Sequence III Surveillance Panel

Teleconference Meeting Minutes
January 13, 2016
11:00 EST

Agenda

1.0) Attendance

The attendance is show in **Attachment 1**.

2.0) Chairman Comments

Chairman Glaenzer noted that the agenda has grown to be too big to handle completely in today's call. Today will be mostly dedicated to IIIF and IIIG business and IIIH items will be addressed time permitting.

3.0) Approval of minutes

3.1) Minutes from 01/06/25016 Conference Call
The minutes were approved without objection.

4.0) Action Item Review

4.1) Define Fuel Injector Cleaning Procedure. Altman/Schweitzer
Addison Schweitzer distributed a spreadsheet, **Attachment 2**. It was noted that the cleaning did not bring injectors with unacceptable flow pattern back to an acceptable flow pattern. Addison volunteered to draft the procedure and will bring it to the panel for review.

5.0) Old Business

5.1) Analysis of IIIF & IIIG run 7-10 data for differences. Dvorak/Boese/Ritchie/Hirano

Three presentations were distributed prior to the meeting.

Todd Dvorak presented for Afton, **Attachment 3**. Todd's general conclusions for IIIG:

- Analysis suggests that there's a statistical difference in LnPVIS and LnACLW that corresponds with 78 and 90 piston sizes/engine builds
- No significant difference was identified for the WPD parameter
- Increase in LnPVIS corresponds with increase in blow-by for the 78 and 90 piston sizes/engine builds

Todd's general conclusions for IIIF:

- Analysis suggests no significant difference in WPD, APV, or Hrs to 275 PVIS test results for the 78 and 90 piston sizes/engine builds
- Analysis suggests that a statistical difference in WPD corresponds with the 12 & 56 piston sizes/engine builds.

Andy Ritchie presented for Infineum, **Attachment 4**. Andy commented that Infineum generally agreed with Afton's work though they approached it differently. Infineum's summary:

Based on valid Reference Oil tests completed since January 2014 :

- Sample size is 43 which after drilling down to subsets becomes somewhat small.
- WPD severity appears to be independent of Engine Run.
- The average WPD severity is slightly less than that needed for a SA.
- PVis appears to be more severe for Engine Runs 5 – 10 than 1 – 4.
- ACLW appears to increase in mildness after Engine Runs 3 & 4.
- The average Yi differs significantly for the 3 Reference Oils, with 434-X having the largest average Yi in magnitude.
- Propose SAs be recalculated omitting 2014 & 2015 results of non-434-X ROs, and that all future ROs tested in IIIG be 434-X.

As a result of their analysis, Infineum drafted the following motions for panel consideration:

1. In the event that an industry test lab has available inventory of block run sizes at or below run size 6, block run numbers 1 through 6 are to be used prior to runs 7 through 10 through the end of the life of the Sequence IIIG test type.
2. Effective with TMC verifying and recalculating the SAs, the SAs will be recalculated using only 434 data over the time frame starting Jan 1st 2014. (Ritchie,
3. Reference Oil 434 will be the only oil assigned for IIIG referencing for the remaining life of the IIIG test. Effective Midnight CST January 13, 2016.

Andy Ritchie moved items 2, 3, and 1 from above (in that order) but none of the motions received a second. Chairman Glaenzer noted that they might be reconsidered following Toyota's presentation.

Toyota presented their concerns (slide 3) on the IIIG severity trend, **Attachment 5**. Toyota also suggested potential steps forward (slides 8 – 10), but ultimately they recommend forming a task force to consider all the options that have been presented for the IIIG severity issues. These options may include (but are not necessarily limited to) revising the severity adjustment calculation methodology, industry correction factor, and/or modifying the referencing process.

At this point a long, wide-ranging discussion took place, at the conclusion of which Chairman Glaenzer agreed to draft a request/instructions for the industry stats task force to work the issue further. Todd Dvorak will contact the stats group with Dave's request in the hopes of addressing in the next few weeks.

5.2) Update on work underway by George <u>Szappanos</u> group.
George Szappanos provided an update, **Attachment 6**.

5.3) Planning for UEB Workshop. Week of February 08 mentioned. <u>Schweitzer/Lang</u>
This will be addressed at a future meeting.

5.4) Update on LTMS plans. <u>Stats Group</u>
This will be addressed at a future meeting.

8.0) <u>Next Meeting</u>

8.1) Wednesday, January 20, 2016 11:00 EST
That meeting will be limited to only IIIH topics.

9.0) <u>Meeting Adjourned</u>

The meeting concluded at 12:30 pm.

ASTM Sequence III Surveillance Panel (22 Voting members) date: 01/13/16

ATTACHMENT 1

Name/Address	Phone/Fax/Email		Signature
Ed Altman	804-788-5279	Voting Member	Present ✓
Jeff Betz	jeff.betz@fcagroup.com	Voting Member	Present
Jason Bowden	440-354-7007	Voting Member	Present ✓
Timothy L. Caudill	606-329-1960 x5708	Voting Member	Present ✓
Richard Grundza	412-365-1031	Voting Member	Present ✓
Jeff Hsu, PE	j.hsu@shell.com	Voting Member	Present ✓
Tracey King	947-517-4107	Voting Member	Present
Teri Kowalski	734-995-4032	Voting Member	Present ✓
Patrick Lang	210-522-2820	Voting Member	Present ✓
Addison Schweitzer	210-706-1586	Voting Member	Present ✓
Bruce Matthews	248-830-9197	Voting Member	Present
David Tsui	973-305-2337	Voting Member	Present
Cliff Salvesen		Voting Member	Present ✓
Andrew Ritchie	908-474-2097	Voting Member	Present ✓
Ron Romano	313-845-4068	Voting Member	Present
Greg Shank	301-790-5817	Voting Member	Present
Kaustav Sinha, Ph.D.	713-432-6642	Voting Member	Present ✓
Thomas Smith	859-357-2766	Voting Member	Present
Scott Stap	scott.stap@tgidirect.com	Voting Member	Present
Mark Sutherland	210-867-8357 Don Lanto	Voting Member	Present ✓
George Szappanos	440-347-2352	Voting Member	Present ✓
Haiying Tang	248-512-0593	Voting Member	Present ✓

KAUSTAV Sinha Oronite NV

ASTM Sequence III Surveillance Panel (22 Voting members) date:

Name/Address	Phone/Fax/Email		Signature
Ricardo Affinito	affinito@chevron.com	Non-Voting Member	Present
Art Andrews	856-224-3013	Non-Voting Member	Present
Dan Lanctot	TEI	Non-Voting Member	Present
Doyle Boese	908-474-3176	Non-Voting Member	Present
Adam Bowden	440-354-7007	Non-Voting Member	Present
Dwight H. Bowden	440-354-7007	Non-Voting Member	Present
Matt Bowden	440-354-7007	Non-Voting Member	Present ✓
Jerome A. Brys	440 347-2631	Non-Voting Member	Present
Bill Buscher III	210-240-8990	Non-Voting Member	Present
Bob Campbell	804-788-5340	Non-Voting Member	Present
Chris Castanien	Chris.Castanien@gmail.com	Non-Voting Member	Present ✓
Martin Chadwick	210-706-1543	Non-Voting Member	Present
Jeff Clark	412-365-1032	Non-Voting Member	Present ✓
Sid Clark	586-873-1255	Non-Voting Member	Present ✓
Todd Dvorak	804-788- 6367	Non-Voting Member	Present ✓
Frank Farber	412-365-1030	Non-Voting Member	Present
Joe Franklin	210-523-4671	Non-Voting Member	Present
David L. Glaenzer	804-788-5214	Non-Voting Member	Present ✓
Karin E. Haumann	281-544-6986	Non-Voting Member	Present ✓
Walter Lerche	313-667-1918	Non-Voting Member	Present
Josephine G. Martinez	510-242-5563	Non-Voting Member	Present
Mike McMillan	mmcmillan123@comcast.net	Non-Voting Member	Present ✓
Bob Olree	248-689-3078	Non-Voting Member	Present
Kevin O'Malley	kevin.omalley@lubrizol.com	Non-Voting Member	Present
Christian Porter	804-788-5837	Non-Voting Member	Present
Phil Rabbat	914-785-2217	Non-Voting Member	Present
Allison Rajakumar	440-347-4679	Non-Voting Member	Present
Scott Rajala	srajala@ilacorp.com	Non-Voting Member	Present

ASTM Sequence III Surveillance Panel (22 Voting members) date:

Name/Address	Phone/Fax/Email		Signature
Jim Rutherford	510-242-3410	Non-Voting Member	Present
Amol Savant	606-320-1960 x5604	Non-Voting Member	Present
Philip R. Scinto	440-347-2161	Non-Voting Member	Present
Don Smolenski	248-255-7892	Non-Voting Member	Present
Jim Linden		Non-Voting Member	Present
Tom Wingfield	wingftm@cpchem.com	Non-Voting Member	Present
Charlie Leverett		Non-Voting Member	Present
Terry Bates	ASTM Facilitator	Non-Voting Member	Present
Chris Taylor	VP Fuels	Non-Voting Member	Present

Gordon Farnsworth ✓

~~Karin Haumann~~ ✓

Haumann ✓

Jeff Shui ✓

Art Andrews

ATTACHMENT 2

Sequence III Fuel Injector Ultrasonic Cleaning

1) Four faulty Sequence III injectors (GM# 17120601) were used for the experiement.

**Three injectors displayed dripping/leaking, one injector displayed an unusual flow pattern.*

2) Faulty fuel injectors flow tested three times prior to ultrasonic cleaning.

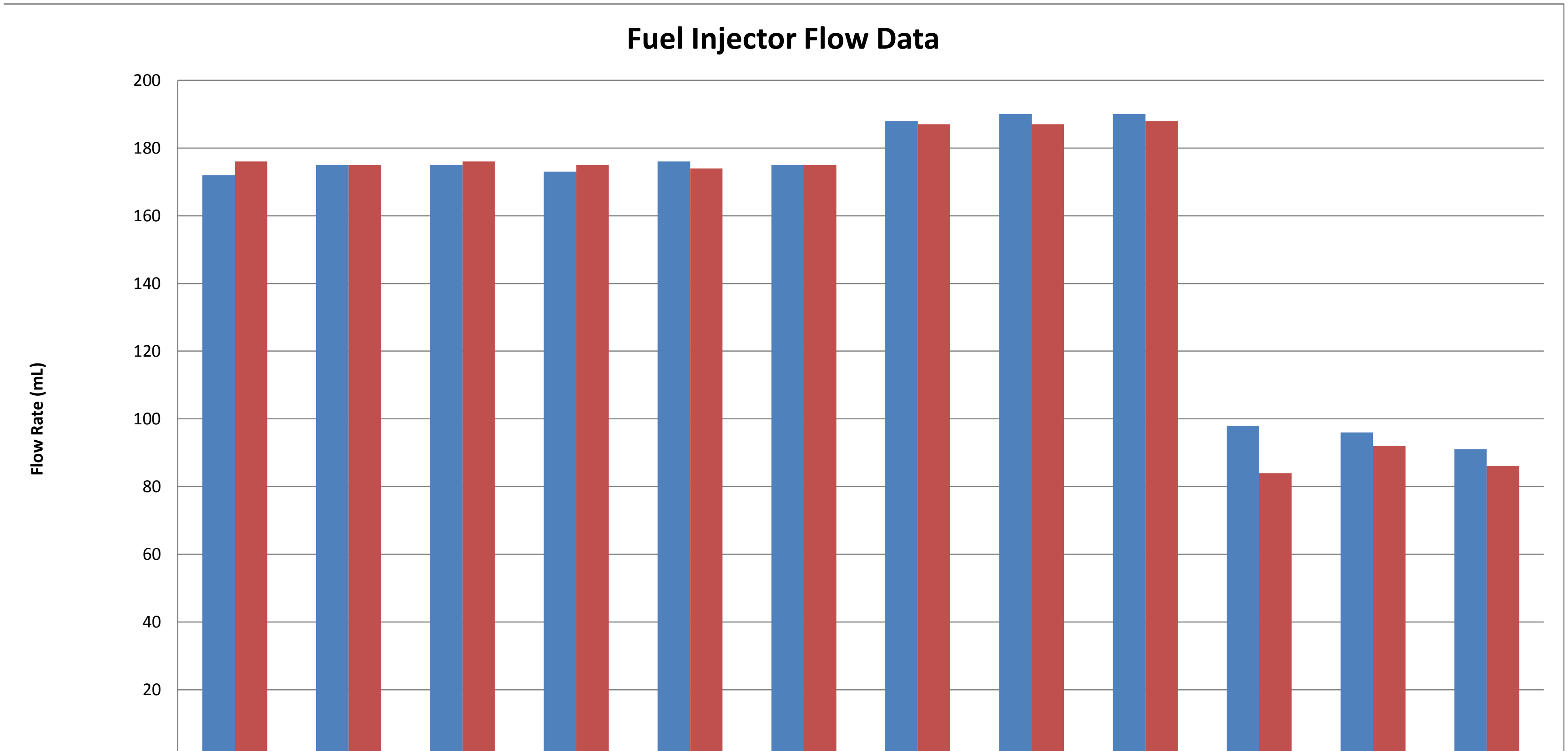
3) Ultrasonic cleaned for 20 minutes using stoddard solvent.

4) Fuel injectors were flow tested three times following ultrasonic cleaning.

5) Results shown below:

FUEL INJECTOR FLOW DATA (BEFORE US CLEANING)					
INJECTOR NUMBER	FLOW RATE (ml)	FLOW PATTERN	INJECTOR LEAKAGE	PASS/FAIL	COMMENTS
1	172	Acceptable	Dripping/Leaking	FAIL	
	175	Acceptable	Dripping/Leaking	FAIL	
	175	Acceptable	Dripping/Leaking	FAIL	
2	173	Acceptable	Dripping/Leaking	FAIL	
	176	Acceptable	Dripping/Leaking	FAIL	
	175	Acceptable	Dripping/Leaking	FAIL	
3	188	Acceptable	Dripping/Leaking	FAIL	
	190	Acceptable	Dripping/Leaking	FAIL	
	190	Acceptable	Dripping/Leaking	FAIL	
4	98	Not Acceptable	None	FAIL	
	96	Not Acceptable	None	FAIL	
	91	Not Acceptable	None	FAIL	

FUEL INJECTOR FLOW DATA (AFTER US CLEANING)					
INJECTOR NUMBER	FLOW RATE (ml)	FLOW PATTERN	INJECTOR LEAKAGE	PASS/FAIL	COMMENTS
1	176	Acceptable	None	PASS	
	175	Acceptable	None	PASS	
	176	Acceptable	None	PASS	
2	175	Acceptable	None	PASS	
	174	Acceptable	None	PASS	
	175	Acceptable	None	PASS	
3	187	Acceptable	None	PASS	
	187	Acceptable	None	PASS	
	188	Acceptable	None	PASS	
4	84	Not Acceptable	None	FAIL	
	92	Not Acceptable	None	FAIL	
	86	Not Acceptable	None	FAIL	



	1	1	1	2	2	2	3	3	3	4	4	4
Before US Clean	172	175	175	173	176	175	188	190	190	98	96	91
After US Clean	176	175	176	175	174	175	187	187	188	84	92	86

ATTACHMENT 3

Investigating the Potential Effects of Piston Size / Engine Build Number on the Sequence IIIG & IIIF Test Severity

By: Todd Dvorak

Date: January 12, 2016

Passion for Solutions™

Overview

- **Purpose of the analysis is to investigate whether the piston size/engine build number (7-10) is related to a possible shift in the Sequence IIIG & IIIF test severity.**
- **Analysis divided into 2 sections:**
  - Section 1: IIIG Severity Analysis
  - Section 2: IIIF Severity Analysis

Section 1: IIIG Severity Analysis

Passion for Solutions™

IIIG Severity Analysis

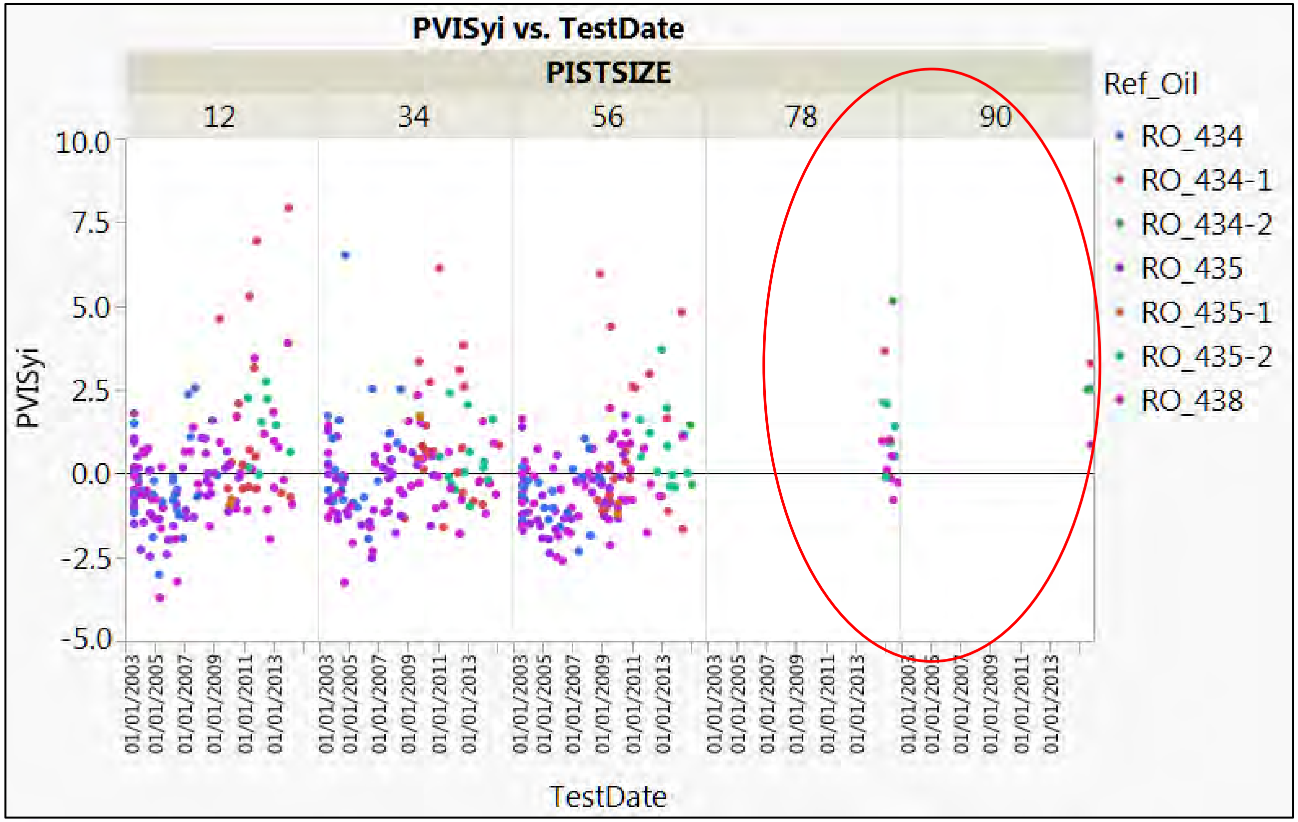
Available IIIG data for analysis:

- A sample size of *n = 430* Chartable (‘Y’) results in the LTMS database
- Number test results on new build/hardware:
  - 78 Piston sizes/engine builds sample size *n = 15*
  - 90 Piston sizes/engine builds sample size *n = 5*

IIIG Severity Analysis

Raw plot of the PVISyi data

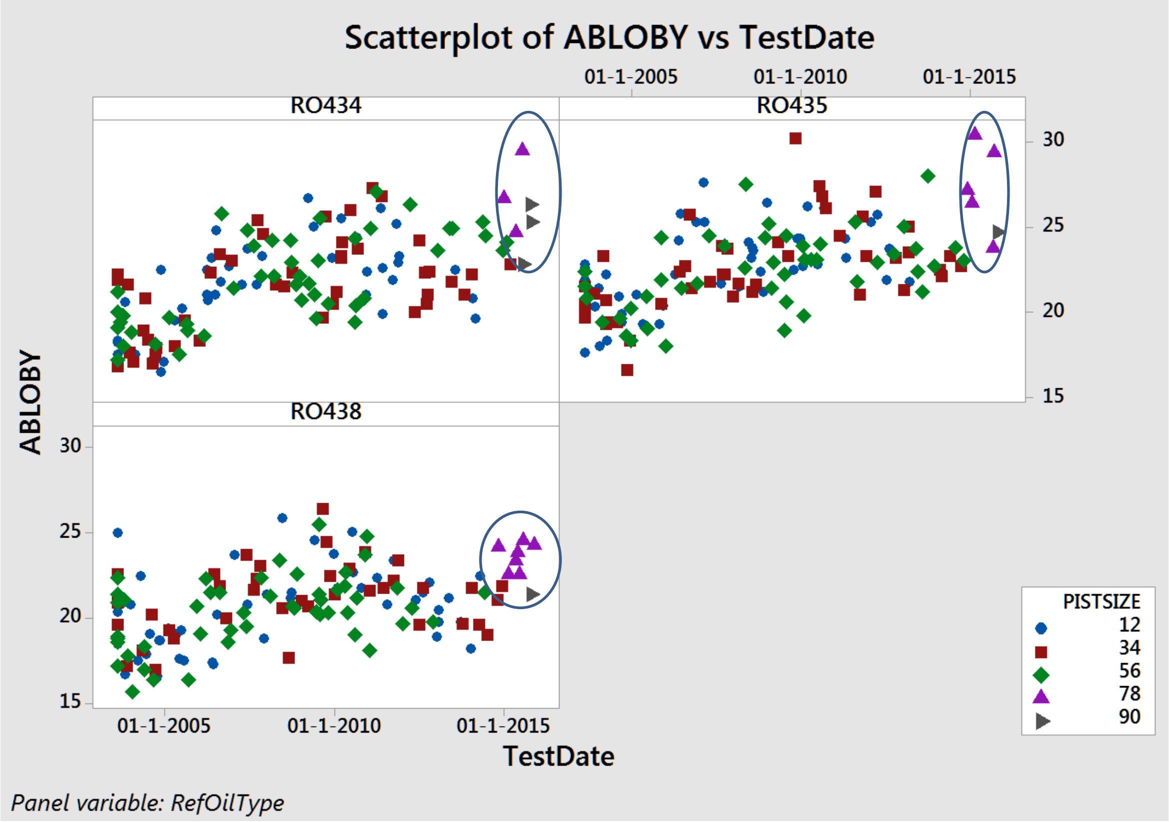
- Data suggest an increase in PVISyi severity corresponds with 78 & 90 piston sizes/engine builds



IIIG Severity Analysis

Blow-by data scatter plot:

- Data plot and ANOVA (not included) suggests a significant increase in blow-by that corresponds with 78 & 90 piston sizes/engine builds



IIIG Severity Analysis

TPVIS Analysis:

- ANOVA analysis suggests statistical difference in TPVIS that corresponds with 78 & 90 piston sizes/engine builds

Response LnPVIS

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	15	49.15769	3.27718	15.3616
Error	414	88.32118	0.21334	Prob > F
C. Total	429	137.47887		<.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.16856	0.061549	83.98	<.0001*
Ref_Oil[RO_434]	-0.366882	0.066325	-5.53	<.0001*
Ref_Oil[RO_434-1]	0.1670495	0.068258	2.45	0.0148*
Ref_Oil[RO_434-2]	0.2726526	0.189505	1.44	0.1510
Ref_Oil[RO_435]	0.006595	0.061487	0.11	0.9146
Ref_Oil[RO_435-1]	0.032852	0.181483	0.18	0.8564
Ref_Oil[RO_435-2]	0.393538	0.078027	5.04	<.0001*
LTMSLAB[A]	0.1072787	0.049116	2.18	0.0295*
LTMSLAB[B]	-0.06963	0.049231	-1.41	0.1580
LTMSLAB[D]	-0.007998	0.055893	-0.14	0.8863
LTMSLAB[E]	-0.075379	0.076137	-0.99	0.3227
LTMSLAB[F]	0.0159345	0.061394	0.26	0.7953
PISTSIZE[12]	-0.108086	0.061631	-1.75	0.0802
PISTSIZE[34]	-0.101685	0.061661	-1.65	0.0999
PISTSIZE[56]	-0.22103	0.060763	-3.64	0.0003*
PISTSIZE[78]	0.0561655	0.108704	0.52	0.6057

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	6	6	41.876759	32.7158	<.0001*
LTMSLAB	5	5	1.534646	1.4387	0.2092
PISTSIZE	4	4	2.892558	3.3897	0.0096*

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	5.0604736	0.05917273	4.87547
34	5.0668753	0.06017111	4.92842
56	4.9475300	0.05777026	4.78532
78	5.2247254	0.12804644	5.19740
90	5.5431955	0.21154513	5.61700

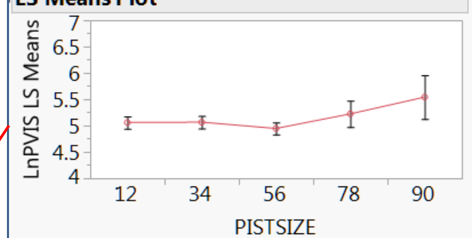
LSMeans Differences Tukey HSD

α= 0.050 Q= 2.73985

Level			Least Sq Mean
90	A		5.5431955
78	A	B	5.2247254
34	A	B	5.0668753
12	A	B	5.0604736
56		B	4.9475300

Levels not connected by same letter are significantly different.

LS Means Plot



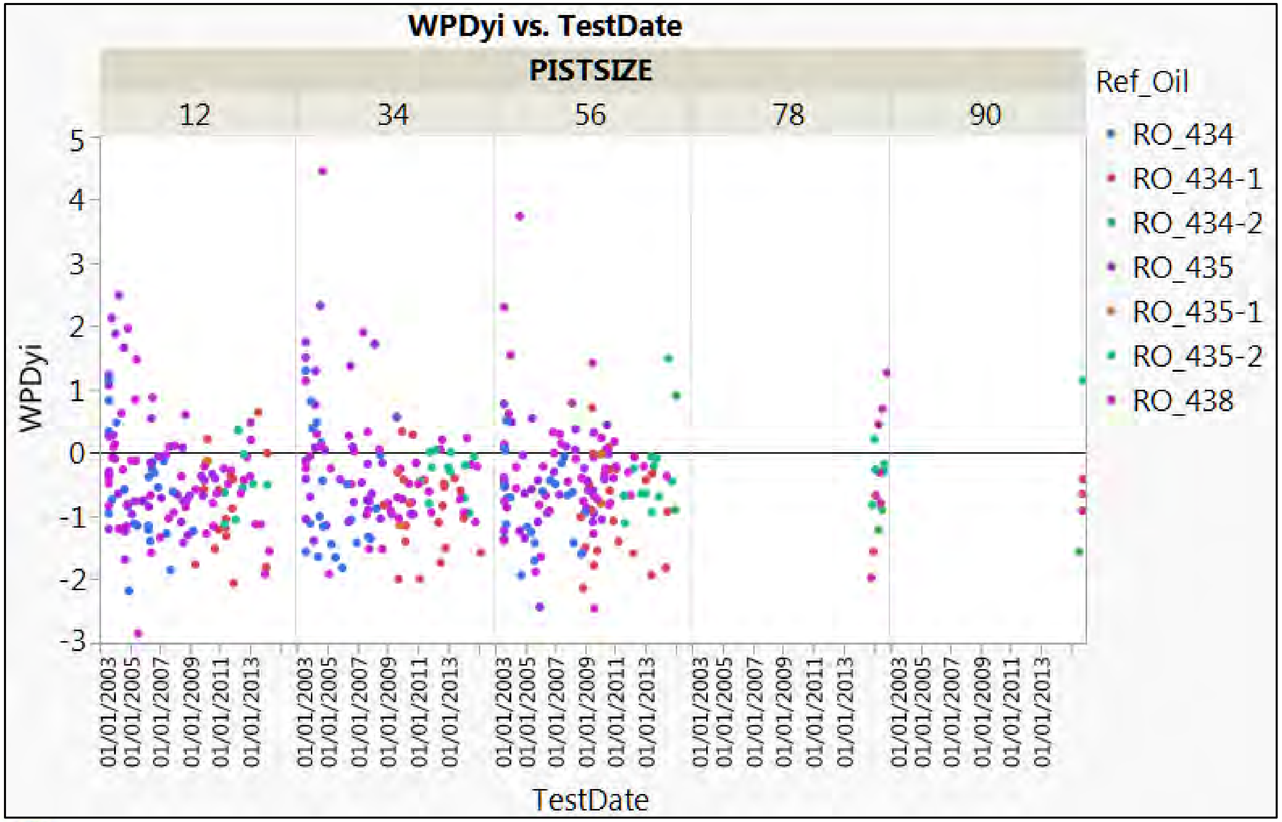
__Statistical Difference__

Pist 90 > Pist 56

IIIG Severity Analysis

Raw plot of the WPDyi data

- Data suggests no change in WPDyi severity with 78 & 90 piston sizes/engine builds



IIIG Severity Analysis

WPD Analysis

- ANOVA analysis suggests no statistical difference in WPD with respect to pistons sizes/engine builds

Response WPD

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	15	76.68616	5.11241	18.5045
Error	414	114.37938	0.27628	Prob > F
C. Total	429	191.06555		<.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.7206457	0.070042	53.12	<.0001*
Ref_Oil[RO_434]	0.5307112	0.075478	7.03	<.0001*
Ref_Oil[RO_434-1]	0.3132043	0.077678	4.03	<.0001*
Ref_Oil[RO_434-2]	0.4985301	0.215656	2.31	0.0213*
Ref_Oil[RO_435]	-0.251037	0.069973	-3.59	0.0004*
Ref_Oil[RO_435-1]	-0.309084	0.206527	-1.50	0.1353
Ref_Oil[RO_435-2]	-0.239733	0.088794	-2.70	0.0072*
LTMSLAB[A]	-0.050191	0.055894	-0.90	0.3697
LTMSLAB[B]	0.0014839	0.056025	0.03	0.9789
LTMSLAB[D]	-0.094239	0.063606	-1.48	0.1392
LTMSLAB[E]	0.1680096	0.086644	1.94	0.0532
LTMSLAB[F]	0.1505479	0.069866	2.15	0.0318*
PISTSIZE[12]	-0.01751	0.070136	-0.25	0.8030
PISTSIZE[34]	-0.012849	0.07017	-0.18	0.8548
PISTSIZE[56]	-0.05901	0.069149	-0.85	0.3939
PISTSIZE[78]	-0.001687	0.123705	-0.01	0.9891

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	6	6	71.650670	43.2237	<.0001*
LTMSLAB	5	5	5.467269	3.9578	0.0016*
PISTSIZE	4	4	0.250221	0.2264	0.9236

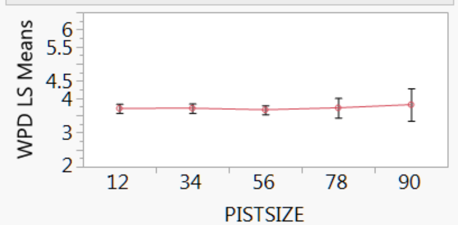
PISTSIZE

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	3.7031361	0.06733844	3.50620
34	3.7077964	0.06847459	3.55819
56	3.6616360	0.06574244	3.49390
78	3.7189586	0.14571657	3.33600
90	3.8117013	0.24073790	3.80800

LS Means Plot



LSMeans Differences Tukey HSD

α= 0.050 Q= 2.73985

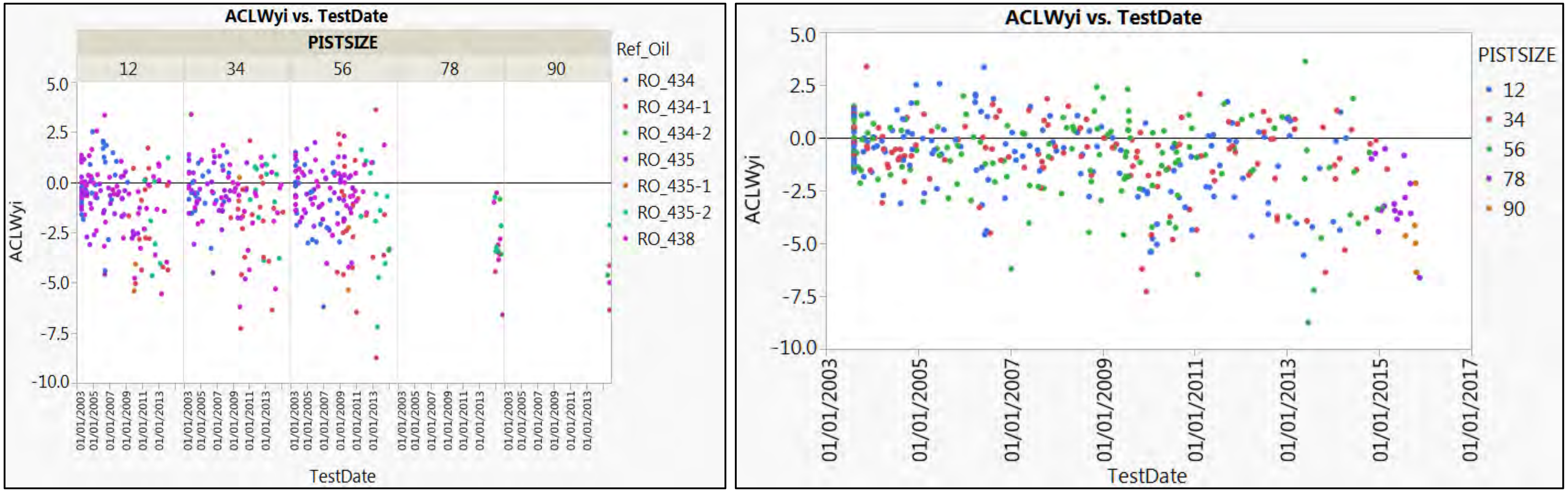
Level		Least Sq Mean
90	A	3.8117013
78	A	3.7189586
34	A	3.7077964
12	A	3.7031361
56	A	3.6616360

Levels not connected by same letter are significantly different.

IIIG Severity Analysis

Raw plot of the ACLWyi data

- Data suggests a possible change in ACLWyi corresponds with 78 & 90 piston sizes/engine builds



IIIG Severity Analysis

LnACLW Analysis

- ANOVA analysis suggests a statistical difference in LnACLW that corresponds with 78 & 90 piston sizes/engine builds

Response LnACLW

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	15	40.771106	2.71807	20.3726
Error	414	55.235167	0.13342	Prob > F
C. Total	429	96.006273		<.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.9320181	0.048674	60.24	<.0001*
Ref_Oil[RO_434]	0.2908834	0.052451	5.55	<.0001*
Ref_Oil[RO_434-1]	-0.004178	0.05398	-0.08	0.9383
Ref_Oil[RO_434-2]	0.0647483	0.149863	0.43	0.6659
Ref_Oil[RO_435]	0.2373287	0.048625	4.88	<.0001*
Ref_Oil[RO_435-1]	-0.367267	0.143519	-2.56	0.0109*
Ref_Oil[RO_435-2]	0.1324684	0.061705	2.15	0.0324*
LTMSLAB[A]	0.06683	0.038842	1.72	0.0861
LTMSLAB[B]	0.0105017	0.038933	0.27	0.7875
LTMSLAB[D]	0.0015285	0.044201	0.03	0.9724
LTMSLAB[E]	0.0058497	0.060211	0.10	0.9227
LTMSLAB[F]	0.0720334	0.048551	1.48	0.1387
PISTSIZE[12]	0.1876007	0.048739	3.85	0.0001*
PISTSIZE[34]	0.2154379	0.048763	4.42	<.0001*
PISTSIZE[56]	0.1769985	0.048053	3.68	0.0003*
PISTSIZE[78]	-0.150413	0.085965	-1.75	0.0809

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	6	6	31.062025	38.8028	<.0001*
LTMSLAB	5	5	3.525261	5.2845	0.0001*
PISTSIZE	4	4	3.152608	5.9074	0.0001*

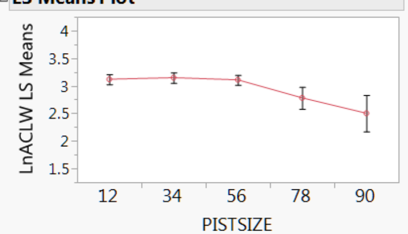
PISTSIZE

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	3.1196188	0.04679474	3.09163
34	3.1474559	0.04758427	3.13555
56	3.1090166	0.04568565	3.07328
78	2.7816047	0.10126116	2.58419
90	2.5023944	0.16729326	2.44283

LS Means Plot



LSMeans Differences Tukey HSD

α= 0.050 Q= 2.73985

Level			Least Sq Mean
34	A		3.1474559
12	A		3.1196188
56	A		3.1090166
78		B	2.7816047
90		B	2.5023944

Levels not connected by same letter are significantly different.

__Statistical Difference(s)__

Pist 12, 34, 56 > Pist 78, 90

IIIG Severity Analysis

Summary

- Analysis suggests that there’s a statistical difference in LnPVIS and LnACLW that corresponds with 78 and 90 piston sizes/engine builds
  - No significant difference was identified for the WPD parameter

- Increase in LnPVIS corresponds with increase in blow-by for the 78 and 90 piston sizes/engine builds

Section 2: IIIF Severity Analysis

IIIF Severity Analysis

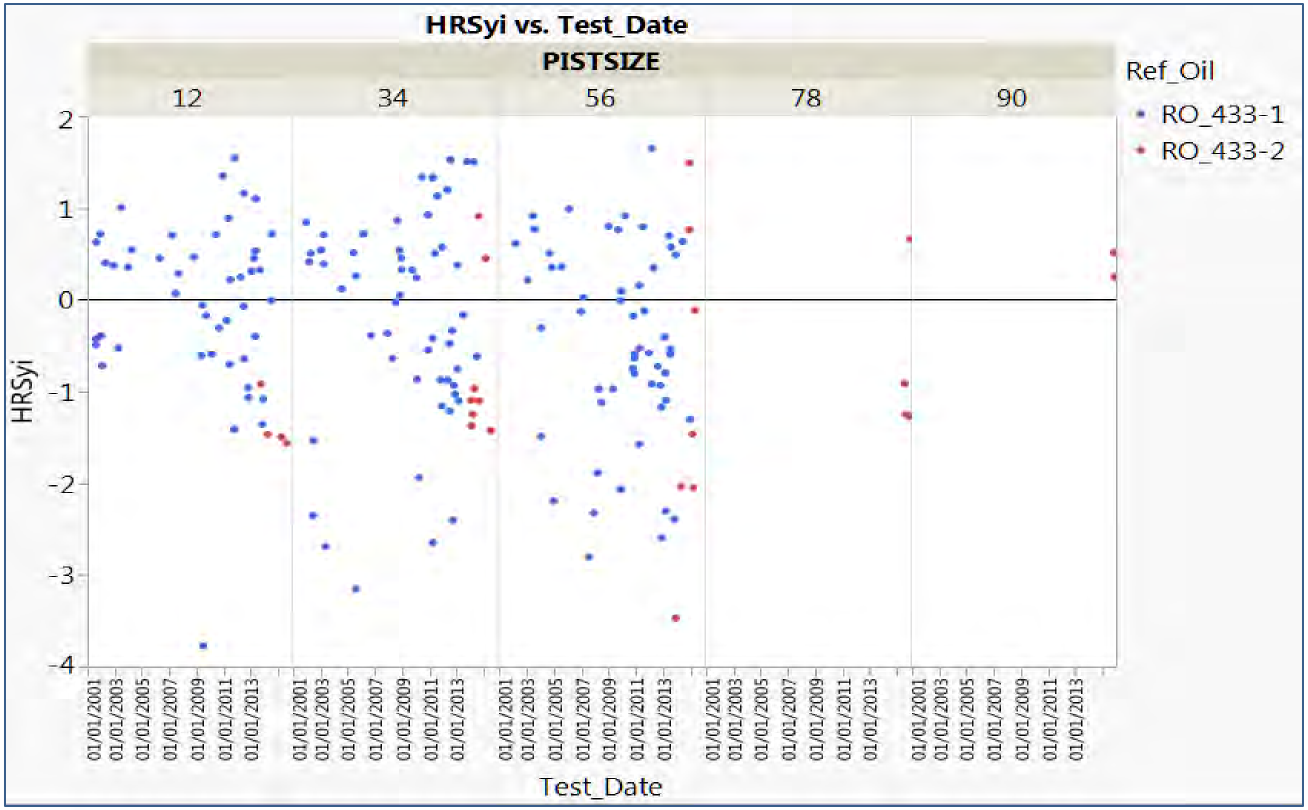
Data used in the analysis:

- A total of n = 183 *Chartable = 'Y'* <u>*and*</u> *ChartHrs = 'Y'* results in the LTMS database
- Number of test results on new engine build hardware:
  - 78 piston sizes/engine builds sample size = 4
  - 90 piston sizes/engine builds sample size = 3

IIIF Severity Analysis

Raw plot of Hrs to 275 PVIS data

- Data suggests no change in Hrs to 275 PVIS severity with 78 & 90 piston sizes/engine builds



IIIF Severity Analysis

ANOVA analysis of Hrs to 275 PVIS

- Analysis suggests no statistical difference in Hrs to 275 PVIS with respect to piston sizes/engine builds

Response HRS

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	116.3479	1.511698	76.97	<.0001*
Ref_Oil[RO_433-1]	2.280134	0.881272	2.59	0.0105*
LTMSLAB[A]	3.0337037	1.347576	2.25	0.0256*
LTMSLAB[B]	-8.108038	4.065883	-1.99	0.0477*
LTMSLAB[B1]	2.3628321	1.376264	1.72	0.0878
LTMSLAB[G]	4.5510753	1.330553	3.42	0.0008*
PISTSIZE[12]	-0.911474	1.527416	-0.60	0.5515
PISTSIZE[34]	-0.589997	1.46661	-0.40	0.6880
PISTSIZE[56]	-3.242412	1.481549	-2.19	0.0300*
PISTSIZE[78]	-0.327276	3.10061	-0.11	0.9161

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	1	1	333.87632	6.6942	0.0105*
LTMSLAB	4	4	929.96738	4.6615	0.0013*
PISTSIZE	4	4	358.37966	1.7964	0.1317

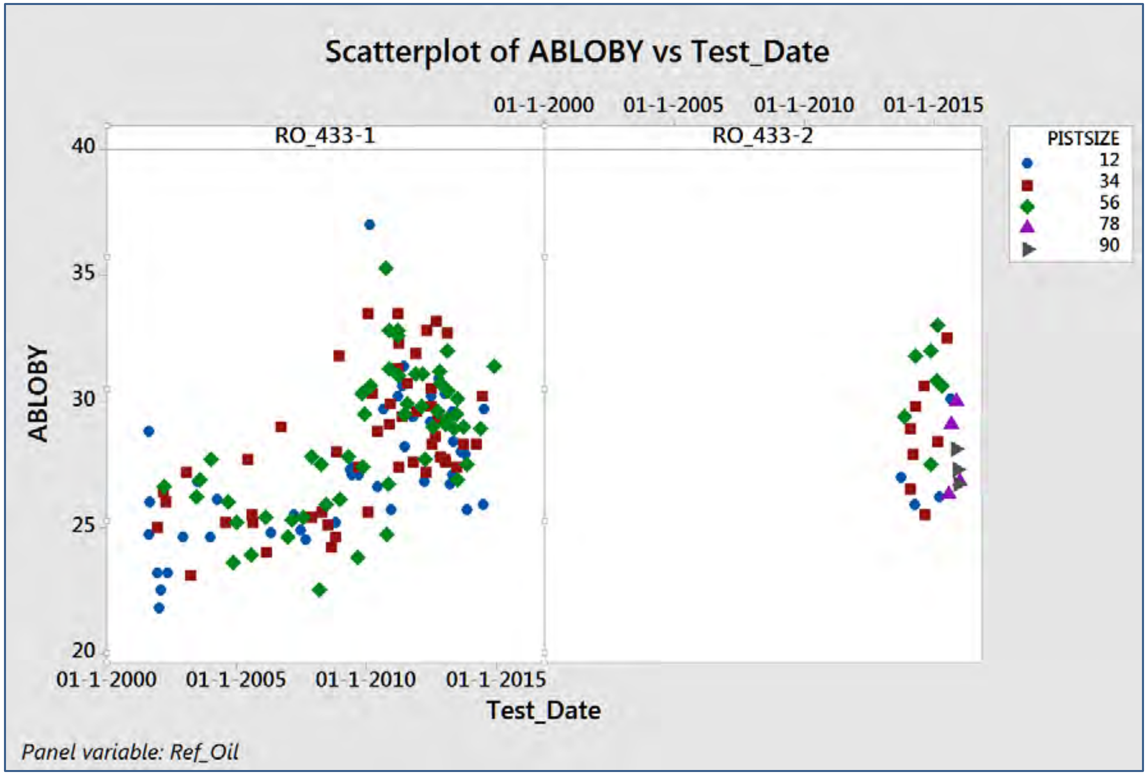
Afton CHEMICAL

Passion for Solutions™

IIIF Severity Analysis

Supplemental plot of the Blowby data

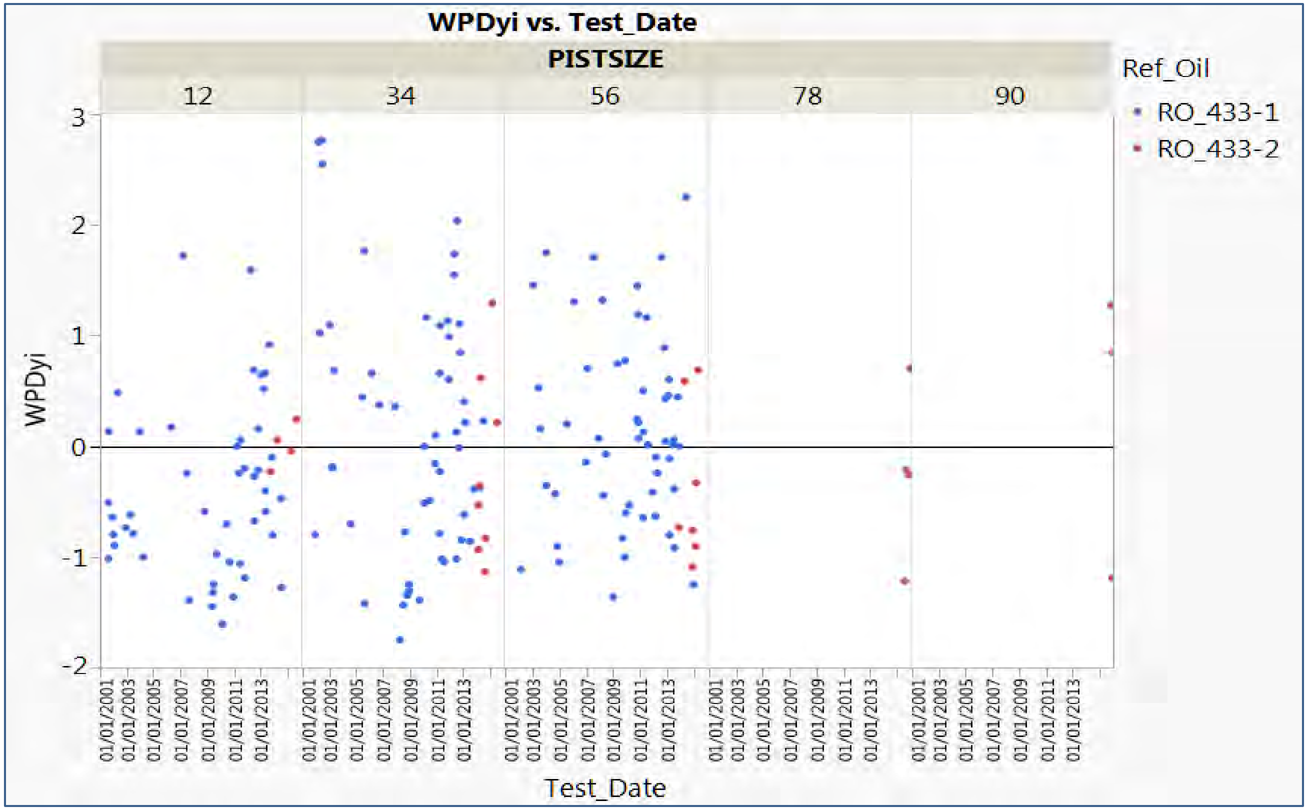
- Data suggest no increase in blow-by corresponds with 78 & 90 piston sizes/engine builds



IIIF Severity Analysis

Raw plot of the WPDyi data

- Data plot suggests no change in severity with 78 & 90 piston sizes / engine builds



IIIF Severity Analysis

WPD Analysis

- Data analysis suggests a statistical difference in WPD that corresponds with 56 & 12 piston sizes/engine builds

Response WPD

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	9	12.843198	1.42702	4.0487
Error	173	60.976937	0.35247	Prob > F
C. Total	182	73.820136		<.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.7959237	0.127082	37.74	<.0001*
Ref_Oil[RO_433-1]	0.1002431	0.074084	1.35	0.1778
LTMSLAB[A]	-0.479703	0.113285	-4.23	<.0001*
LTMSLAB[B]	0.9278171	0.3418	2.71	0.0073*
LTMSLAB[B1]	-0.265401	0.115696	-2.29	0.0230*
LTMSLAB[G]	-0.261944	0.111853	-2.34	0.0203*
PISTSIZE[12]	-0.306671	0.128403	-2.39	0.0180*
PISTSIZE[34]	-0.073984	0.123291	-0.60	0.5492
PISTSIZE[56]	0.053951	0.124547	0.43	0.6654
PISTSIZE[78]	-0.046226	0.260654	-0.18	0.8594

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	1	1	0.6453175	1.8309	0.1778
LTMSLAB	4	4	8.0688808	5.7231	0.0002*
PISTSIZE	4	4	4.1993225	2.9785	0.0207*

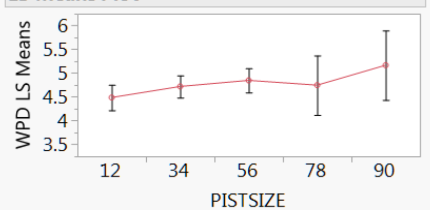
PISTSIZE

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	4.4892529	0.13568271	4.27608
34	4.7219398	0.11857955	4.58492
56	4.8498747	0.12882516	4.64387
78	4.7496973	0.31666795	4.41750
90	5.1688536	0.36932429	4.80667

LS Means Plot



LSMeans Differences Tukey HSD

α= 0.050 Q= 2.75676

Level			Least Sq Mean
90	A	B	5.1688536
56	A		4.8498747
78	A	B	4.7496973
34	A	B	4.7219398
12		B	4.4892529

Levels not connected by same letter are significantly different.

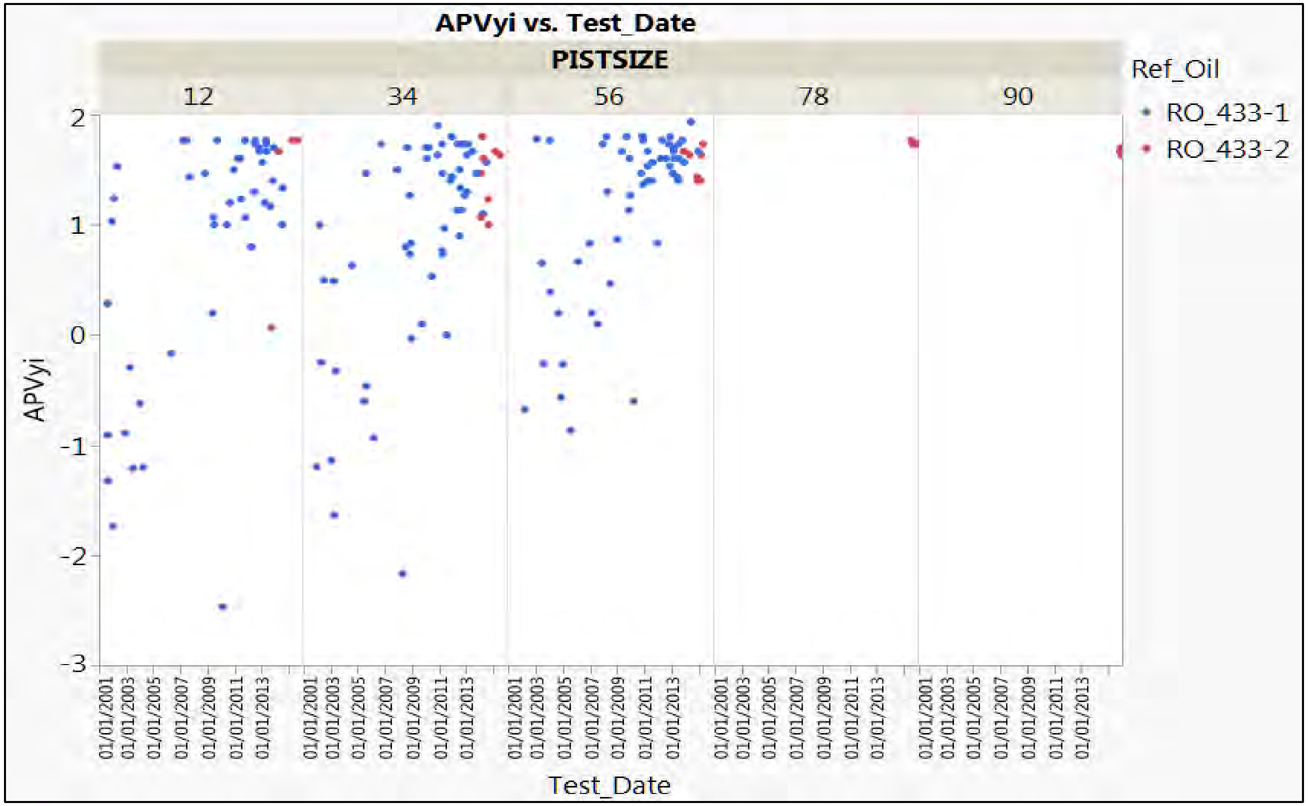
Statistical Difference

Pist 56 > Pist 12

IIIF Severity Analysis

Raw plot of the APVyi data

- Data plot suggests no change in severity with 78 & 90 piston sizes / engine builds



IIIF Severity Analysis

APV Analysis

- Data analysis suggests no statistical difference in APV with respect to the piston sizes/engine builds

Response APV

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	9	2.334602	0.259400	4.0260
Error	173	11.146642	0.064431	Prob > F
C. Total	182	13.481244		0.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	9.677315	0.054334	178.11	<.0001*
Ref_Oil[RO_433-1]	-0.045929	0.031675	-1.45	0.1489
LTMSLAB[A]	-0.087993	0.048435	-1.82	0.0710
LTMSLAB[B]	-0.135903	0.146137	-0.93	0.3537
LTMSLAB[B1]	0.0483635	0.049466	0.98	0.3296
LTMSLAB[G]	-0.003566	0.047823	-0.07	0.9406
PISTSIZE[12]	-0.073408	0.054899	-1.34	0.1829
PISTSIZE[34]	-0.085483	0.052713	-1.62	0.1067
PISTSIZE[56]	0.0132889	0.05325	0.25	0.8032
PISTSIZE[78]	0.0652802	0.111443	0.59	0.5588

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Ref_Oil	1	1	0.1354686	2.1025	0.1489
LTMSLAB	4	4	1.3300972	5.1609	0.0006*
PISTSIZE	4	4	0.4211525	1.6341	0.1678

IIIF Severity Analysis

Summary

- Analysis[1] suggests no significant difference in WPD, APV, or Hrs to 275 PVIS test results for the 78 and 90 piston sizes/engine builds

- Analysis suggests that a statistical difference in WPD corresponds with the 12 & 56 piston sizes/engine builds.

Note 1: Small Sample size of n=7 may have insufficient power to detect a potential difference in test results for the 78 and 90 piston sizes/engine builds

ATTACHMENT 4

IIIG SEVERITY ANALYSIS FOR 2014 & 2015

January 13th 2016

For review at the Sequence III Surveillance Panel call

Performance you can rely on.

Infineum

Background

- Sequence IIIG is now in its final months of existence.
- Most of the tests are run in San Antonio with one lab running the majority of the calibration tests.
- Recently, to extend the life of the test, the option to run 7-8 and 9-10 engine block runs was introduced because it was understood that some labs had exhausted all of their Engine run 1-6 blocks.
- The IIIG test is generally recognized as having gone severe on WPD and PVIS and mild on ACLW, which may be related to the move to 7-10 Engine block runs.
- Infineum conducted a study of the IIIG reference oil results from 2014 and 2015 to get some clarity on the current severity of the test and develop options to address the situation.
  - During this time period 10 of the 14 valid 434 WPD results were below 4.0
- Infineum recognizes that the analysis approach adopted here is unusual. We have followed the normal TMC analysis methods and believe it is appropriate to consider the options put forward for the remaining life of the IIIG test.

Summary

Based on valid Reference Oil tests completed since January 2014 :

- Sample size is 43 which after drilling down to subsets becomes somewhat small.
- WPD severity appears to be independent of Engine Run.
- The average WPD severity is slightly less than that needed for a SA.
- PVis appears to be more severe for Engine Runs 5 – 10 than 1 – 4.
- ACLW appears to increase in mildness after Engine Runs 3 & 4.
- The average Yi differs significantly for the 3 Reference Oils, with 434-X having the largest average Yi in magnitude.
- Propose SAs be recalculated omitting 2014 & 2015 results of non-434-X ROs, and that all future ROs tested in IIIG be 434-X.

Analysis of Engine Run Impact on Severity

Engine Run	n	PVis			WPD			ACLW		
		Yi Avg, s	- (Mild)	+ (Severe)	Yi Avg, s	- (Severe)	+ (Mild)	Yi Avg, s	- (Mild)	+ (Severe)
1 & 2	5	2.17	2	3	-1.15	4	0	-1.46	4	1
3 & 4	11	0.20	5	6	-0.61	10	1	-1.37	9	2
5 & 6	7	0.94	2	5	-0.29	5	2	-2.12	6	1
7 & 8	15	1.14	4	11	-0.42	11	4	-2.89	15	0
9 & 10	5	2.34	0	5	-0.48	4	1	-4.46	5	0

- Basis of analysis is valid RO data from January 1, 2014 through January 8, 2016.
- Keep in mind the small sample size.
- This data indicates:
  - WPD has been severe regardless of Engine Run (note average as well as Severe / Mild ratio).
    - Note that the average Yi for Runs 5 – 10 (absolute value) is just less than the threshold of 0.55 for obtaining a SA.
  - PVis appears to be more severe for Engine Runs after 3 / 4.
    - Lab mix could be a factor as it differs by Engine Run.
  - ACLW appears to increase in mildness after Engine Run 3 & 4.

IIIG Severity by Reference Oil (2014 & 2015)

Oil	n	PVis			WPD			ACLW		
		Yi Avg, s	- (Mild)	+ (Severe)	Yi Avg, s	- (Severe)	+ (Mild)	Yi Avg, s	- (Mild)	+ (Severe)
434-1	9	2.20	3	6	-1.09	8	0	-3.06	9	0
434-2	5	1.94	1	4	-0.73	4	1	-3.12	5	0
434-X	14	2.11	4	10	-0.96	12	1	-3.08	14	0
435-2	13	0.95	2	11	-0.12	10	3	-1.69	11	3
438	16	0.42	7	9	-0.51	12	4	-2.36	15	1

- The reblends of 434 have similar average Yi indicating minimal differences in severity of the reblends.
- The average Yis for the 3 ROs, however, do show significant differences in severity.
  - 434-X, the passing oil, and therefore the oil most closely related to candidates, has a more severe shift than the other oils.
  - Because the run frequency is equal for the 3 ROs, the weight of 434-X is only approximately 1/3 which biases the SAs low (in magnitude)..

IIIG LTMS Proposed Modification

Lab	Version of LTMS	RO Tests Omitted	WPD		ACLW		PVis	
			Zi	SA	Zi	SA	Zi	SA
A	Current	0	-0.0782	0	-1.9442	0.3700	0.7293	-0.2129
A	Modified	4	-0.1426	0	-2.2911	0.4360	0.9572	-0.2794
B	Current	0	-1.2240	0.73	-2.0669	0.3933	1.3263	-0.3871
B	Modified	5	-1.3210	0.79	-1.4861	0.2828	2.1432	-0.6256
D	Current	0	-0.1442	0.00	-2.6573	0.5057	1.4162	-0.4134
D	Modified	7	-0.6044	0.36	-2.9041	0.5526	1.3950	-0.4072
G	Current	0	-0.0989	0	-4.0857	0.7775	1.0973	-0.3203
G	Modified	11	-0.7803	0.47	-3.4081	0.6486	1.3797	-0.4027

- SAs were calculated by two methods:
  - Current
  - Modified: Same rules as Current except omit all non-434-X RO results for 2014 and 2015.
- Except for Lab B, applying the “Modified” SA calculation method, has minimal impact on ACLW and PVis.
- Application of “Modified” SA calculation method to WPD moves each of the 4 calibrated labs to a more negative Zi consistent with general observations.
  - Lab A is moved least because, of the last two 434-X WPD results, one was on target and the other was mild.
- Propose “Modified” calculation method be applied to all parameters and all future IIIG RO assignments be 434-X.
  - If proposal is accepted, TMC should verify above unofficial SAs.

Motions for 1/13/16 Surveillance Panel Call

- Infineum invites a second for these motions which would be followed by discussion

1. In the event that an industry test lab has available inventory of block run sizes at or below run size 6, block run numbers 1 through 6 are to be used prior to runs 7 through 10 through the end of the life of the Sequence IIIG test type.
2. Effective with TMC verifying and recalculating the SAs, the SAs will be recalculated using only 434 data over the time frame starting Jan 1st 2014.
3. Reference Oil 434 will be the only oil assigned for IIIG referencing for the remaining life of the IIIG test. Effective Midnight CST January 13, 2016.

TOYOTA

ATTACHMENT 5

Proposal for Sequence IIIG Severity Correction

Sequence III Surveillance Panel

January 13th, 2016

Toyota Motor Corporation

Agenda

TOYOTA

- Concerns on Recent Sequence IIIG Severity Trend
- Operational Difference between 1 – 6th run and 7 – 9th run
- Response of each ASTM TMC REO to WPD Severity
- Proposals to Step Forward

Concerns on Recent IIIG Severity Trend

TOYOTA

- Toyota's Impression and Concerns
  - Toyota has proceeded our internal development work toward API SN/RC 0W-16, since it was approved at API LG.
  - We have seen several WPD failing results on formulations with which we expected passing WPD results around 4 – 4.5 range.
  - We spoke with several different oil companies and additive suppliers and confirmed that they had similar impression regarding recent WPD trend.
  - Some people expressed that there may be influence from 7th and higher run engine tests.

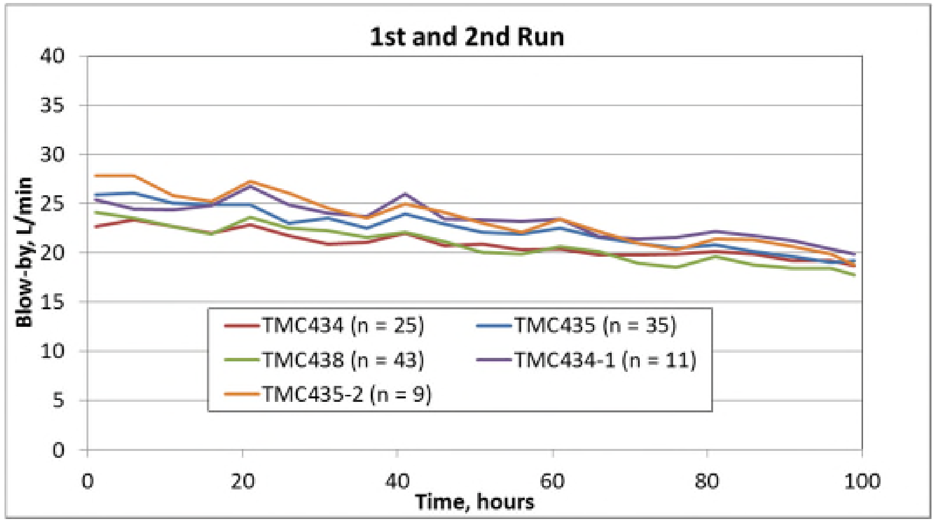
Operational Difference

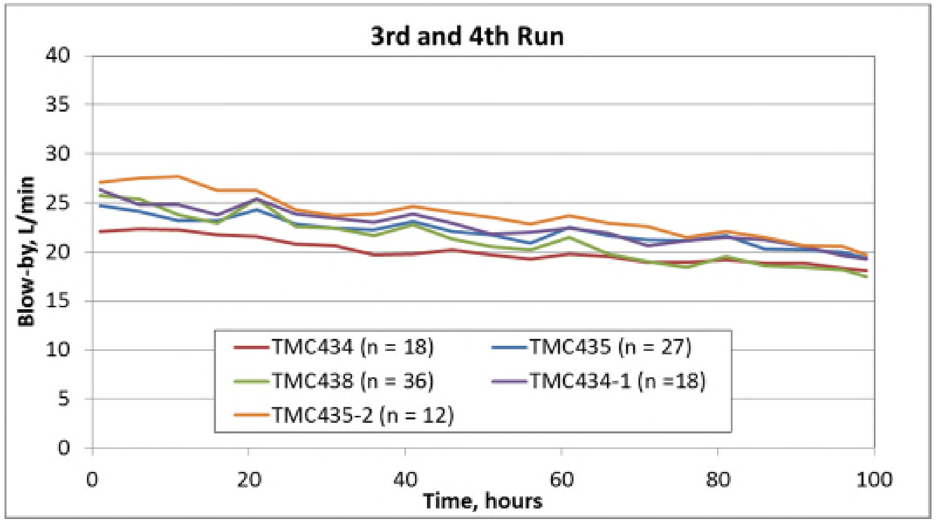
TOYOTA

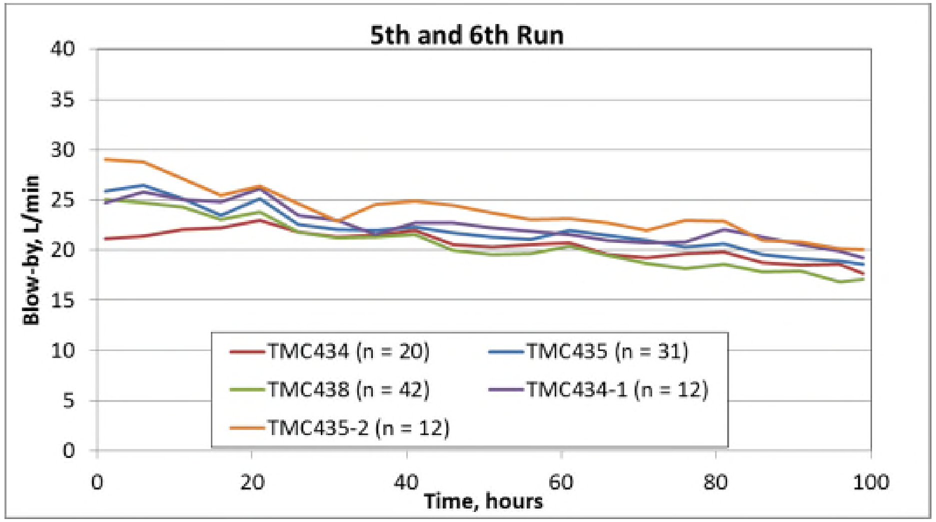
- ASTM TMC Database
  - Toyota has reviewed available data on the ASTM TMC website to check if there is any apparent difference between 1 – 6th runs and 7 – 9^{th} runs.
  - Only clear difference is blow-by trend through the test
    - Plots are shown in the next pate
- Possible Cause to Influence WPD
  - Lubrizol reported the correlation between ring gap chamfers and WPD severity in the Seq III SP on Oct 2015.
  - Blow-by rate is influenced by piston ring gaps and chamfers on ring gap edges.
  - Higher blow-by rate may indicate some difference in ring gap areas of 7 -9^{th} runs and result in severe WPD trend.

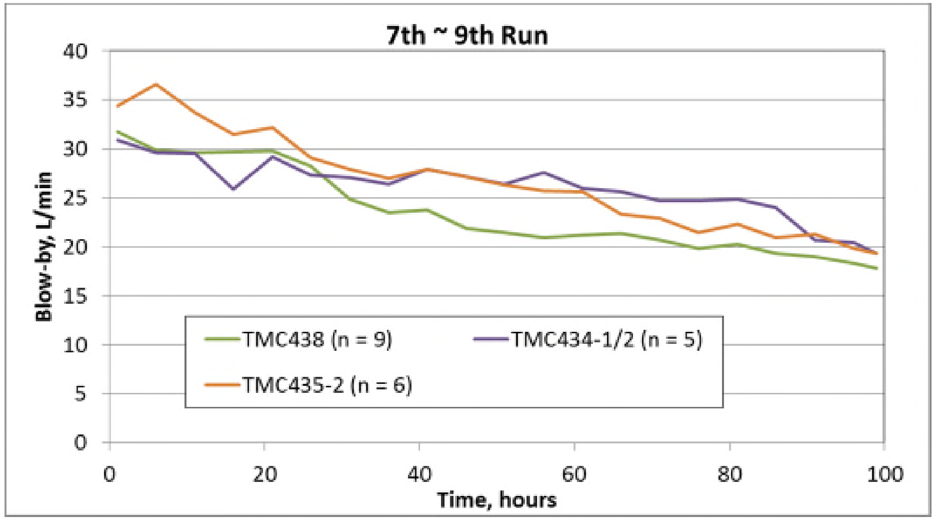
Blow-By Trends by Run Numbers

TOYOTA









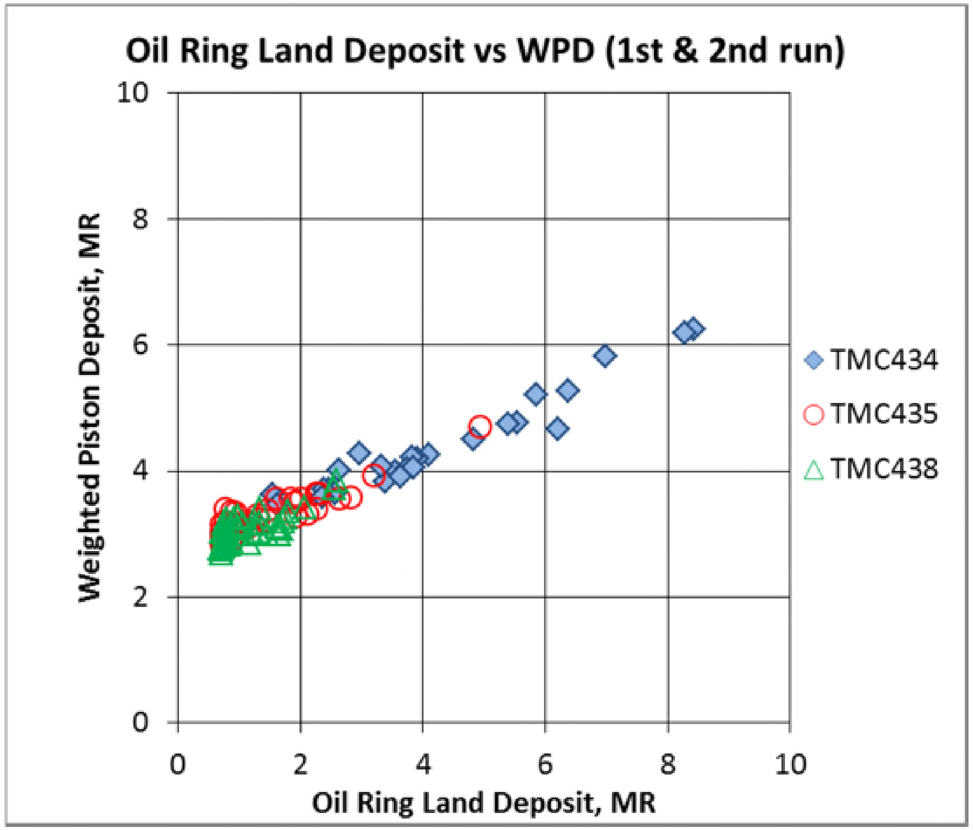
7 – 9th runs show higher blow-by trend compared with 1 -6th runs.

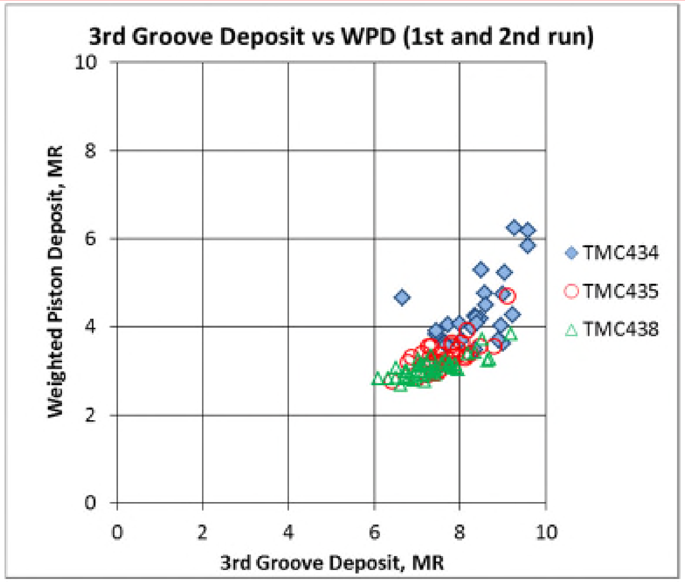
Response of each ASTM TMC REO to WPD Severity TOYOTA

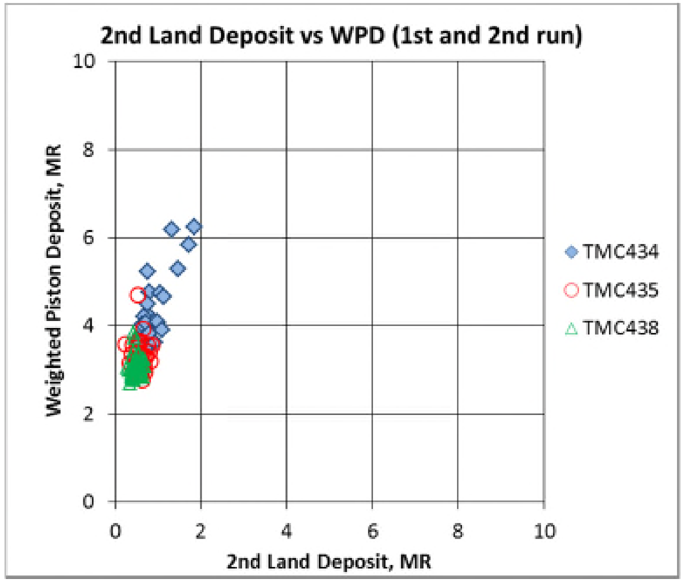
- WPD Calculation
  - WPD calculation equation consists of 7 items of piston ratings with weight factors.
  - Because of its response and technical concerns, 3rd land (oil ring land) has highest weight factor and variability in test results.
  - TMC434 (WPD target = 4.8) has high ORLD values compared with other TMC REOs and most sensitive to variability of tests.

Position	Wt Factor
1st Groove	0.05
2nd Groove	0.10
3rd Groove	0.20
2nd Land	0.15
3rd Land (Oil Ring Land)	0.30
Undercrown	0.10
Piston Skirt	0.10

Response of each ASTM TMC REO to WPD Severity TOYOTA







- ***ORLD is most influencing factor to WPD and shows wide range of variation for TMC 434.***
- ***Low deposit rating cannot become too worse….***

Proposals to Step Forward

TOYOTA

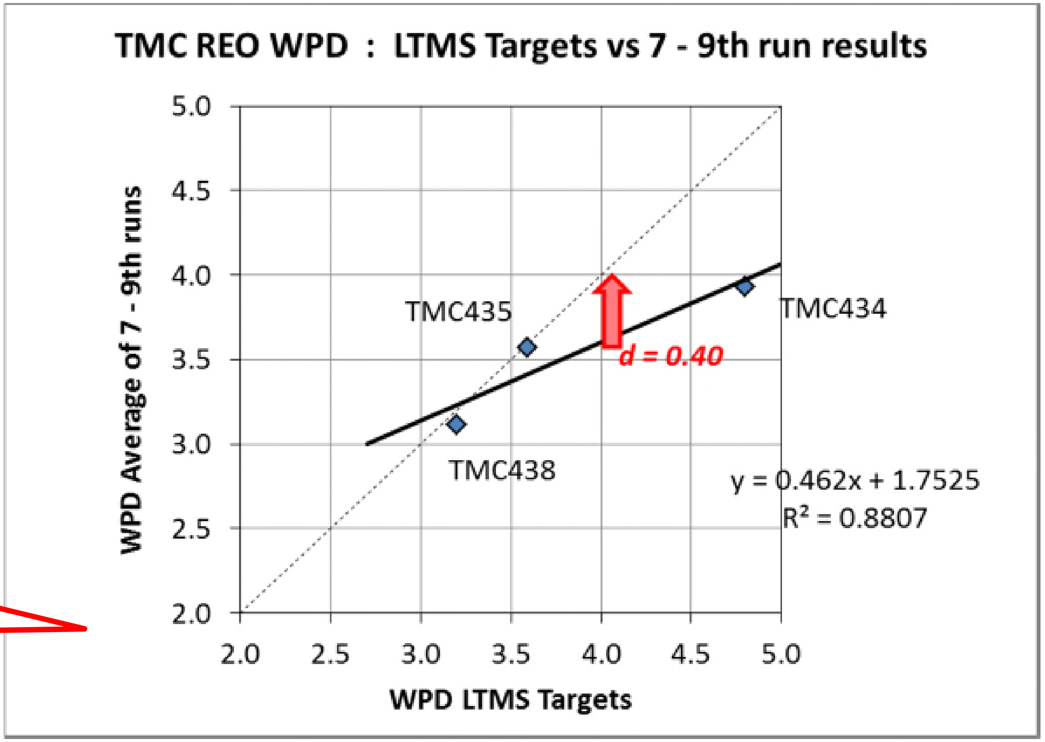
- Continuation of Seq IIIG
  - Toyota supports to have Seq IIIG test as a part of ILSAC GF-5 and API SN qualification by extending its life with 7^{th} to 10^{th} runs.
  - In order to solve the current concerns in the industry, the methodology of severity adjustment for the WPD is strongly desired.
  - Provisional license cannot be a high priority option, since Seq IIIG is the key engine test to ensure engine oil quality in the market.

- Possible Ideas for the WPD SA (just examples !)
  - Industry correction with fixed factor
  - Modification of referencing process

Proposals to Step Forward

TOYOTA

- Idea-1 : Industry Correction
  - Based on the WPD severity trend for 7 – 9th runs on TMC REOs, apply fixed SA as industry correction.
  - For candidate oils with true performance of WPD at 4.0, + 0.40 will be ideal correction.



Jan 19, 2016 : S. Hirano
Labels for X-axis and Y-Axis are corrected.

TOYOTA

- Idea-2 : Modification of Referencing Process
  - TMC434 is the only REO that shows the severity trend in the WPD, because of its nature as explained in page 7.
  - If only TMC434 is used for severity adjustment, it will pick up the severity shift more sensitively and appropriately.
  - If the Seq III SP can agree, we could apply this calculation back to certain time period, especially to fix the concerns around 7 – 10th runs.

Proposals to Step Forward

TOYOTA

- Formation of Taskforce
  - Toyota would like to propose the Seq III SP to form taskforce to come up with solution for the WPD severity concerns of 7 – 10th run IIIG tests.
  - All potential ideas from industry stakeholders should be reviewed by statistical viewpoint.

ATTACHMENT 6

Sequence IIIH Task Force to Improve Precision

1/13/2016

summary of discussions held on 12/16, 12/22, 1/6, and 1/12

Review of followup test by Lab D on RO434

- continued mild result
- in depth data review comparing operational data
- no apparent relationship with any measured parameter
- CONCLUSION: the source of the variability is with a parameter either not being measured, or not being measured accurately
- ACTION: continue to search for the source of variability (in process)

Discussion about stand differences

- ACTION: Ed to send photos of stand and engine (done)
- ACTION: Labs to provide photos of crankcase ventilation system (done)
- CONCLUSION: Discovered differences between labs that might affect the restriction and flow of blowby gas
- ACTION: task force to revise procedure to standardize the hardware
- Ed feels that other parts of the test stand and engine should also be reviewed
- ACTION: labs to provide photos of entire stand for review by the TF (in process)

Discussion about engine operation difficulties

- Several labs have experienced issues with engine “de-rate” or “limp home mode”
- ACTION: need Chrysler’s help to understand problem and implement a robust solution (in process)
- ACTION: labs to capture ECU parameters by monitoring the CANbus (in process)
- ACTION: need Chrysler’s help to capture proprietary parameters related to oil pressure, oil temp, and oil pressure solenoid position (in process)

Discussion regarding engine build differences

- CONCLUSION: Round robin measurements of cylinder bore diameter and surface finish show minor differences; measurement resolution may prohibit a more thorough understanding
- ACTION ITEM: labs to bore/hone a block and send to Jeff Betz at Chrysler for measurement
- ACTION ITEM: review of the surface finish data suggests that new limits need to be established for Rz and Rzk to address consistently out of spec measurements

Discussion on engine swapping between labs

- ACTION: the group suggested that SWRI should build an engine that Afton would run which might reveal whether the severity issue is engine-build or test operation related (12/22)
- During the 1/6 Seq III SP call Afton voiced their concern that the test would not be valuable
- ACTION: on 1/8 an alternate suggestion was offered by LZ to run an engine built by Afton
- During the 1/12 TF call Afton believed that continued review of the test stands should be done first

TF team: Szappanos, Altman, Haumann, Schweitzer, Savant, Grundza, Chaudhry, Bowden, OMalley, Clark, Tang, Leverett, Brys