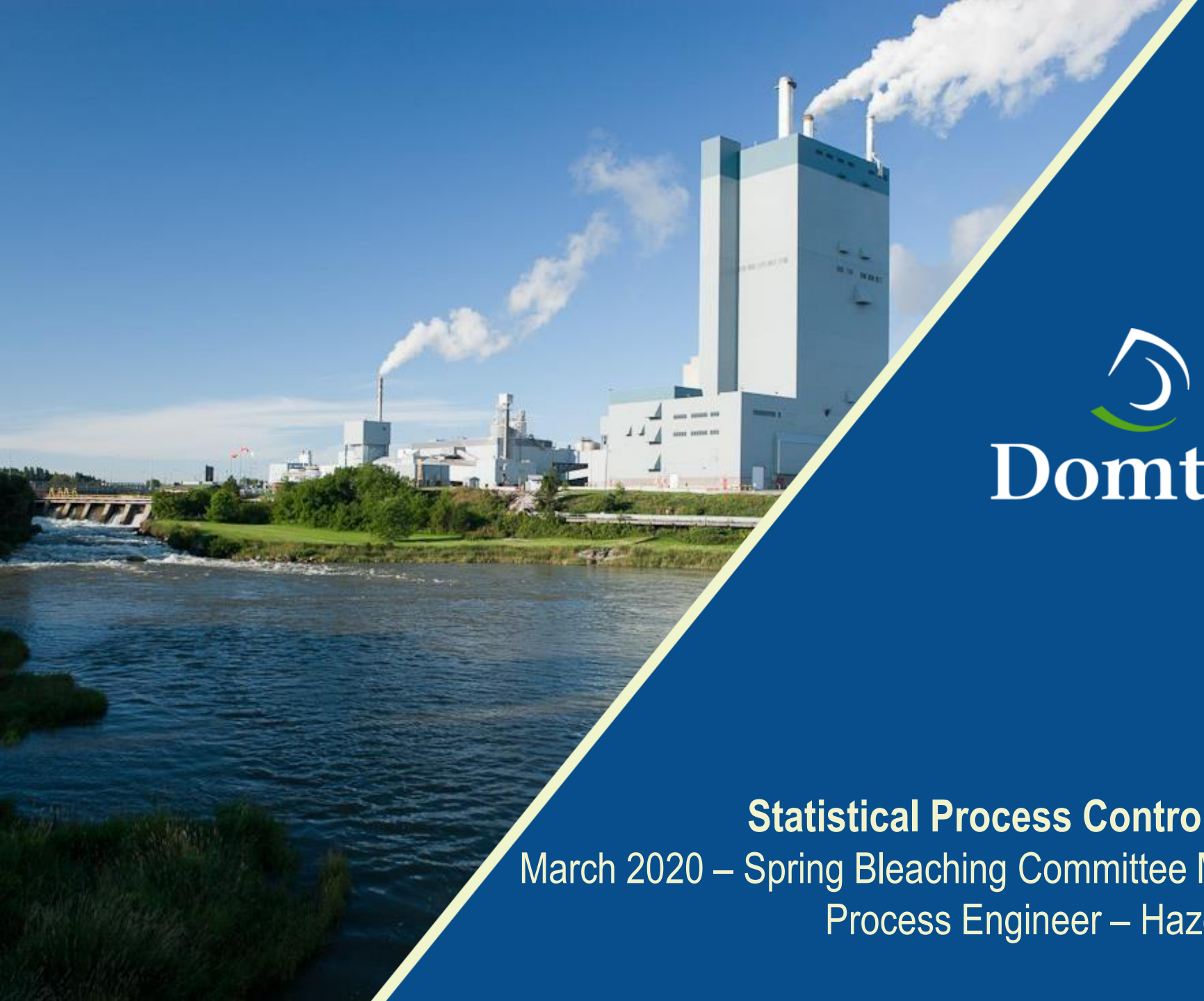


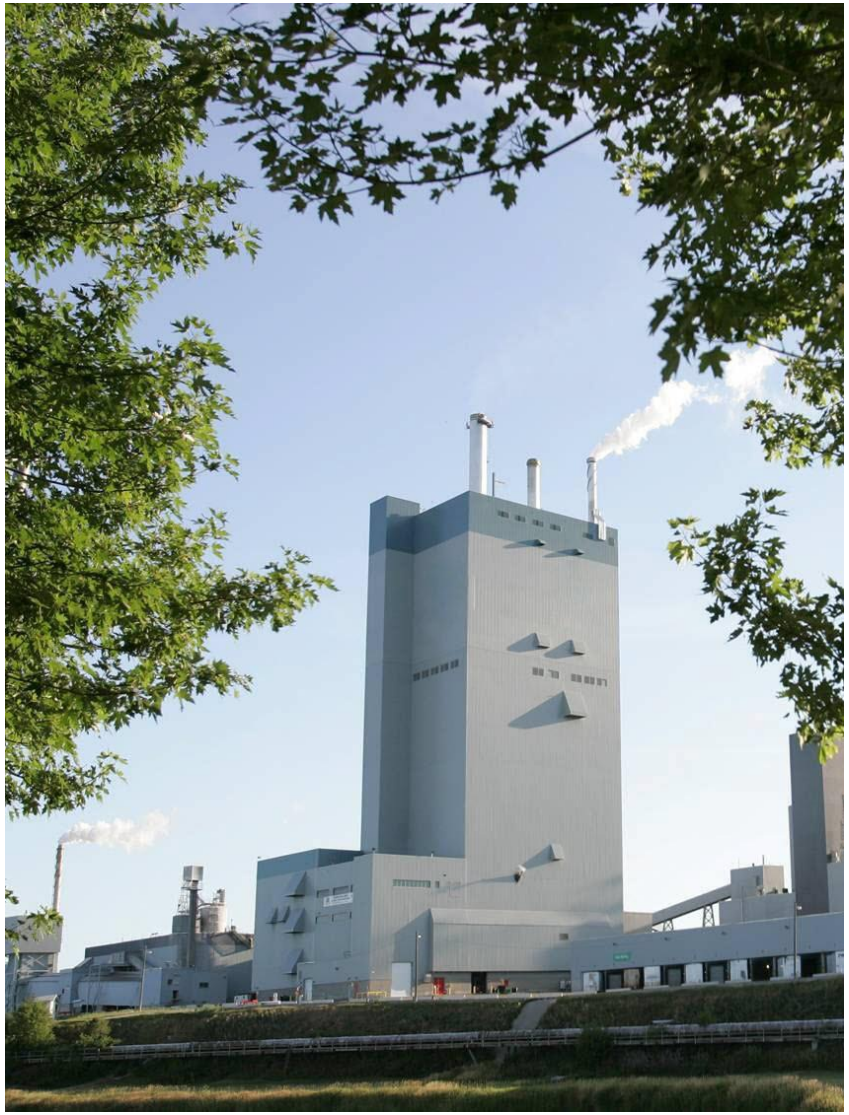
Domtar

Statistical Process Control (SPC)

March 2020 – Spring Bleaching Committee Meeting

Process Engineer – Hazel Babu

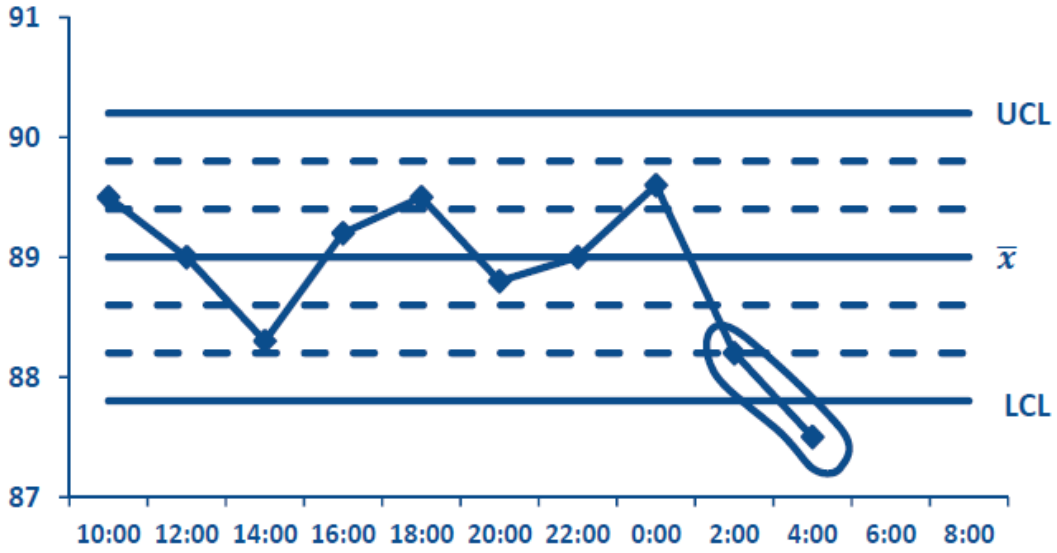
PRESENTATION AGENDA



- Historical Process Changes
- Continuous Improvement
- Plan
- Implementation
- Process Changes today
- Evaluation

STATISTICAL PROCESS CONTROL (SPC)

- SPC is a graph used to study how a process changes over time
- Data is plotted in real time
- Values on the charts are compared to “rules”, based on statistical analysis
- If a rule is violated, operators respond to violations with standardized responses
- Process values return back to the target range



WHY SPC?

To standardize operator response/reduce operator variability

To identify reasons for process variability

To reduce process variability

BEFORE 2016

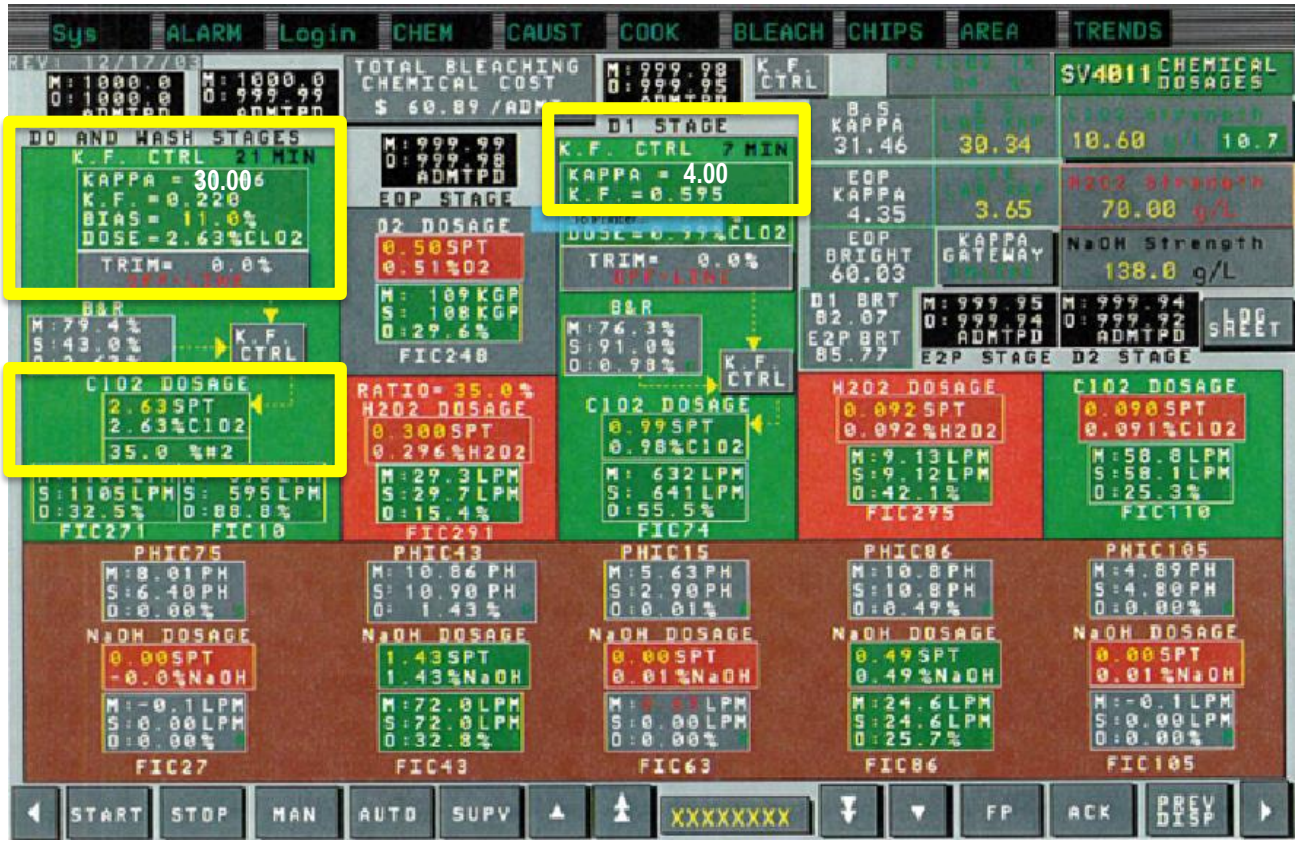
Bleach Plant Logsheet																				
	Upper Limit		80.00	125.00		87.00	75.00			11.00	62.00		5.61		5.00	40.00	3200.00	-200.00	15.00	1.60	1050.00
	Target		70.00	110.00	0.35	85.00	65.00			10.60	53.00		4.75	23.00	4.10	35.00		-300.00	0.00	1.10	705.00
	Lower Limit		60.00	60.00		78.00	60.00			10.20	44.00		3.46		2.81	28.00	1700.00	-375.00	-15.00	0.70	350.00
																EOP/D1					
	Start Time	EOP NaOH % (%)	EOP NaOH Flow (LPM)	Oxygen Flow (kg/h)	EOP H2O2 Dosage	EOP Steam Mixer Temp (C)	EOP Tower Level (%)	EOP pH (pH)	Eop Measured Temp (C)	Eop pH at 25C	EOP Bright (ISO)	EOP Residual (g/L)	EOP Kappa (Inst.) (Kappa)	EOP Kappa Water Temp (C)	EOP Kappa (Kappa)	Scrubber Weak Wash Flow (LPM)	Scrubber ReCirc Flow (LPM)	Scurbber Recirc ORP (mV)	D1 Kappa Factor Bias (%)	D1 ClO2 to Chem Mixer (%)	D1 ClO2 to Chem Mixer Flow (LPM)
	02-16-20 15:00																				
	02-16-20 16:00	1.48	76.00	111.00	0.30	82.00	65.00	9.80	77.00	10.74	50.50		4.59			49.00	1284.00	-426.00	-14.00	0.98	628.00
	02-16-20 17:00																				
	02-16-20 18:00	1.47	76.00	109.00	0.30	82.00	65.00	9.80	77.00	10.74			5.00			42.50	1282.00	-402.00	-14.00	1.04	657.00
	02-16-20 19:00																				
	02-16-20 20:00	1.45	76.00	112.00	0.30	82.00	65.00	9.90	75.00	10.82	51.70		4.80			41.60	1269.00	-436.00	-9.00	1.06	691.00
	02-16-20 21:00																				
	02-16-20 22:00	1.43	74.00	111.00	0.30	83.00	65.00	9.90	73.00	10.77			4.10			40.00	1304.00	-396.00	-9.00	0.96	654.00
	02-16-20 23:00																				
	02-17-20 00:00	1.31	68.00	110.00	0.30	82.00	65.00	9.90	77.00	10.87	51.00		4.22			39.90	1288.00	-396.00	-9.00	0.97	674.00
	02-17-20 01:00																				
	02-17-20 02:00	1.33	59.00	97.00	0.30	82.00	65.00	9.90	72.00	10.75			5.10			39.50	1272.00	-400.00	-6.00	1.16	706.00
	02-17-20 03:00																				
	02-17-20 04:00	1.27	56.00	97.00	0.30	82.00	66.00	9.70	74.00	10.54	51.10		5.14			40.50	1264.00	-400.00	-1.00	1.23	731.00
	02-17-20 05:00																				
	02-17-20 06:00																				
	02-17-20 07:00																				
	02-17-20 08:00	1.38	59.00	92.00		82.00	70.00	9.80	76.00	10.72	50.90		4.80			41.00	1246.00	-412.00	-1.00	1.16	626.00
	02-17-20 09:00																				
	02-17-20 10:00	1.36	58.00	92.00		82.00	68.00	9.70	74.00	10.54	53.20		3.93			41.00	1243.00	-426.00	-1.00	1.01	544.00
	02-17-20 11:00																				
	02-17-20 12:00	1.30	61.80	102.00	0.30	82.00	68.00	9.70	75.00	10.57	53.70		4.04			39.42	1245.00	-445.00	-1.00	1.02	645.00
	02-17-20 13:00																				
	02-17-20 14:00	1.36	65.00	103.00	0.30	82.00	68.00	9.70	76.00	10.59	54.20		3.80			40.80	1234.00	-463.00	-1.00	0.99	610.00

- Routine tests
- Process changes were based on operator experience
- Variability in process control, new operator training
- Over operating/under operating

EXAMPLE (PRE-2016)

Operator A

- Eop Kappa Target = 4.5
- Eop Kappa Test = 4.00
- Current D0 Bias = 11.0%
- Therefore, cut D0 Bias to 7.0-8.0%
  - Based on operator experience



Operator B

- If Incoming Kappa = 30.0
- Best operating range = 2.2 -2.4% CLO2 applied (D0)

Operator C

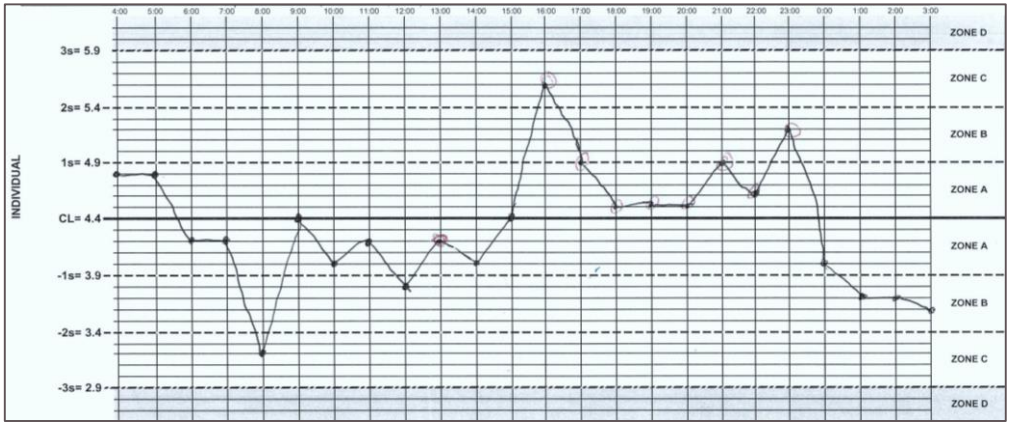
Look back at old paper logs to see how other operators handled similar situations

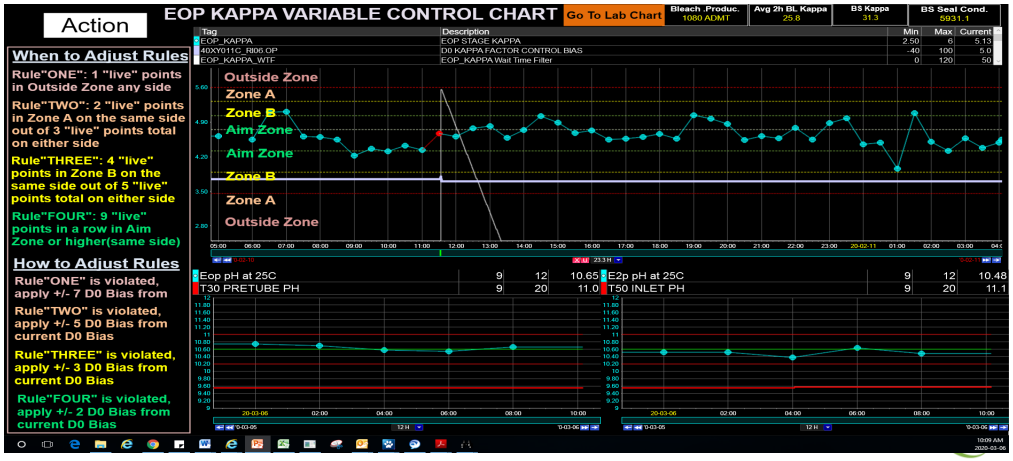
Opportunity to reduce operator variability!

STATISTICAL PROCESS CONTROL AT DRYDEN MILL

1. Change Logs (first gen. rules)
2. Paper logs
3. Excel Charts
4. Parcview SPC

Time	Operator	BL Kappa	K Factor	D0 Bias	EoP Kappa





Domtar

Domtar

BLEACH PLANT CHANGE LOG

DAYS

Date Time	Parameter	Initial Value	Final Value	Reason for Change
6:00	D_2 ClO_2 Dose	.21	.24	D2+E2 Bright low side
12:	D_2 ClO_2 Dose	.24	.22	D2+E2 Bright BACK
13:20	D_0 Bias	+5	0	rule 4, spc
3:00	E_0 P.H SET PT	10.7	10.8	
4:15	E_2 H_2O_2 Dose	.350	.320	E_2 Bright High
8:00	Eop H_2O_2 RATIO	327	302	Brown Stock Kappa Hi CANT KEEP UP MAKING H_2O_2
8:05	H_2O_2 Dose to E_2	.320	.30	E_2 Bright High
10:00	Eop H_2O_2 Dose	ON MAN	.750	H_2O_2 Tripping out.
11:00	D_0 BIAS	0	5	High EOP KAPPA AND RULE #4
3:00	D_0 BIAS	5	0	Low Eop KAPPA.
3:50	D_1 ClO_2 BIAS	16	14	D_1 High Bright
3:50	E_2 H_2O_2 DSE	.30	.25	E_2 Bright high
3:50	D_2 ClO_2 DOSE	.22	.20	D_0 Bright high

Form Reference	Revised	Hard Copies
None	7/15/2015	None - Print as needed

Domtar

D.

BLEACH PLANT OPPORTUNITY LOG

Date Time	What was the issue	What can be done to Eliminate / Minimize the issue
	E_2 P.H WILL NOT RUN ON AUTO.	

Form Reference	Revised	Hard Copies
None	7/15/2015	None- Print as needed

EOP KAPPA VARIABLE CONTROL CHART (I & MR)

Day Shift	Night Shift	AVERAGE	MOVING RANGE AVERAGE
OPERATOR	OPERATOR	UNIT OF MEASURE	

When To Adjust

I) **1** "live" point in **Zone D** (any side)

II) **2 out of 3** "live" points in **Zone C** or higher (same side) *MUST INCLUDE CURRENT "LIVE" POINT*

III) **4 out of 5** "live" points in **Zone B** or higher (same side) *MUST INCLUDE CURRENT "LIVE" POINT*

IV) **8** "live" points in a row in **Zone A** or higher (same side) *MUST INCLUDE CURRENT "LIVE" POINT*

Note When bleach plant production is back to be equal or greater than 975 tpd, please set the D0 Bias at 0 and start the charting

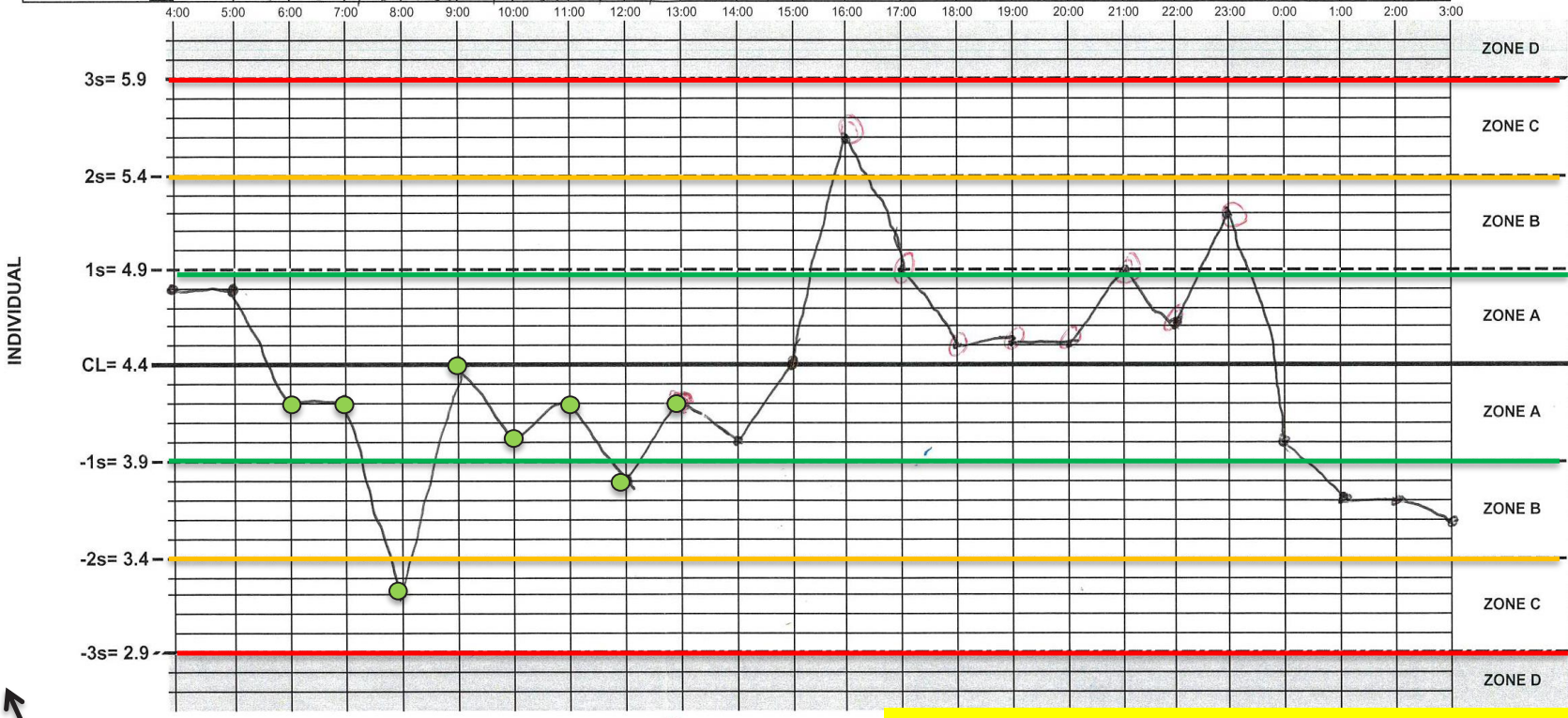
Chemical Change Lag Times: 2 hours

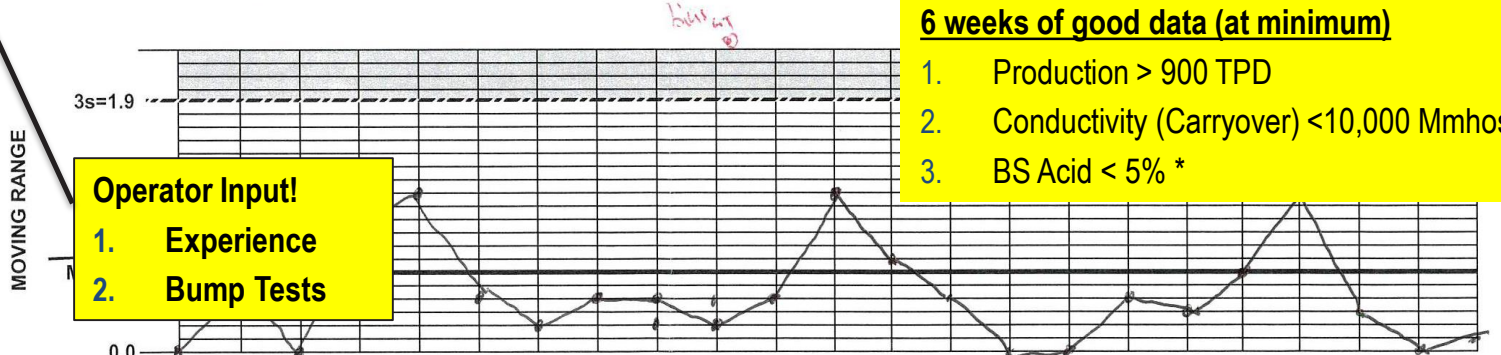
Rule of Thumb:

1. If Rule "ONE" is violated, apply +/- 15% D0 Bias.
2. If Rule "TWO" is violated, apply +/- 10% D0 Bias.
3. If Rule "Three" is violated, apply +/- 5% Bias
4. If Rule "Four" is violated, set the D0 Bias at 0% or remain D0 Bias at 0%.

DATE Sept 12 /16

Time	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00	1:00	2:00	3:00
Bleach Production	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
D0 Bias	5	5	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	5	5	5	5
EOP Kappa	4.8	4.8	4.2	4.2	3.2	4.4	4	4.2	3.8	4.2	4.0	4.4	5.6	4.9	4.5	4.5	4.5	4.5	4.6	5.2	4.0	3.7	3.7	3.6
Moving Range	0	.6	0	1.0	1.2	.4	.2	.4	.4	.2	.4	.12	.7	.4	0	0	.4	.5	.6	.12	.3	0	.1	





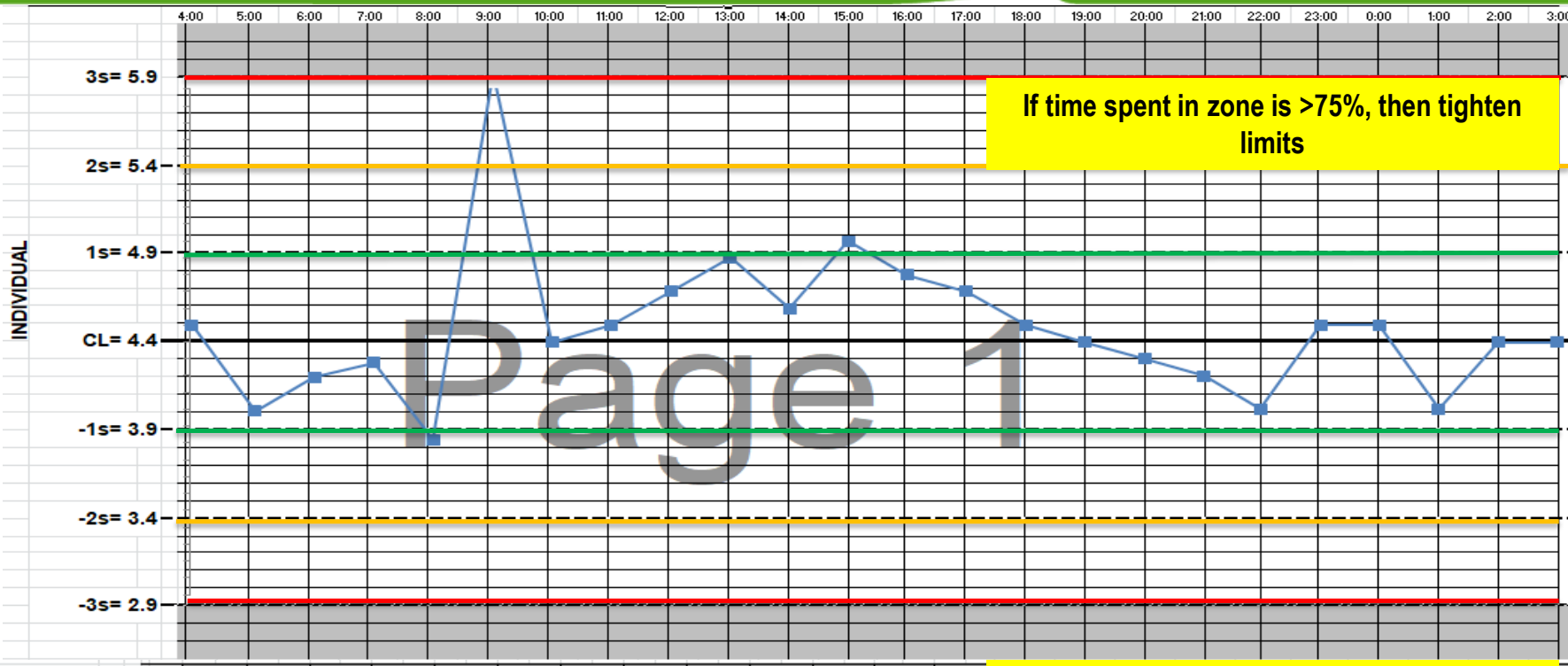
Operator Input!

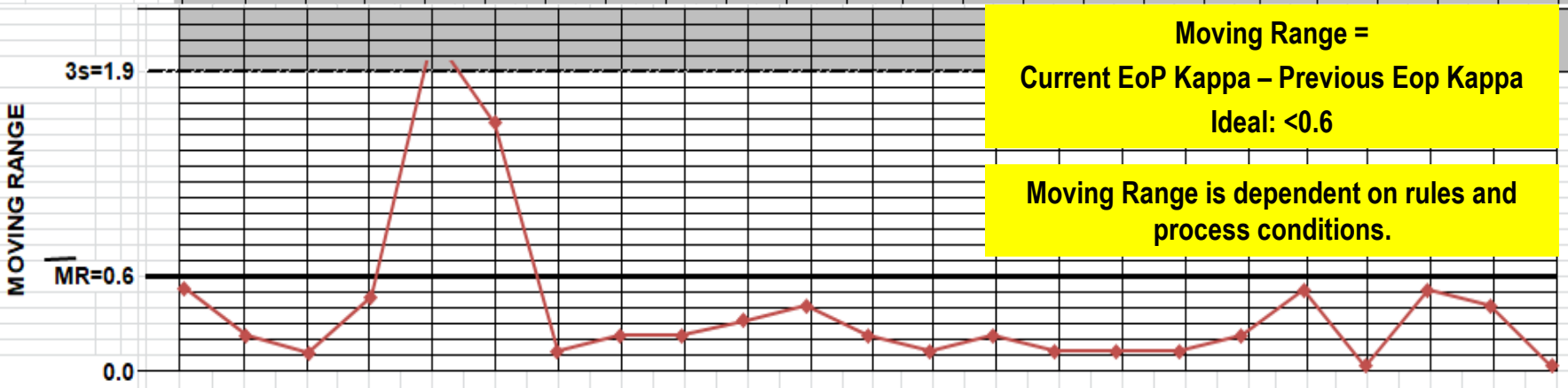
1. **Experience**
2. **Bump Tests**

6 weeks of good data (at minimum)

1. Production > 900 TPD
2. Conductivity (Carryover) <10,000 Mmhos
3. BS Acid < 5% *

ITERATIONS





If time spent in zone is >75%, then tighten limits

Moving Range =
Current EoP Kappa – Previous Eop Kappa
Ideal: <0.6

Moving Range is dependent on rules and process conditions.

STATISTICAL PROCESS CONTROL – EOP KAPPA

Action

When to Adjust Rules

Rule"ONE": 1 "live" points in Outside Zone any side

Rule"TWO": 2 "live" points in Zone A on the same side out of 3 "live" points total on either side

Rule"THREE": 4 "live" points in Zone B on the same side out of 5 "live" points total on either side

Rule"FOUR": 9 "live" points in a row in Aim Zone or higher(same side)

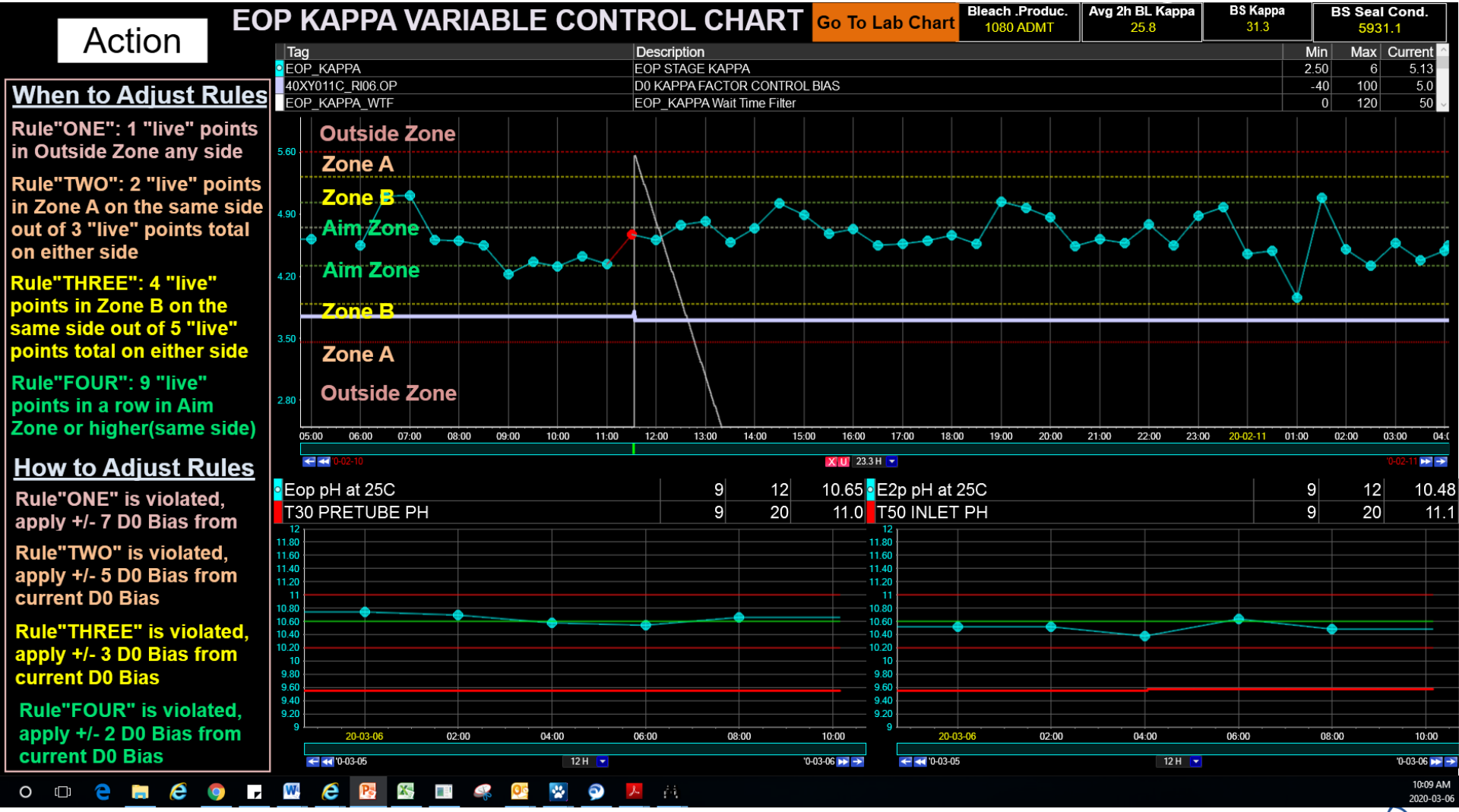
How to Adjust Rules

Rule"ONE" is violated, apply +/- 7 D0 Bias from

Rule"TWO" is violated, apply +/- 5 D0 Bias from current D0 Bias

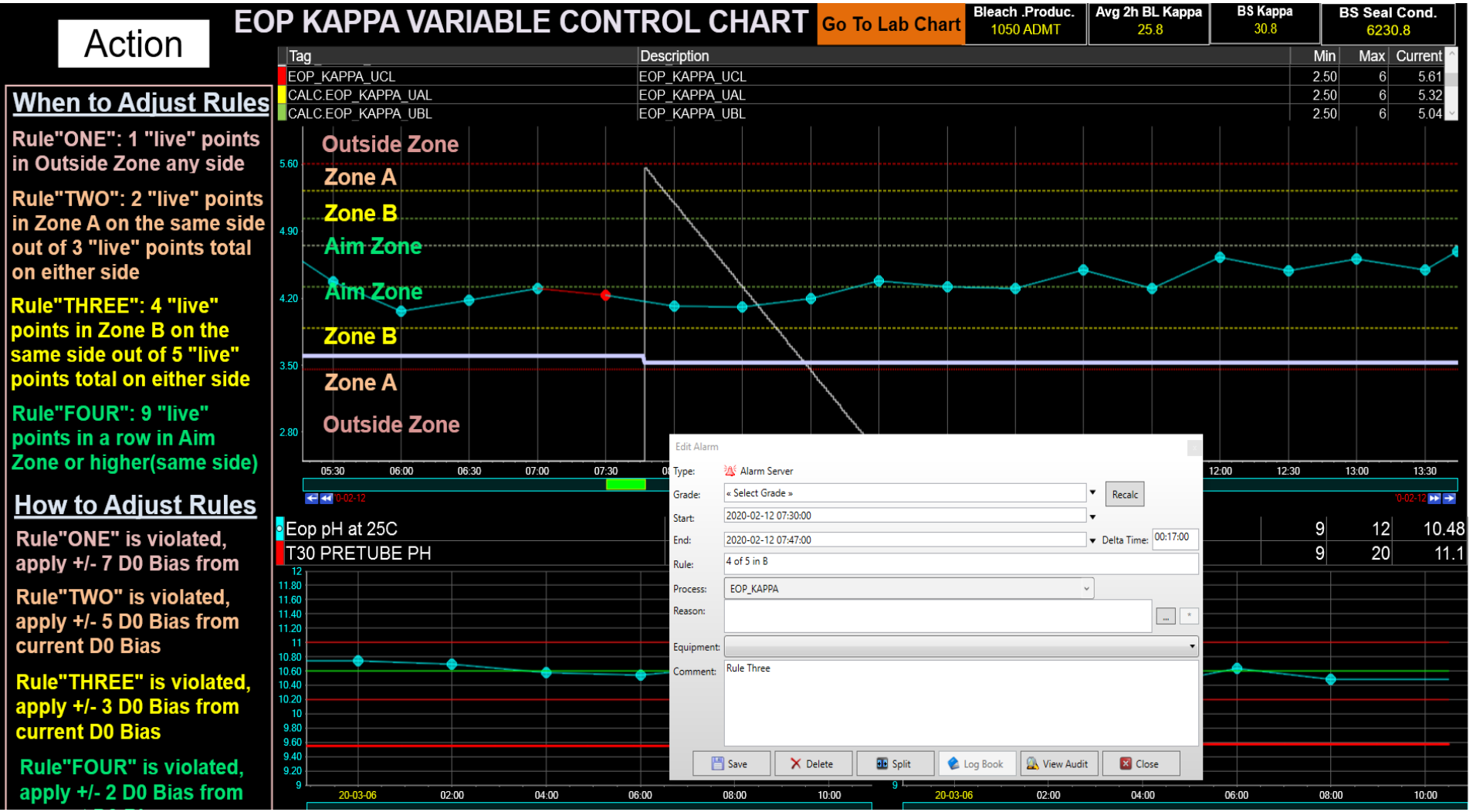
Rule"THREE" is violated, apply +/- 3 D0 Bias from current D0 Bias

Rule"FOUR" is violated, apply +/- 2 D0 Bias from current D0 Bias



Domtar

ALARMS, WAIT TIME FILTER AND OPERATOR ACKNOWLEDGMENTS



Domtar

ALARMS, WAIT TIME FILTER AND OPERATOR ACKNOWLEDGMENTS

Action

When to Adjust Rules

Rule"ONE": 1 "live" points in Outside Zone any side

Rule"TWO": 2 "live" points in Zone A on the same side out of 3 "live" points total on either side

Rule"THREE": 4 "live" points in Zone B on the same side out of 5 "live" points total on either side

Rule"FOUR": 9 "live" points in a row in Aim Zone or higher(same side)

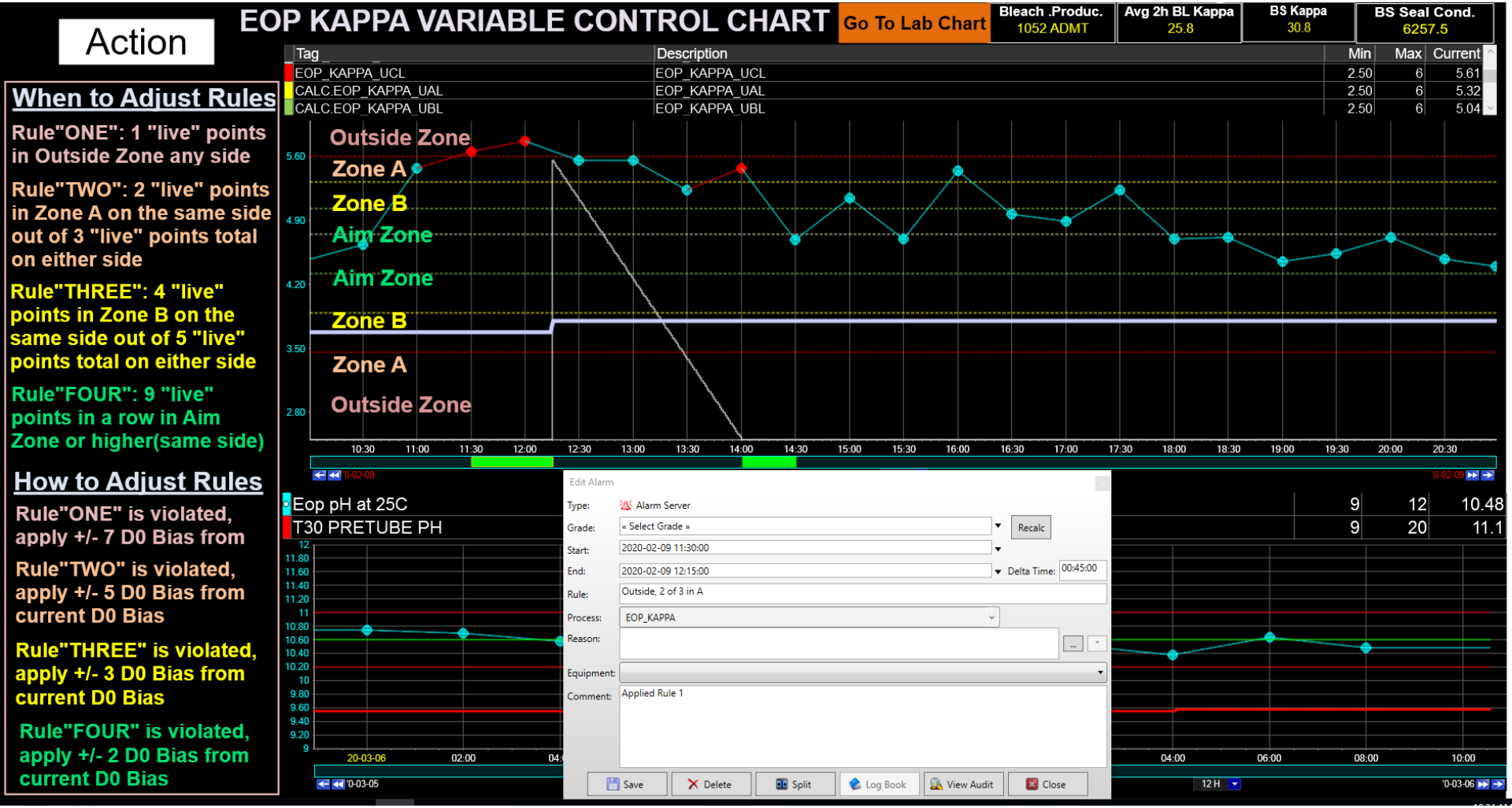
How to Adjust Rules

Rule"ONE" is violated, apply +/- 7 D0 Bias from

Rule"TWO" is violated, apply +/- 5 D0 Bias from current D0 Bias

Rule"THREE" is violated, apply +/- 3 D0 Bias from current D0 Bias

Rule"FOUR" is violated, apply +/- 2 D0 Bias from current D0 Bias



Domtar

STATISTICAL PROCESS CONTROL – D1/D2 BRIGHT

Action

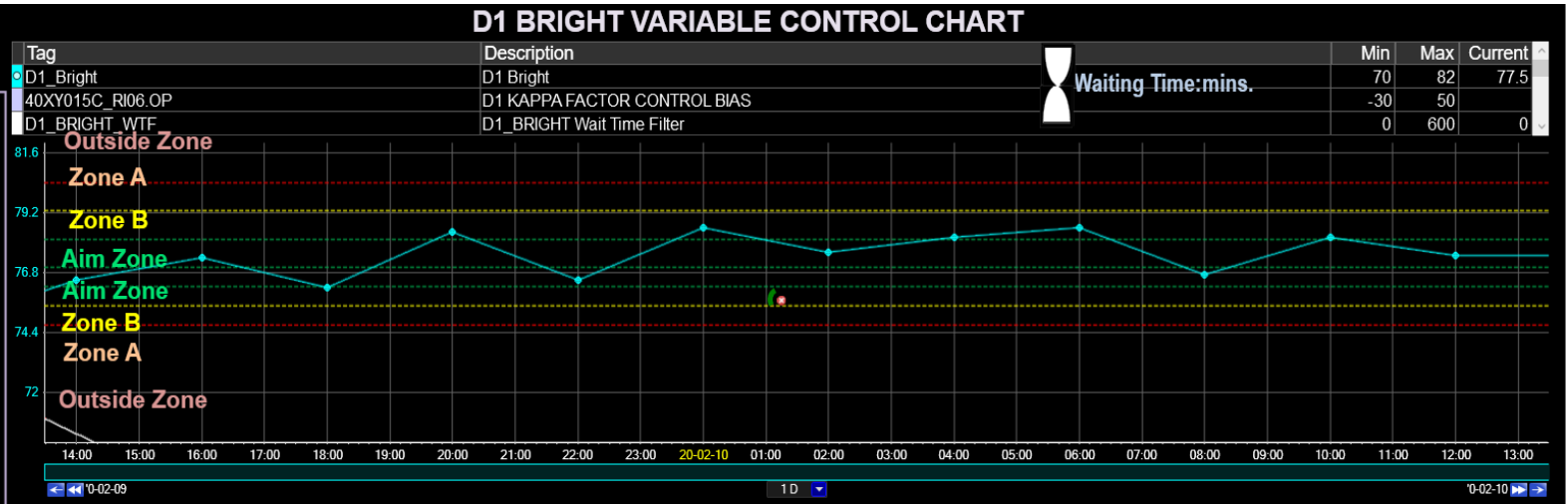
How to Adjust D1 Rules

Rule"ONE" is violated, apply +/- 5 bias D1 Bias from current D1 Bias

Rule"TWO" is violated, apply +/- 3 bias D1 Bias from current D1 Bias

Rule"THREE" is violated, apply +/- 2 bias D1 Bias from current D1 Bias

Rule"FOUR" is violated, apply +/- 1 bias D1 Bias from current D1 Bias



Action

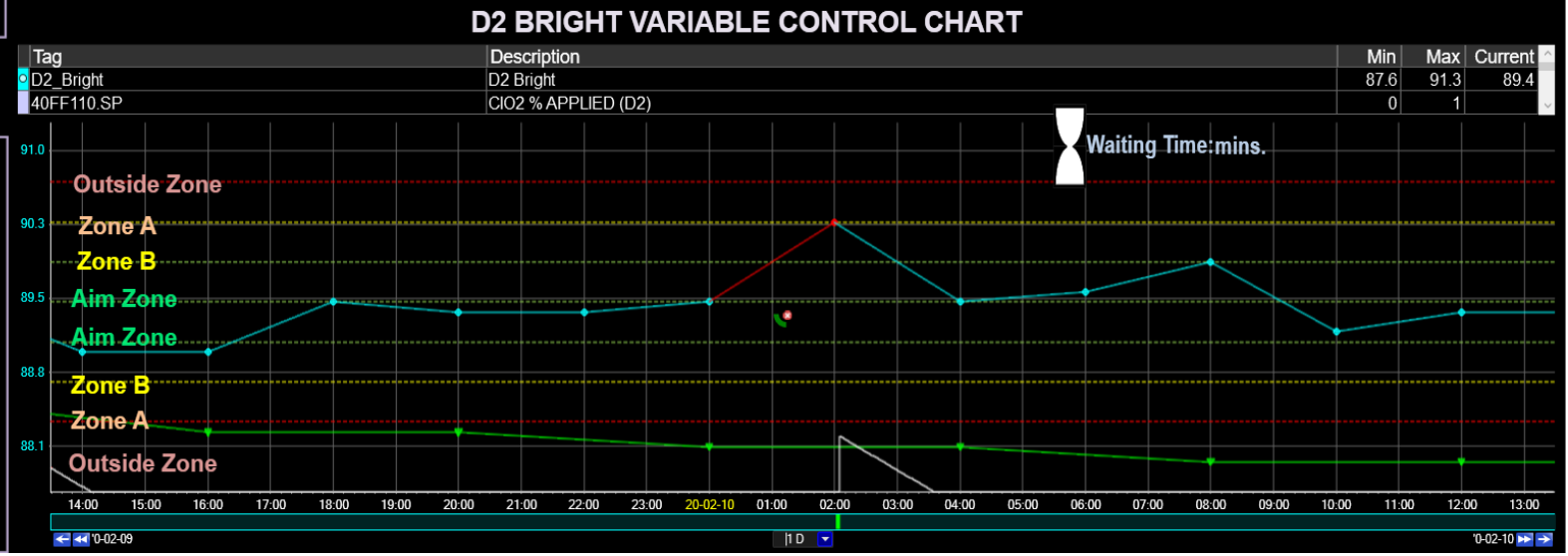
How to Adjust D2 Rules

Rule"ONE" is violated, apply +/- 0.02 % D2 ClO2

Rule"TWO" is violated, apply +/- 0.015 % D2 ClO2

Rule"THREE" is violated, apply +/- 0.01 % D2 ClO2

Rule"FOUR" is violated, apply +/-0.005 % D2 ClO2

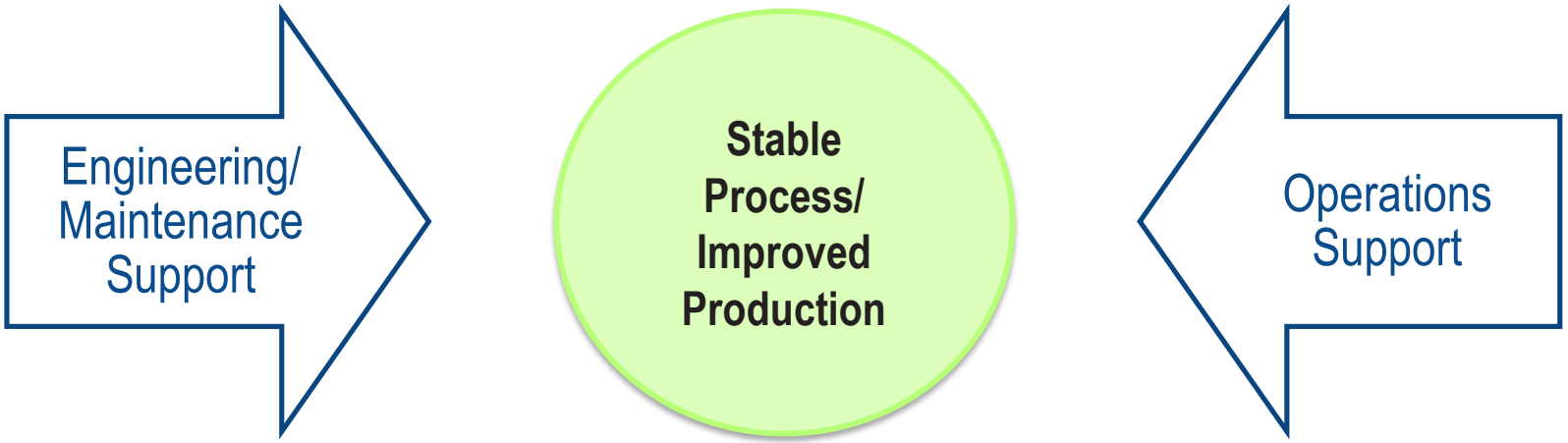


OPERATOR BUY IN?

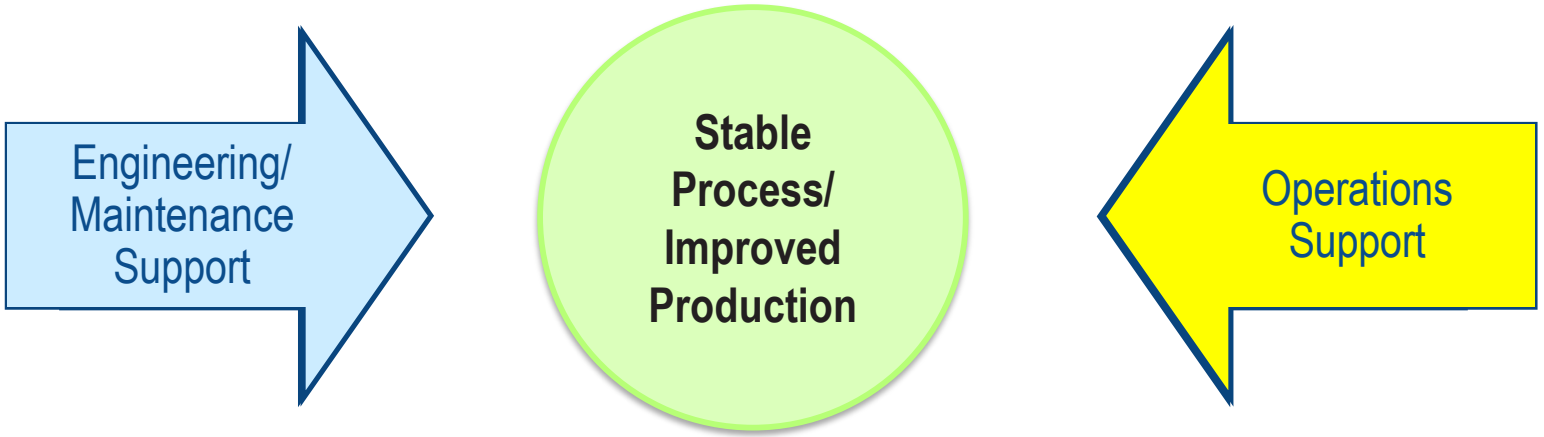
Challenge: How do we get operator support on this continuous improvement initiative?

- Some operators have 30-40 years experience
- Challenging routines and patterns

Used this project as an opportunity to build a stronger relationship with the operating team



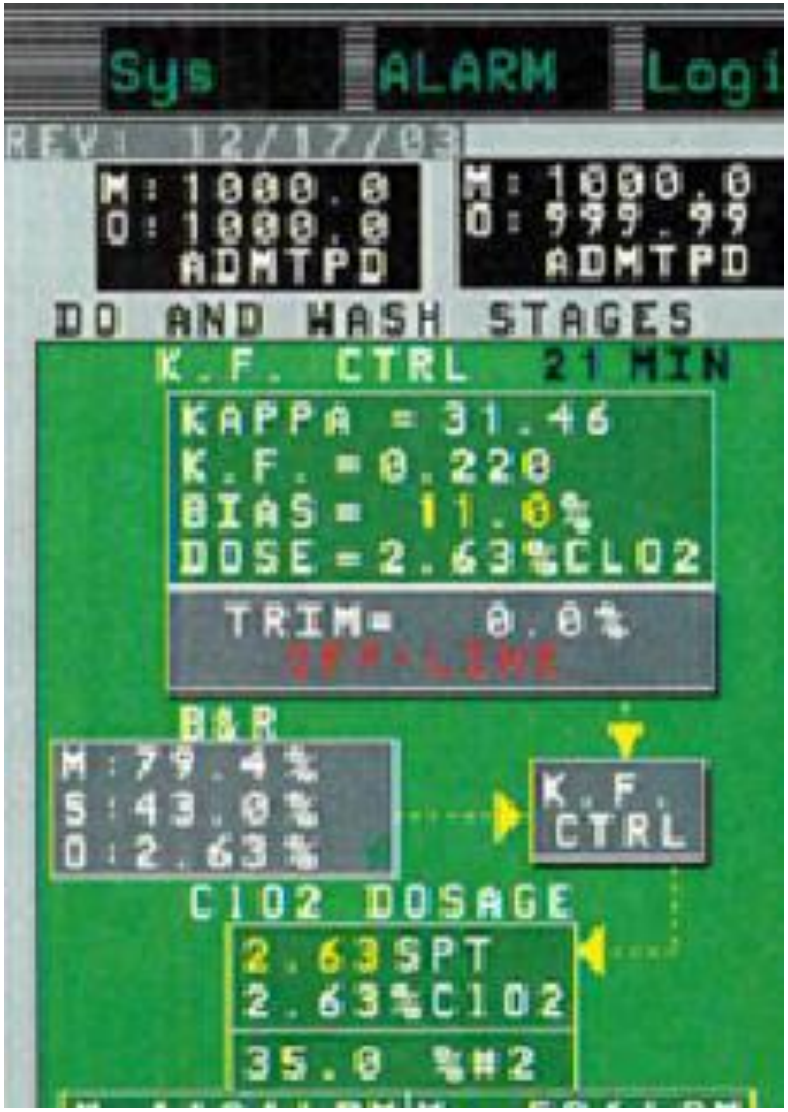
MUTUAL WORKING RELATIONSHIP



- Control room meetings:
  - Operators identified EoP Kappa as the first variable to control
  - Good Eop Kappa control will achieve good final bright product
  - Unexplained variability could also be indicating external/background factors

Identified opportunities to explain external factors; i.e. instrumentation, valves, control loops

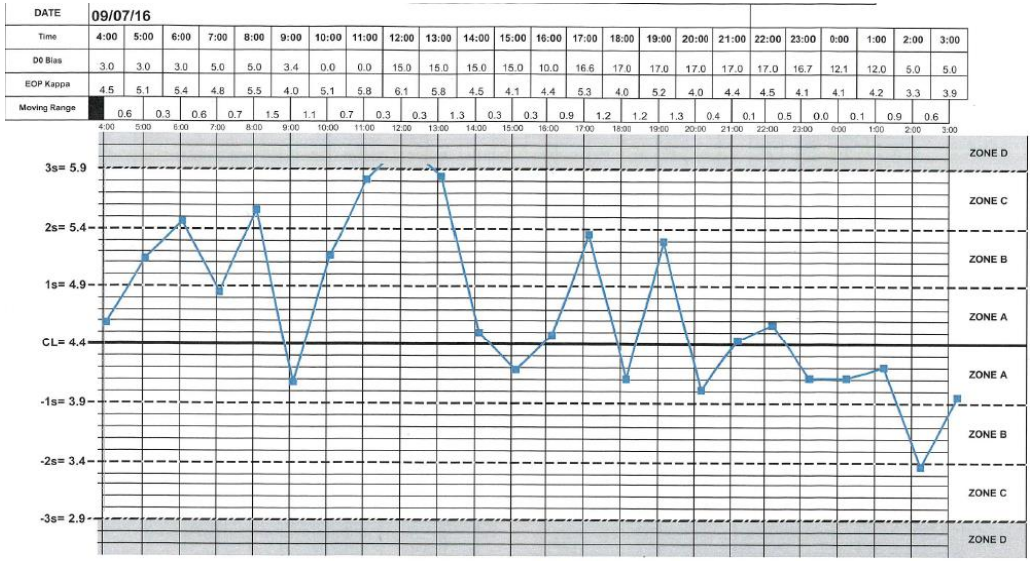
ENGINEERING/MAINTENANCE SUPPORT



- Internal Kappa Curve
- Kappa → Kappa Factor (K.F.) → ClO_2 Dosage

Low Kappa ----------- High Kappa

Underdose Overdose

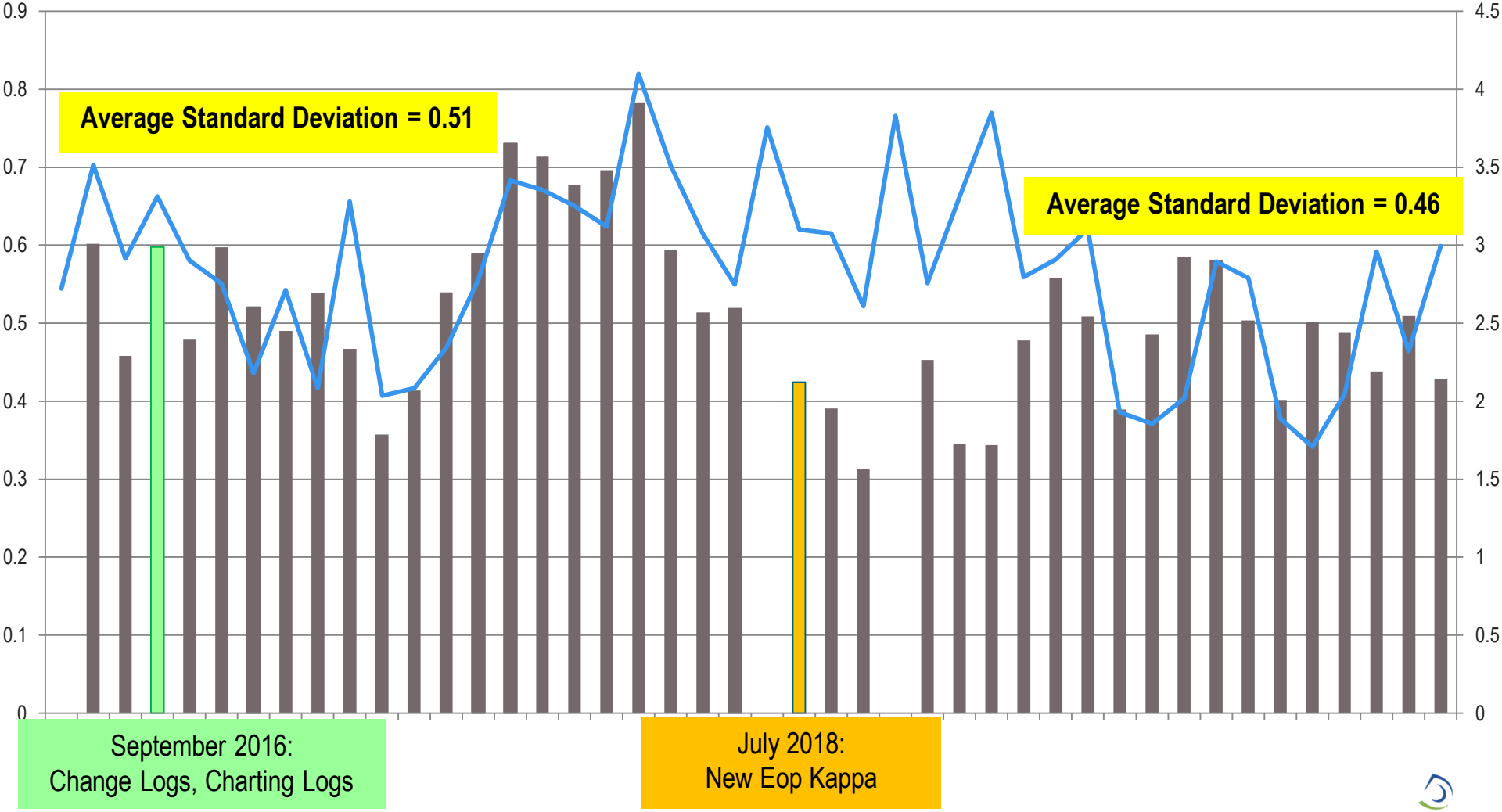


WEEKLY CONTINUOUS IMPROVEMENT MEETINGS

#	Action Id	Action type	SMART Description
	9069	Proactive	Improve communication between lab and instrumentation
	9070	Proactive	Evaluate the effect of different pH sample locations
	9071	Proactive	Check pH probes more frequently
	9072	Proactive	Determine why E2P steam mixer temperature varies
	9073	Proactive	E2P pH probe needs tuning PHIC086
	9074	Proactive	Correct D0 kappa curve
	9075	Proactive	Oven temperature variability
	9076	Proactive	

- New action items for continuous improvement
- Improved communication between instrumentation, lab, and operators
  - I.e. Instrument mechanic visits 2 days/week (loops, valves)
- Strong support from Engineering (4 process engineers)
- Mid 2016 – 2018

EOP KAPPA STANDARD DEVIATION OVER THE YEARS



EVALUATION

- Reduced operator variability
  - Standardized rules for operator responses
  - Standardized training
  - Room for flexibility

- Discovered opportunities for continuous improvement (process and measurement)
  - Improved communication between operations, engineering, maintenance and instrumentation
  - Reduce process variability

THE FIBER *of* Domtar

AGILE | CARING | INNOVATIVE

Domtar