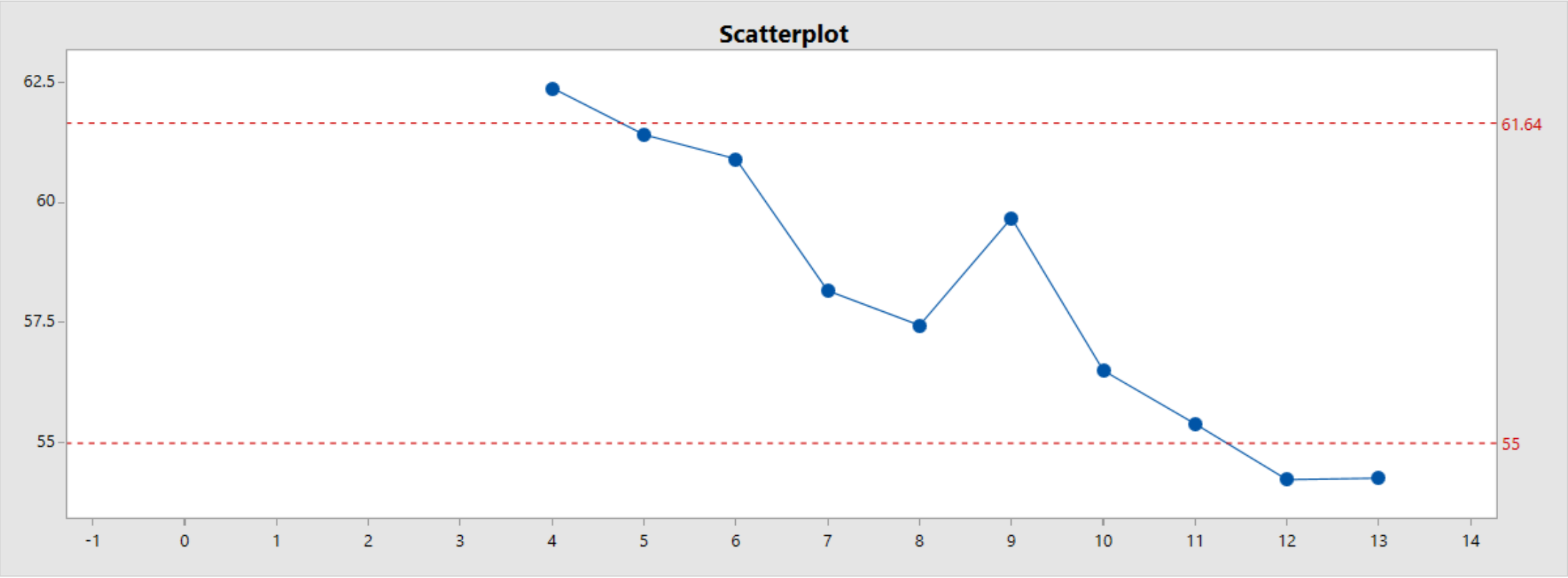
CONTROLS

- STANDARD WORK CHECK AND ADJUST
- CONTROL CHARTING BY HAND
- KAPPA Q CONTROL WORK REFINEMENT

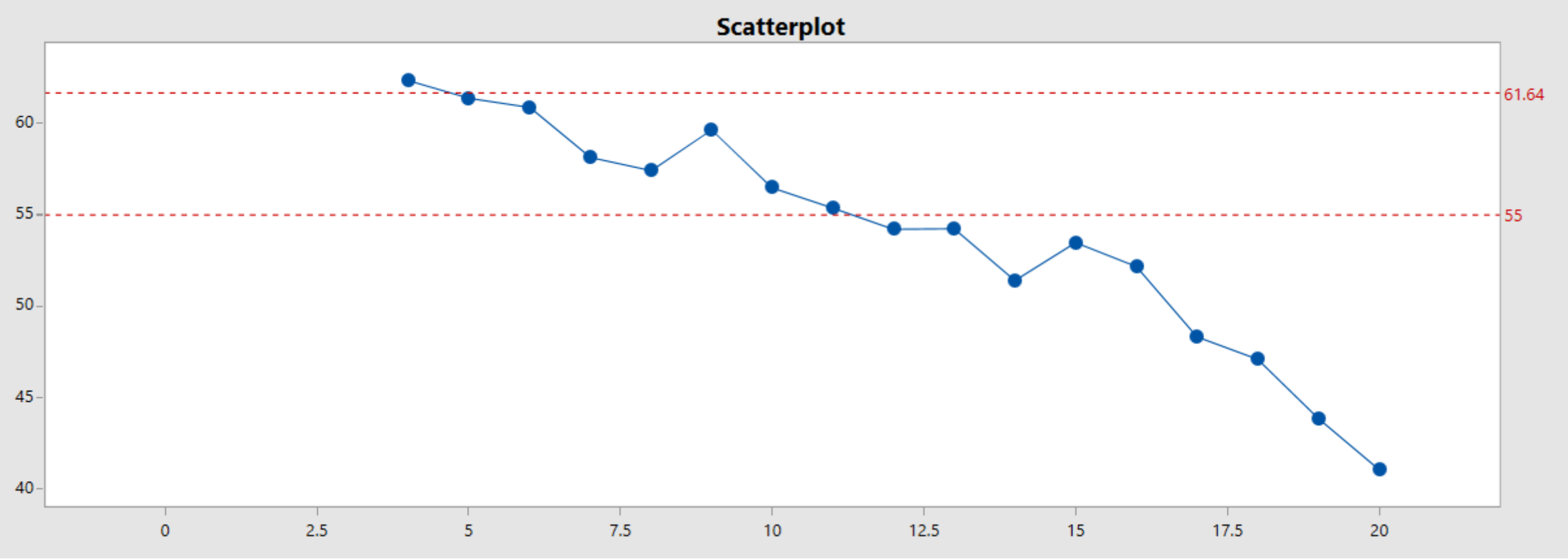
Control Chart Limits



ClO_2 Reduction gets to target



Add in Kappa Q Controls…



Conclusions and Gains

- Significantly reduced the chance of ClO_2 production bottleneck
- Increased operational flexibility
  - Higher kappa targets are an option
  - Week before last ran 90% of production rate on just 1 Lurgi plant
- More efficient with less chemical, less waste per ton to treatment
- Cost reduction