

Cummins Surveillance Panel Conference Call Meeting Minutes

Monday, February 2, 2015

10:00 - 11:00 a.m. EST

Attendance:

Jim Moritz, Mey Dewey - Intertek
Zack Bishop, Dan Lanctot - TEI
Jeff Clark, Sean Moyer - TMC
Martin Thompson, Jim McCord, Perry Grosch, Jose Starling - SwRI
Nick Secue, Michael Conrad, Kevin O'Malley - Lubrizol
Elisa Santos, Jim Gutzwiller, Bob Salgueiro - Infineum
Jim Rutherford, Mark Cooper, Marnix Torreman - ChevronOronite
Dan Nyman - Cummins
Bob Campbell - Afton

ISM Oil Filters:

Intertek has cut open and examined a new filter; the media is the same and the pleat count is correct. As agreed upon earlier, since all looks to be in good order, the filters can now be used for all tests (no need to bring in with a reference test).

ISB Hardware:

- Update on delivery of Batch D Tappets

Dan Nyman reported that Batch D tappets are currently being shipped to TEI.

ISB Data Review:

Kevin O'Malley review his analysis, which is attached, in detail. Following Kevin's presentation, there was open discussion. After several ideas were considered, it was decided that an effort should be made to run coordinated reference tests on the new cam and tappet batches. The discussion then focused on accomplishing this. Three test labs agreed to participate in the coordinated references as soon as hardware is available. The following motion (**Campbell, McCord**) was made: ***allow the TMC to adjust calibration periods (with no net gain/loss) to assist in the coordinated reference runs, with large adjustments being split over two reference periods.*** The motion passed without objection and two waives (TMC, TEI).

Kevin will continue analyzing the data based on some feedback he received during the discussion.

ISB Hardware:

- Introduction of Batch K cams

This topic was not directly discussed during the call, but was included as part of the discussion above.

The meeting adjourned at 11:30 a.m.



Cummins ISB Industry Severity

Feb 2014

Kevin O'Malley

Statistician

The Lubrizol Corporation

Current State of LTMS for ISB



LTMS file contains test results from 20050629 to 20141229

Severity adjustments are not currently applicable

1. These would affect candidate results only

Values used to LTMS calculations for the ISB

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Action	0.3	0.3	2.10	2.36	2.10	1.96
Industry	Warning	0.2	0.2	2.10	2.36	--	--
	Action	0.2	0.2	2.80	3.00	--	--

Current State of LTMS for ISB



Correction factors are currently in place for:
 Average Tappet Weight Loss (ATWL)
 Average Camshaft Wear (ACSW)

ISB	April 21, 2011	***	All tests using batch B tappets with batch E, F, and G cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	December 11, 2011	November 12, 2012	All tests using batch C Tappets with batch H cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	November 13, 2012	***	All tests using batch C tappets with batch H and J cams	Multiply ATWL by 0.711; Add -5.6 to ACSW

History of Reference Oil Targets (831-2 is new batch introduced Oct 2013)

ISB Reference Oil Targets							
Oil	n	Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss	
		From	To ¹	\bar{X}	s	\bar{X}	s
821 (PC10E)	6	6-4-05	12-31-05	34.6	4.6	56.2	9.6
830-2	6	6-4-05	12-31-05	39.8	9.0	85.9	16.0
831 (PC10B)	6	6-4-05	1-24-07	41.9	5.6	88.7	15.9
	10	1-25-07	8-6-07	42.8	5.4	94.9	15.3
	14	8-7-07	***	42.5	5.0	97.2	14.8
831-1 ²	--	8-7-07	***	42.5	5.0	97.2	14.8
831-2 ²	--	8-6-13	***	42.5	5.0	97.2	14.8

1 *** = currently in effect

2 Targets based on oil 831

831-1 and 831-2 currently based on 831 targets



Current State of LTMS for ISB



Camshaft, Tappet, and Crosshead batches were assigned according to the following table

ISB Camshaft Batch	Starting Kit #	Date
A	1	Jun-2004
B	135	Feb-2006
C	244	Aug-2007
D	290	Jul-2008
E	337	Apr-2009
F	389	Mar-2010
G	441	Mar-2011
H	486	Nov-2011
J	569	Aug-2012
K	821 need Tappets	Jan-2015
ISB Tappet Batch	Starting Kit #	Date
A	1	Jun-2004
B	279	Jan-2008
C	475	Aug-2011
D	?	Jan-2015 ?
ISB Crosshead Batch	Starting Kit #	Date
A	1	Jun-2004
B	279	Jan-2008
C	475	Aug-2011
D	569	Aug-2012

Pushrod Batches

New pushrods estimated to start with Kit# 556

- 5000 were obtained on June 22, 2012
- We cannot guarantee these 5000 came from the same batch

Prior to new pushrod “batch”, pushrods came in small quantities from different batches

ISB ACSWyi calculation: Pre-2007 Valid Test Results



TESTKEY	LTMSI	IND	LTMSAPP	STRUN	VAL	LTMSDATE	CHART	ACSWorig	ACSWCF	ACSW	ACSWyi	ACSWxbar	ACSWs	ACSWyi (Kevin's calc)	(Kevin's Calc)-(ACSWyi)
55841-ISB	G	PC10B	2	9	AO	20050604	Y	44.1	0	44.1	0.2407	42.8	5.4	0.240740741	0.0000
55851-ISB	A	PC10B	2	5	AO	20050606	Y	45.1	.	45.1	0.4259	42.8	5.4	0.425925926	0.0000
55839-ISB	G	830-2	2	10	AO	20050624	Y	41.1	.	41.1	0.1444	39.8	9	0.144444444	0.0000
55853-ISB	A	PC10E	2	6	AO	20050627	Y	26.5	.	26.5	-1.7609	34.6	4.6	-1.760869565	0.0000
55840-ISB	G	830-2	1	12	AO	20050629	Y	27.1	.	27.1	-1.4111	39.8	9	-1.411111111	0.0000
55843-ISB	G	PC10E	2	11	AO	20050711	Y	35.3	.	35.3	0.1522	34.6	4.6	0.152173913	0.0000
55850-ISB	A	830-2	2	7	AO	20050713	Y	32.8	.	32.8	-0.7778	39.8	9	-0.777777778	0.0000
56361-ISB	B	PC10E	1	8	AO	20050715	Y	40.3	.	40.3	1.2391	34.6	4.6	1.239130435	0.0000
55842-ISB	G	PC10B	1	13	OO	20050717	Y	30.8	.	30.8	-2.2222	42.8	5.4	-2.222222222	0.0000
55844-ISB	G	PC10E	2	12	AO	20050730	Y	35.1	.	35.1	0.1087	34.6	4.6	0.108695652	0.0000
55852-ISB	A	PC10B	2	8	AO	20050801	Y	42.2	.	42.2	-0.1111	42.8	5.4	-0.111111111	0.0000
55846-ISB	B	830-2	1	9	AO	20050804	Y	45.7	.	45.7	0.6556	39.8	9	0.655555556	0.0000
55845-ISB	G	PC10E	1	14	AO	20050805	Y	33.4	.	33.4	-0.2609	34.6	4.6	-0.260869565	0.0000
55907-ISB	A	830-2	3	3	AC	20050806	Y	52.5	.	52.5	1.4111	39.8	9	1.411111111	0.0000
55847-ISB	B	830-2	1	11	AO	20050829	Y	39.4	.	39.4	-0.0444	39.8	9	-0.044444444	0.0000
56950-ISB	B	PC10B	2	7	AC	20050907	Y	46.1	.	46.1	0.6111	42.8	5.4	0.611111111	0.0000
56972-ISB	B	PC10B	1	12	AO	20050915	Y	43.1	.	43.1	0.0556	42.8	5.4	0.055555556	0.0000
55909-ISB	A	PC10E	4	12	AC	20051016	Y	36.9	.	36.9	0.5	34.6	4.6	0.5	0.0000
58241-ISB	A	PC10B	2	21	AC	20060924	Y	52.4	0	52.4	1.7778	42.8	5.4	1.777777778	0.0000
57939-ISB	B	PC10B	1	23	AC	20061113	Y	43.1	0	43.1	0.0556	42.8	5.4	0.055555556	0.0000
58207-ISB	G	PC10B	2	21	AC	20061215	Y	40.9	0	40.9	-0.3519	42.8	5.4	-0.351851852	0.0000
58242-ISB	A	PC10B	3	20	AC	20061220	Y	40.7	0	40.7	-0.3889	42.8	5.4	-0.388888889	0.0000

When I change the mean and standard deviation to 42.8 & 5.4 for PC10B, respectively, my ACSWyi calculation matches the LTMS file (These values are for PC10B post 2006)

Corrected values used

Oil	n	Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss	
		From	To ¹	\bar{X}	s	\bar{X}	s
821 (PC10E)	6	6-4-05	12-31-05	34.6	4.6	56.2	9.6
830-2	6	6-4-05	12-31-05	39.8	9.0	85.9	16.0
831 (PC10B)	6	6-4-05	1-24-07	41.9	5.6	88.7	15.9
	10	1-25-07	8-6-07	42.8	5.4	94.9	15.3
	14	8-7-07		42.5	5.0	97.2	14.8



ISB ATWLy_i calculation: Pre-2007 Valid Test Results

TESTKEY	LTMSIIND	LTMSAPP	STRUN	VAL	LTMSDATE	CHART	ATWLorig	ATWLCF	ATWL	ACWL	ATWLy _i	ATWLxbar	ATWLs	ATWLy _i (Kevin's Calc)	(Kevin's Calc)-(ATWLy _i)	
55841-ISB	G	PC10B	2	9	AO	20050604	Y	85.2	0	85.2	2.5	-0.634	94.9	15.3	-0.633986928	0.0000
55851-ISB	A	PC10B	2	5	AO	20050606	Y	84.9	.	84.9	1.6	-0.6536	94.9	15.3	-0.653594771	0.0000
55839-ISB	G	830-2	2	10	AO	20050624	Y	89	.	89	2.6	0.2883	85.9	16	0.19375	-0.0946
55853-ISB	A	PC10E	2	6	AO	20050627	Y	46.8	.	46.8	1.4	-0.7708	56.2	9.6	-0.979166667	-0.2084
55840-ISB	G	830-2	1	12	AO	20050629	Y	75.9	.	75.9	1.7	-0.5153	85.9	16	-0.625	-0.1097
55843-ISB	G	PC10E	2	11	AO	20050711	Y	62.8	.	62.8	1.8	0.8958	56.2	9.6	0.6875	-0.2083
55850-ISB	A	830-2	2	7	AO	20050713	Y	61.4	.	61.4	1.3	-1.4049	85.9	16	-1.53125	-0.1264
56361-ISB	B	PC10E	1	8	AO	20050715	Y	68.1	.	68.1	2.7	1.4479	56.2	9.6	1.239583333	-0.2083
55842-ISB	G	PC10B	1	13	OO	20050717	Y	79.7	.	79.7	2.2	-0.9935	94.9	15.3	-0.993464052	0.0000
55844-ISB	G	PC10E	2	12	AO	20050730	Y	46	.	46	2.1	-0.8542	56.2	9.6	-1.0625	-0.2083
55852-ISB	A	PC10B	2	8	AO	20050801	Y	77.8	.	77.8	1.6	-1.1176	94.9	15.3	-1.117647059	0.0000
55846-ISB	B	830-2	1	9	AO	20050804	Y	101.8	.	101.8	2.2	1.0736	85.9	16	0.99375	-0.0799
55845-ISB	G	PC10E	1	14	AO	20050805	Y	55.4	.	55.4	2	0.125	56.2	9.6	-0.083333333	-0.2083
55907-ISB	A	830-2	3	3	AC	20050806	Y	102.3	.	102.3	2.2	1.1043	85.9	16	1.025	-0.0793
55847-ISB	B	830-2	1	11	AO	20050829	Y	75.5	.	75.5	2.5	-0.5399	85.9	16	-0.65	-0.1101
56950-ISB	B	PC10B	2	7	AC	20050907	Y	110.4	.	110.4	2.6	1.0131	94.9	15.3	1.013071895	0.0000
56972-ISB	B	PC10B	1	12	AO	20050915	Y	90.4	.	90.4	1.9	-0.2941	94.9	15.3	-0.294117647	0.0000
55909-ISB	A	PC10E	4	12	AC	20051016	Y	45.9	.	45.9	1.5	-0.8646	56.2	9.6	-1.072916667	-0.2083
58241-ISB	A	PC10B	2	21	AC	20060924	Y	123.8	0	123.8	0.8	1.8889	94.9	15.3	1.888888889	0.0000
57939-ISB	B	PC10B	1	23	AC	20061113	Y	102.7	0	102.7	1.3	0.5098	94.9	15.3	0.509803922	0.0000
58207-ISB	G	PC10B	2	21	AC	20061215	Y	107.6	0	107.6	1.7	0.8301	94.9	15.3	0.830065359	0.0000
58242-ISB	A	PC10B	3	20	AC	20061220	Y	86.1	0	86.1	1.4	-0.5752	94.9	15.3	-0.575163399	0.0000

When I change the mean and standard deviation of PC10B to 94.9 & 15.3, respectively, my ATWLy_i calculation matches the LTMS file (These values are for PC10B post 2006)

However, I still cannot confirm the yi calculations for other tests in the table above

Corrected values used

ISB Reference Oil Targets							
Oil	n	Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss	
		From	To ¹	\bar{X}	s	\bar{X}	s
821 (PC10E)	6	6-4-05	12-31-05	34.6	4.6	56.2	9.6
830-2	6	6-4-05	12-31-05	39.8	9.0	85.9	16.0
831 (PC10B)	6	6-4-05	1-24-07	41.9	5.6	88.7	15.9
	10	1-25-07	8-6-07	42.8	5.4	94.9	15.3
	14	8-7-07		42.5	5.0	97.2	14.8

Average Camshaft Wear ACSWzi EWMA Control Chart



CUMMINS ISB INDUSTRY OPERATIONALLY VALID DATA



AVERAGE CAMSHAFT WEAR

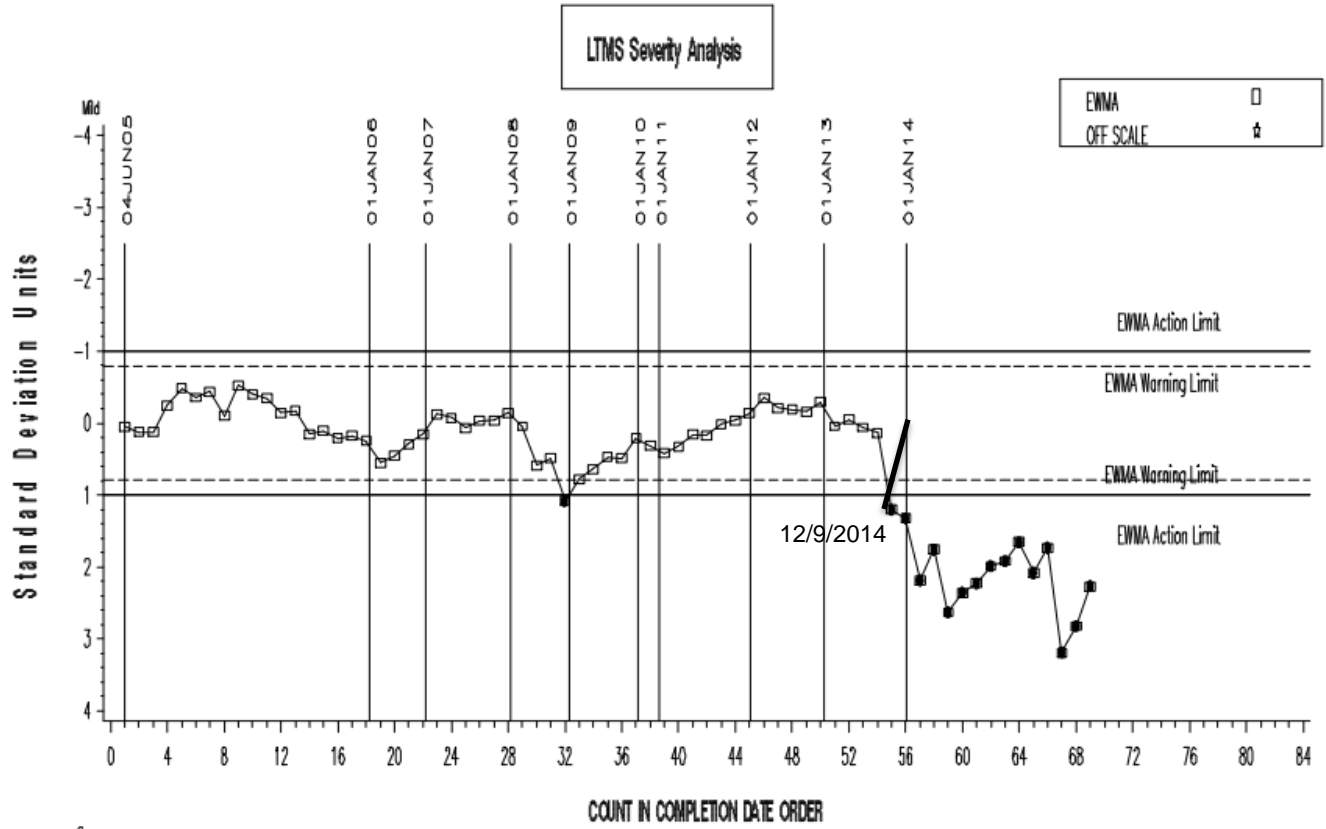


Chart indicates ACSW trending severe since around beginning of 2014



Average Tappet Weight Loss ATWLzi EWMA Control Chart



CUMMINS ISB INDUSTRY OPERATIONALLY VALID DATA



AVERAGE TAPPET WEIGHT LOSS

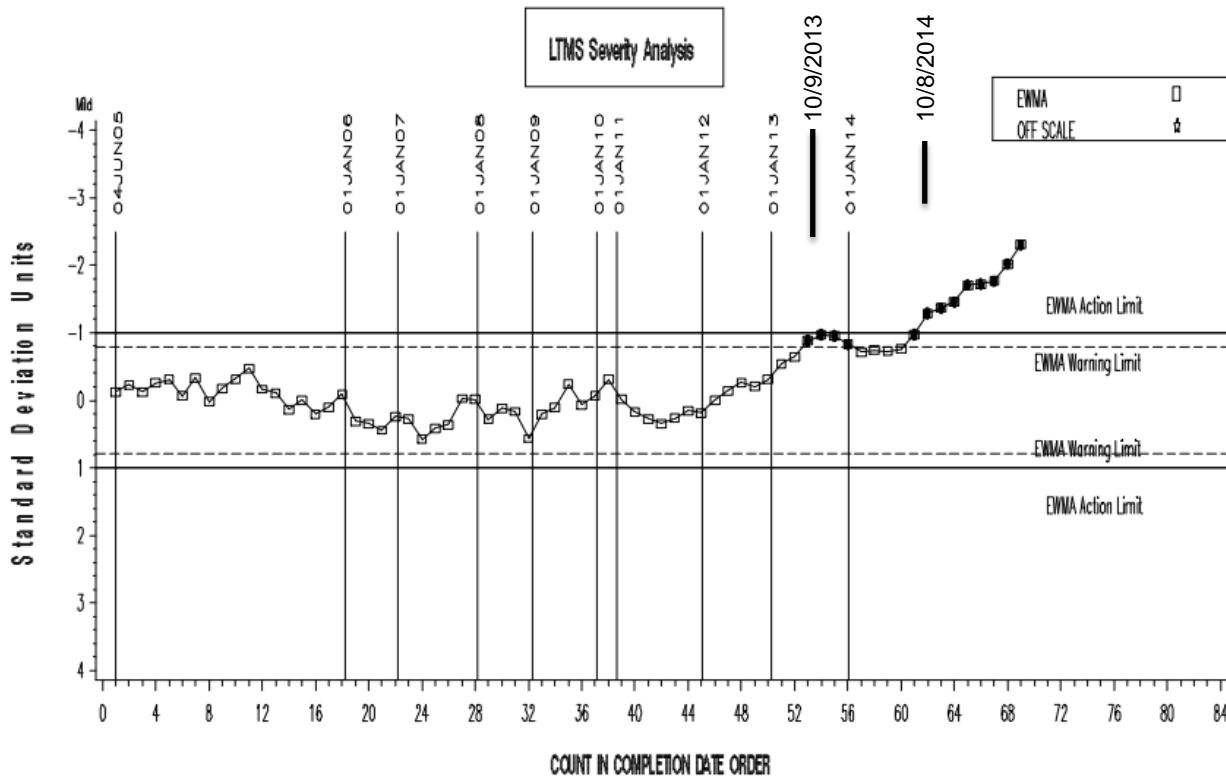


Chart indicates ATWL trending mild since about Oct 2014
(Possibly since Oct 2013)



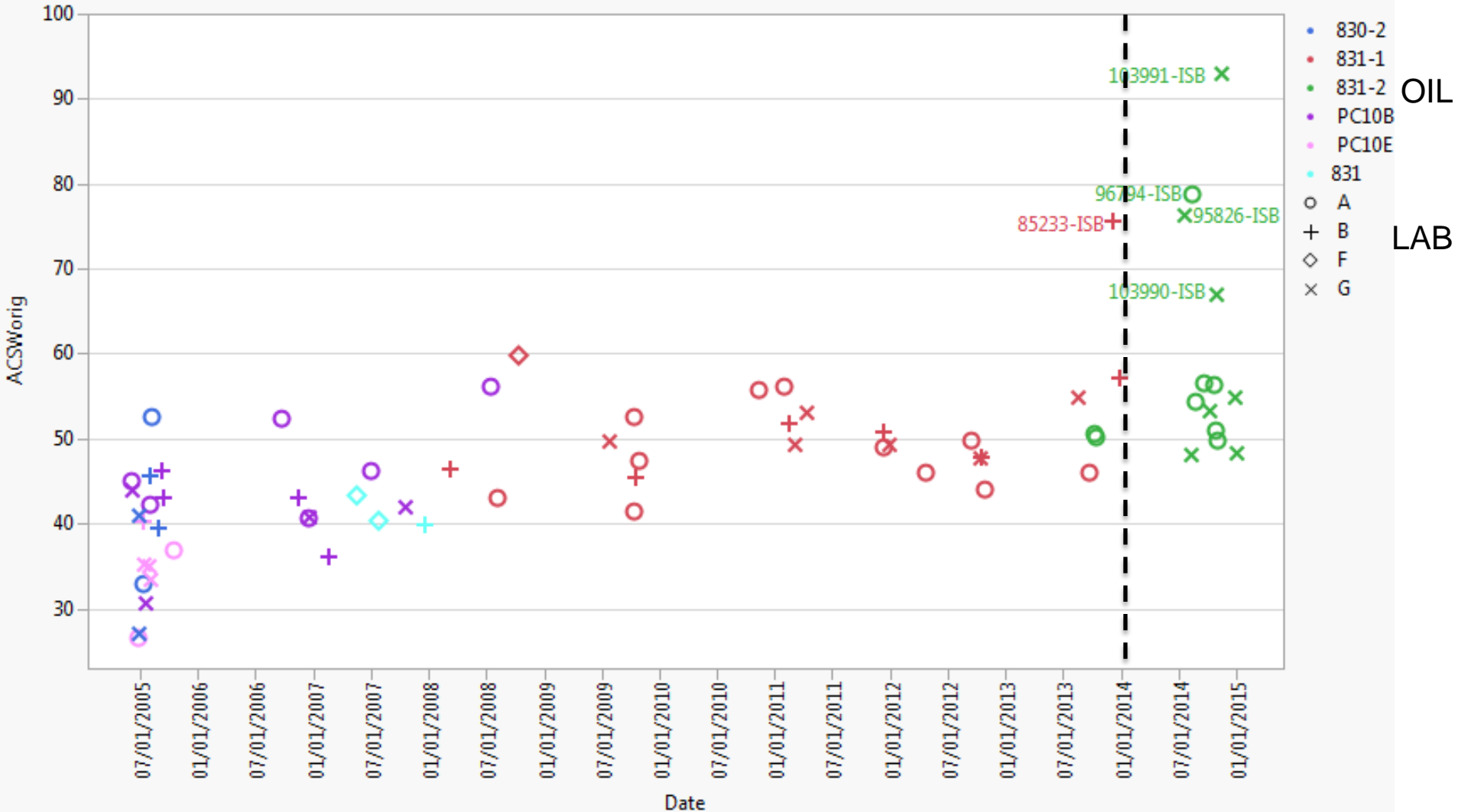


Average Camshaft Wear Uncorrected Original Results

Average Camshaft Wear (ACSWorig):



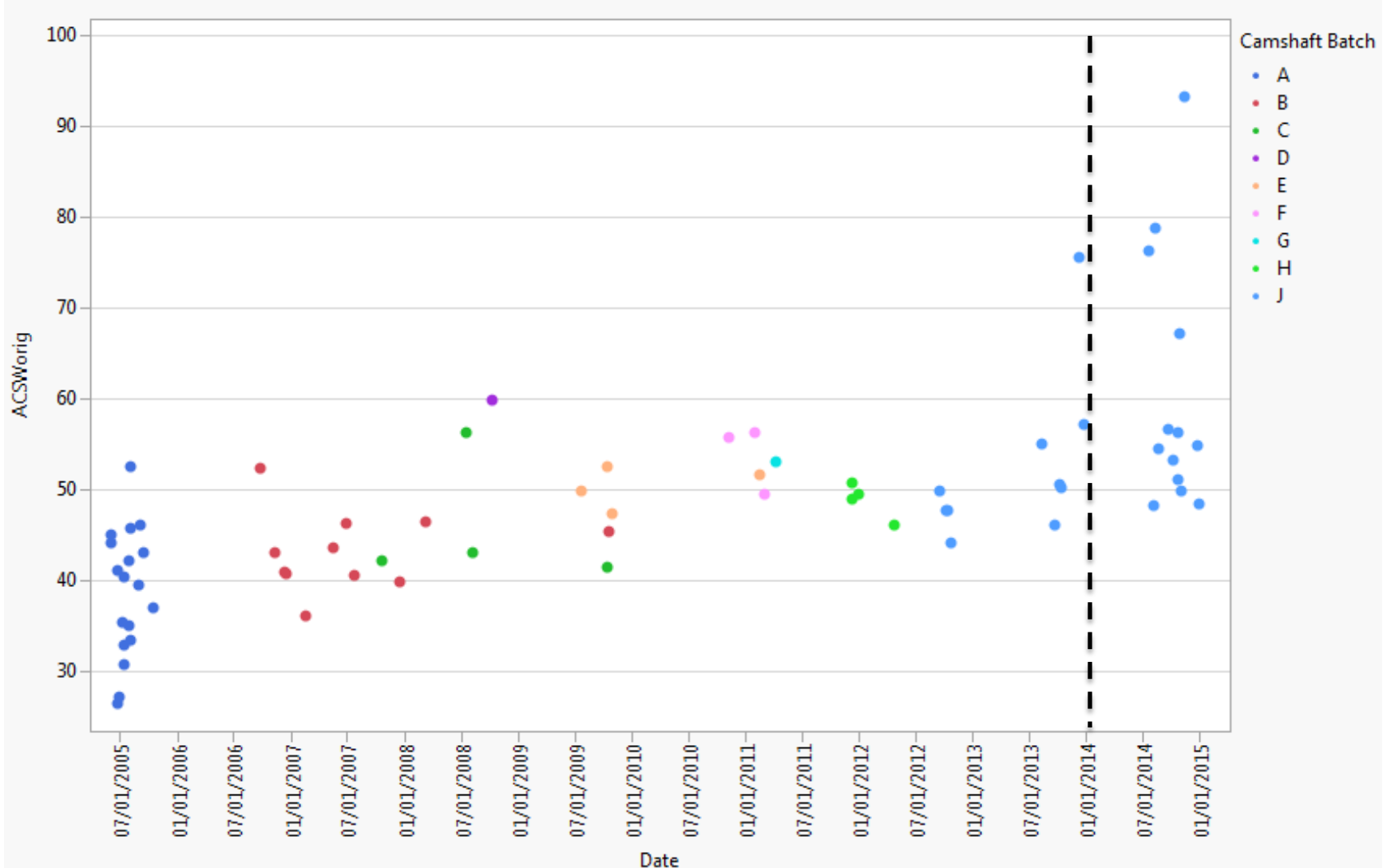
SUCCESS TOGETHER



Average Camshaft Wear (ACSWorig):



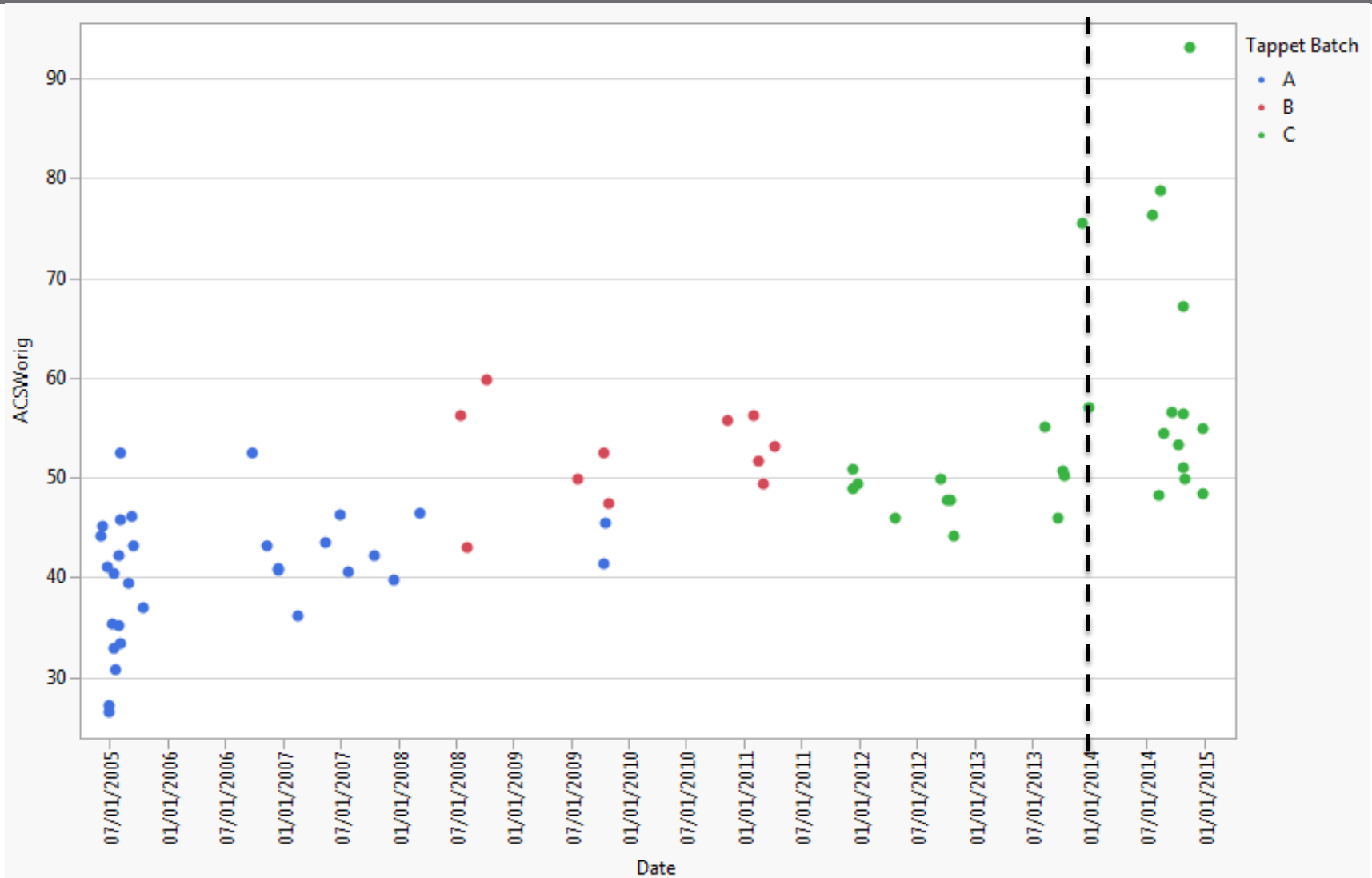
SUCCESS
TOGETHER



Average Camshaft Wear (ACSWorig):



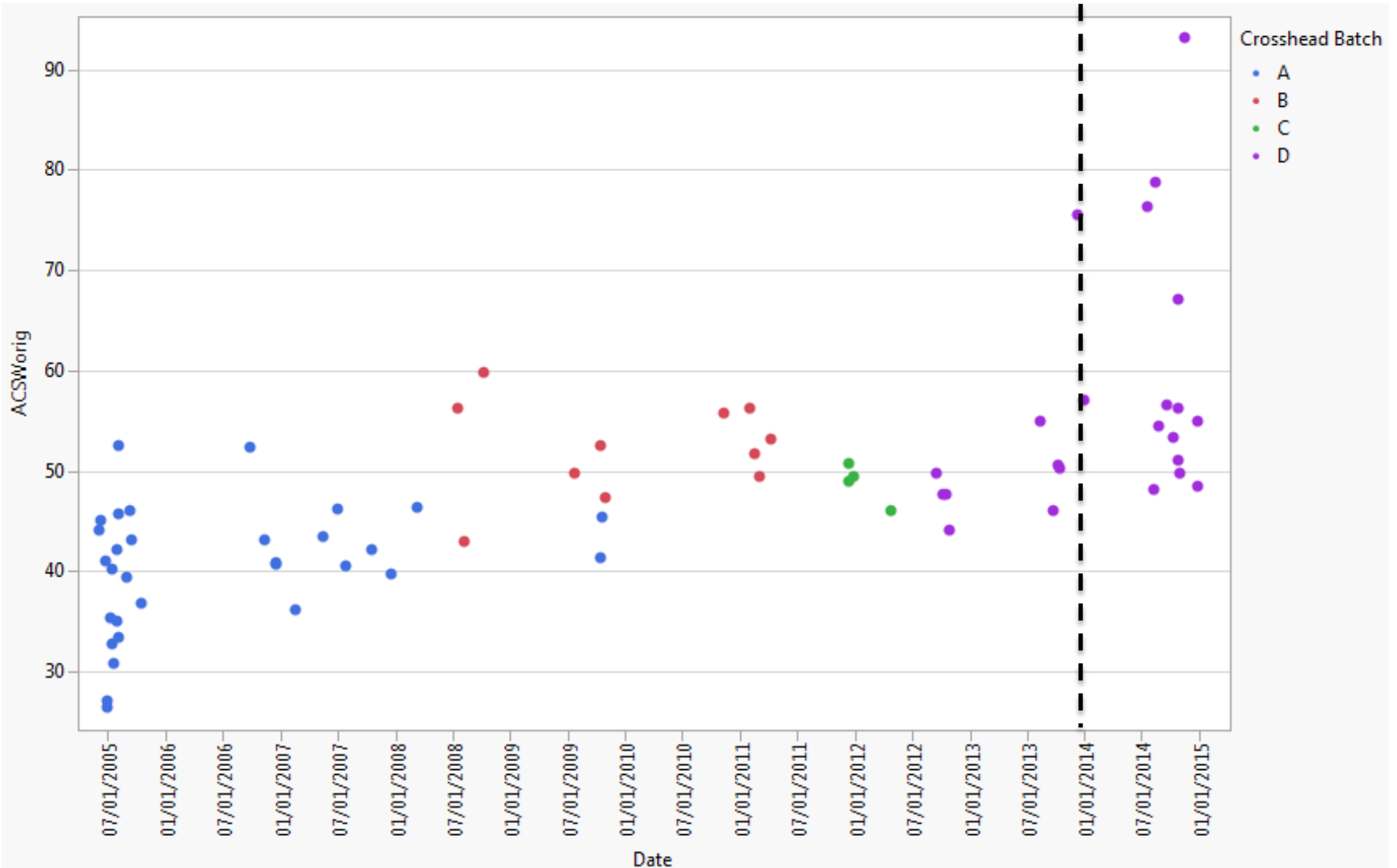
SUCCESS
TOGETHER



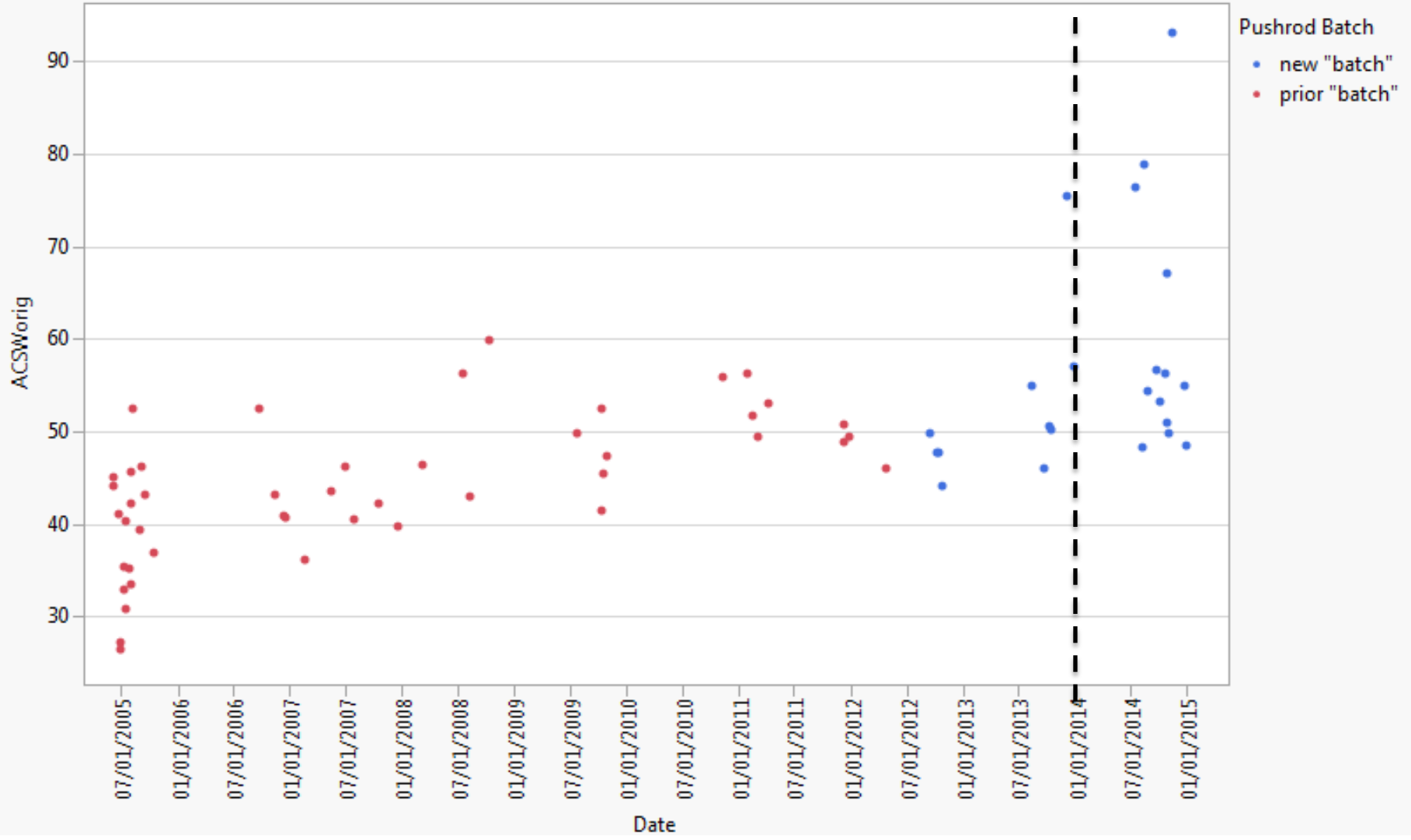
Average Camshaft Wear (ACSWorig):



SUCCESS
TOGETHER



Average Camshaft Wear (ACSWorig):



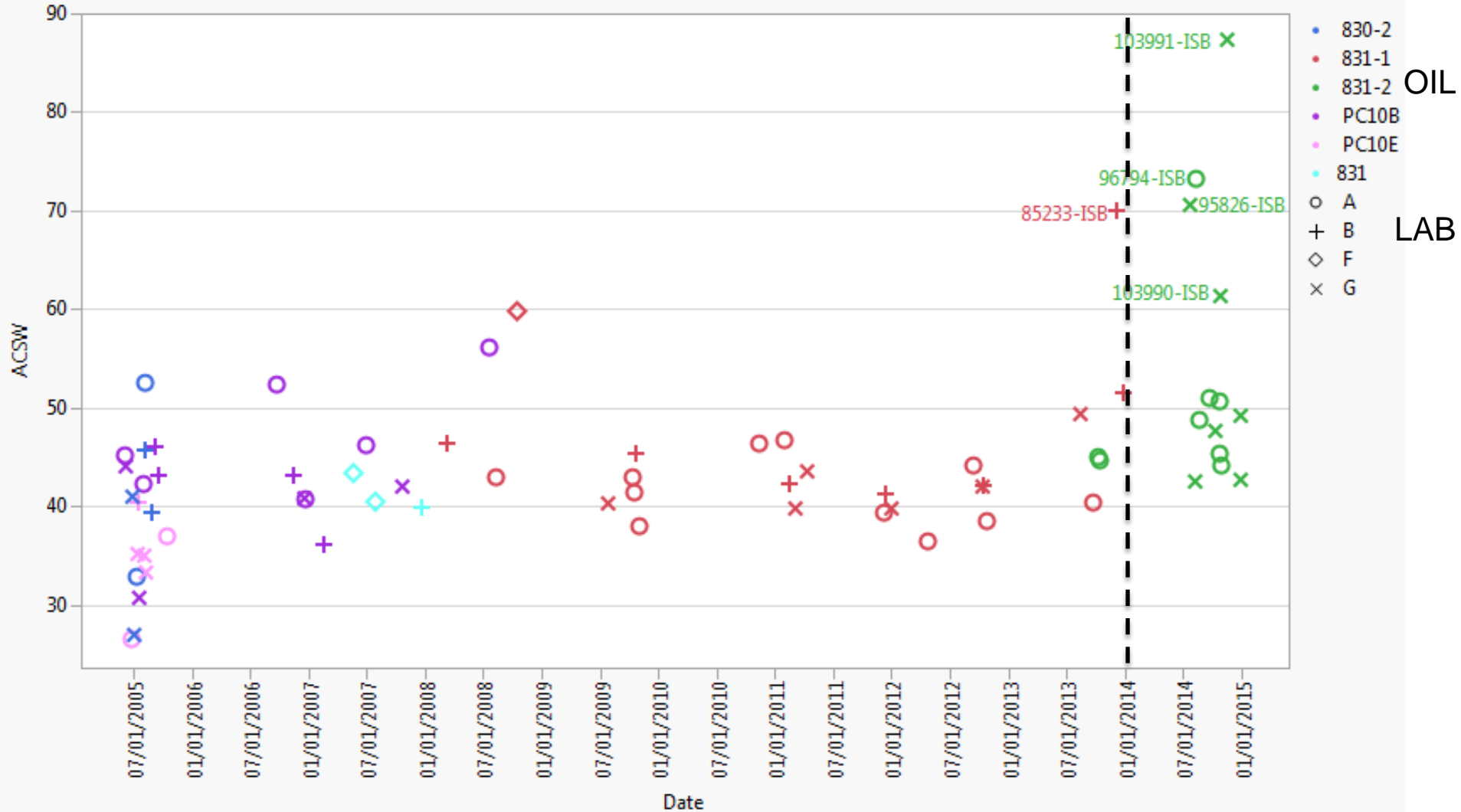


Average Camshaft Wear Correction Factors Applied

Average Camshaft Wear Correction Factors Applied (ACSW):



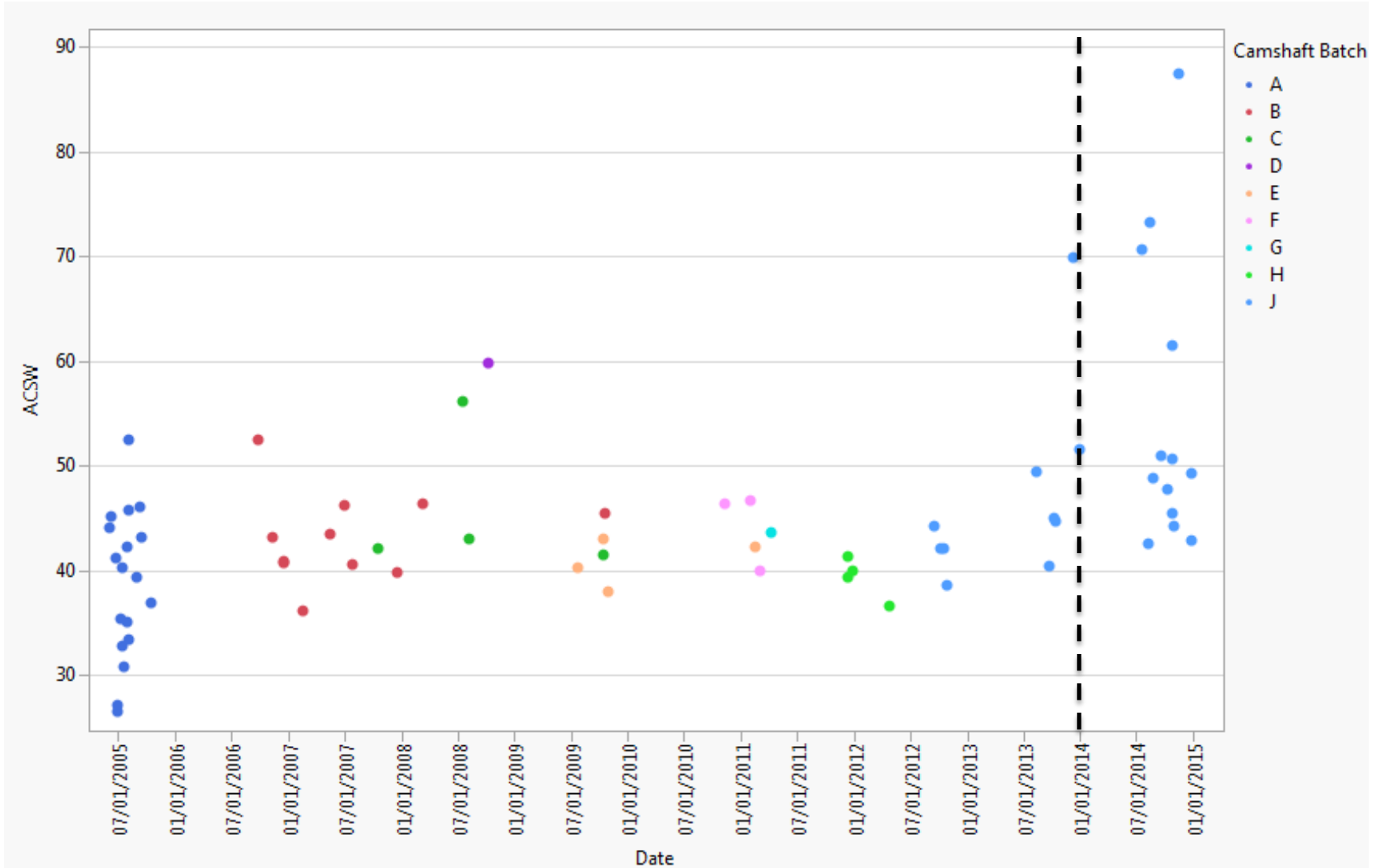
SUCCESS
TOGETHER



Average Camshaft Wear Correction Factors Applied (ACSW):



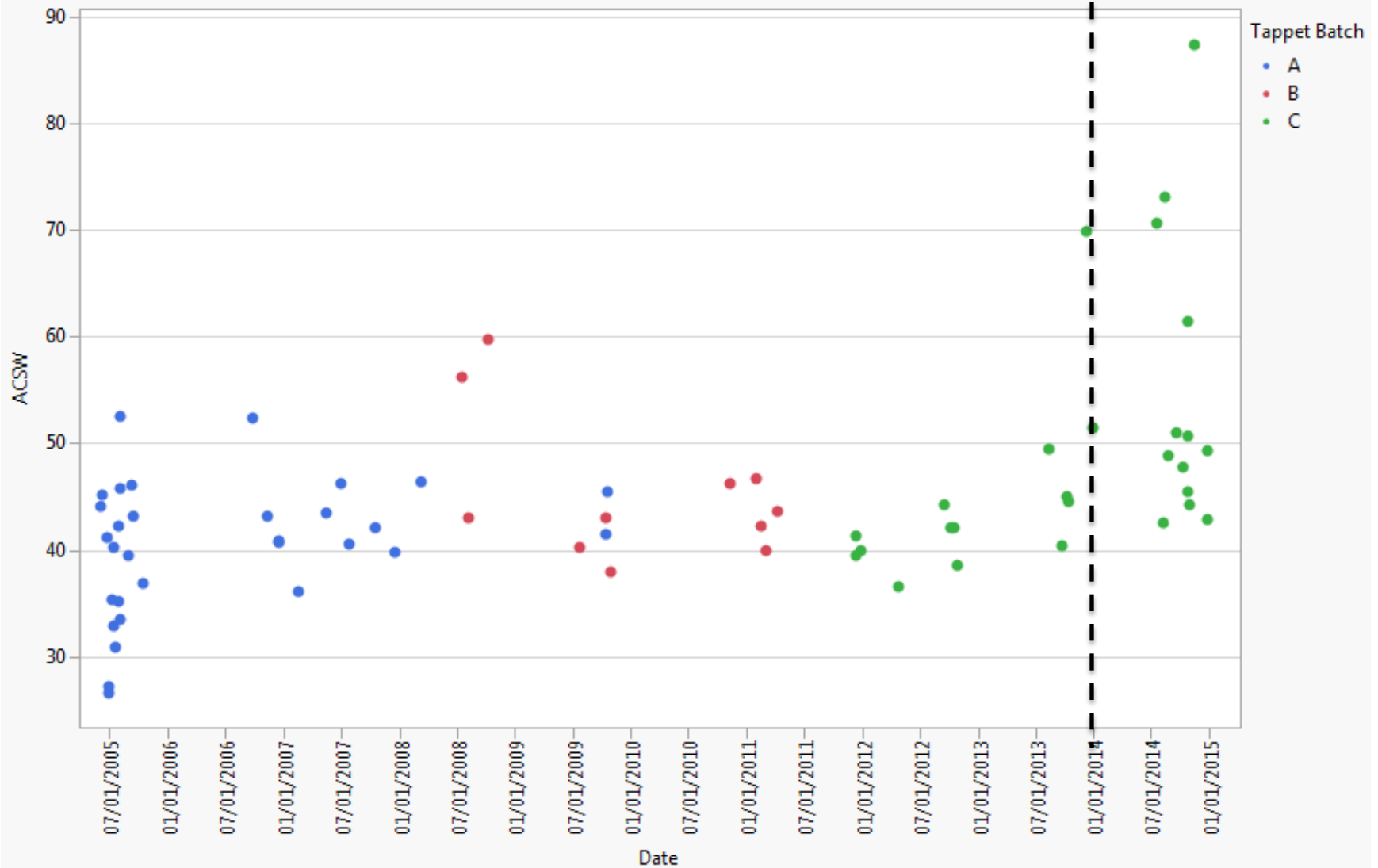
SUCCESS
TOGETHER



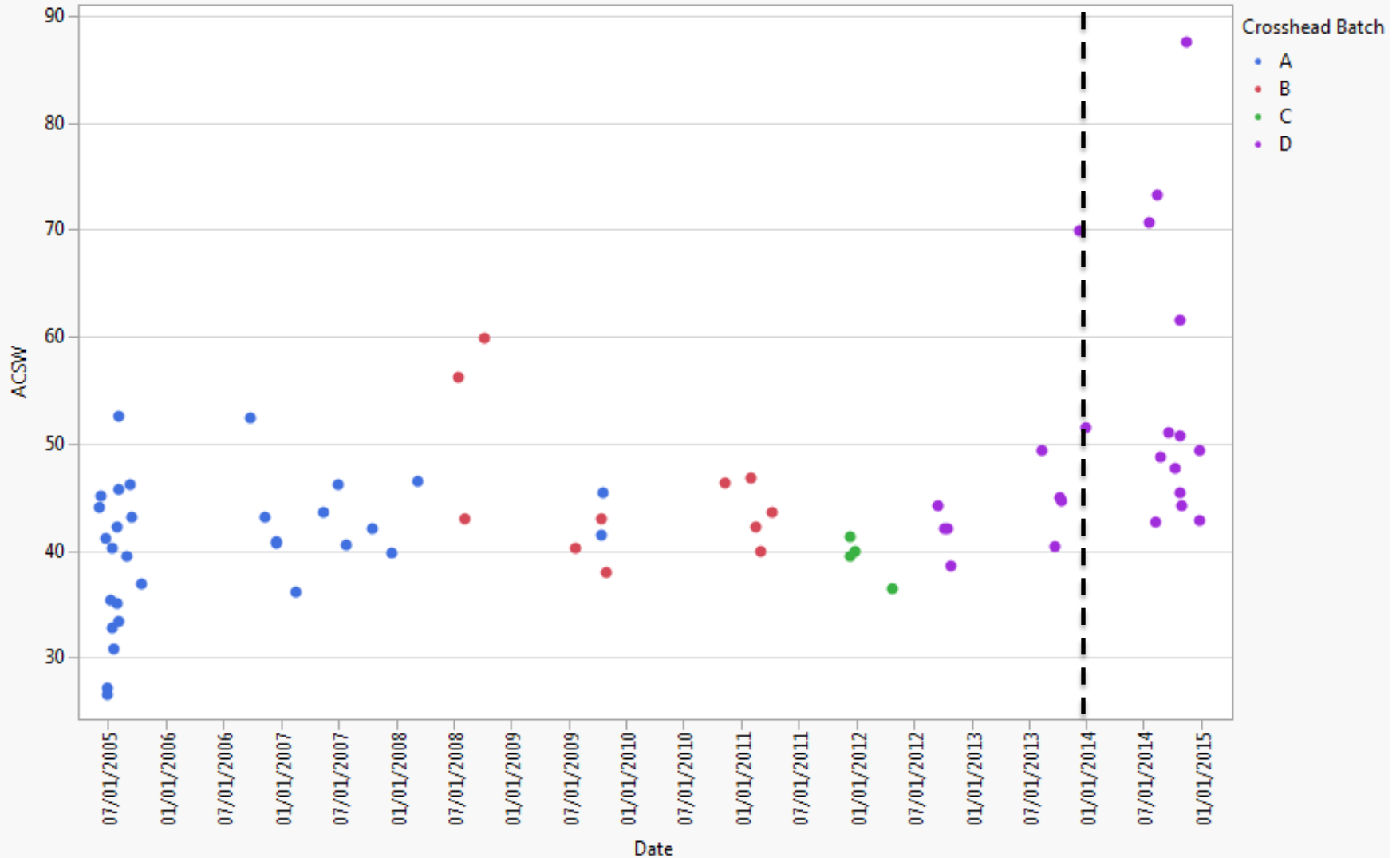
Average Camshaft Wear Correction Factors Applied (ACSW):



SUCCESS
TOGETHER



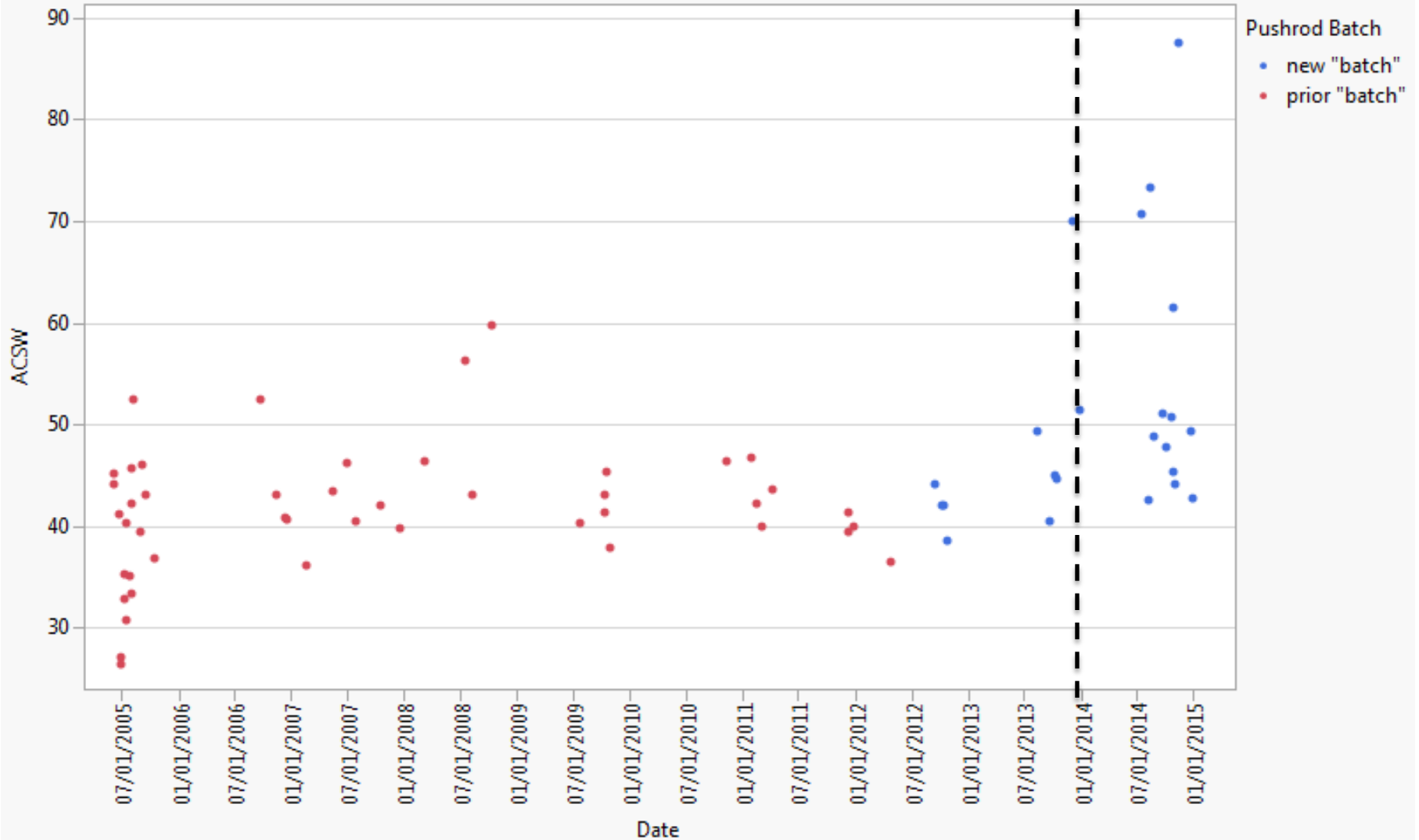
Average Camshaft Wear Correction Factors Applied (ACSW):



Average Camshaft Wear Correction Factors Applied (ACSW):



SUCCESS
TOGETHER



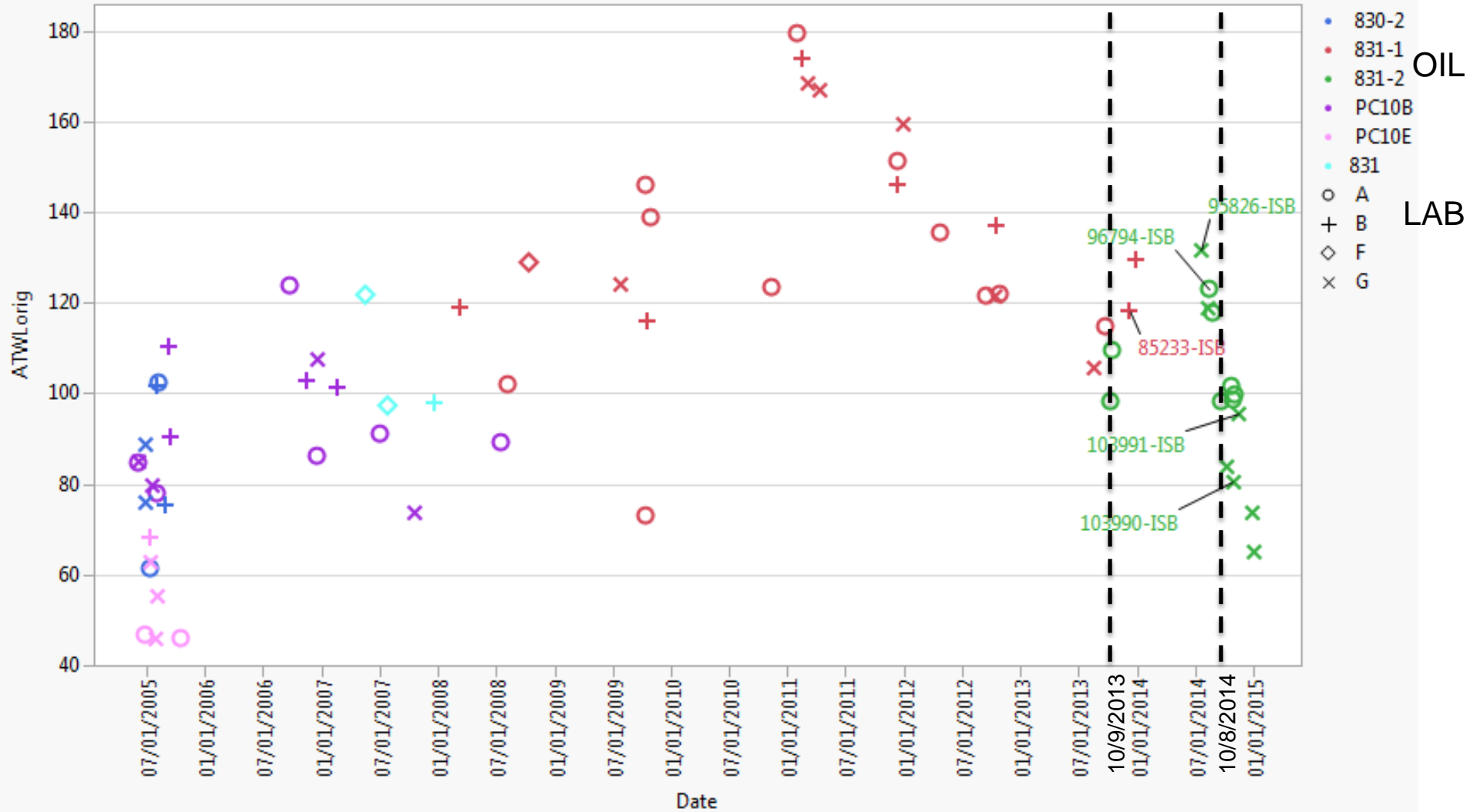


Average Tappet Weight Loss Uncorrected Original Results

Average Tappet Weight Loss (ATWLorig):



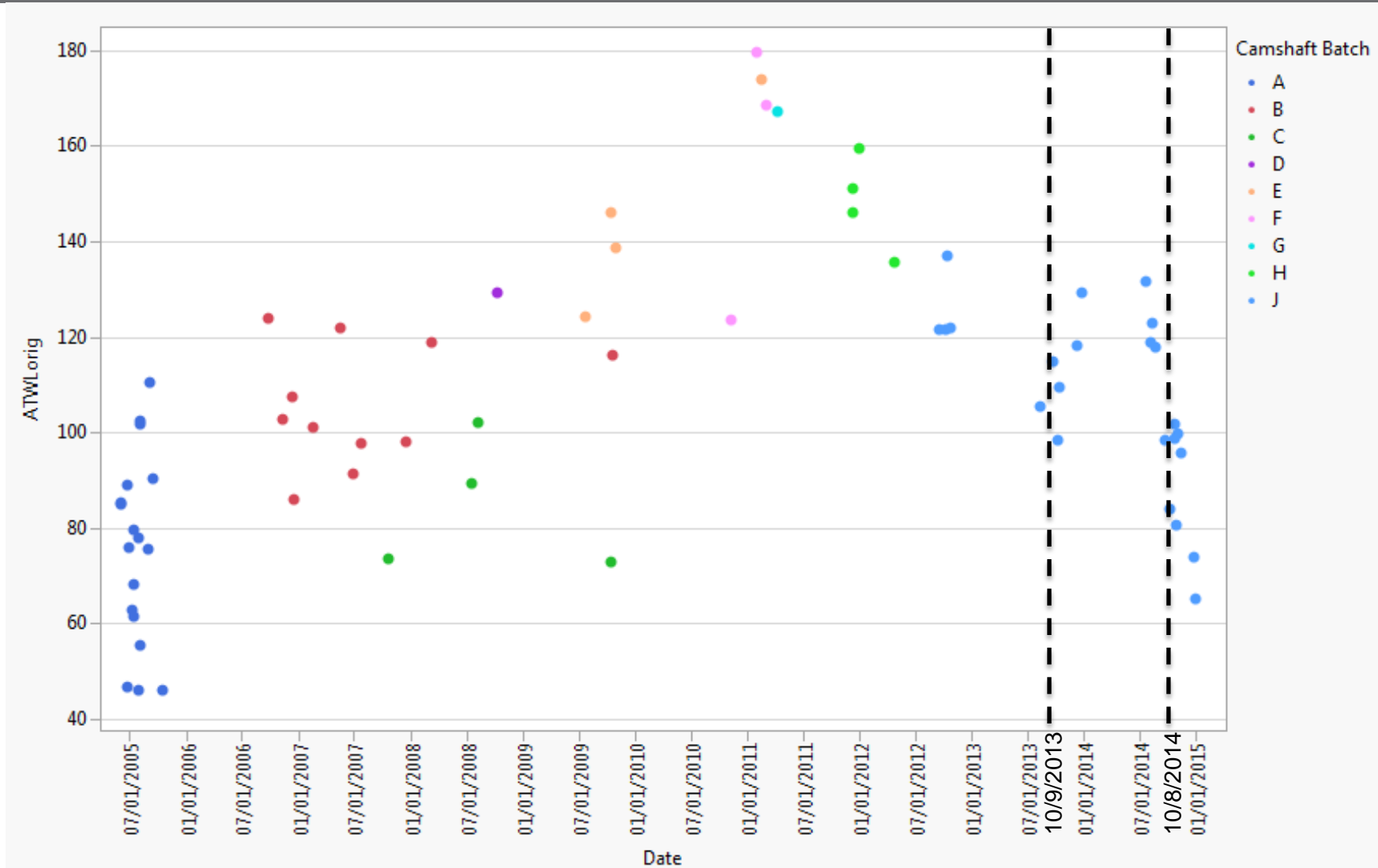
SUCCESS TOGETHER



Average Tappet Weight Loss (ATWLOrig):



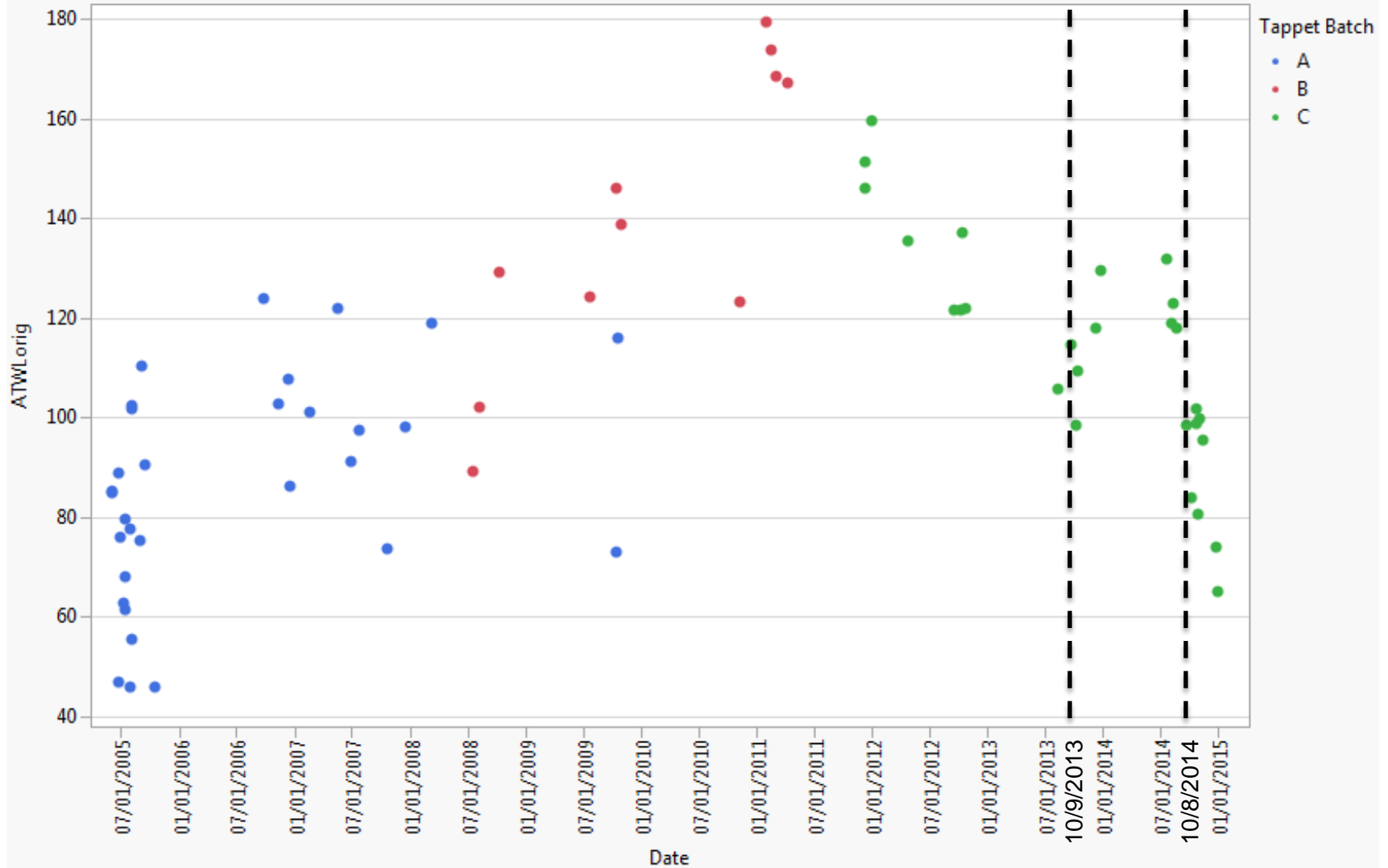
SUCCESS
TOGETHER



Average Tappet Weight Loss (ATWLOrig):



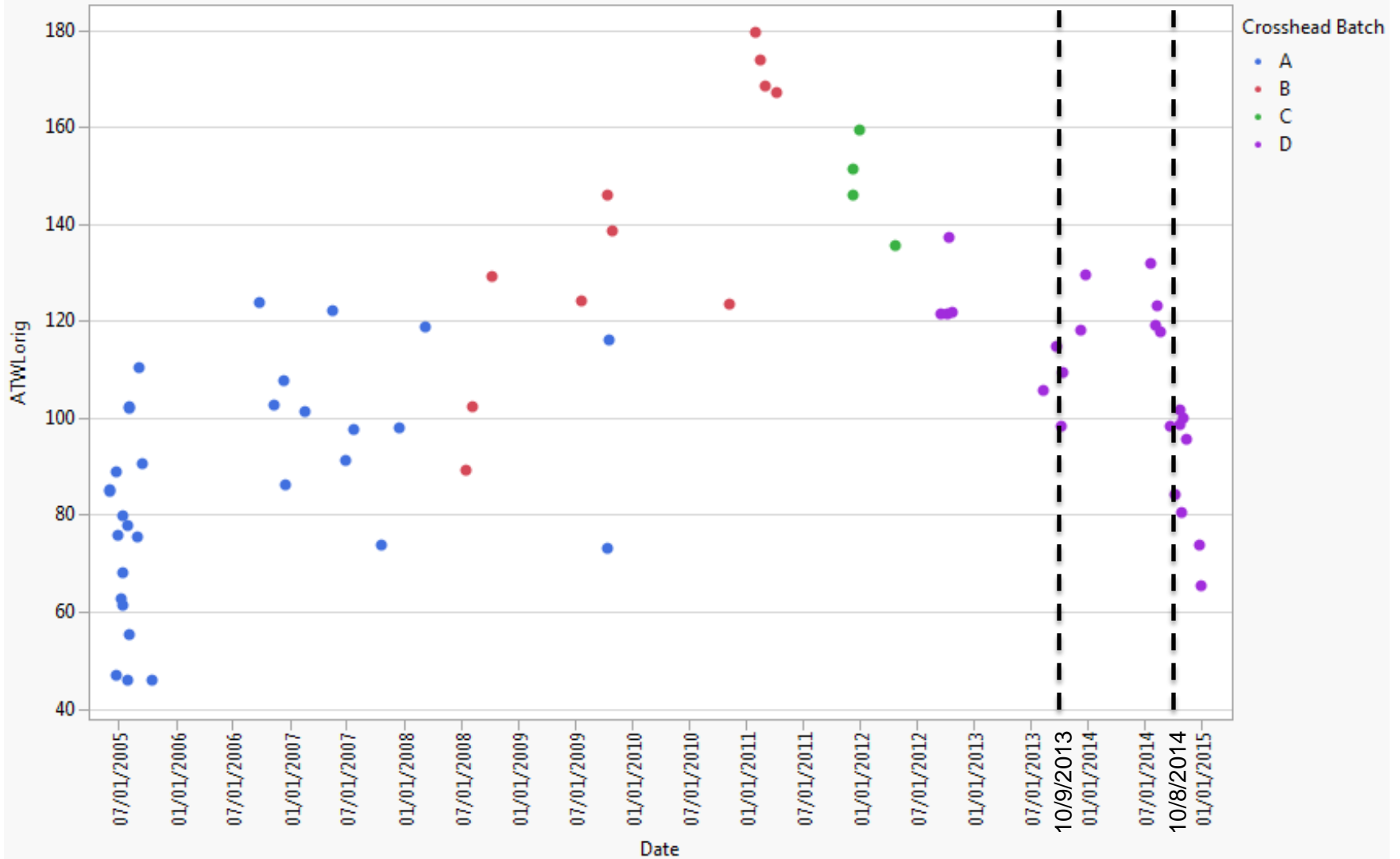
SUCCESS
TOGETHER



Average Tappet Weight Loss (ATWLOrig):



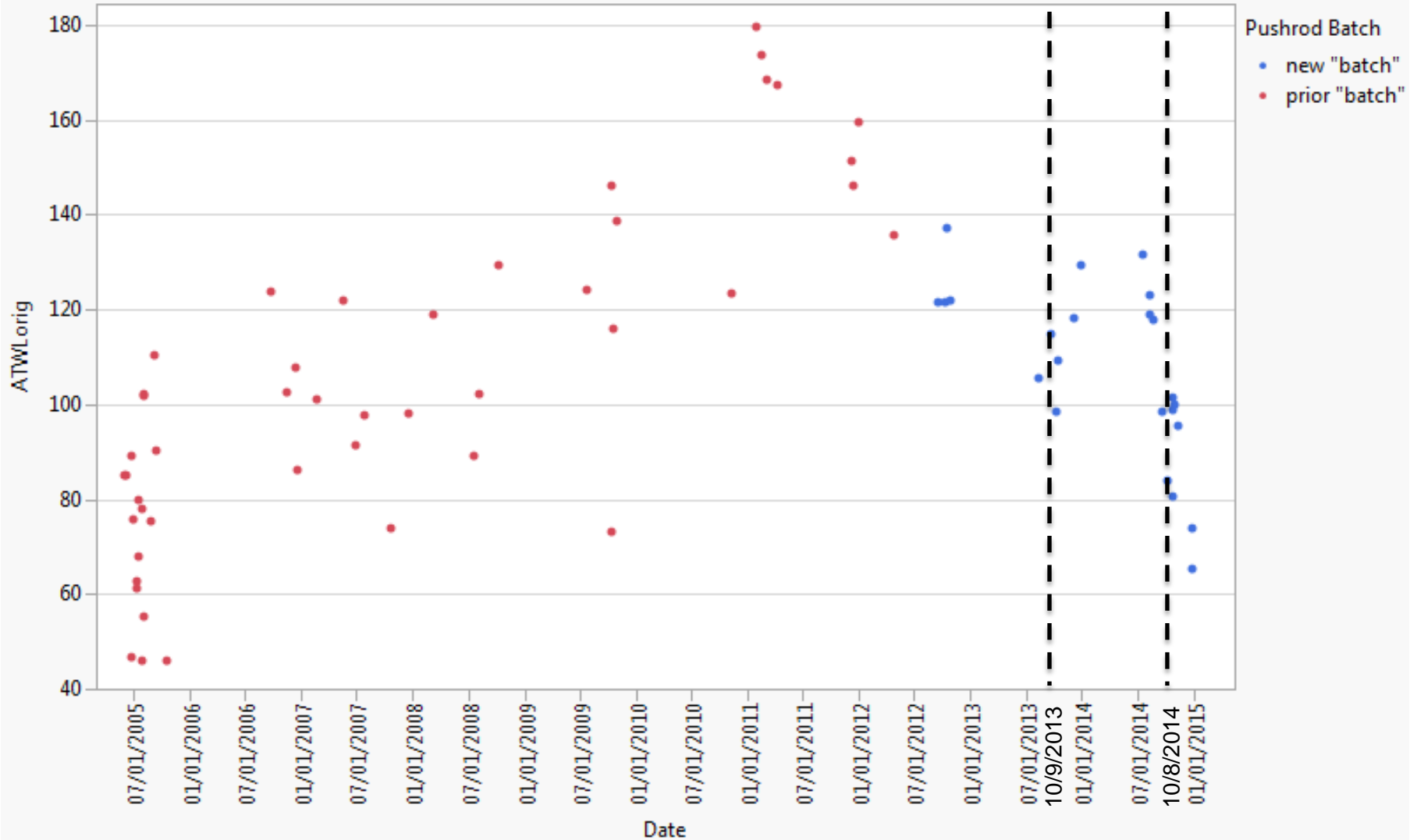
SUCCESS
TOGETHER



Average Tappet Weight Loss (ATW_{Orig}):



SUCCESS
TOGETHER



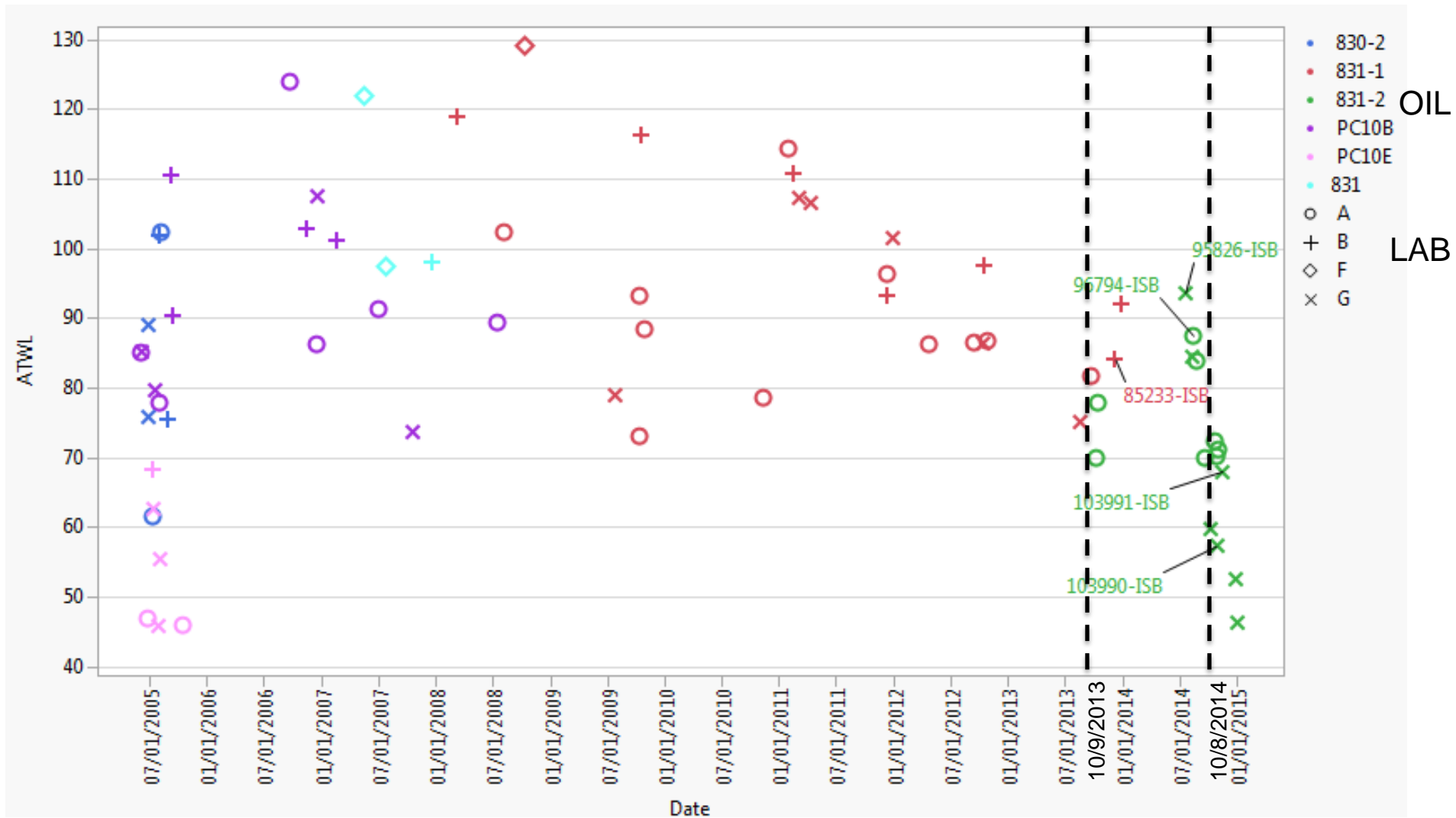


Average Tappet Weight Loss Correction Factors Applied

Average Tappet Weight Loss Correction Factors Applied (ATWL):



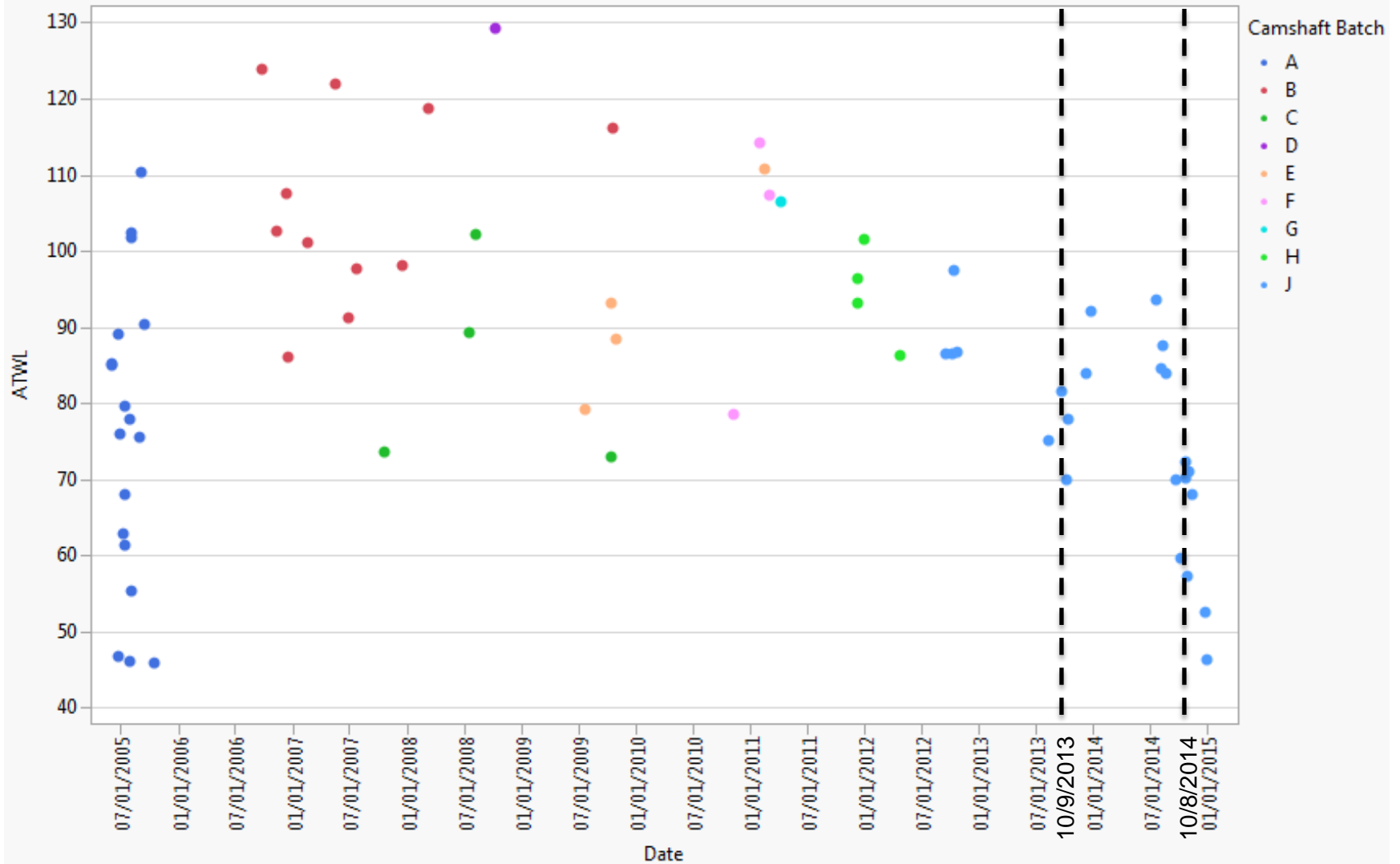
SUCCESS
TOGETHER



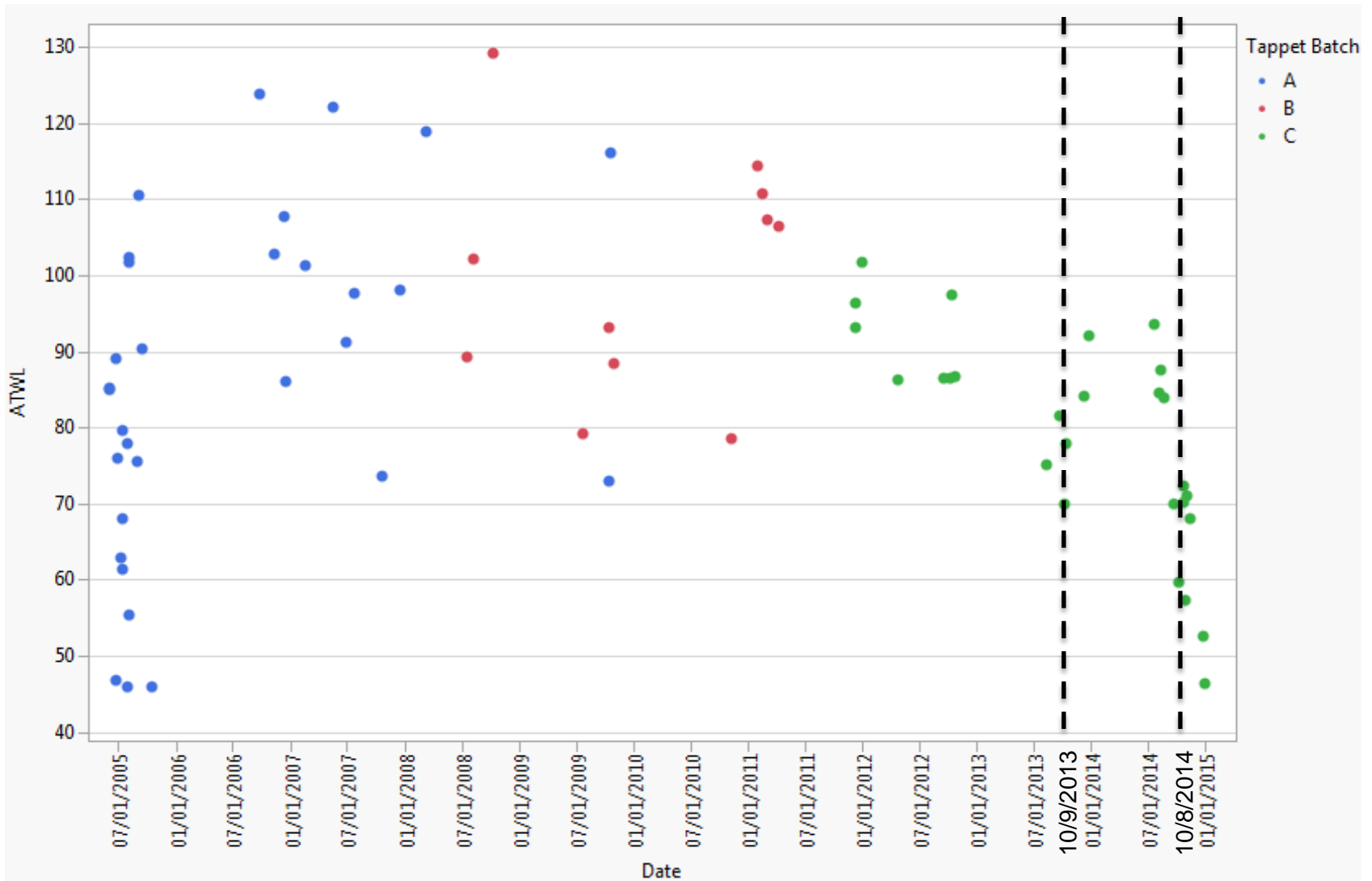
Average Tappet Weight Loss Correction Factors Applied (ATWL):



SUCCESS
TOGETHER



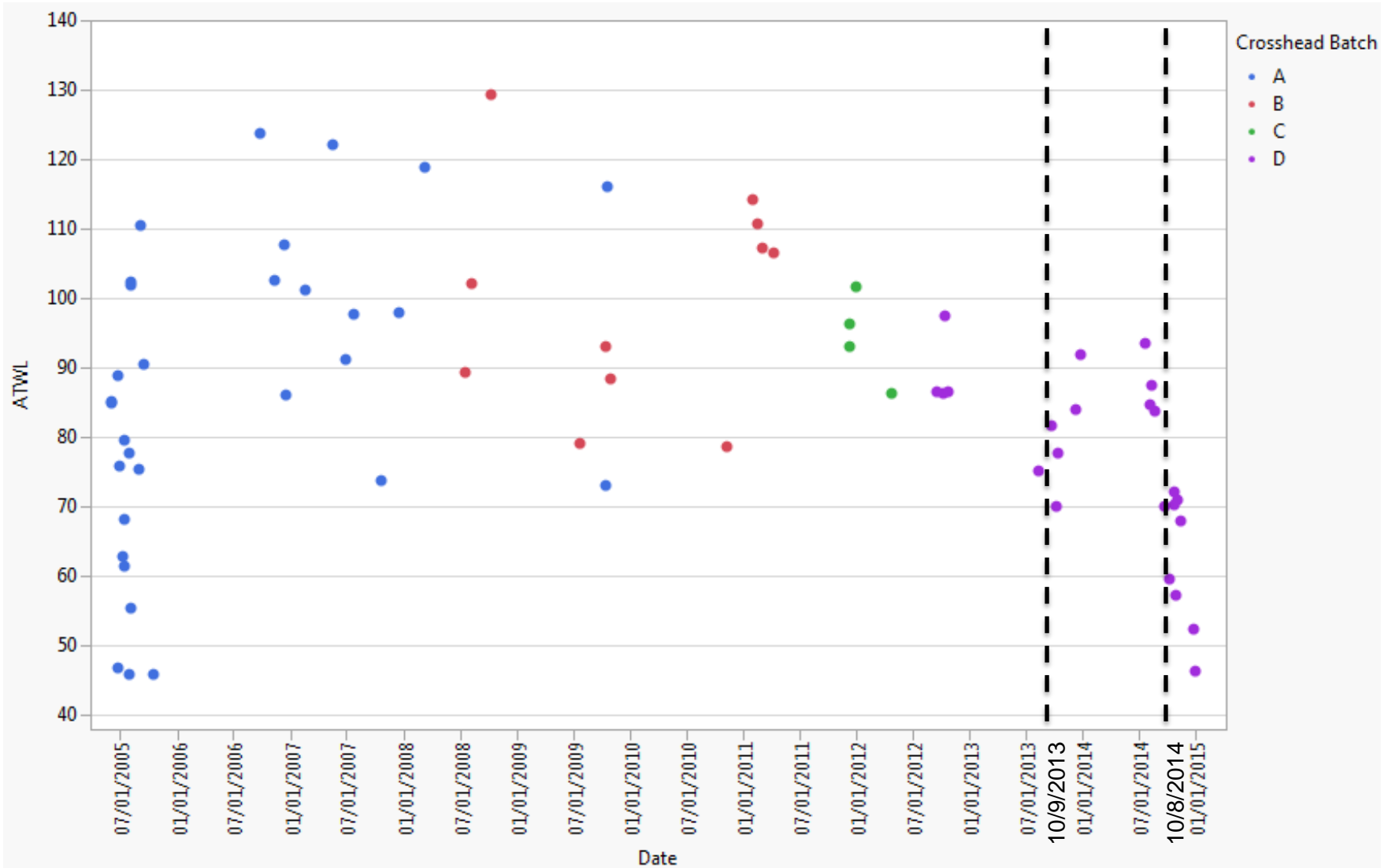
Average Tappet Weight Loss Correction Factors Applied (ATWL):



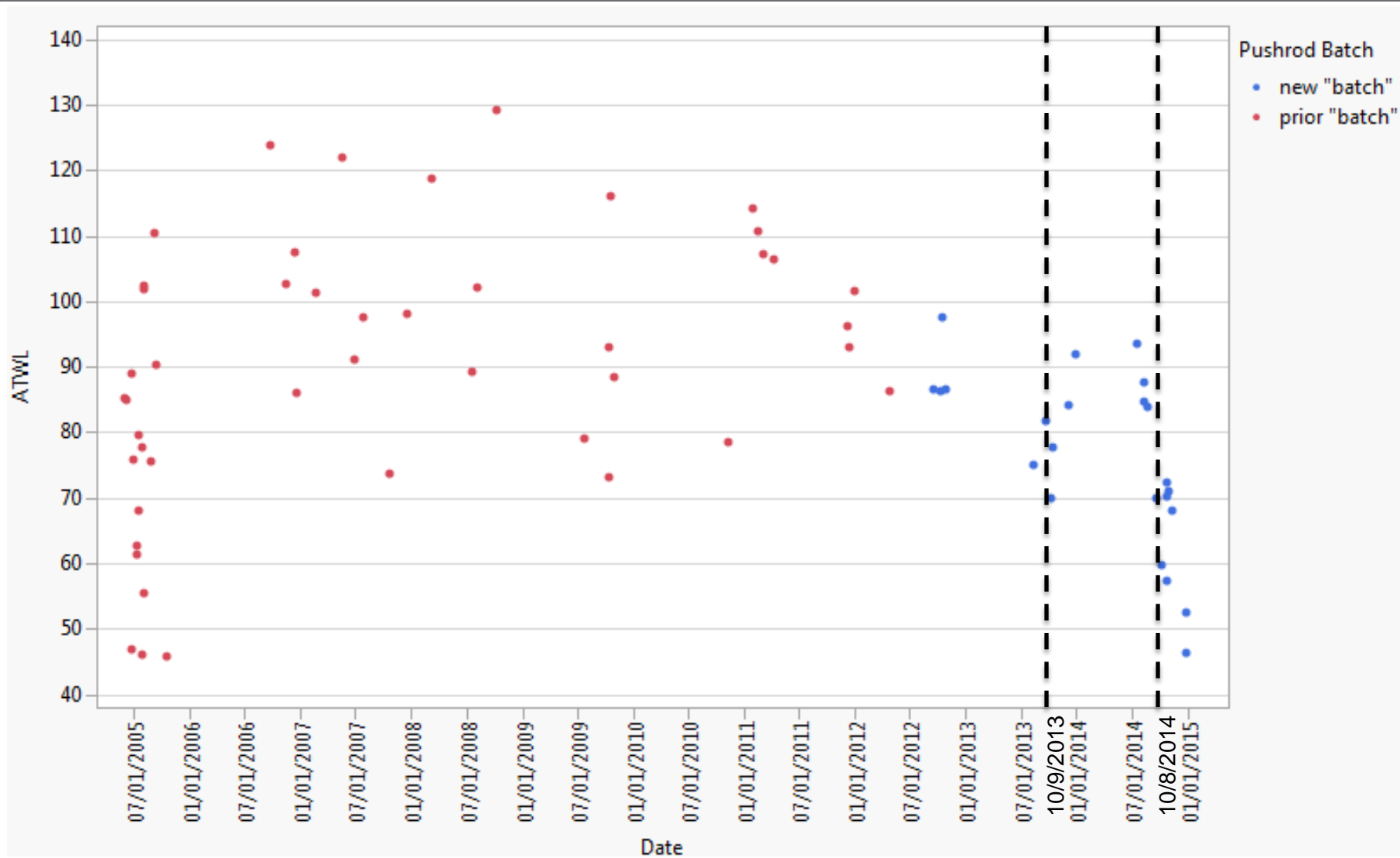
Average Tappet Weight Loss Correction Factors Applied (ATWL):



SUCCESS
TOGETHER



Average Tappet Weight Loss Correction Factors Applied (ATWL):



Options for Path Forward



Option 1: Update 831-2 Oil Targets

Option 1A: Use raw corrected data

Option 1B: Use model estimates from corrected

Calculations done using corrected test results to maintain current test severity

Option 2: Update Correction Factors

Option 2A: Use raw uncorrected results and latest pushrod, crosshead, or camshaft batches

Option 2B: Use raw uncorrected results and latest Tappet Batch

Option 2C: Use model estimates and latest pushrod, crosshead, or camshaft batches

Option 2D: Use model estimates and latest Tappet Batch

Correct back to 831-1 original targets

Options 2C & 2D still need to be pursued

Chart="Y" test results Used for calculations

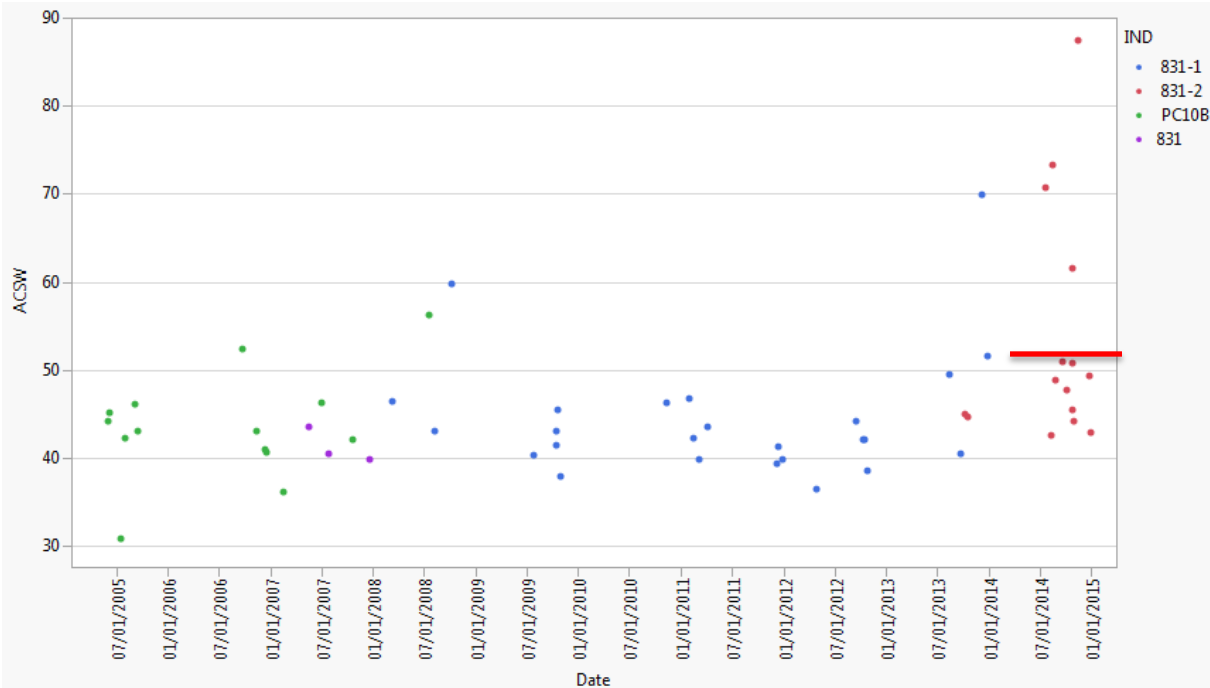
Option 1: Update Targets

Option 1A (use raw corrected results):

ACSW target calculations:

831-2 Average ACSW = 53.67

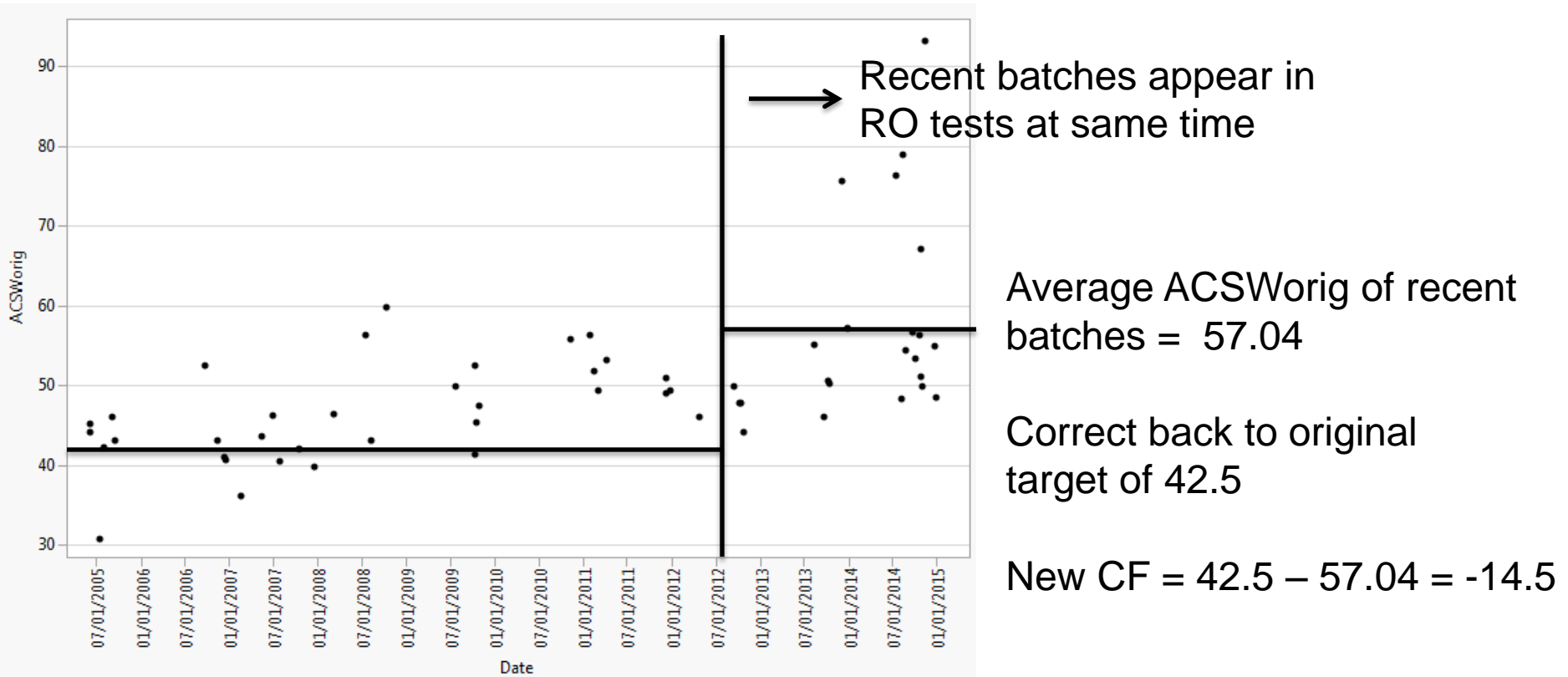
831-2 Standard Deviation of ACSW = 13.44



Option 1B (use model estimates):

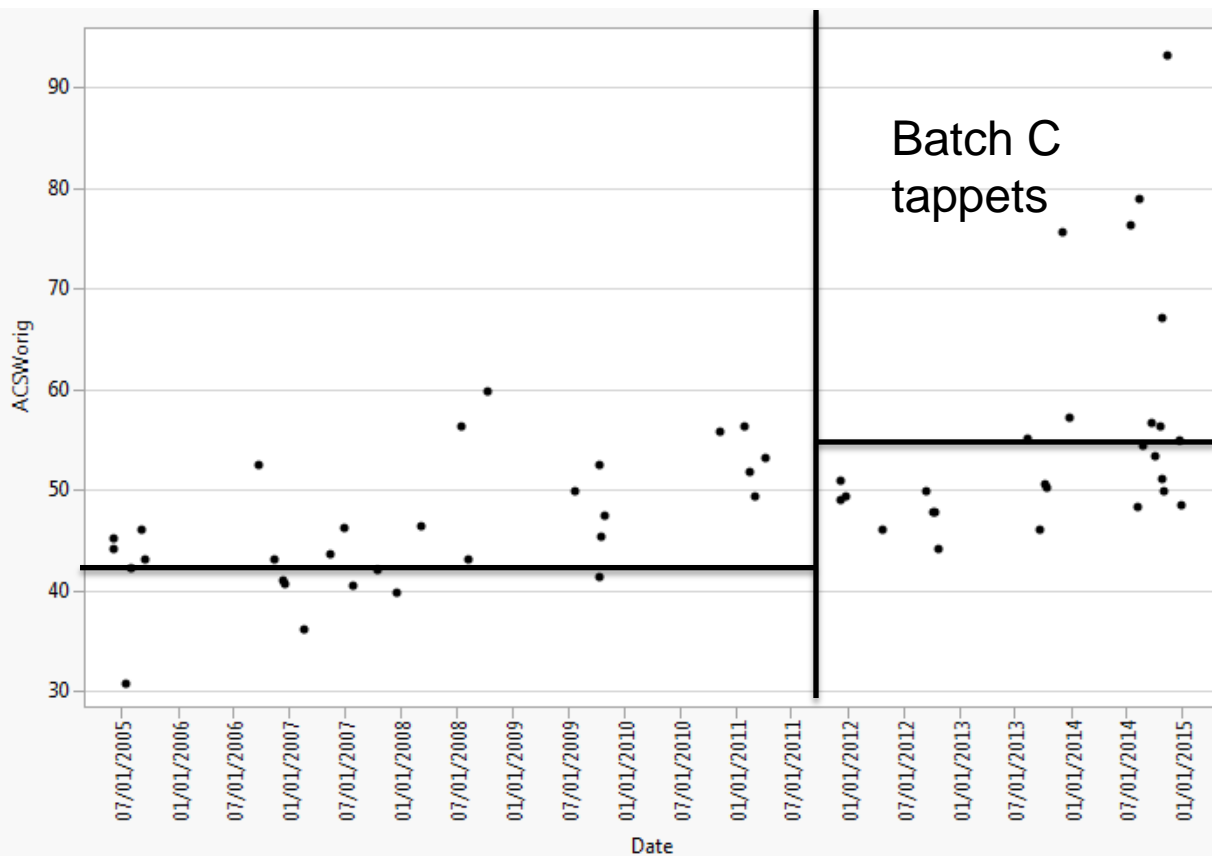
- Same estimates as Option 1A
- No strong evidence that operational data affect ACSW

Option 2A (Use raw uncorrected data;
CF based on pushrod, crosshead, & camshaft batch changes):



Concern: More variability in recent test results; consider transformation

Option 2B (Use raw uncorrected data;
CF based on tappet batch change):



Average ACSWorig of
batch C = 55.81

Correct back to original
target of 42.5

$$\text{New CF} = 42.5 - 55.81 = -13.3$$

Concern: More variability in recent test results; consider transformation

Option 1: Update Targets



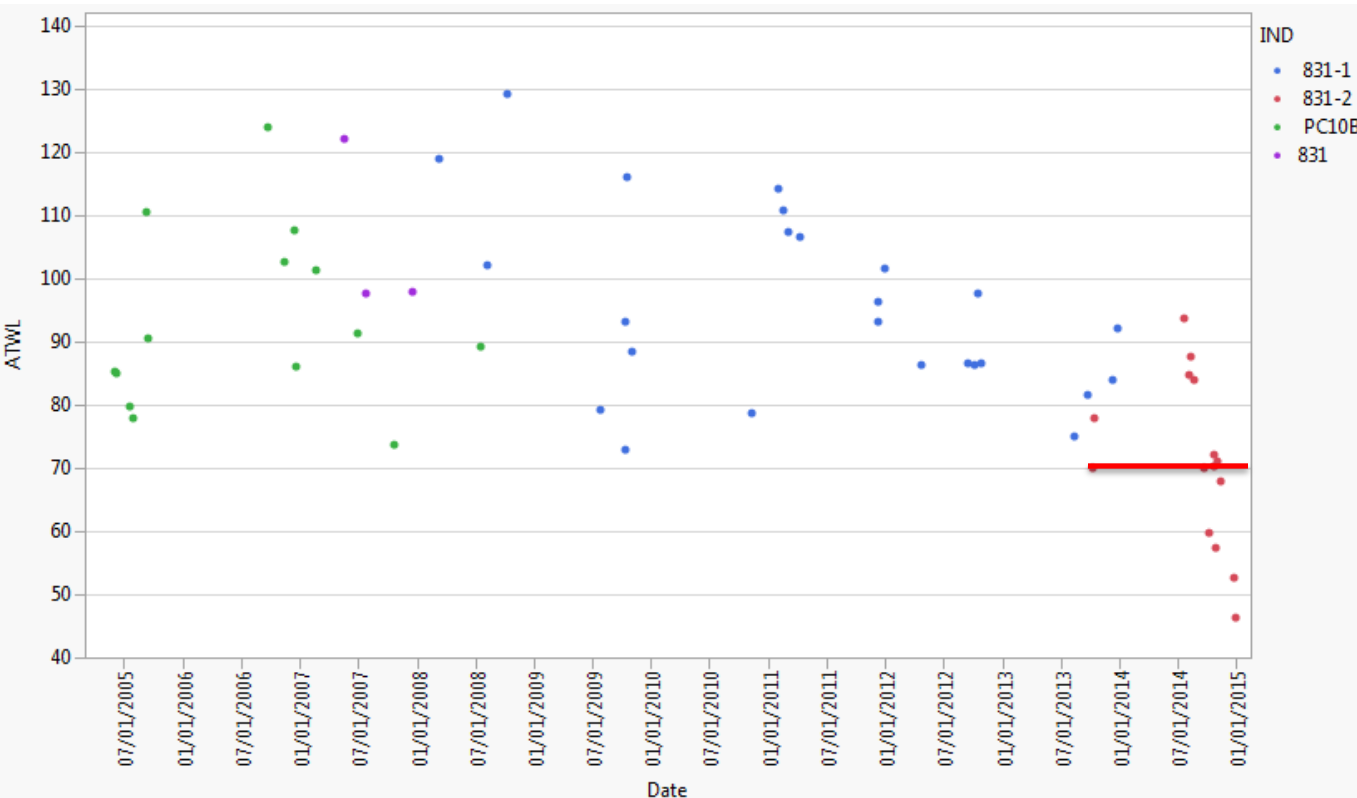
Option 1A (use raw corrected results):

Calculations done using corrected test results to maintain current test severity

ATWL target calculations:

831-2 Average ATWL = 70.97

831-2 Standard Deviation ATWL = 13.24



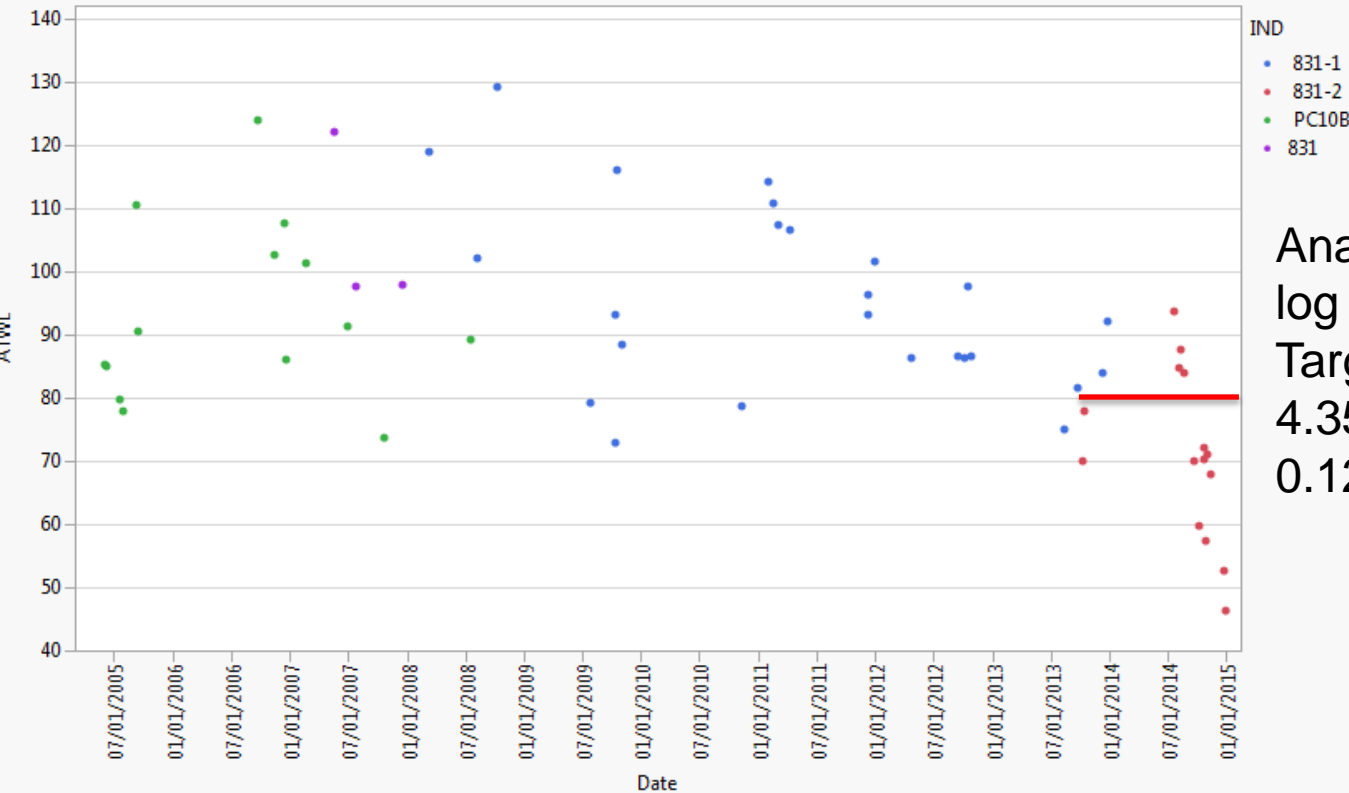
Option 1B (use model estimates; 831 data only for simplicity):

Calculations done using corrected test results to maintain current test severity

ATWL target calculations:

831-2 Average ATWL = 79.75

831-2 Standard Deviation ATWL = 11.917 (this is a pooled estimate from model)



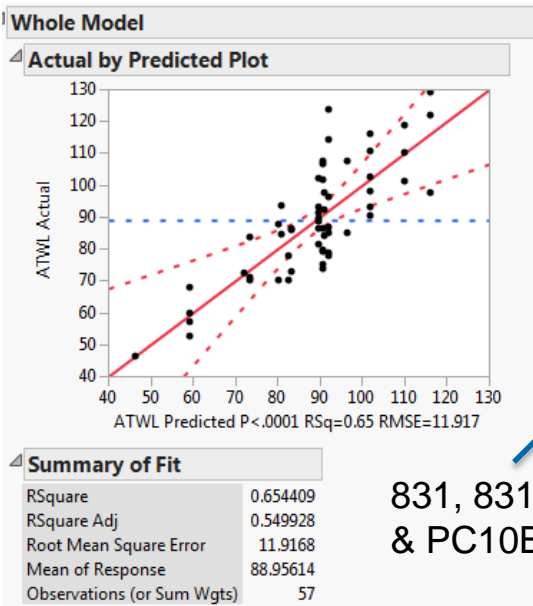
Analysis suggests natural log transformation

Targets:

4.35 for the mean

0.128 for the SD

Option 1B (use model estimates; 831 data only for simplicity):
Model Output



831, 831-2,
& PC10B

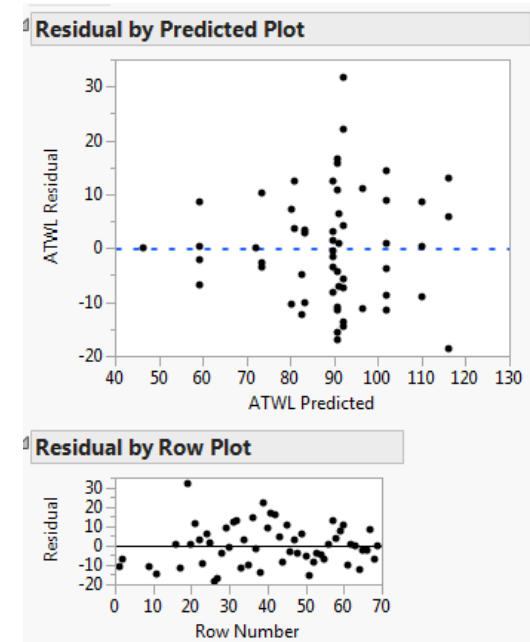
Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
OIL	1	1	574.8506	4.0480	0.0505
LabStand	12	12	4980.0058	2.9223	0.0048*

Expanded Estimates

Nominal factors expanded to all levels

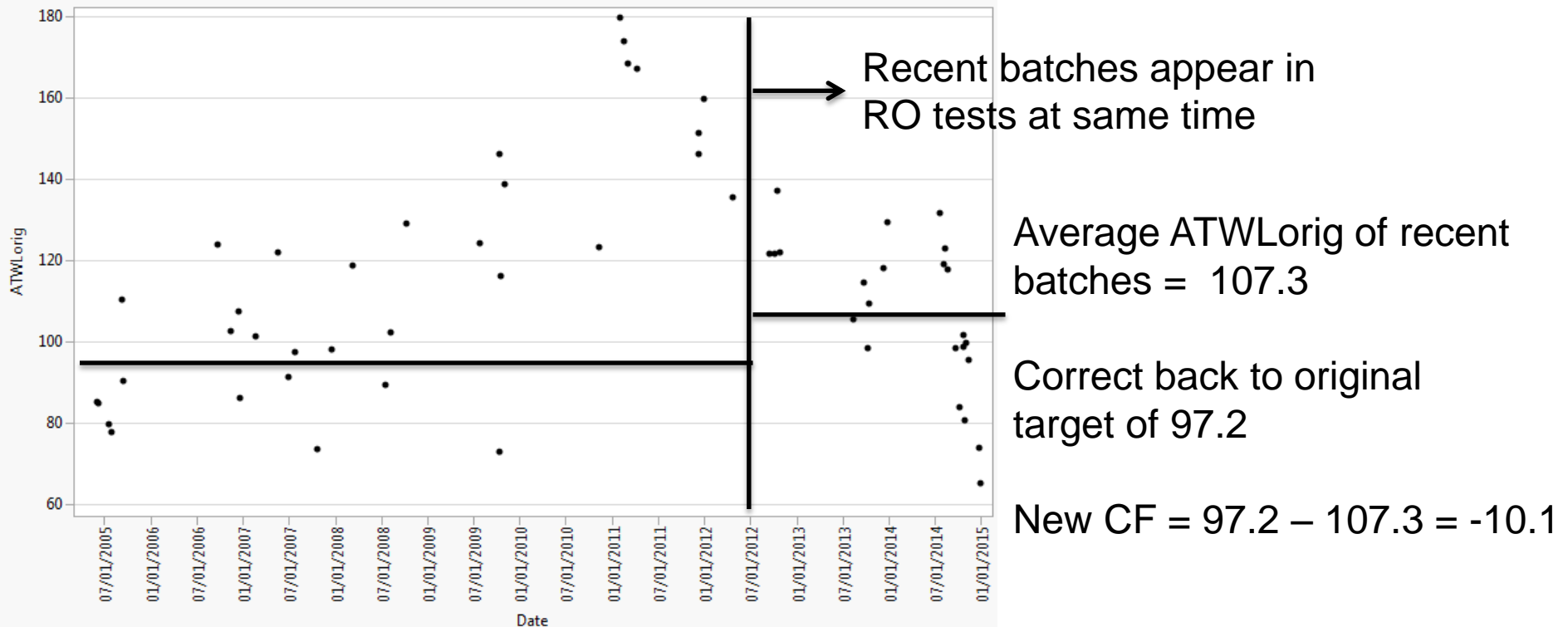
Term	Estimate	Std Error	t Ratio	Prob > t
Intercept	84.55773	2.15823	39.18	<.0001*
OIL[831]	4.8101968	2.390809	2.01	0.0505
OIL[831-2]	-4.810197	2.390809	-2.01	0.0505
LabStand[A1]	-6.15773	8.046064	-0.77	0.4483
LabStand[A2]	2.8032716	4.237981	0.66	0.5118
LabStand[A3]	-6.15773	5.890548	-1.05	0.3017
LabStand[A4]	0.5032716	4.237981	0.12	0.9060
LabStand[A5]	-7.547533	11.56719	-0.65	0.5176
LabStand[B1]	12.465406	5.209368	2.39	0.0212*
LabStand[B2]	20.765406	6.867647	3.02	0.0042*
LabStand[B3]	1.7987397	6.867647	0.26	0.7946
LabStand[F1]	26.89874	6.867647	3.92	0.0003*
LabStand[G1]	1.3161518	4.09559	0.32	0.7495
LabStand[G2]	7.0320731	8.197051	0.86	0.3957
LabStand[G3]	-20.37253	6.608934	-3.08	0.0036*
LabStand[G4]	-33.34753	11.56719	-2.88	0.0061*



Used to estimate mean equally across labstands

Used lab*stand in model instead of stand(lab) to get model table for estimates

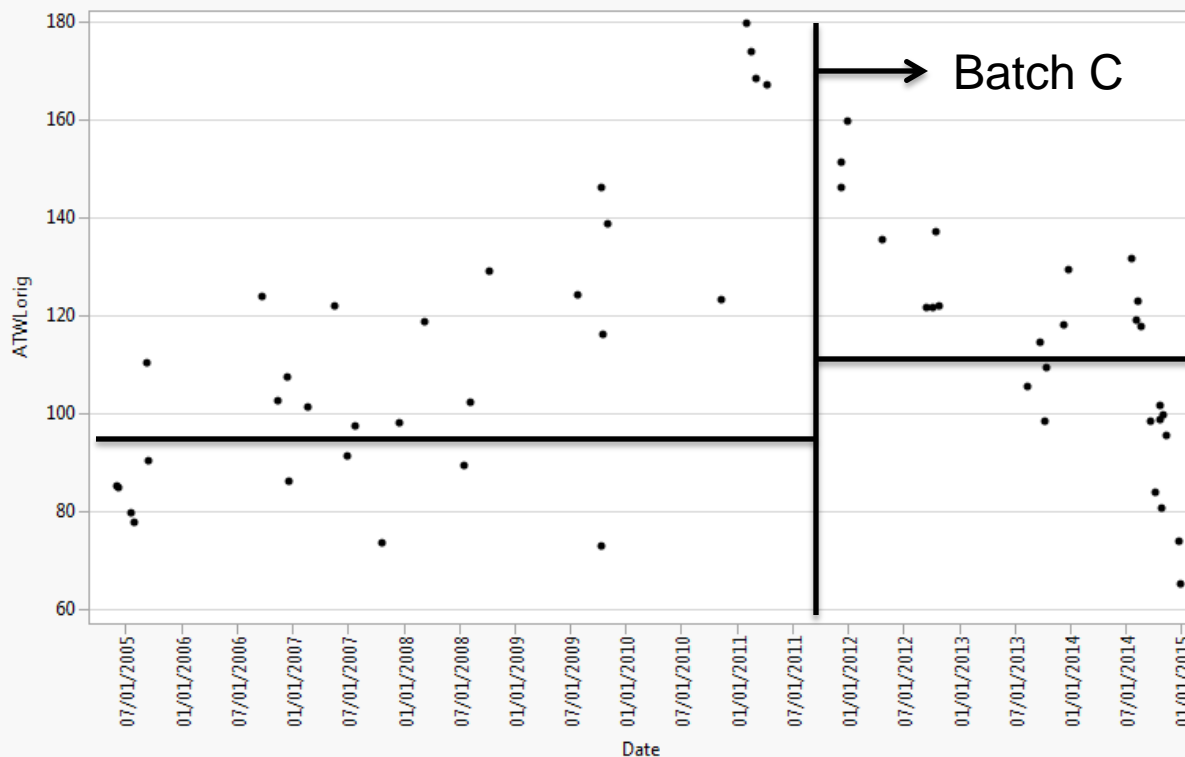
Option 2A (Use raw uncorrected data;
CF based on pushrod, crosshead, & camshaft batch changes):



Another option would be to keep multiplicative correction: $97.2/107.3 = 0.90587$
So, CF = ATWLorig * 0.90587

Option 2: New Correction Factor

Option 2B (Use raw uncorrected data;
CF based on tappet batch change):



Average ATWLorig of recent
batches = 113.3

Correct back to original
target of 97.2

New CF = $97.2 - 113.3 = -16.1$

Another option would be to keep multiplicative correction: $97.2/113.3 = 0.8579$

So, CF = ATWLorig * 0.8579

Summary of Options



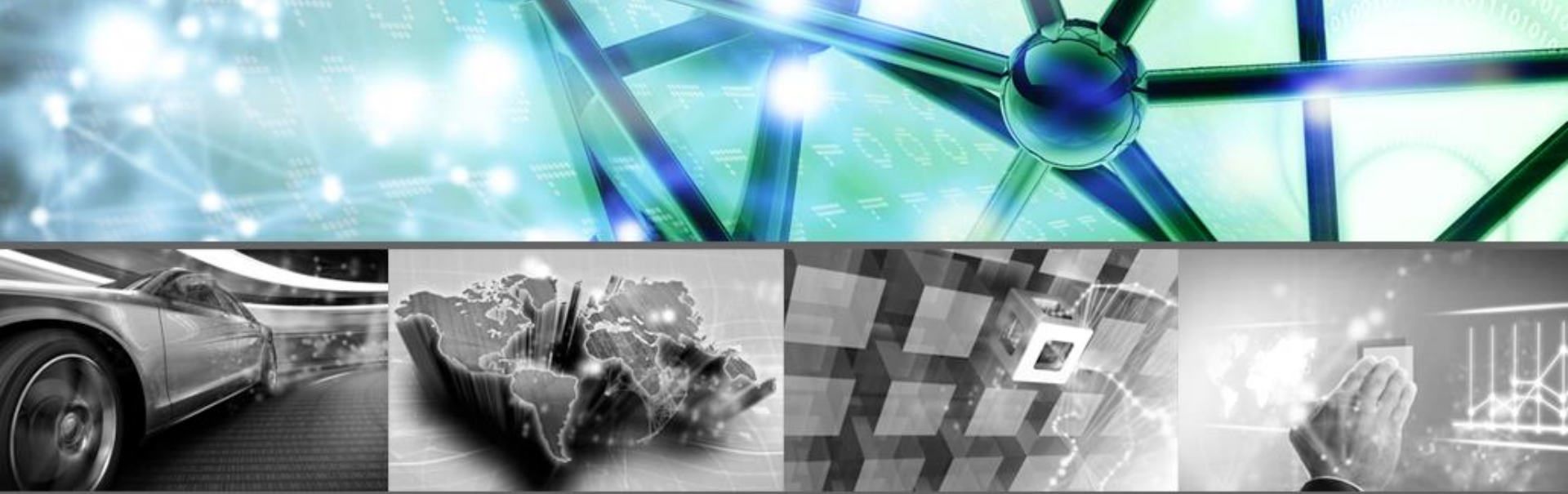
Option 1: Update 831-2 Targets

		Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss		
Oil	n	From	To	Mean	s	mean	s	
Use raw transformed results	831-2	15	TBD	***	53.67	13.44	70.97	13.24
Use Model estimates	831-2	15	TBD	***	53.67	13.44	79.75	11.92
Use model estimates(ln transformation)	831-2	15	TBD	***			4.35	0.128

Option 2: Update Correction Factors

Batch Change	Data or Model	ACSWorig CF	ATWOrig CF	ATWOrig Multiplicative CF
new pushrod crosshead D camshaft J	raw data	ACSWorig - 14.5	ATWOrig - 10.1	ATWOrig*0.90587
tappet C	raw data	ACSWorig - 13.3	ATWOrig - 16.1	ATWOrig*0.8579

Model estimates: TBD



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When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.