

Using the PI System to Increase Throughput by Improving Process Stability & Capability

Presented by Mike Jackson

Nalco Industry Technical Consultant



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 Nalco Company: Essential Expertise for Water, Energy, and AirSM



- World's leading process
 improvement company
- 70,000 customers in more than 130 countries
- 75 years of experience in the hydrocarbon industries



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Methods to Improve Stability & Capability

(PI System Provides Data to help get the Answers)

- DMAIC (Define-<u>Measure</u>-<u>Analyze</u>-Implement-<u>Control</u>)
- PDCA (Plan-Do-<u>Check</u>-Act)
- AIM (<u>Analyze</u>-Improve-<u>Monitor</u>)
- TQM (Total Quality Management)
- LEAN
- Six Sigma
- PI System

An advantage of using the PI System over other methods of quality control, such as "inspection" is that they emphasize *early* detection and prevention of problems, rather than the correction of problems *after* they have occurred.

A Process Engineer's 'Dirty Dozen' Questions

- 1. Is the Process 'Stable' & consistent *(controlled)* over time with respect to important characteristics?
- 2. Is the Process 'Capable' of meeting the product/customers' specifications?
- 3. What are the Process Key Performance Indicators (KPIs)?
- 4. Did the metrics dashboard give an early indication of systemic problems?
- 5. Are the batch durations staying within the Control & Specification Limits?
- 6. Are the batch durations under Statistical Control?
- 7. When & Why did they go outside of these rules/limits?
- 8. Who was informed that they went outside of these limits?
- 9. By Whom, When & How was the Alert Acknowledged?
- 10. How many times did they go outside of these limits during the Month?
- 11. How do I show & measure improvement?
- 12. Did any changes in operation have an effect on Production cycle time?

PI Client Tools

(Ways to Answer the Dirty Dozen)

- Batch Gantt Charts of KPIs
- Trends and Analytics of Batch Duration Times
- PI SQC Monitors the Duration Times of each Batch in real-time
- Alerts if the Duration Times Break any of the Western Electric SQC Rules
- Enables Comments & Pareto Chart Reporting
- Sends E-mail Alerts/Notifications
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Process Engineer's 'OLD' View of Process (How are Batches Comparing?)



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Process Engineer's 'NEW' View of Process

(Provides the *Hard* to Define Batch & Sub Batch Start and End Times)







All 'RECYCLE' SUB Batches Presented!



Batch Trend



Batch Trend 2



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Batch Gantt			1
RECYCLE			
RECYCLE			
RECYCLE	•		
RECYCLE			· · · · · · · · · · · · · · · · · · ·
		All 'RECYCLE' SUB	Batches Aligned!
			Batorioo, aigrioa.
	30 minutes	60 90	
Batch Trend			
<u>}7800 ────</u> ── <u>→</u> ── <u>→</u> ──			
17460			KPI 1
47080			
17060			
16860			
1646U			
3	30 minutes	60 90	
Batch Trend 2			
1/2			
31			KPI 2
316			
314			
312	+		
310			
306		✓ How was this 'RECVCL	E' SUB Batch Different?
3	30 minutes	EL HOW WAS THIS RECICE	L SOB Batch Different?

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PI DataLink Metrics Dashboard

(Analytice)

					(Anai	yuc	,3)											
Reactor	Product	BatchID	Batch Start Time	Batch End Time	Batch Duration	Reactor Down Time	Monthly Recycle Average	Monthly Recycle Maximum	Monthly Recycle Minimum	Monthly Recycle Total	Start Up	Ramp	Agitate	Recycle	Cool Down	Transfer	Idle Time	% Good
R-1010	L-123	A15537	16-Jan-13 02:16:55	17-Jan-13 00:19:39	22:02:44	14	148	200	54	4939	22	200	100	333	89	5	66	50
R-1010	L-123	A15536	15-Jan-13 02:16:55	15-Jan-13 21:30:55	19:16:37	9	102	155	54	3617	12	200	100	155	100	5	67	99
R-1010	L-123	A15535	14-Jan-13 16:55:17	15-Jan-13 09:20:39	16:32:22	4	84	100	54	2452	13	202	100	100	111	5	77	98
R-1010	L-123	A15534	13-Jan-13 00:25:57	13-Jan-13 16:20:13	16:02:16	7	77	99	54	1460	14	211	100	99	99	5	55	66
R-1010	L-123	A15533	11-Jan-13 17:39:38	12-Jan-13 01:57:46	8:18:08	3	54	54	54	498	13	199	100	54	113	5	93	96

PI DataLink can provide Excel Reports & Metrics of all the PI System data, either from the plant processes or from other ancillary data sources such as LIMS, Safety or Environmental

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Uses of PI Client Tools

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All Recent 'Product A' Batch Durations



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SQC Plot - 1 : [Individuals]



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Possible PI SQC Chart Inputs

- Types
 - Individuals
 - X-Bar
 - Moving Average
 - <u>EWMA</u> (Exponentially-Weighted Moving Average)
 - Standard Deviation
 - Moving Standard Deviation
 - Range
 - Moving Range

- Examples
 - Batch Time Durations
 - LIMS References/Results
 - Pump Flow Rates
 - Product Test Specifications
 - Environmental Testing Limits
 - Maintenance Equipment Monitoring

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From:	PI_Admin@Nalco.com
To:	Michael K Jackson
Cc:	
Subject:	IFG Batch Alarms\SQC\Notifications[R-1030 Duration RTSQC] generated a new n
<u></u>	· · · 1 · · · · 2 · · · · · · · · · · ·
Name:	RTSQC
Server:	
Databas	e: MDB
Start Ti	me.7/9/2012 8:47:43 AM Central Daylight Time (GMT-05:00:00)
Trigger	Time: 7/9/2012 8:47:43 AM Central Davlight Time (GMT-05:00:00)
Target:	MFG Batch Alarms\SOC
State: 0	utsideControl
Priority	· Normal
Thorny	. Normai

Trigger Input: MFG Batch Alarms\SQC|R-1030 Duration: 14 MFG Batch Alarms\SQC|R-1030 Duration CL: 8 MFG Batch Alarms\SQC|R-1030 Duration LL: 4 MFG Batch Alarms\SQC|R-1030 Duration UL: 12 OutsideControl 1 of 1; Trend 8

Actions: <u>Acknowledge</u> Acknowledge With Comment

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From:	PI_Admin@Nalco.com
To:	Michael K Jackson
Cc:	
Subject:	Batch Alarms\SQC\Notifications[R-1030 Duration RTSQC] generated a new
8	· · 1 · · · 1 · · · 2 · · · 1 · · · 3 · · · 1 · · · 4 · · · 1 · · · 5 · · · 1 · · · · 5 · · · 1 · · · ·
Name:]	RTSQC
Server:	
Database	: MDB
Start Tim	e: 7/9/2012 8:47:43 AM Central Daylight Time (GMT-05:00:00)
Trigger T	Time: 7/9/2012 8:47:43 AM Central Daylight Time (GMT-05:00:00)
Target:	MFG Batch Alarms\SQC
State: Out	tsideControl
Priority: 1	Normal

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Comment (Leave empty to acknowledge without a comment)

We lost power in bldg 30 again last night, switched over to generator power and lined out plant.



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- optione

Time			
View Notifications	Timerange	•	→
Start Time	*-100d	•	
End Time	t	•	

	Start Time 🤜	≂ End Time	Duration	State	Priority	Acknowledged	Action	Contact	Contact Method	Comment	8
	8/2/2012 1:44:17	Active	Active	OutsideControl	Normal	N/A					
	8/2/2012 1:50:2						Comment	Michael K Jack	Email	His will be done	
	8/2/2012 1:46:3						Subscription manually acknowledged	Michael K Jack	Email		
	8/2/2012 1:44:1						Instance acknowledged automatically				
	8/2/2012 1:44:1						Sent	Michael K Jack	Email		
	7/17/2012 10:02:	7/17/2012 10:	00:49:17	OutsideControl	Normal	N/A					
	7/17/2012 10:5						Sent	Michael K Jack	Email		
	7/17/2012 10:0						Instance acknowledged automatically				
	7/17/2012 10:0						Sent	Michael K Jack	Email		
	7/9/2012 8:47:43	7/9/2012 8:48	00:00:39	OutsideControl	Normal	N/A					
	7/9/2012 8:48:2						Sent	Michael K Jack	Email		
	7/9/2012 8:47:4						Instance acknowledged automatically				
	7/9/2012 8:47:4						Sent	Michael K Jack	Email		
•	- <mark>7/9/2012 8:39:59</mark>	7/9/2012 8:47	00:07:44	Trend	Normal	N/A					
	7/9/2012 8:40:0						Instance acknowledged automatically				
	7/9/2012 8:40:0						Sent	Michael K Jack	Email		
	7/9/2012 8:25:05	7/9/2012 8:25	00:00:03	OutsideControl	Normal	N/A					
	7/9/2012 8:25:0						Sent	Michael K. Jack	Email		
	7/9/2012 8:25:0			Notifi	cations	s History –	When, How Long	, What, F	low Ack	To Whom, W	hy?
			111111	110	-				1 - 4		

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- In process improvement efforts, the process capability index or process capability ratio is a statistical measure of process capability: the ability of a process to produce output within specification limits.^[1] The concept of process capability only holds meaning for processes that are in a state of statistical control. Process capability indices measure how much <u>"natural variation"</u> a process experiences relative to its specification limits and allows different processes to be compared with respect to how well an organization controls them.
- If the upper and lower <u>specification</u> limits of the process are USL and LSL, the target process mean is T, the estimated mean of the process is mu and the estimated variability of the process (expressed as a <u>standard deviation</u>) is sigma, then commonly-accepted process capability indices include:

$$\hat{C}_p = \frac{USL - LSL}{6\hat{\sigma}} \qquad \qquad \hat{C}_{pk} = \min\left[\frac{USL - \hat{\mu}}{3\hat{\sigma}}, \frac{\hat{\mu} - LSL}{3\hat{\sigma}}\right]$$

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Knowing Process Stability & Capability can...

- Predict the percent of time that the process will fail to operate as required
 - defects, downgrades or rework
- Set the performance **baseline** from which to measure any improvements made
- Establish a **benchmark** against which we can compare other equipment, other plants, etc.
- Justify new technology if current process is incapable
- Forecast the **probability** of missing a performance characteristic
 - Cash flow
 - On-time delivery

Results In...

(More Stuff – More Better)

- Increased Quality
- Increased Throughput
- Reduced Waste
- Reduced Rework
- Reduced Staff Attrition
- Less Discounted Off-Spec Batches
- Increased Customer Loyalty

Harley Davidson Believes in Improving Process Stability & Capability & So Does 'REPO MAN'

"By Improving Process Stability and Capability, Harley Davison went from a manufacturer of inferior and poor selling motorcycles to the worlds' premier seller of top quality bikes."

Harley Owners' Group



As for Repo Man:

- No Oil on His Garage Floor
- REPO Man not left on the side of the road
- <u>Thinks Harley Davidson would do</u> even better if THEY had the PI System too!



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