Cummins ISB
Industry Severity

Jan 2014

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Current State of LTMS for ISB:

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							
		Effective Dates		Average Camshaft Wear		Average Tappet Weight Loss	
Oil	n	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

ISB ACSWyi calculation:

	TESTKEY	LTMS LAB	IND	LTMSAPP	STRUN	VAL	LTMSDATE	CHART	ACSWorig	ACSWCF	ACSW	ATWLorig	ATWLCF	ATWL	ACSWyi	ATWLyi	ACSWxbar	ACSWs	ACSWyi (Kevin's calc)	(Kevin's Calc)-(ACSWyi)
2	55841-ISB	G	PC10B	2	9	AO	20050604	Y	44.1	0	44.1	85.2	0	85.2	0.2407	-0.634	41.9	5.6	0.392857143	0.1522
3	55851-ISB	A	PC10B	2	5	AO	20050606	Y	45.1	.	45.1	84.9	.	84.9	0.4259	-0.6536	41.9	5.6	0.571428571	0.1455
4	55839-ISB	G	830-2	2	10	AO	20050624	Y	41.1	.	41.1	89	.	89	0.1444	0.2883	39.8	9	0.144444444	0.0000
5	55853-ISB	A	PC10E	2	6	AO	20050627	Y	26.5	.	26.5	46.8	.	46.8	-1.7609	-0.7708	34.6	4.6	-1.760869565	0.0000
6	55840-ISB	G	830-2	1	12	AO	20050629	Y	27.1	.	27.1	75.9	.	75.9	-1.4111	-0.5153	39.8	9	-1.411111111	0.0000
7	55843-ISB	G	PC10E	2	11	AO	20050711	Y	35.3	.	35.3	62.8	.	62.8	0.1522	0.8958	34.6	4.6	0.152173913	0.0000
8	55850-ISB	A	830-2	2	7	AO	20050713	Y	32.8	.	32.8	61.4	.	61.4	-0.7778	-1.4049	39.8	9	-0.777777778	0.0000
9	56361-ISB	B	PC10E	1	8	AO	20050715	Y	40.3	.	40.3	68.1	.	68.1	1.2391	1.4479	34.6	4.6	1.239130435	0.0000
10	55842-ISB	G	PC10B	1	13	OO	20050717	Y	30.8	.	30.8	79.7	.	79.7	-2.2222	-0.9935	41.9	5.6	-1.982142857	0.2401
11	55844-ISB	G	PC10E	2	12	AO	20050730	Y	35.1	.	35.1	46	.	46	0.1087	-0.8542	34.6	4.6	0.108695652	0.0000
12	55852-ISB	A	PC10B	2	8	AO	20050801	Y	42.2	.	42.2	77.8	.	77.8	-0.1111	-1.1176	41.9	5.6	0.053571429	0.1647
13	55846-ISB	B	830-2	1	9	AO	20050804	Y	45.7	.	45.7	101.8	.	101.8	0.6556	1.0736	39.8	9	0.655555556	0.0000
14	55845-ISB	G	PC10E	1	14	AO	20050805	Y	33.4	.	33.4	55.4	.	55.4	-0.2609	0.125	34.6	4.6	-0.260869565	0.0000
15	55907-ISB	A	830-2	3	3	AC	20050806	Y	52.5	.	52.5	102.3	.	102.3	1.4111	1.1043	39.8	9	1.411111111	0.0000
16	55847-ISB	B	830-2	1	11	AO	20050829	Y	39.4	.	39.4	75.5	.	75.5	-0.0444	-0.5399	39.8	9	-0.044444444	0.0000
17	56950-ISB	B	PC10B	2	7	AC	20050907	Y	46.1	.	46.1	110.4	.	110.4	0.6111	1.0131	41.9	5.6	0.75	0.1389
18	56972-ISB	B	PC10B	1	12	AO	20050915	Y	43.1	.	43.1	90.4	.	90.4	0.0556	-0.2941	41.9	5.6	0.214285714	0.1587
19	55909-ISB	A	PC10E	4	12	AC	20051016	Y	36.9	.	36.9	45.9	.	45.9	0.5	-0.8646	34.6	4.6	0.5	0.0000
20	58241-ISB	A	PC10B	2	21	AC	20060924	Y	52.4	0	52.4	123.8	0	123.8	1.7778	1.8889	41.9	5.6	1.875	0.0972
21	57939-ISB	B	PC10B	1	23	AC	20061113	Y	43.1	0	43.1	102.7	0	102.7	0.0556	0.5098	41.9	5.6	0.214285714	0.1587
22	58207-ISB	G	PC10B	2	21	AC	20061215	Y	40.9	0	40.9	107.6	0	107.6	-0.3519	0.8301	41.9	5.6	-0.178571429	0.1733
23	58242-ISB	A	PC10B	3	20	AC	20061220	Y	40.7	0	40.7	86.1	0	86.1	-0.3889	-0.5752	41.9	5.6	-0.214285714	0.1746

My ACSWyi calculation prior to 2007 does not match the LTMS file for PC10B

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

Is there a reason why the PC10B oil mean and sd used in pre-2007 tests match post-2007 targets?

ISB Reference Oil Targets

Oil	n	Effective Dates From	Effective Dates To[1]	Average Camshaft Wear $\bar{X}$	Average Camshaft Wear s	Average Tappet Weight Loss $\bar{X}$	Average Tappet Weight Loss 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	[illegible]	42.5	5.0	97.2	14.8

ISB ATWLyi calculation:

	TESTKEY	LTMS LAB	IND	LTMSAPP	STRUN	VAL	LTMSDATE	CHART	ACSWorig	ACSWCF	ACSW	ATWLorig	ATWLCF	ATWL	ACSWyi	ATWLyi	ATWLxbar	ATWLs	ATWLyi (Kevin's Calc)	(Kevin's Calc)-(ATWLyi)
2	55841-ISB	G	PC10B	2	9	AO	20050604	Y	44.1	0	44.1	85.2	0	85.2	0.2407	-0.634	88.7	15.9	-0.220125786	0.4139
3	55851-ISB	A	PC10B	2	5	AO	20050606	Y	45.1	.	45.1	84.9	.	84.9	0.4259	-0.6536	88.7	15.9	-0.238993711	0.4146
4	55839-ISB	G	830-2	2	10	AO	20050624	Y	41.1	.	41.1	89	.	89	0.1444	0.2883	85.9	16	0.19375	-0.0946
5	55853-ISB	A	PC10E	2	6	AO	20050627	Y	26.5	.	26.5	46.8	.	46.8	-1.7609	-0.7708	56.2	9.6	-0.979166667	-0.2084
6	55840-ISB	G	830-2	1	12	AO	20050629	Y	27.1	.	27.1	75.9	.	75.9	-1.4111	-0.5153	85.9	16	-0.625	-0.1097
7	55843-ISB	G	PC10E	2	11	AO	20050711	Y	35.3	.	35.3	62.8	.	62.8	0.1522	0.8958	56.2	9.6	0.6875	-0.2083
8	55850-ISB	A	830-2	2	7	AO	20050713	Y	32.8	.	32.8	61.4	.	61.4	-0.7778	-1.4049	85.9	16	-1.53125	-0.1264
9	56361-ISB	B	PC10E	1	8	AO	20050715	Y	40.3	.	40.3	68.1	.	68.1	1.2391	1.4479	56.2	9.6	1.239583333	-0.2083
10	55842-ISB	G	PC10B	1	13	OO	20050717	Y	30.8	.	30.8	79.7	.	79.7	-2.2222	-0.9935	88.7	15.9	-0.566037736	0.4275
11	55844-ISB	G	PC10E	2	12	AO	20050730	Y	35.1	.	35.1	46	.	46	0.1087	-0.8542	56.2	9.6	-1.0625	-0.2083
12	55852-ISB	A	PC10B	2	8	AO	20050801	Y	42.2	.	42.2	77.8	.	77.8	-0.1111	-1.1176	88.7	15.9	-0.685534591	0.4321
13	55846-ISB	B	830-2	1	9	AO	20050804	Y	45.7	.	45.7	101.8	.	101.8	0.6556	1.0736	85.9	16	0.99375	-0.0799
14	55845-ISB	G	PC10E	1	14	AO	20050805	Y	33.4	.	33.4	55.4	.	55.4	-0.2609	0.125	56.2	9.6	-0.083333333	-0.2083
15	55907-ISB	A	830-2	3	3	AC	20050806	Y	52.5	.	52.5	102.3	.	102.3	1.4111	1.1043	85.9	16	1.025	-0.0793
16	55847-ISB	B	830-2	1	11	AO	20050829	Y	39.4	.	39.4	75.5	.	75.5	-0.0444	-0.5399	85.9	16	-0.65	-0.1101
17	56950-ISB	B	PC10B	2	7	AC	20050907	Y	46.1	.	46.1	110.4	.	110.4	0.6111	1.0131	88.7	15.9	1.364779874	0.3517
18	56972-ISB	B	PC10B	1	12	AO	20050915	Y	43.1	.	43.1	90.4	.	90.4	0.0556	-0.2941	88.7	15.9	0.106918239	0.4010
19	55909-ISB	A	PC10E	4	12	AC	20051016	Y	36.9	.	36.9	45.9	.	45.9	0.5	-0.8646	56.2	9.6	-1.072916667	-0.2083
20	58241-ISB	A	PC10B	2	21	AC	20060924	Y	52.4	0	52.4	123.8	0	123.8	1.7778	1.8889	88.7	15.9	2.20754717	0.3186
21	57939-ISB	B	PC10B	1	23	AC	20061113	Y	43.1	0	43.1	102.7	0	102.7	0.0556	0.5098	88.7	15.9	0.880503145	0.3707
22	58207-ISB	G	PC10B	2	21	AC	20061215	Y	40.9	0	40.9	107.6	0	107.6	-0.3519	0.8301	88.7	15.9	1.188679245	0.3586
23	58242-ISB	A	PC10B	3	20	AC	20061220	Y	40.7	0	40.7	86.1	0	86.1	-0.3889	-0.5752	88.7	15.9	-0.163522013	0.4117

My ATWLyi calculations prior to 2007 do not match the LTMS file (all oils)

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

However, I cannot confirm the yi calculations for the rest of the tests in the table above.

Is there a reason for these discrepancies?

ISB Reference Oil Targets

Oil	n	Effective Dates From	Effective Dates To[1]	Average Camshaft Wear $\bar{X}$	Average Camshaft Wear s	Average Tappet Weight Loss $\bar{X}$	Average Tappet Weight Loss 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

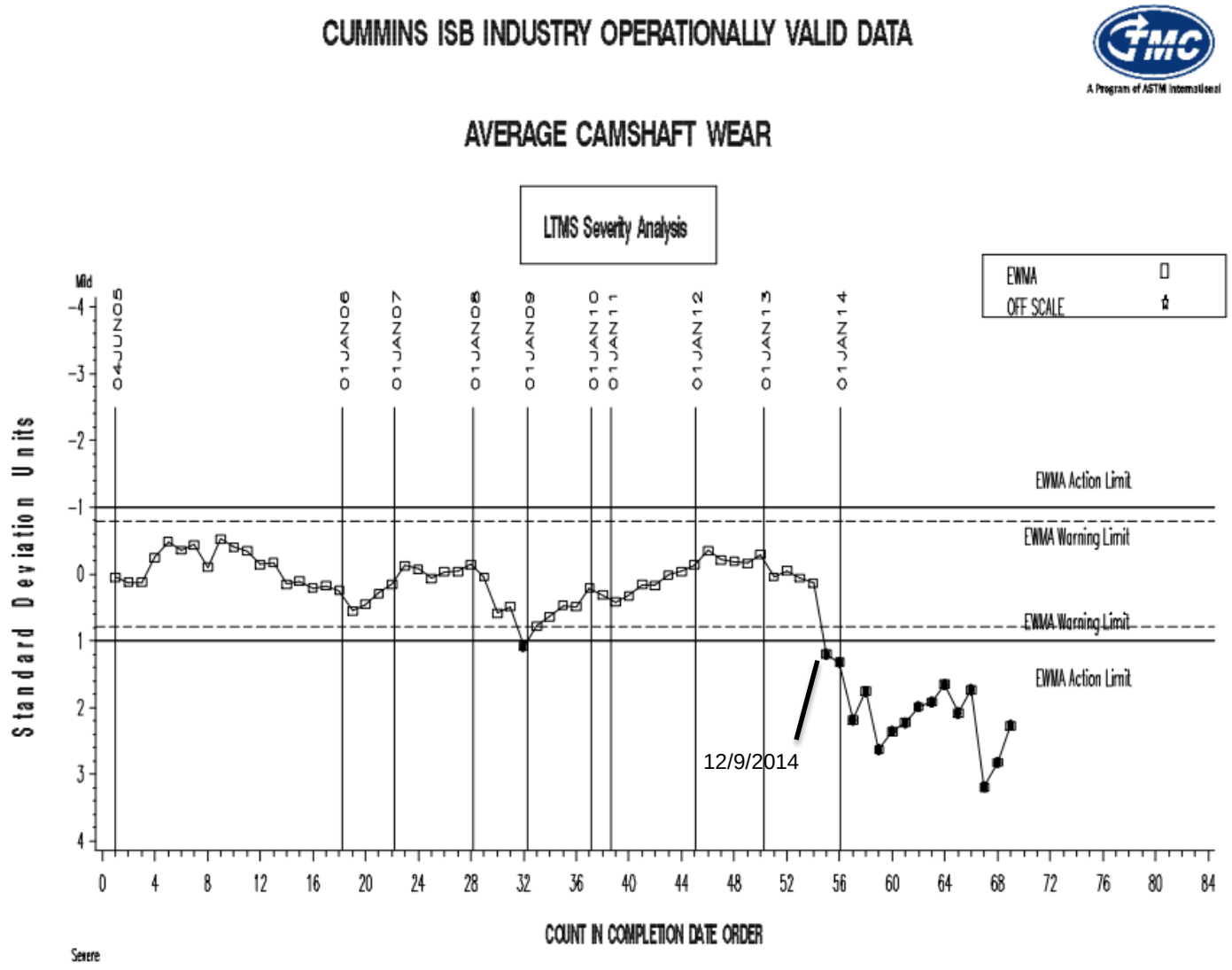


Chart indicates ACSW trending severe since around beginning of 2014

Average Tappet Weight Loss: ATWLzi EWMA Control Chart

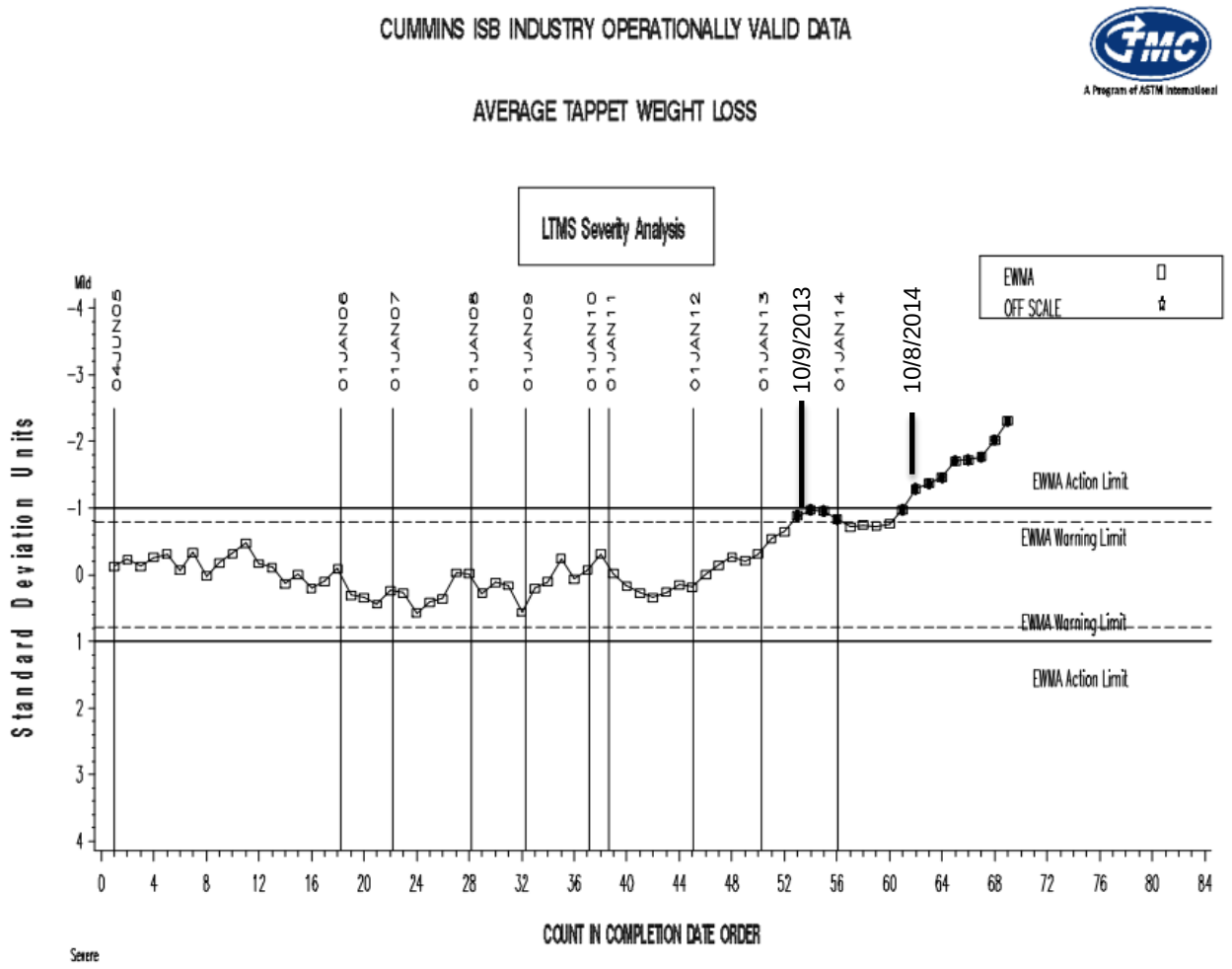
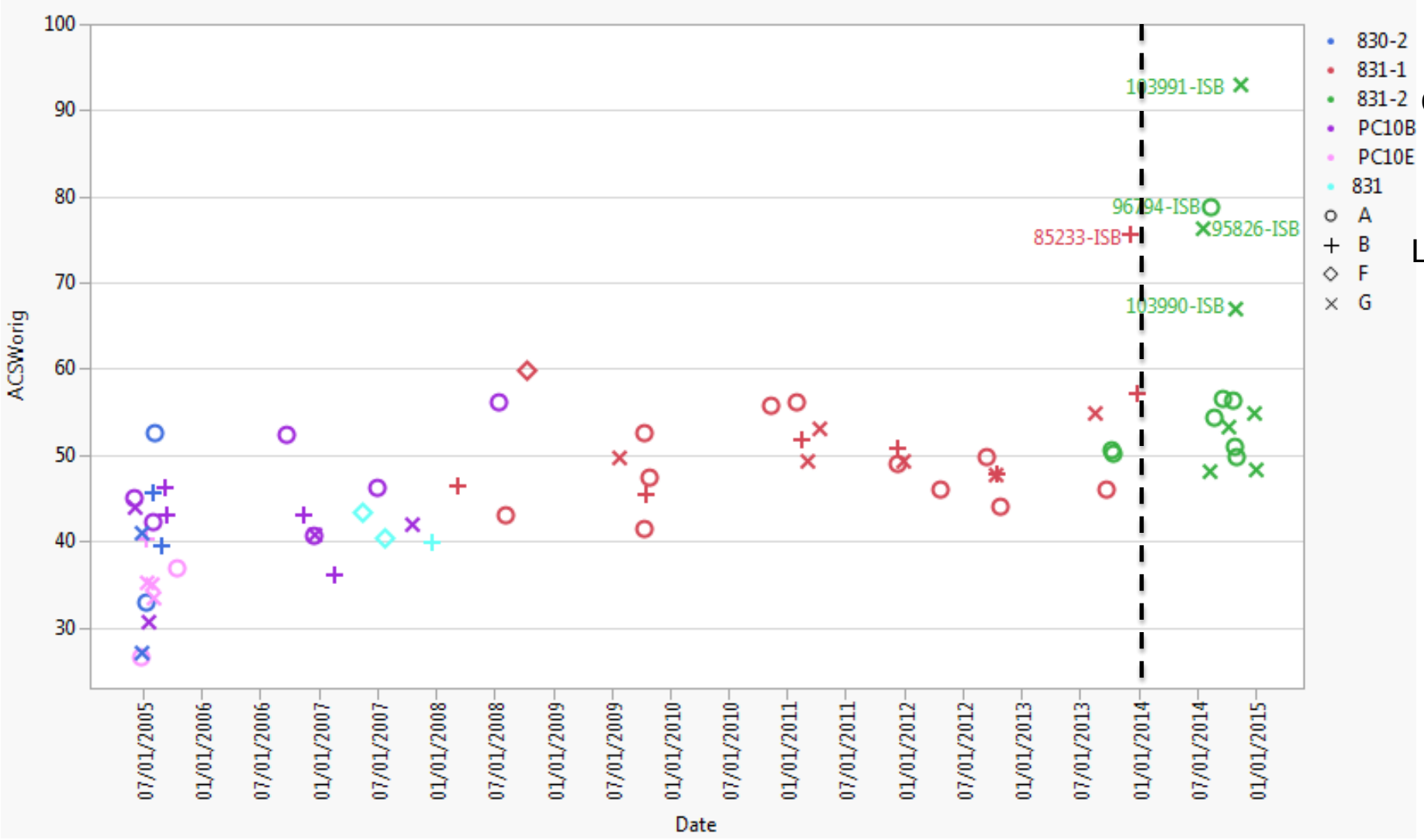


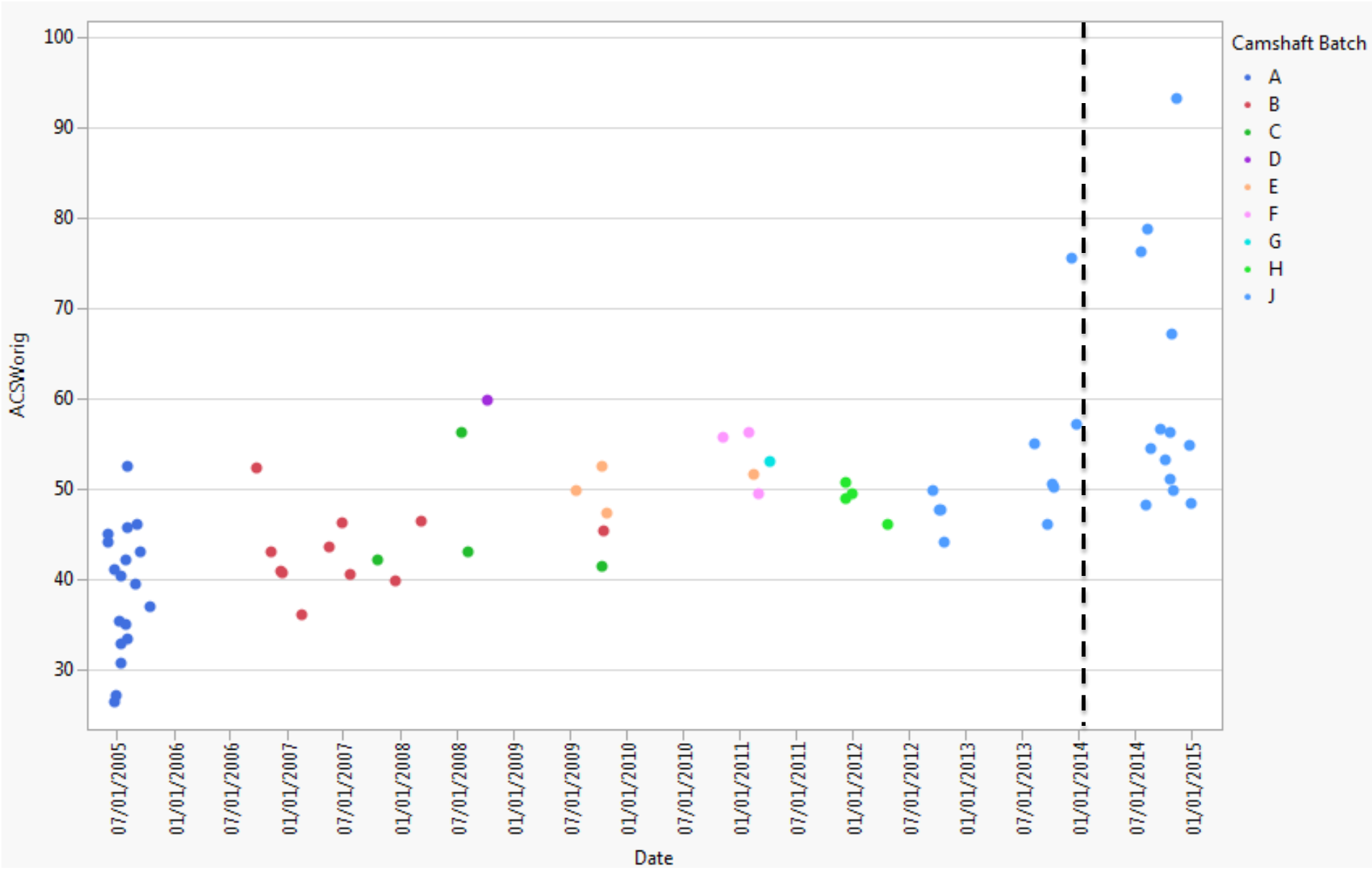
Chart indicates ATWL trending mild since about Oct 2014
(Possibly since Oct 2013)

Average Camshaft Wear
Uncorrected
Original Results

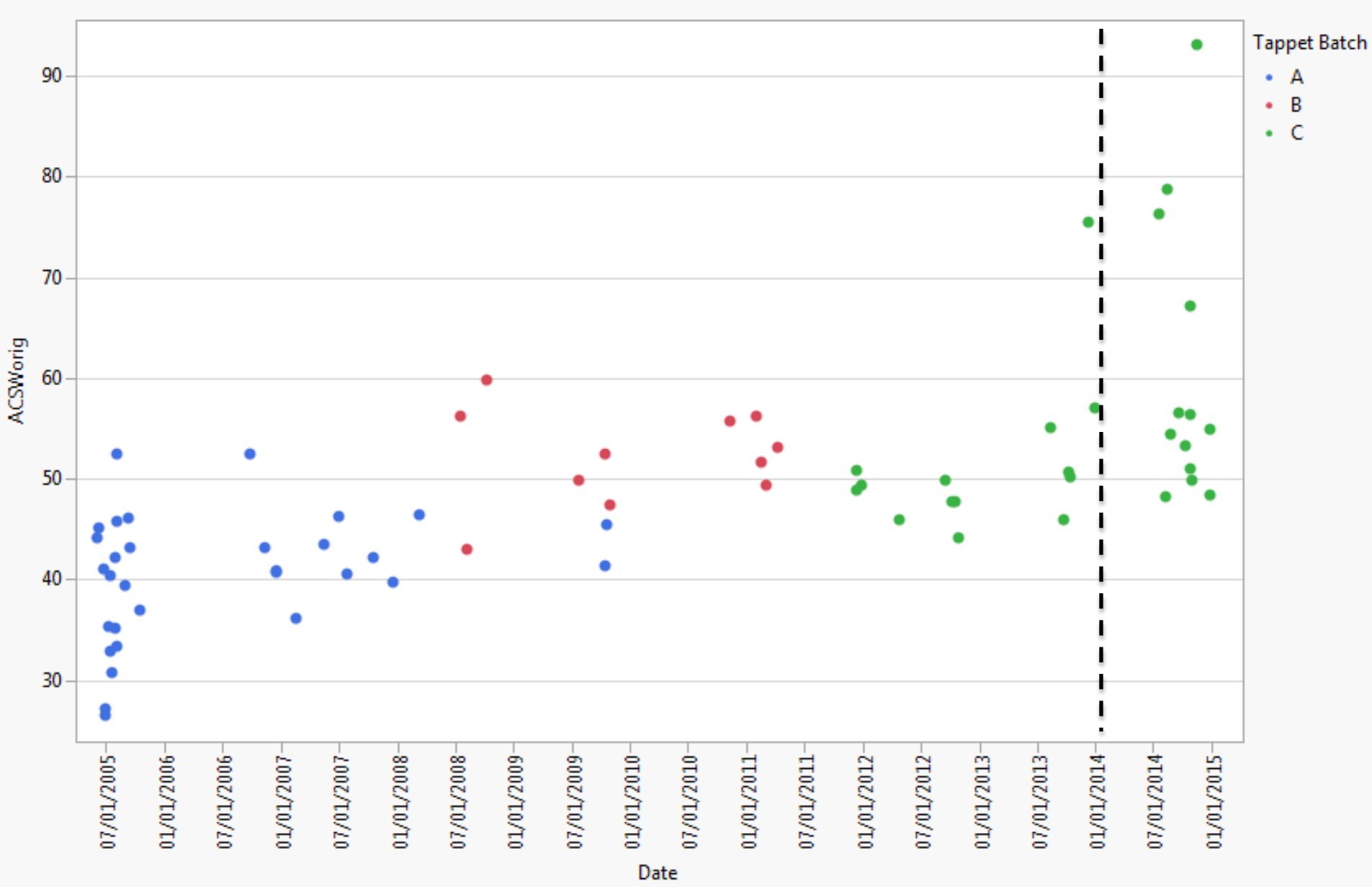
Average Camshaft Wear (ACSWorig):



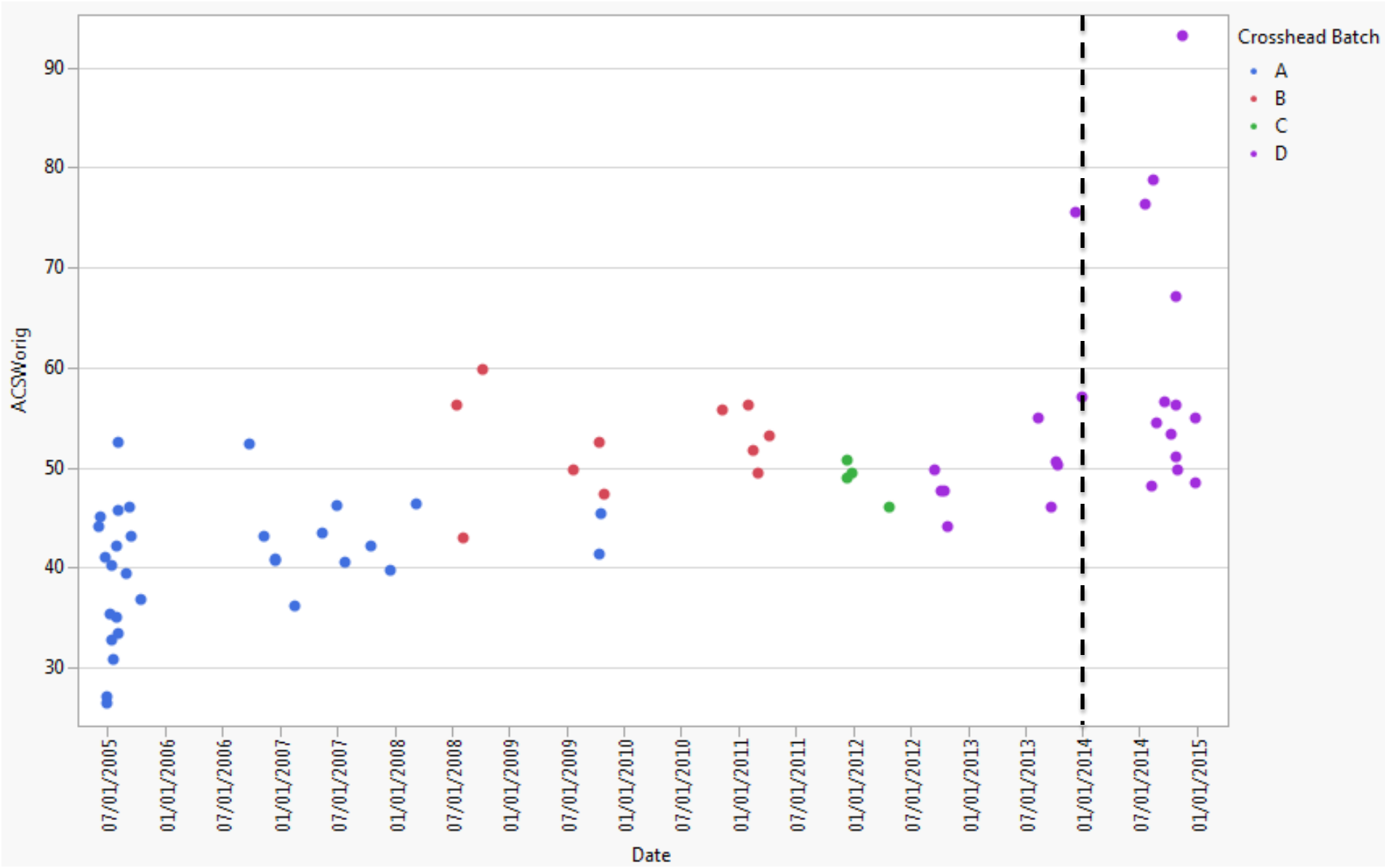
Average Camshaft Wear (ACSWorig):



Average Camshaft Wear (ACSWorig):

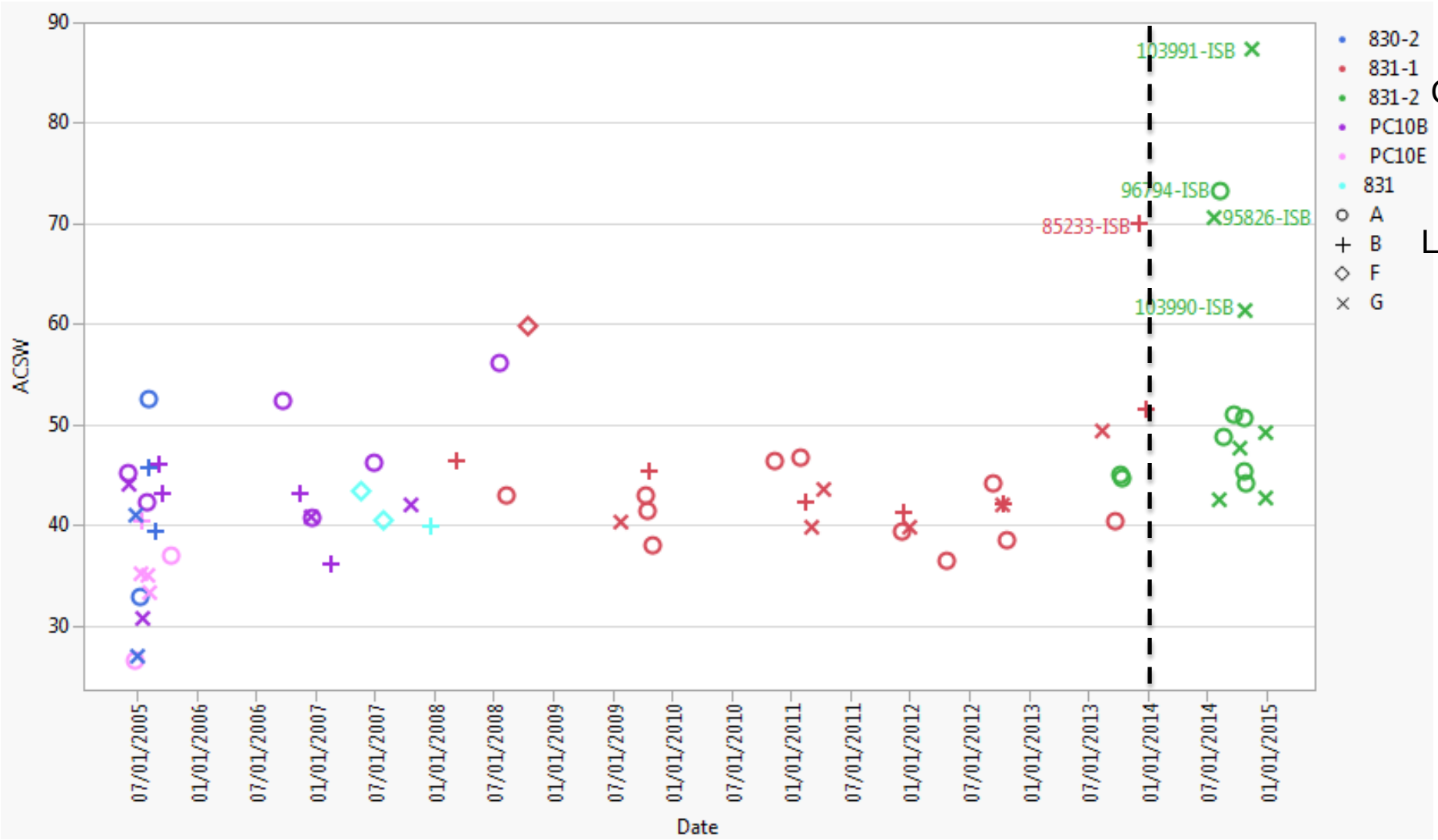


Average Camshaft Wear (ACSWorig):

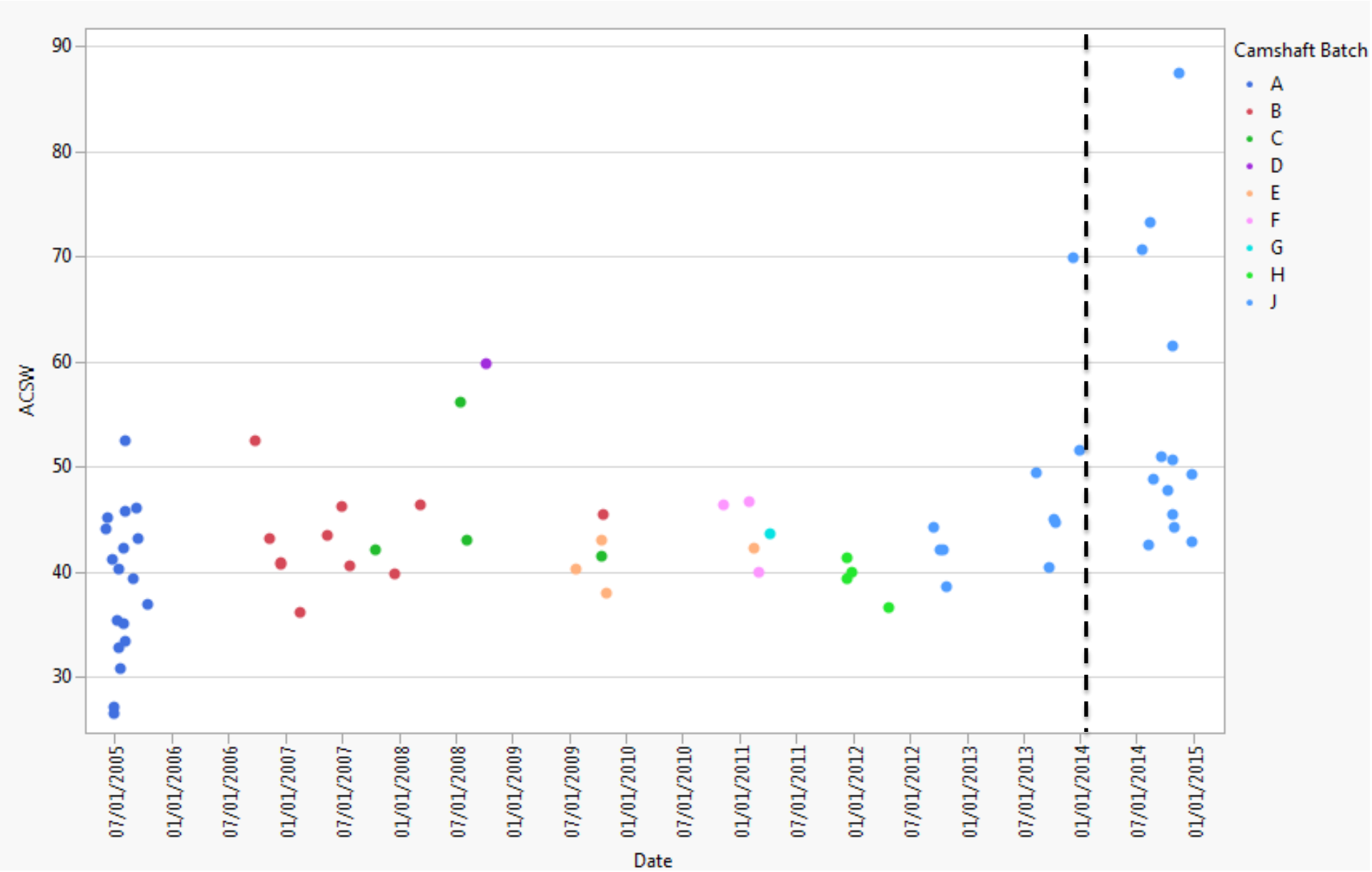


Average Camshaft Wear Correction Factors Applied

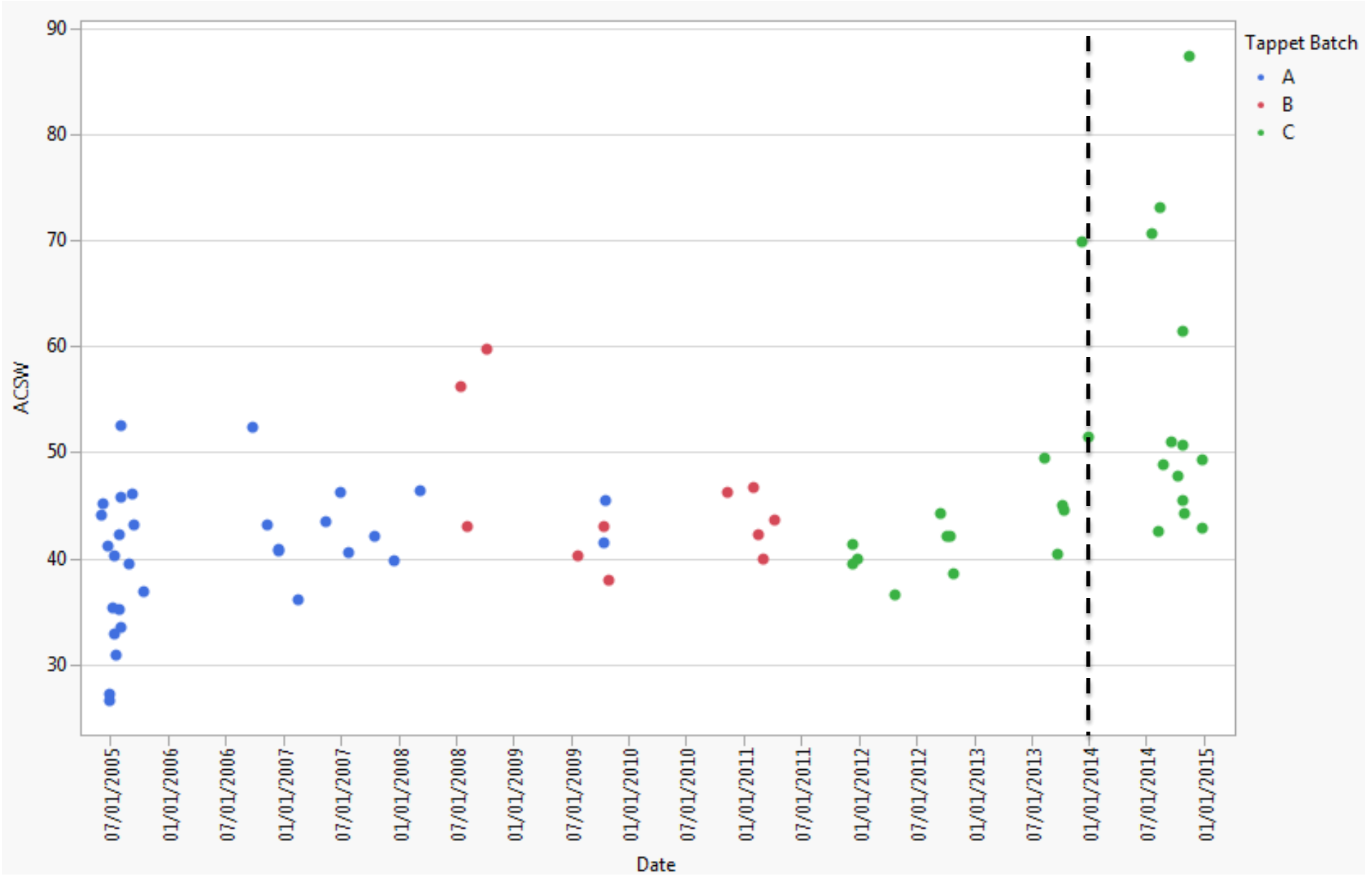
Average Camshaft Wear Correction Factors Applied (ACSW):



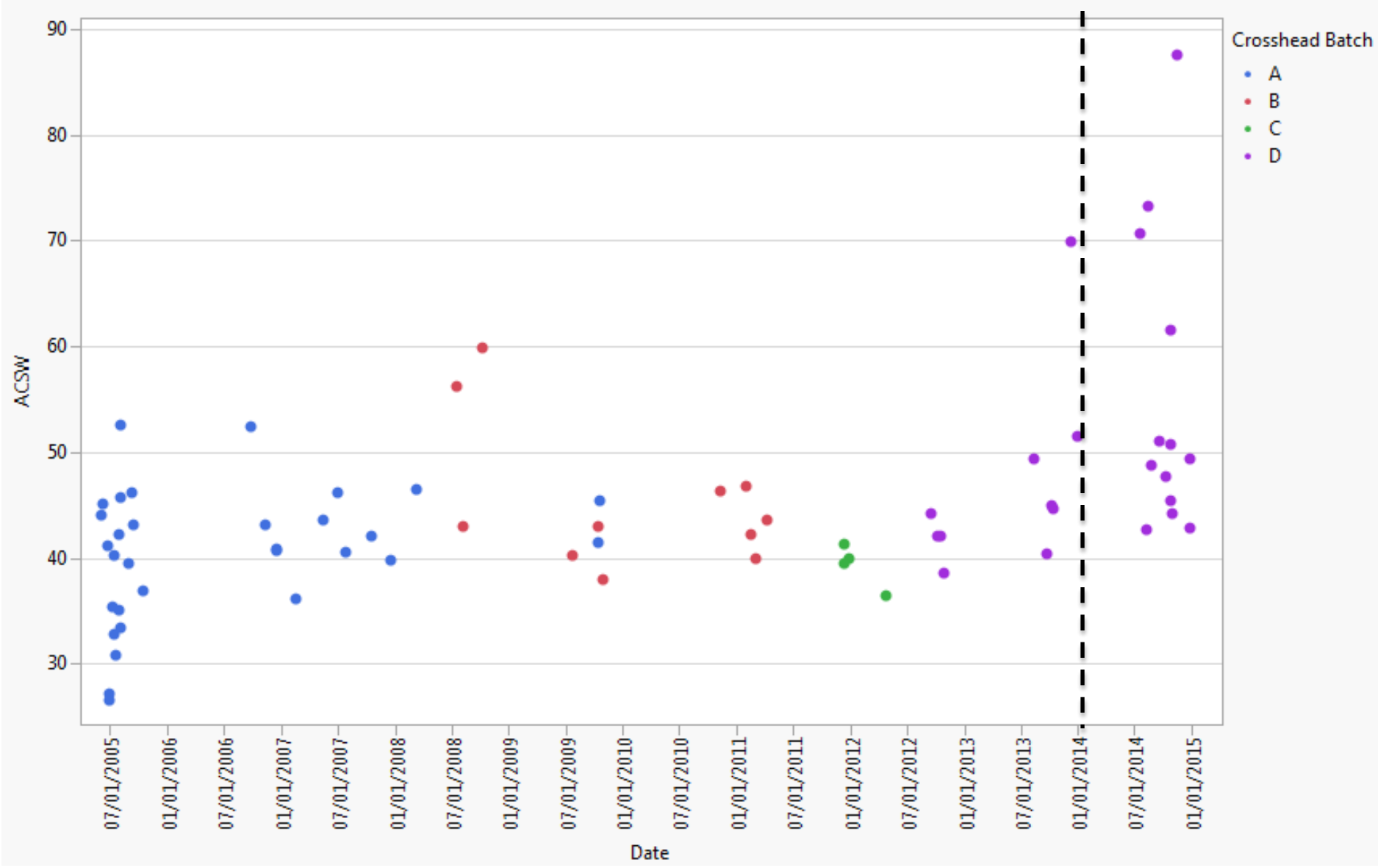
Average Camshaft Wear Correction Factors Applied (ACSW):



Average Camshaft Wear Correction Factors Applied (ACSW):

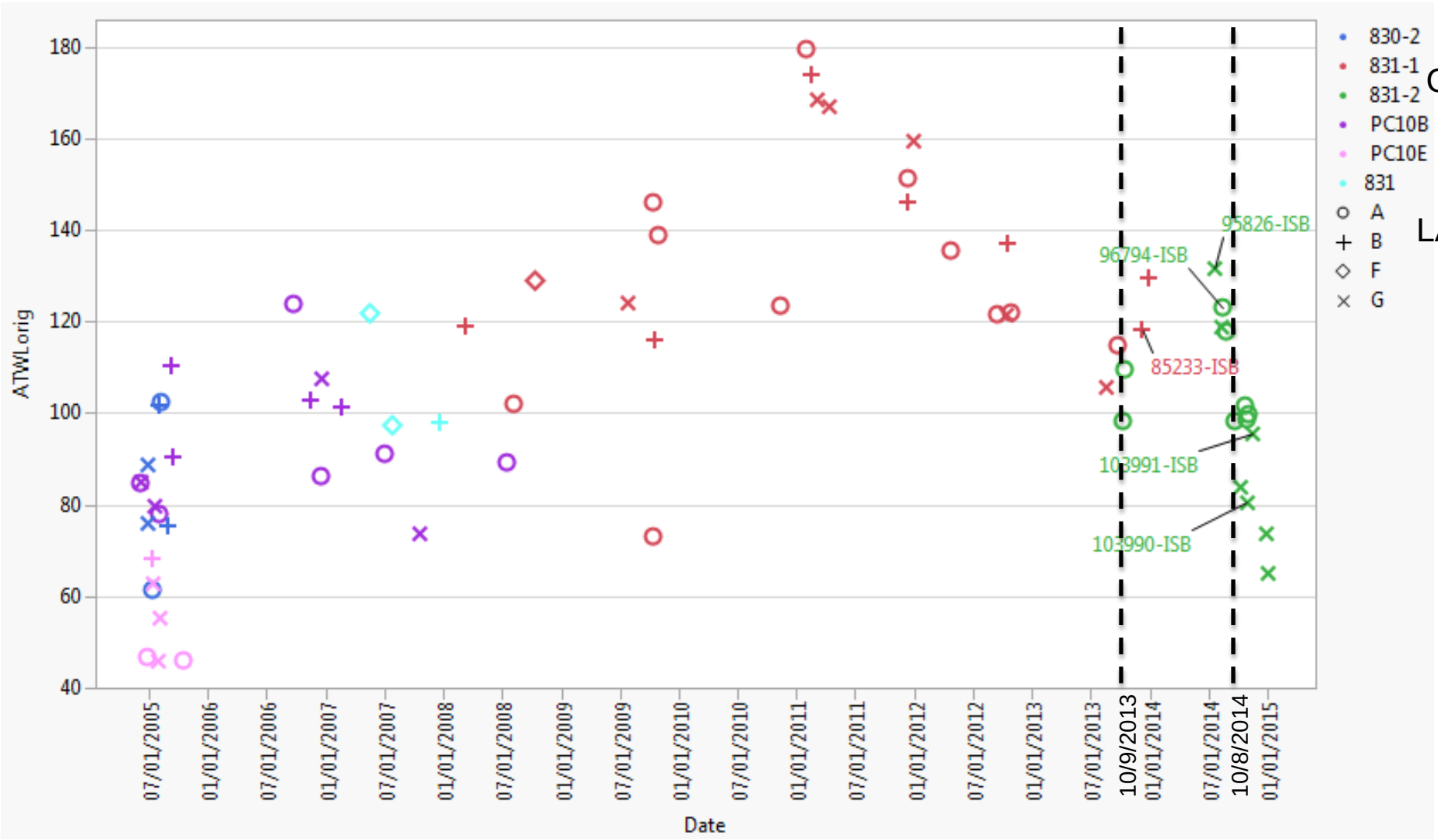


Average Camshaft Wear Correction Factors Applied (ACSW):

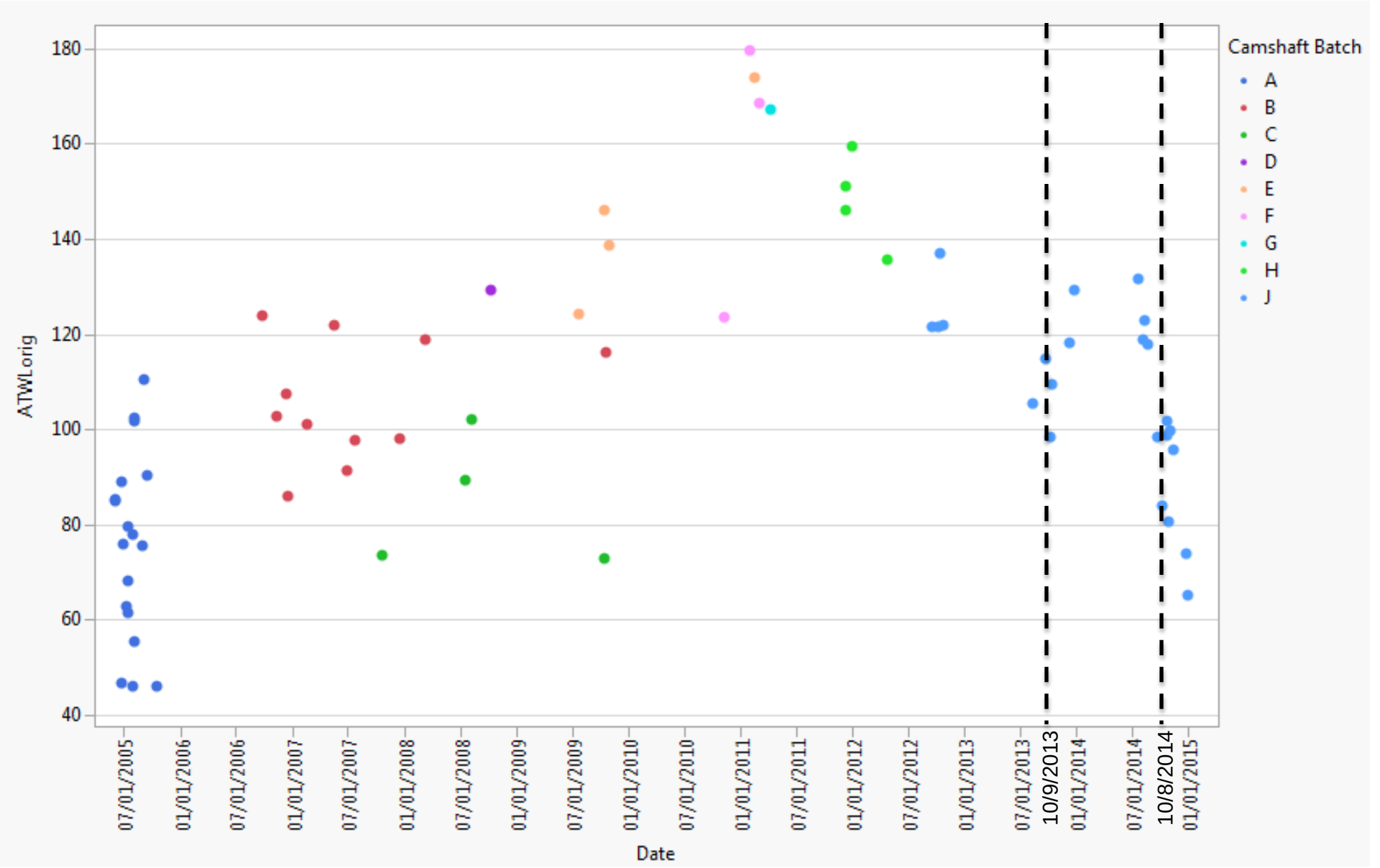


Average Tappet Weight Loss
Uncorrected
Original Results

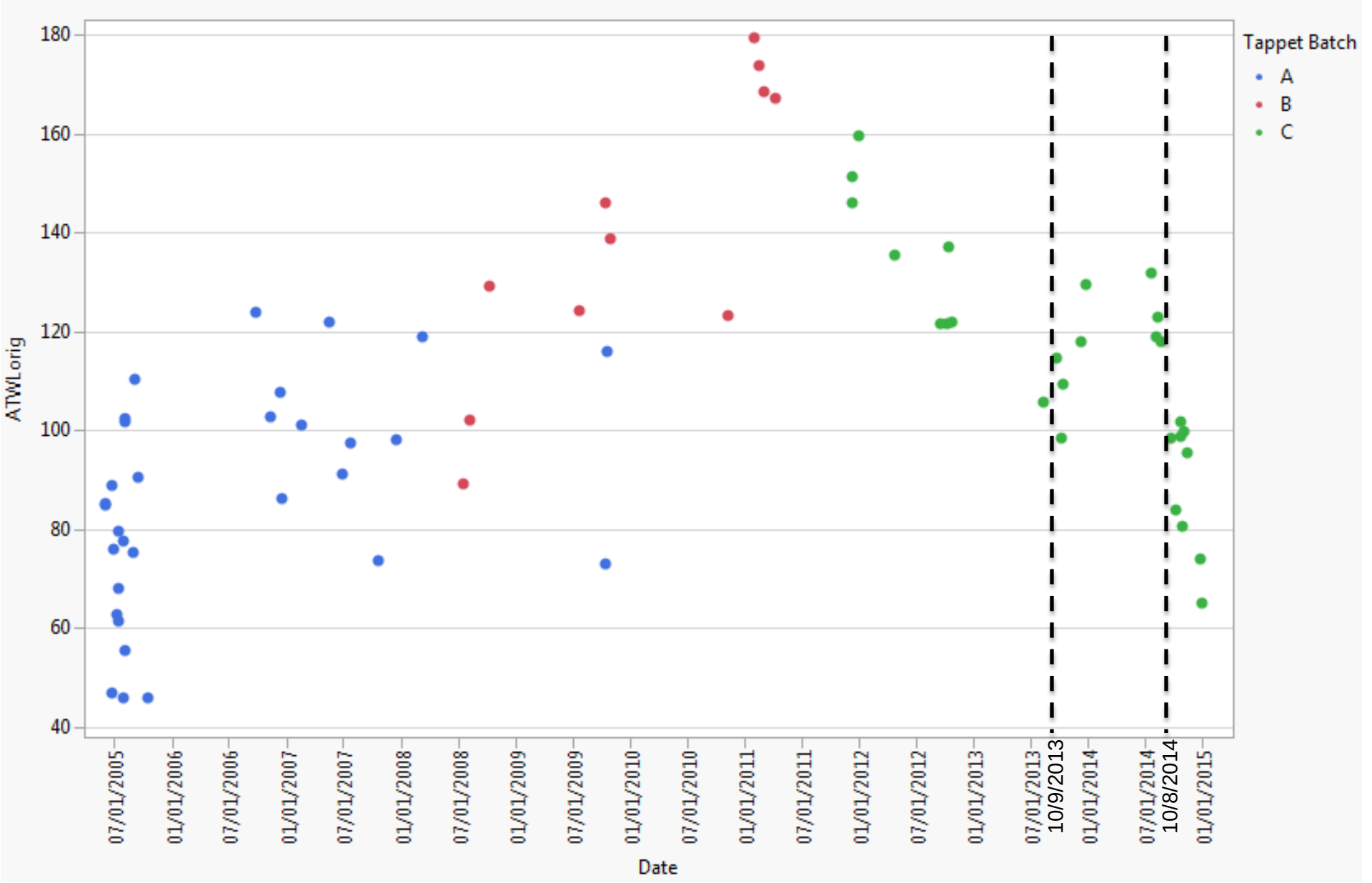
Average Tappet Weight Loss (ATWLorig):



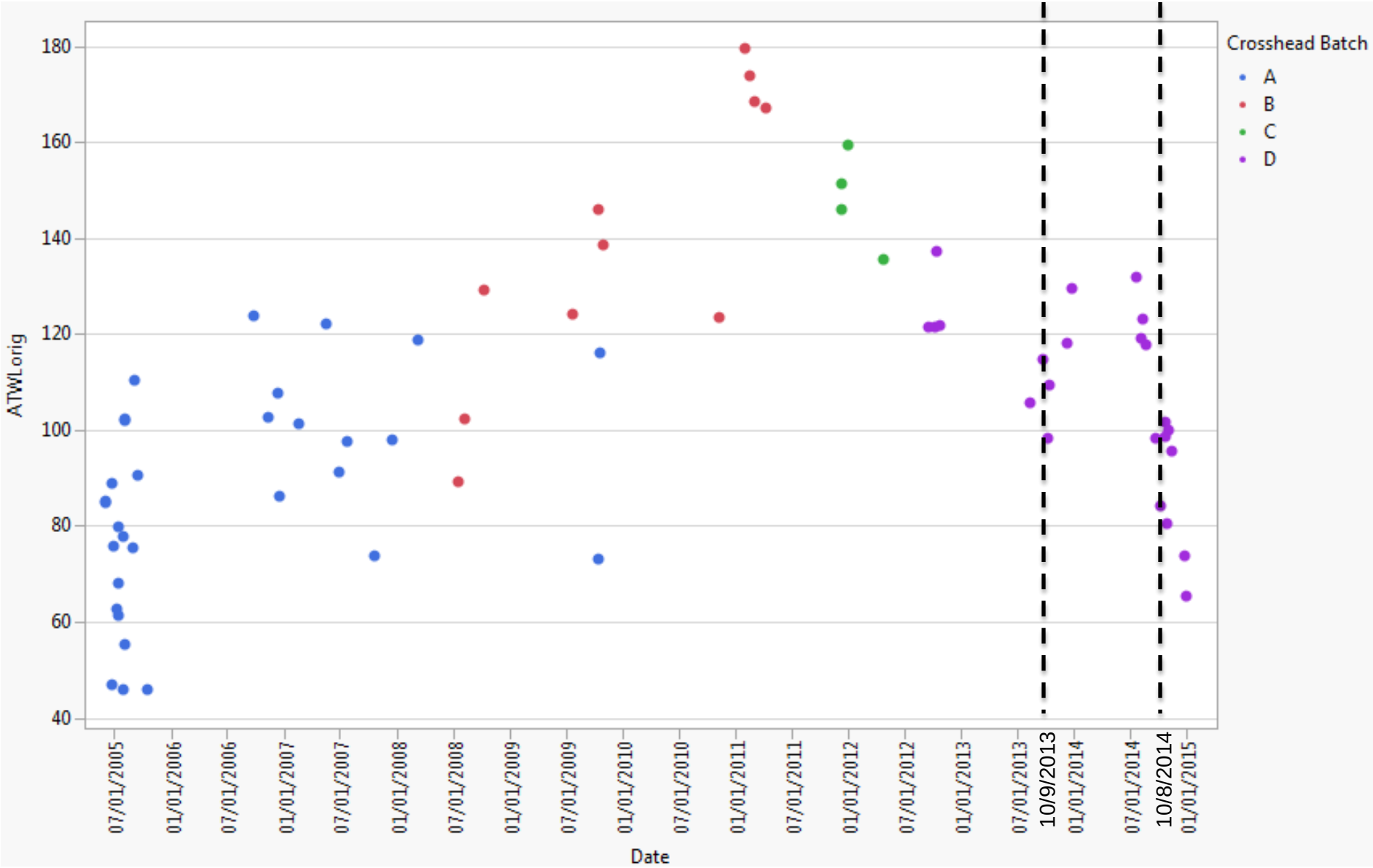
Average Tappet Weight Loss (ATWLorig):



Average Tappet Weight Loss (ATWLorig):

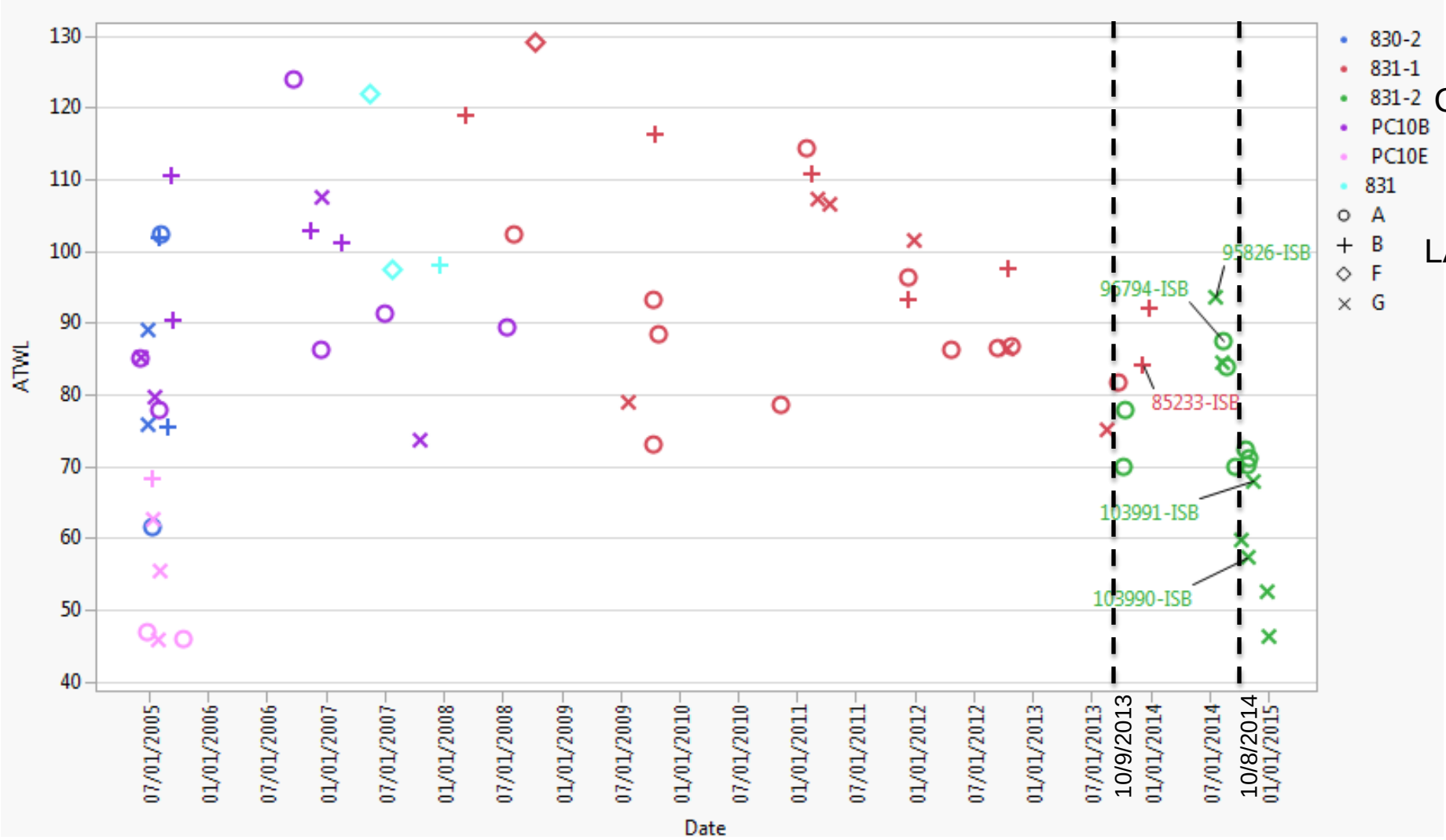


Average Tappet Weight Loss (ATWLorig):

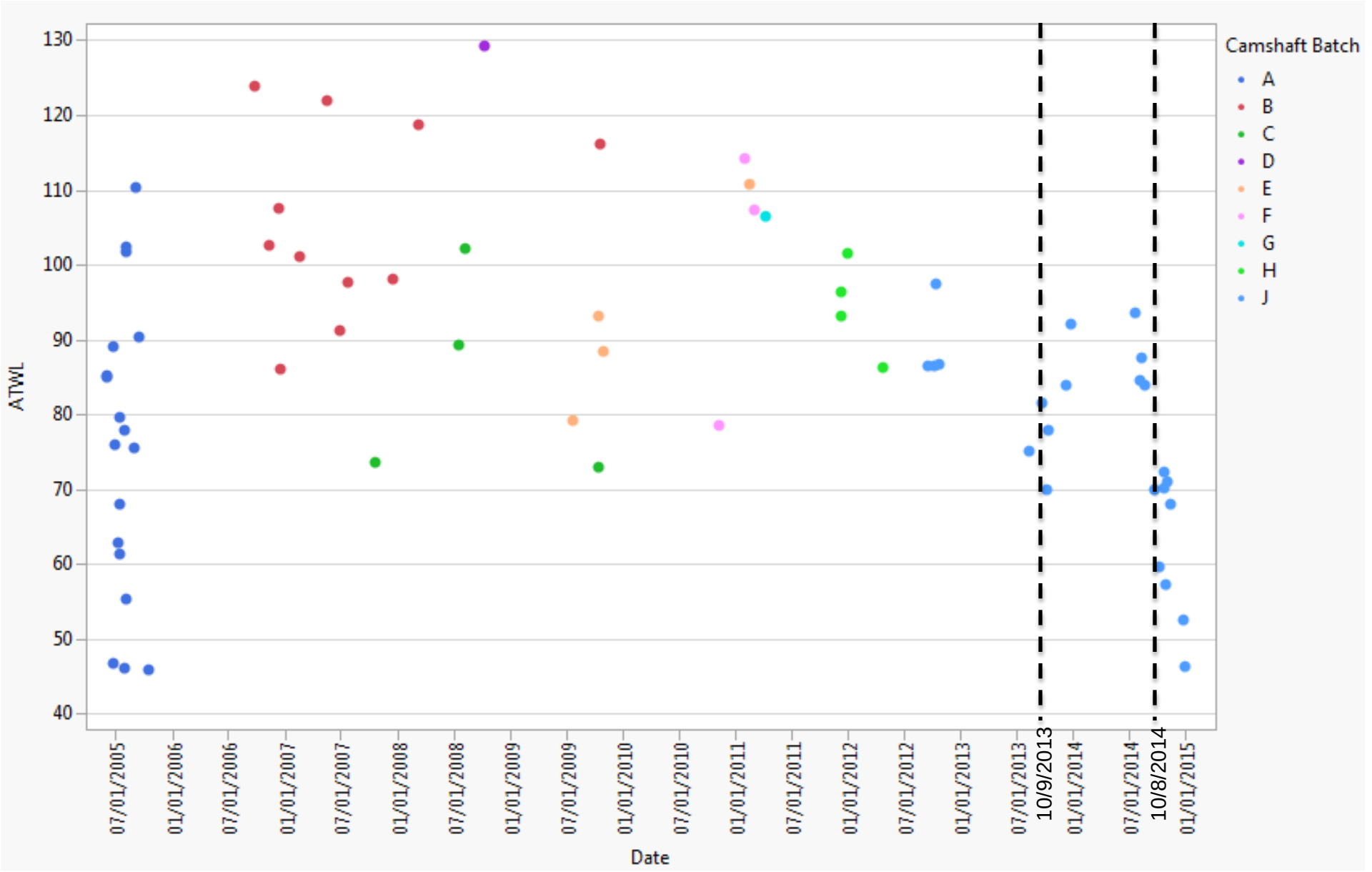


Average Tappet Weight Loss
Correction Factors Applied

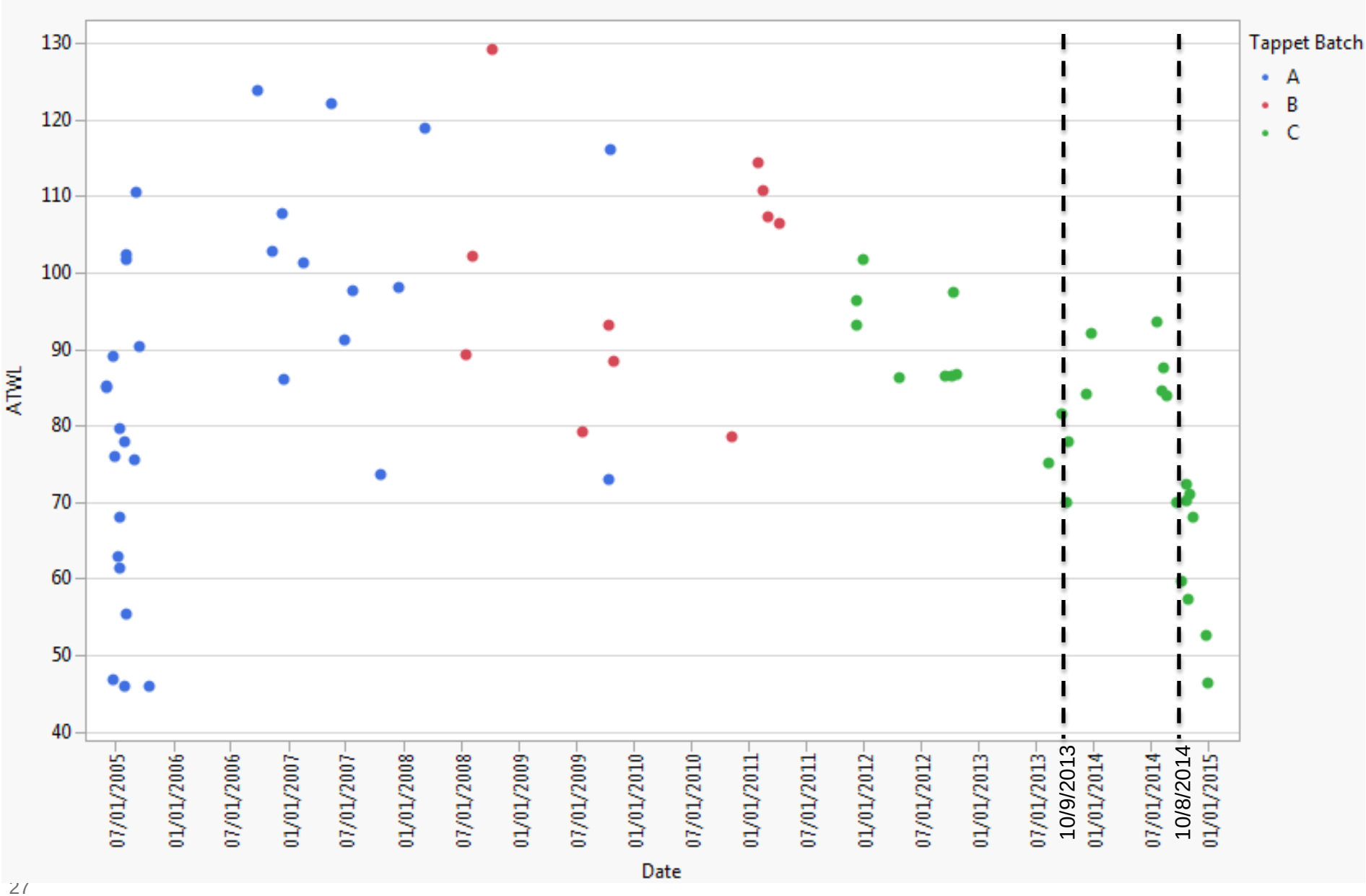
Average Tappet Weight Loss Correction Factors Applied (ATWL):



Average Tappet Weight Loss Correction Factors Applied (ATWL):



Average Tappet Weight Loss Correction Factors Applied (ATWL):



Average Tappet Weight Loss Correction Factors Applied (ATWL):