Sequence III Surveillance Panel

March 09, 2016 11:00 – 12:30 EST

Agenda

1.0) Attendance

The attendance is shown in Attachment 1.

2.0) Chairman Comments

Chairman Glaenzer noted that both the IIIH improvement Task Force and the Stats Group are making progress. Membership changes: Mark Overaker replaces Tracey King for Haltermann and Dan Lanctot replaces Zack Bishop for TEI.

3.0) Approval of minutes

3.1) Minutes from 03/2/2016 Conference Call

The minutes of March 2, 2016 were approved unanimously.

4.0) Action Item Review

4.1) Analysis of IIIF & IIIG run 7-10 data for differences.

Todd Dvorak gave the presentation prepared by the Statistical Analysis group regarding severity of 7 – 10 pistons. WPD does not appear to be influenced by the use of the increased piston size while PVIS may be influenced, but date may also have some influence as well. ACLW was not analyzed. Conclusions were that piston size and data may be influencing PVIS results. All oils appear to be trending upward for PVIS, while only oils 435 and 438 may not be trending for WPD. Correction factor may not consistent for 7 – 10 pistons, but may be appropriate for 9-10 size pistons on PVIS, while a linear correction factor may be appropriate for WPD. Pooled s has changed over time for PVIS and has improved for WPD recently. Adopting a continuous SA may provide some relief for WPD, but would do little for PVIS as all calibrated labs have a severity adjustment in effect. A motion was made to amend the ltms document for IIIG to allow for continuous severity adjustments for all three parameters, PVIS, WPD and ACLW. Motion, Ed Altman, second Robert Stockwell. Effective two weeks from today (3/23/16). Motion was approved 13-0-3. An action item was assigned to review the implementation in 4 months.

Old Business

5.1) Test Improvement Task Force.

George Szappanos updated the group. Meetings have been ongoing and the task force is closing in on its remaining work. Sid has been working on the build manual and is currently out for lab comment. The blowby ventilation configuration has also been identified as an area of improvement via standardization. There is still some work to do on addressing the blowby system design. A review of the proposed system was undertaken during the call. Additional work is still needed before the final configuration can be put forward. A conference call is planned for Friday, March 11, 2016. Sid asked every member be present or have someone who can make a decision at that meeting represent them.

5.2) Test procedure update.

Karin Haumann is putting the final touches on the draft procedure and will forward the draft to the TMC for posting on the website.

5.3) Engine Build manual update.

Sid has incorporated a number of changes in the document and labs are reviewing.

6.0) New Business

6.1) Determine if Precision Matrix stands can be considered calibrated based on their matrix tests in light of test procedure enhancements. This item will be addressed after seeing additional changes put forth by the test improvement task force.

6.2) Review and finalize the Qi Limits Rich Grundza indicated that this item was discussed during a previous test improvement task force call. Rich indicated the task force felt limits for Fuel Temperature and Intake air pressure are the only parameters needing review. Rich will put together limits based on worst tests from the matrix.

6.3) Update on LTMS plans for Sequence IIIH. Several members of the statistics working group are working on ltms proposals. This will be addressed during the face to face meeting on March 29, 2016

7.0) Work Remaining

7.1 Set up LTMS. **Underway** The statistical methods group is working on a draft.
7.2) Determine calibration and referencing protocols. **Discuss at SAT March 29**
7.3) Appendix K Update. **Martinez**
7.4) Surveillance Panel recommendation regarding test readiness for the category. **June, 2015**
7.5) Publish research report **TBD**
7.6) The chair was asked if the status of critical test parts was known. The chair agreed to attempt to complete a survey of the test labs to determine the amount of critical parts remaining. Dave hoped to have this completed in time for the March 29, 2016 meeting.

8.0) Next Meeting

8.2) Tentative, teleconference on March 16, 2016.
8.3) Face-to-Face on March 29, 2016.

9.0) Meeting Adjourned

The meeting adjourned at 12:22 pm.

Attachment 1 3/09/16

ASTM Sequence III Surveillance Panel (22 Voting members) date: page 1

Name/Address	Phone/Fax/Email	LTMS MOTION		Signature
Ed Altman	ed.altman@aftonchemical.com	A	Voting Member	Present ✓
Jeff Betz	jeff.betz@fcagroup.com	A	Voting Member	Present ✓
Jason Bowden	jhbowden@ohtech.com	A	Voting Member	Present ✓
Timothy L. Caudill	tlcaudill@ashland.com	A	Voting Member	Present ✓
Richard Grundza	reg@astmtmc.cmu.edu	W	Voting Member	Present ✓
Jeff Hsu, PE	j.hsu@shell.com	A	Voting Member	Present ✓
Teri Kowalski	teri.kowalski@tema.toyota.com	—	Voting Member	Present____
Dan Lanctot	dlanctot@tei-net.com	W	Voting Member	Present ✓
Patrick Lang	plang@swri.org	A	Voting Member	Present ✓
Bruce Matthews	bruce.matthews@gm.com	W	Voting Member	Present ✓ TIM CUSHING
Mark Overaker	mhoveraker@jhaltermann.com	—	Voting Member	Present____
Andrew Ritchie	andrew.ritchie@infineum.com	A	Voting Member	Present ✓ GORDON FARNSWORTH
Ron Romano	rromano@ford.com	A	Voting Member	Present ✓
Cliff Salvesen	clifford.r.salvesen@exxonmobil.com	A	Voting Member	Present ✓
Addison Schweitzer	addison.schweitzer@intertek.com	A	Voting Member	Present ✓
Greg Shank	greg.shank@volvo.com	—	Voting Member	Present ✓
Kaustav Sinha, Ph.D.	LFNQ@chevron.com	—	Voting Member	Present____
Thomas Smith	trsmith@ashland.com	—	Voting Member	Present____
Scott Stap	scott.stap@tgidirect.com	—	Voting Member	Present ✓
George Szappanos	george.szappanos@lubrizol.com	A	Voting Member	Present ✓
Haiying Tang	HT146@chrysler.com	A	Voting Member	Present ✓
David Tsui	david.tsui@bp.com	A	Voting Member	Present ✓

MOTION

13 Affirmative

0 Negative

3 Waive

Name/Address	Phone/Fax/Email		Signature
Ricardo Affinito	affinito@chevron.com	Non-Voting Member	Present
Art Andrews	856-224-3013	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
Jim Rutherford	510-242-3410	Non-Voting Member	Present

ASTM Sequence III Surveillance Panel (22 Voting members) date: 3/09/16 p 3

Name/Address	Phone/Fax/Email		Signature
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

TIM CUSHING GM ✓
MIKE RAINEY GM ✓
GORDON FARNSWORTH ✓

Attachment 2

IIIG Severity Review

Industry Statistician Team – Data Review

Date: 03-03-16

Statistics Group - Team Members

- Art Andrews, Exxon Mobil
- Martin Chadwick, Intertek
- Jo Martinez, Chevron Oronite
- Richard Grundza, TMC
- Travis Kostan, SwRI
- Lisa Dingwell, Afton Chemical
- Todd Dvorak, Afton Chemical
- Doyle Boese, Infineum
- Kevin O'Malley, Lubrizol

Executive Summary

- Are the WPD and PVIS test results different with size 7-10 pistons?
  - There is some evidence that the PVIS parameter has been more severe with piston sizes 7 through 10 but not significant in WPD parameter.
    - PVIS severity could also be coincidental with time (date $\geq$ 01/01/14) or other hardware changes.
    - Data also suggests that average blow-by has increased with piston sizes 7-10. Analysis of PVIS, WPD, and average blow-by data suggests that an increase in average blow-by negatively affects PVIS and WPD test severity.

- Is a correction factor warranted? If so, what kind?
  - A linear correction for the WPD parameter is technically feasible. It may also be technically feasible to create a correction factor for PVIS with piston sizes 9 – 10. However, it's difficult to attribute any kind of severity shift to only piston sizes because there have been other hardware changes, reference oil blend changes, a potential time related shift, and a potential blow-by effect.

Executive Summary

- Are all three ROs acting similarly in terms of Y_i performance?
  - RO434X tends to be more severe in terms of PVIS and WPD (Y_i) test results as compared to RO435X and RO438X.
  - All oils have generally trended up in PVIS over time.
  - All oils have remained in varying degrees on the severe side for a long time for WPD. 435 and 438 are trending slightly less severe in the recent past.

- Is the pooled s we currently use for severity adjustments still appropriate?
  - The pooled standard deviations have increased and decreased for the PVIS and WPD test parameters, respectively. This will affect the magnitude of SA's that are applied to candidate test results.

- Adoption of continuous SAs?
  - Continuous SAs will provide some help for the WPD parameter. It will not have any impact for the PVIS parameter. SAs are a way to bring labs to parity and ensure equitable assessment of candidate oils across the industry. There is general consensus among the industry statisticians to implement continuous SAs where applicable.

Agenda

- Review data and analyses to answer below list of questions from the Sequence III Surveillance Panel Chair:

  1. What data set should be used? Look at both historic and recent data.
  2. Are the wpd, pvis, ~~and aclw~~ test results different with size 7-10 pistons?
  3. Are all three ROs acting similarly in terms of Yi performance?
  4. There are also different ring batches associated with size 7-10 pistons.
  5. Are there gaps in the data? Is there data you would like to see to help render a decision?
  6. Is a correction factor warranted? If so, what kind?
  7. Is the pooled s we currently use for severity adjustments still appropriate?

- Reach consensus on next steps

Are the WPD and PVIS test results different with size 7-10 pistons?

Are the WPD and PVIS test results different with size 7-10 pistons?

- Previous analysis (presented at SP conference call) suggests that TPVIS is different with piston sizes 7–10 as compared to sizes 1–6.
  - When considering date (results ≥ 01/01/14), piston sizes 7–10 are no longer significant.
- No evidence that 7-10 piston sizes have different WPD severity as compared to sizes 1-6.

Response TPVIS

Whole Model

Summary of Fit

RSquare	0.269261
RSquare Adj	0.248482
Root Mean Square Error	0.489825
Mean of Response	4.88482
Observations (or Sum Wgts)	435

Analysis of Variance

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	VIF
Intercept	5.0771737	0.051799	98.02	<.0001*	.
RefOil_NoReblend[RO434X]	0.0567674	0.033654	1.69	0.0924	1.3496614
RefOil_NoReblend[RO435X]	0.2764056	0.033046	8.36	<.0001*	1.342625
LTMSLAB[A]	0.079165	0.05167	1.53	0.1262	2.3343888
LTMSLAB[B]	-0.082097	0.051832	-1.58	0.1140	2.3628815
LTMSLAB[D]	0.0238601	0.058035	0.41	0.6812	2.5841246
LTMSLAB[E]	-0.077572	0.080546	-0.96	0.3361	3.6820737
LTMSLAB[F]	0.0197869	0.065237	0.30	0.7618	2.877105
Date>=01/01/14[0]	-0.131341	0.051042	-2.57	0.0104*	1.8547943
PISTSIZE[12]	-0.095857	0.070835	-1.35	0.1767	2.2136904
PISTSIZE[34]	-0.060514	0.068958	-0.88	0.3807	1.9776557
PISTSIZE[56]	-0.172861	0.070851	-2.44	0.0151*	2.1990118
PISTSIZE[78]	-0.056385	0.119706	-0.47	0.6379	1.3570343

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	27.903571	58.1497	<.0001*
LTMSLAB	5	5	1.399309	1.1664	0.3249
[illegible]>=01/01/14	1	1	1.588653	6.6214	0.0104*
[illegible]E	4	4	2.029804	2.1150	0.0781

RefOil_NoReblend

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	5.1339410	0.06201013	4.94356
RO435X	5.3535793	0.06106822	5.16154
RO438X	4.7440006	0.06170336	4.54609

LTMSLAB

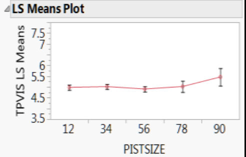
Date>=01/01/14

PISTSIZE

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	4.9813169	0.06338534	4.87652
34	5.0166595	0.06119249	4.93115
56	4.9043128	0.06367442	4.78533
78	5.0207882	0.13178802	5.16012
90	5.4627910	0.20787699	5.65200

LS Means Plot



LSMeans Differences Tukey HSD

LSMeans Differences Student's t

Response WPD

Whole Model

Actual by Predicted Plot

Summary of Fit

RSquare	0.393359
RSquare Adj	0.376109
Root Mean Square Error	0.524489
Mean of Response	3.51508
Observations (or Sum Wgts)	435

Analysis of Variance

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	3.5917486	0.055465	64.76	<.0001*
RefOil_NoReblend[RO434X]	0.550725	0.036035	15.28	<.0001*
RefOil_NoReblend[RO435X]	-0.128138	0.035385	-3.62	0.0003*
LTMSLAB[A]	-0.045459	0.055327	-0.82	0.4117
LTMSLAB[B]	0.0002304	0.0555	0.00	0.9967
LTMSLAB[D]	-0.095396	0.062142	-1.54	0.1255
LTMSLAB[E]	0.1670924	0.086246	1.94	0.0534
LTMSLAB[F]	0.1511245	0.069854	2.16	0.0311*
Date>=01/01/14[0]	0.0231224	0.054654	0.42	0.6725
PISTSIZE[12]	-0.024134	0.075848	-0.32	0.7505
PISTSIZE[34]	-0.02527	0.073838	-0.34	0.7323
PISTSIZE[56]	-0.071266	0.075865	-0.94	0.3481
PISTSIZE[78]	0.0272618	0.128177	0.21	0.8317

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	70.294174	127.7666	<.0001*
LTMSLAB	5	5	5.568523	4.0485	0.0013*
Date>=01/01/14	1	1	0.049237	0.1790	0.6725
PISTSIZE	4	4	0.295015	0.2681	0.8984

RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	4.1424736	0.06639840	4.06786
RO435X	3.4636105	0.06538983	3.39752
RO438X	3.1691617	0.06606992	3.10500

LTMSLAB

Date>=01/01/14

PISTSIZE

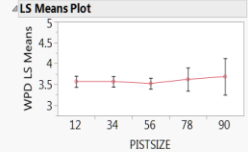
Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	3.5676148	0.06787093	3.50699
34	3.5664788	0.06552289	3.55492
56	3.5204824	0.06818047	3.49390
78	3.6190104	0.14111426	3.38176
90	3.6851564	0.22258781	3.73333

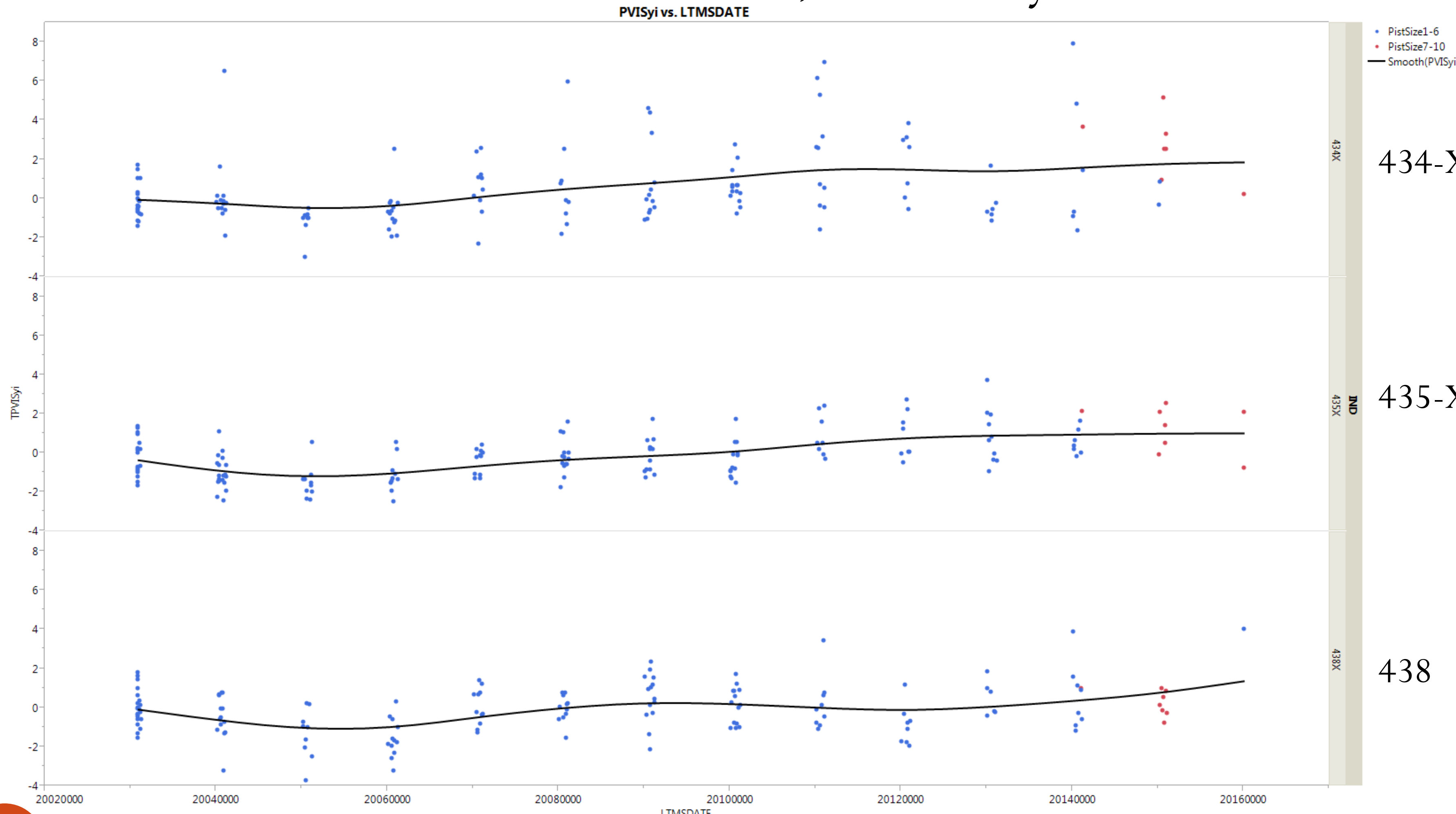
LSMeans Differences Tukey HSD

LS Means Plot



Are the WPD and PVIS test results different with size 7-10 pistons?

- Plot of TPVISYi vs LTMS Date , Colored by Piston Size



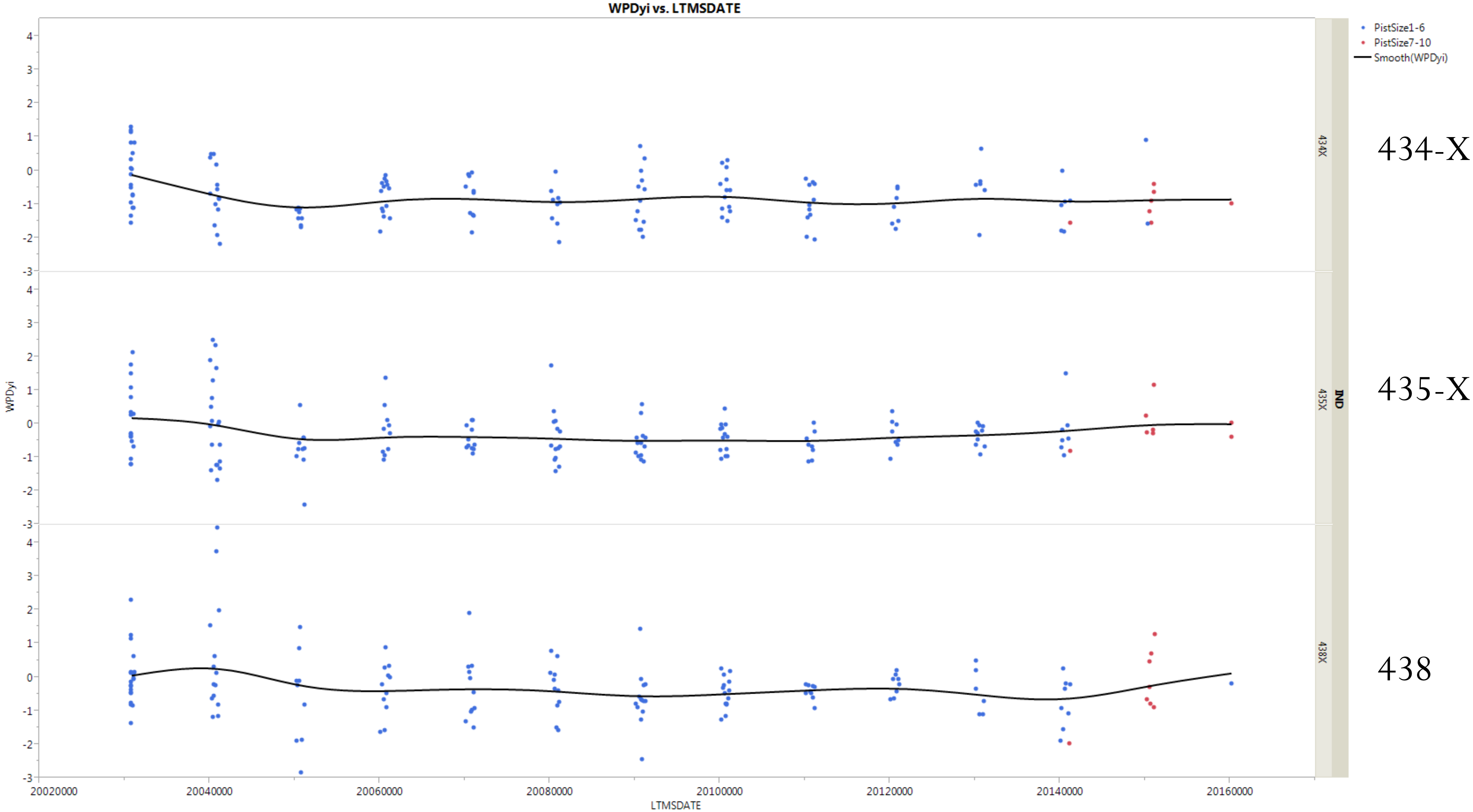
434-X

435-X

438

Are the WPD and PVIS test results different with size 7-10 pistons?

- Plot of WPD Yi vs LTMS Date, Colored by Piston Size



Are the WPD and PVIS test results different with size 7-10 pistons?

- Is TPVIS severity for Piston Sizes 7 -10 related to Blow-by?
  - Analysis suggests a significant relationship with TPVIS and WPD w.r.t. Avg Blow-by (and calendar date for TPVIS).

Response WPD

Whole Model

Actual by Predicted Plot

Summary of Fit

RSquare	0.417419
RSquare Adj	0.405082
Root Mean Square Error	0.512165
Mean of Response	3.51508
Observations (or Sum Wgts)	435

Analysis of Variance

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.6081839	0.243427	18.93	<.0001*
RefOil_NoReblend[RO434X]	0.5538981	0.035102	15.78	<.0001*
RefOil_NoReblend[RO435X]	-0.086239	0.035813	-2.41	0.0165*
ABLOBY	-0.045402	0.010506	-4.32	<.0001*
LTMSLAB[A]	-0.086552	0.054611	-1.58	0.1137
LTMSLAB[B]	-0.043244	0.054389	-0.80	0.4270
LTMSLAB[D]	-0.0654	0.06052	-1.08	0.2805
LTMSLAB[E]	0.2434297	0.085553	2.85	0.0047*
LTMSLAB[F]	0.1325536	0.068169	1.94	0.0525
Date>=01/01/14[0]	-0.044703	0.041142	-1.09	0.2778

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	74.355971	141.7314	<.0001*
ABLOBY	1	1	4.899214	18.6770	<.0001*
LTMSLAB	5	5	6.182637	4.7139	0.0003*
Date>=01/01/14	1	1	0.309693	1.1806	0.2778

RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	4.1719438	0.05708014	4.06786
RO435X	3.5318062	0.05778975	3.39752
RO438X	3.1503870	0.05406313	3.10500

ABLOBY

LTMSLAB

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	3.5314932	0.06545836	3.52110
B	3.5748017	0.06381717	3.56663
D	3.5526457	0.07171584	3.50177
E	3.8614754	0.10636725	3.68036
F	3.7505993	0.08564548	3.67804
G	3.4372586	0.05379315	3.39515

Date>=01/01/14

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0	3.5733423	0.02879640	3.52168
1	3.6627490	0.07970791	3.46188

Response TPVIS

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	3.7514027	0.225955	16.60	<.0001*
RefOil_NoReblend[RO434X]	0.0561523	0.032583	1.72	0.0855
RefOil_NoReblend[RO435X]	0.2283531	0.033242	6.87	<.0001*
ABLOBY	0.0551388	0.009752	5.65	<.0001*
LTMSLAB[A]	0.116618	0.050691	2.30	0.0219*
LTMSLAB[B]	-0.041515	0.050485	-0.82	0.4113
LTMSLAB[D]	0.0125532	0.056176	0.22	0.8233
LTMSLAB[E]	-0.159828	0.079412	-2.01	0.0448*
LTMSLAB[F]	0.0323978	0.063276	0.51	0.6089
Date>=01/01/14[0]	-0.116906	0.038189	-3.06	0.0023*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	18.043034	39.9166	<.0001*
ABLOBY	1	1	7.225896	31.9717	<.0001*
LTMSLAB	5	5	1.997227	1.7674	0.1183
Date>=01/01/14	1	1	2.118009	9.3714	0.0023*

RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	5.0100368	0.05298317	4.94356
RO435X	5.1822376	0.05364184	5.16154
RO438X	4.6693791	0.05018270	4.54609

ABLOBY

LTMSLAB

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	5.0705025	0.06076003	4.93076
B	4.9123691	0.05923664	4.77910
D	4.9664377	0.06656837	4.96301
E	4.7940562	0.09873265	4.79360
F	4.9862823	0.07949820	4.83714
G	4.9936592	0.04993210	4.92144

Date>=01/01/14

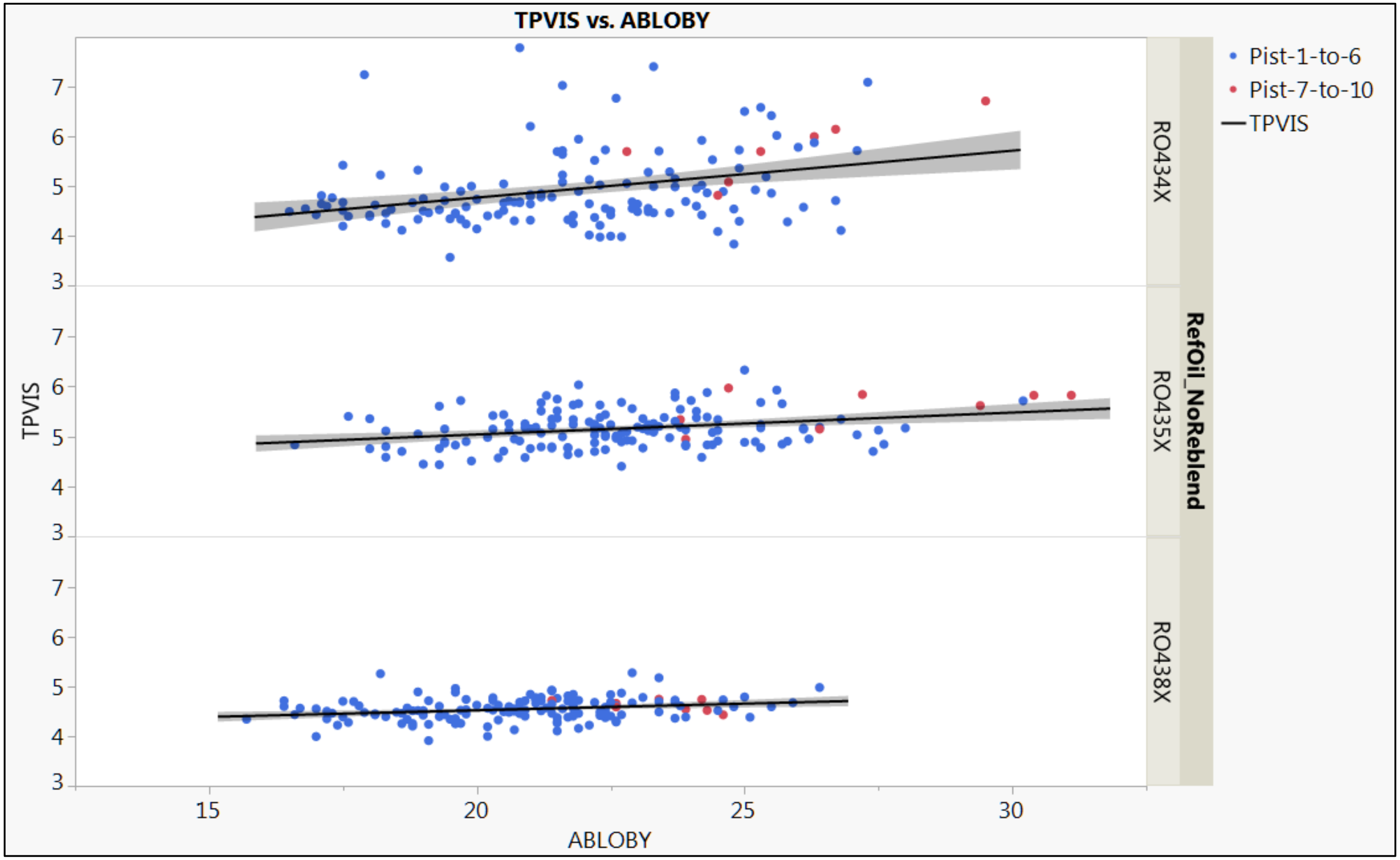
Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0	4.8369782	0.02672951	4.84736
1	5.0707908	0.07398681	5.18680

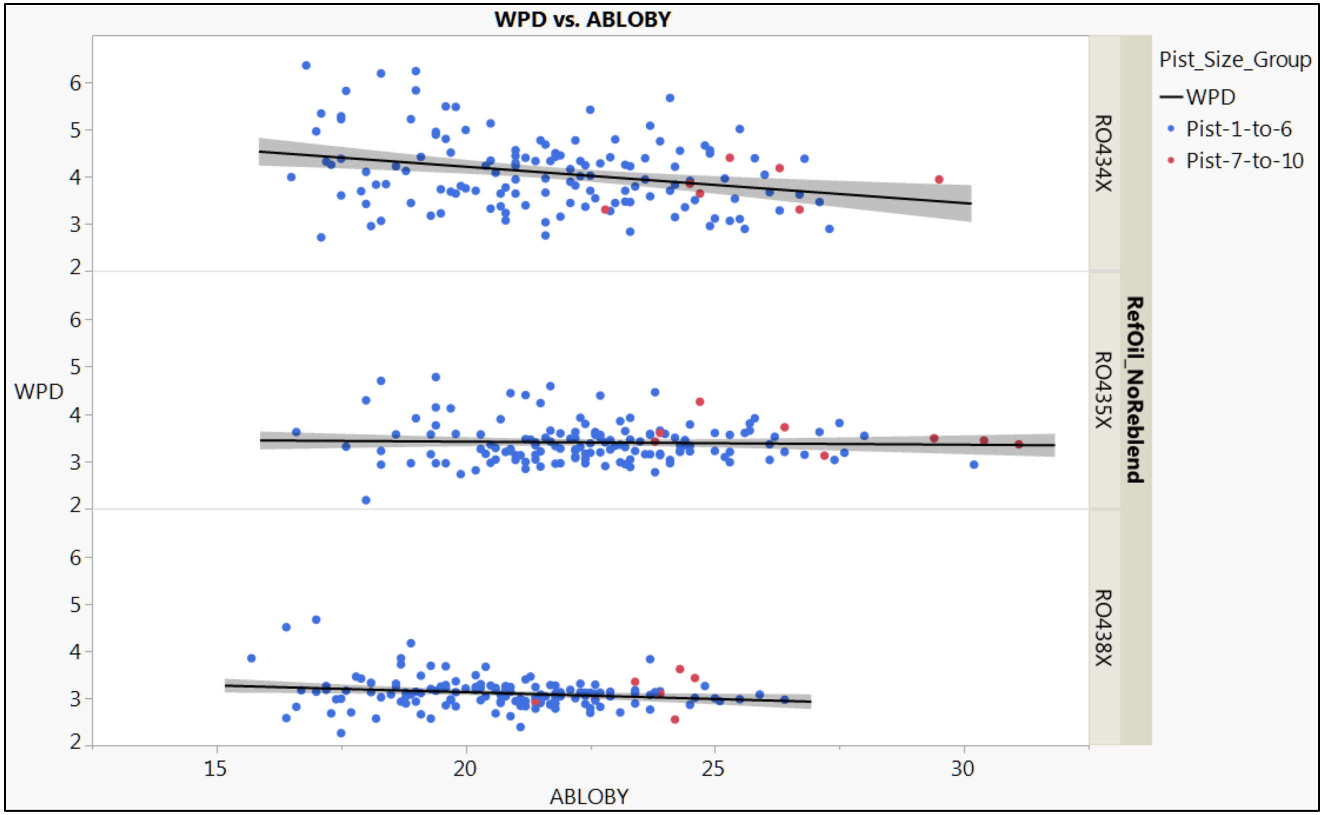
Are the WPD and PVIS test results different with size 7-10 pistons?

- Plot of TPVIS vs. Average Blow-by



Are the WPD and PVIS test results different with size 7-10 pistons?

- Plot of WPD vs. Average Blow-by



Are the WPD and PVIS test results different with size 7-10 pistons?

- Is Average blow-by different with Piston Sizes 7 - 10?
  - Analysis suggests a significant increase in average blow-by for piston sizes 7 – 10 (date ≥ 01/01/2014 is not significant).

Response ABLOBY

Whole Model

Effect Summary

Actual by Predicted Plot

Summary of Fit

RSquare	0.258627
RSquare Adj	0.237545
Root Mean Square Error	2.309858
Mean of Response	21.80828
Observations (or Sum Wgts)	435

Analysis of Variance

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	23.317361	0.244269	95.46	<.0001*
PISTSIZE[12]	-1.347841	0.334035	-4.04	<.0001*
PISTSIZE[34]	-1.224976	0.325185	-3.77	0.0002*
PISTSIZE[56]	-1.171966	0.334111	-3.51	0.0005*
PISTSIZE[78]	2.073762	0.564494	3.67	0.0003*
RefOil_NoReblend[RO434X]	0.0762971	0.1587	0.48	0.6309
RefOil_NoReblend[RO435X]	0.897053	0.155836	5.76	<.0001*
Date>=01/01/14[0]	-0.268154	0.240698	-1.11	0.2659
LTMSLAB[A]	-0.859002	0.243661	-3.53	0.0005*
LTMSLAB[B]	-0.795127	0.244424	-3.25	0.0012*
LTMSLAB[D]	0.4631792	0.273675	1.69	0.0913
LTMSLAB[E]	1.724691	0.379831	4.54	<.0001*
LTMSLAB[F]	-0.371258	0.307639	-1.21	0.2282

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
PISTSIZE	4	4	125.15819	5.8645	0.0001*
RefOil_NoReblend	2	2	257.88410	24.1671	<.0001*
Date>=01/01/14	1	1	6.62210	1.2412	0.2659
LTMSLAB	5	5	192.88289	7.2302	<.0001*

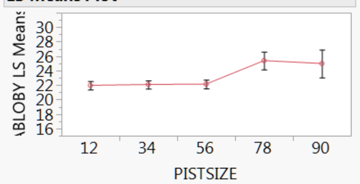
PISTSIZE

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	21.969520	0.29890499	21.5371
34	22.092385	0.28856419	21.7906
56	22.145395	0.30026821	21.5170
78	25.391123	0.62147013	25.4176
90	24.988382	0.98028136	25.2667

LS Means Plot



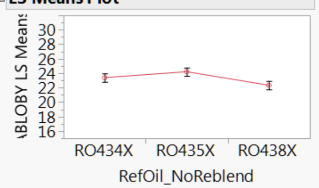
RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	23.393658	0.29241995	21.8407
RO435X	24.214414	0.28797818	22.7389
RO438X	22.344011	0.29097329	20.8274

LS Means Plot



Date>=01/01/14

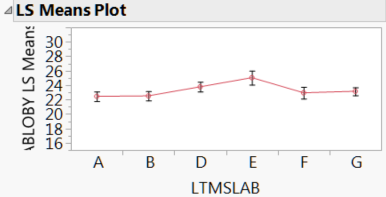
LTMSLAB

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	22.458359	0.33623517	21.0951
B	22.522234	0.32632651	21.1627
D	23.780540	0.34647876	22.7306
E	25.042052	0.49373519	23.5786
F	22.946103	0.41390890	21.4022
G	23.154878	0.28097225	21.9873

LS Means Plot



Are the WPD and PVIS test results different with size 7-10 pistons?

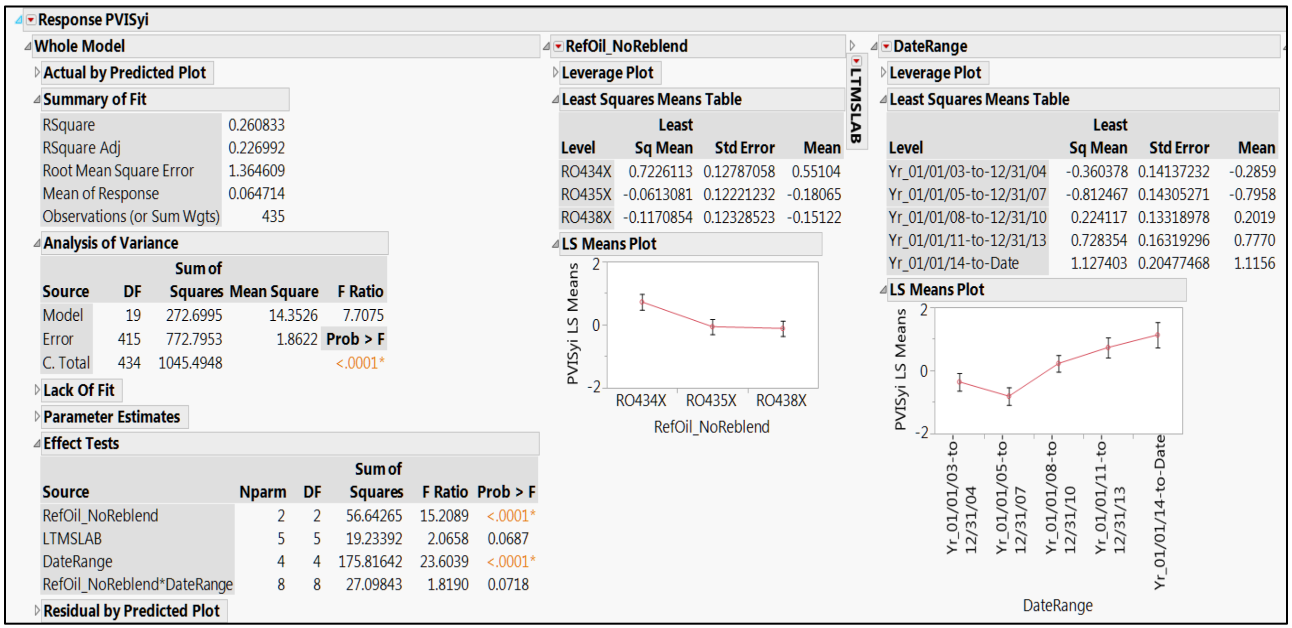
- Conclusions / Highlights:
  - Calendar date ($\geq$01/01/14) and piston sizes 7 – 10 do coincide with recent severity change in PVIS.
    - However, piston sizes 7-10 do not coincide with WPD severity.
  - Analysis suggests a significant increase in average blow-by for piston sizes 7 – 10.
  - There is a *significant relationship in TPVIS and WPD test severity w.r.t. the average blow-by
    - WPD decreases with increased levels of average blow-by
    - TPVIS increases with increased levels of average blow-by

Statistical significance or correlation is not to be confused with causation.

Are all three ROs acting similarly in terms of Yi performance?

Are all three ROs acting similarly in terms of Yi performance?

- Data was analyzed with date coded as a categorical factor
- Analysis of Y_i data for TPVIS suggests that oil RO434X > (RO435X, RO438X)



Response PVISyi

Whole Model

Actual by Predicted Plot

Summary of Fit

RSquare	0.260833
RSquare Adj	0.226992
Root Mean Square Error	1.364609
Mean of Response	0.064714
Observations (or Sum Wgts)	435

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	19	272.6995	14.3526	7.7075
Error	415	772.7953	1.8622	Prob > F
C. Total	434	1045.4948		<.0001*

Lack Of Fit

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	56.64265	15.2089	<.0001*
LTMSLAB	5	5	19.23392	2.0658	0.0687
DateRange	4	4	175.81642	23.6039	<.0001*
RefOil_NoReblend*DateRange	8	8	27.09843	1.8190	0.0718

Residual by Predicted Plot

RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	0.7226113	0.12787058	0.55104
RO435X	-0.0613081	0.12221232	-0.18065
RO438X	-0.1170854	0.12328523	-0.15122

LS Means Plot

LTMSLAB

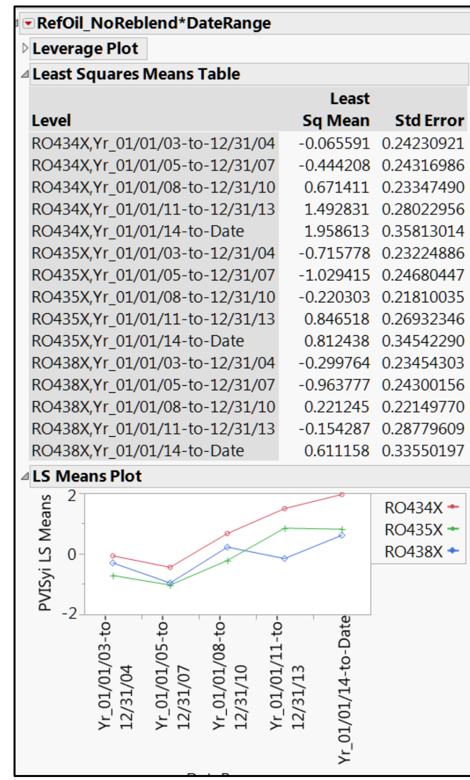
DateRange

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
Yr_01/01/03-to-12/31/04	-0.360378	0.14137232	-0.2859
Yr_01/01/05-to-12/31/07	-0.812467	0.14305271	-0.7958
Yr_01/01/08-to-12/31/10	0.224117	0.13318978	0.2019
Yr_01/01/11-to-12/31/13	0.728354	0.16319296	0.7770
Yr_01/01/14-to-Date	1.127403	0.20477468	1.1156

LS Means Plot



RefOil_NoReblend*DateRange

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error
RO434X,Yr_01/01/03-to-12/31/04	-0.065591	0.24230921
RO434X,Yr_01/01/05-to-12/31/07	-0.444208	0.24316986
RO434X,Yr_01/01/08-to-12/31/10	0.671411	0.23347490
RO434X,Yr_01/01/11-to-12/31/13	1.492831	0.28022956
RO434X,Yr_01/01/14-to-Date	1.958613	0.35813014
RO435X,Yr_01/01/03-to-12/31/04	-0.715778	0.23224886
RO435X,Yr_01/01/05-to-12/31/07	-1.029415	0.24680447
RO435X,Yr_01/01/08-to-12/31/10	-0.220303	0.21810035
RO435X,Yr_01/01/11-to-12/31/13	0.846518	0.26932346
RO435X,Yr_01/01/14-to-Date	0.812438	0.34542290
RO438X,Yr_01/01/03-to-12/31/04	-0.299764	0.23454303
RO438X,Yr_01/01/05-to-12/31/07	-0.963777	0.24300156
RO438X,Yr_01/01/08-to-12/31/10	0.221245	0.22149770
RO438X,Yr_01/01/11-to-12/31/13	-0.154287	0.28779609
RO438X,Yr_01/01/14-to-Date	0.611158	0.33550197

LS Means Plot

Are all three ROs acting similarly in terms of Yi performance?

- Analysis of Y_i data for WPD suggests that oil RO434X < (RO435X, RO438X)

Response WPDyi

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	19	71.37824	3.75675	5.9610
Error	415	261.54150	0.63022	Prob > F
C. Total	434	332.91974		<.0001*

Lack Of Fit

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	20.471429	16.2415	<.0001*
LTMSLAB	5	5	20.620247	6.5438	<.0001*
DateRange	4	4	28.201411	11.1871	<.0001*
RefOil_NoReblend*DateRange	8	8	2.218982	0.4401	0.8967

Residual by Predicted Plot

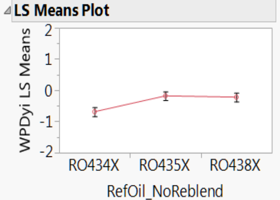
RefOil_NoReblend

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	-0.6859103	0.07438900	-0.77447
RO435X	-0.1778880	0.07109729	-0.28435
RO438X	-0.2189947	0.07172146	-0.29223

LS Means Plot



LSMeans Differences Tukey HSD

LTMSLAB

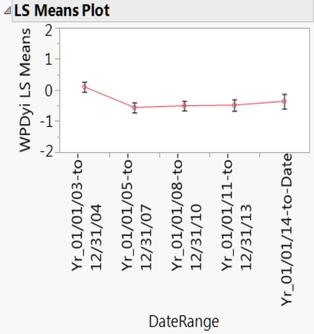
DateRange

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
Yr_01/01/03-to-12/31/04	0.1033303	0.08224366	-0.00856
Yr_01/01/05-to-12/31/07	-0.5588198	0.08322124	-0.61420
Yr_01/01/08-to-12/31/10	-0.5042724	0.07748345	-0.59111
Yr_01/01/11-to-12/31/13	-0.4847696	0.09493787	-0.56992
Yr_01/01/14-to-Date	-0.3601237	0.11912813	-0.51330

LS Means Plot



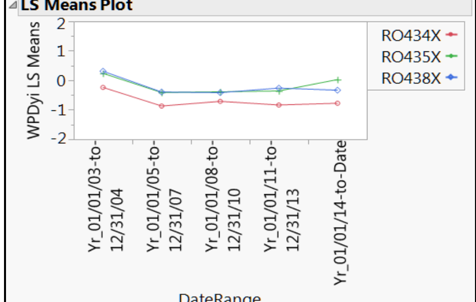
RefOil_NoReblend*DateRange

Leverage Plot

Least Squares Means Table

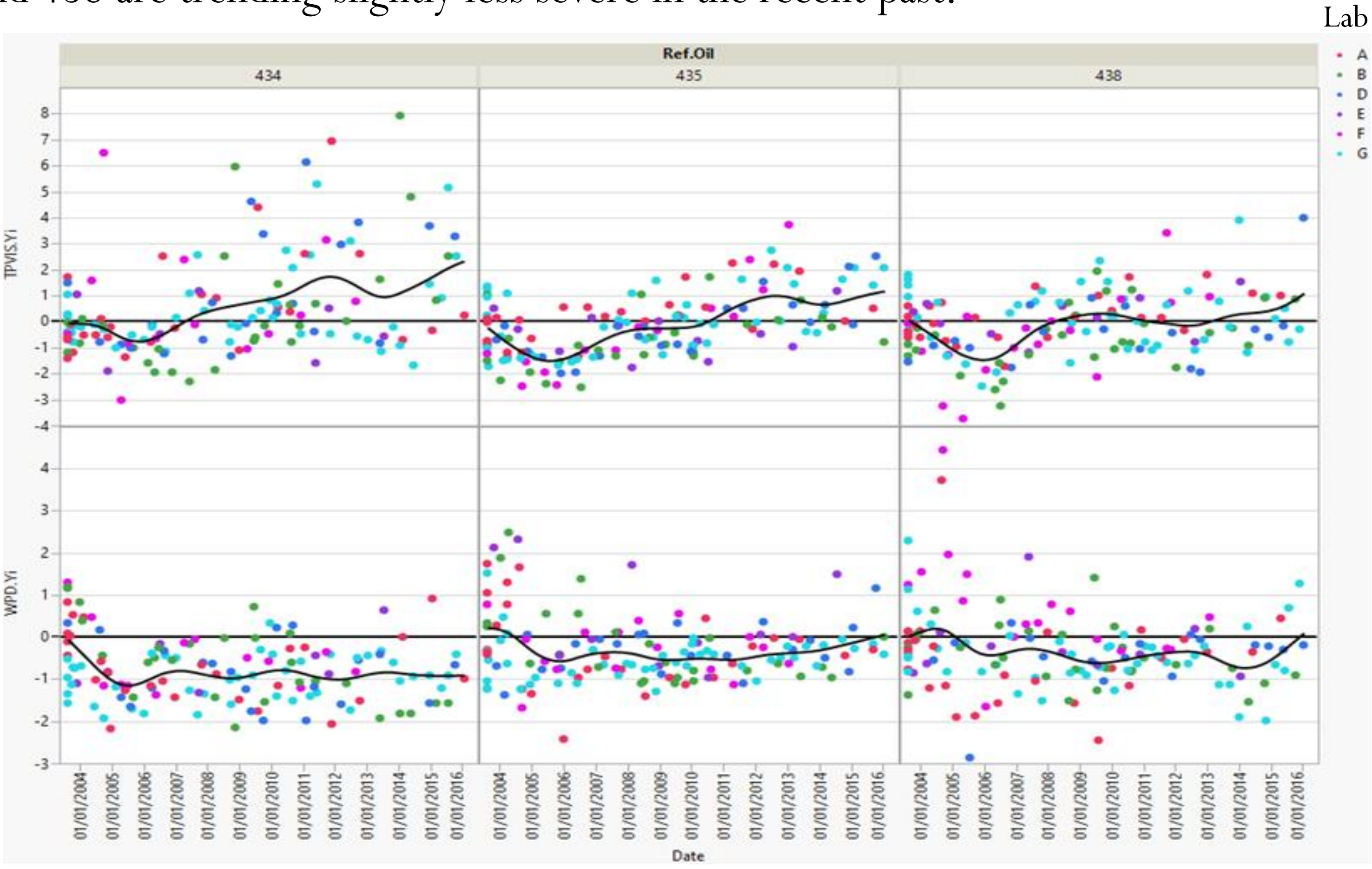
Level	Least Sq Mean	Std Error
RO434X,Yr_01/01/03-to-12/31/04	-0.2390388	0.14096393
RO434X,Yr_01/01/05-to-12/31/07	-0.8695122	0.14146461
RO434X,Yr_01/01/08-to-12/31/10	-0.7106906	0.13582455
RO434X,Yr_01/01/11-to-12/31/13	-0.8351148	0.16302418
RO434X,Yr_01/01/14-to-Date	-0.7751953	0.20834301
RO435X,Yr_01/01/03-to-12/31/04	0.2385448	0.13511130
RO435X,Yr_01/01/05-to-12/31/07	-0.4125079	0.14357906
RO435X,Yr_01/01/08-to-12/31/10	-0.3861470	0.12688037
RO435X,Yr_01/01/11-to-12/31/13	-0.3572263	0.15667953
RO435X,Yr_01/01/14-to-Date	0.0278965	0.20095055
RO438X,Yr_01/01/03-to-12/31/04	0.3104850	0.13644594
RO438X,Yr_01/01/05-to-12/31/07	-0.3944392	0.14136670
RO438X,Yr_01/01/08-to-12/31/10	-0.4159795	0.12885678
RO438X,Yr_01/01/11-to-12/31/13	-0.2619678	0.16742602
RO438X,Yr_01/01/14-to-Date	-0.3330722	0.19517903

LS Means Plot



IIIG PVIS and WPD Yis

- All oils have generally trended up in PVIS over time.
- All oils have remained in varying degrees on the severe side for a long time for WPD. 435 and 438 are trending slightly less severe in the recent past.



Are all three ROs acting similarly in terms of Yi performance?

- Conclusions / Highlights:
  - All oils have generally trended up in PVIS over time.
  - Data suggests that there is a significant difference in Y_i test results for RO434X as compared to RO435X and RO438X for WPD and TPVIS parameters.

Is a correction factor warranted? If so, what kind?

Is a correction factor warranted? If so, what kind?

- How does TPVIS severity differ from the target values?
  - LSMean Summary below for TPVIS with LTMS data dates ≥ 01/01/14
  - Relationship between TPVIS targets and LSMeans is neither a constant or linear.

Response TPVIS

Whole Model

Actual by Predicted Plot

Summary of Fit

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	8.516196	1.41937	3.7377
Error	41	15.569274	0.37974	Prob > F
C. Total	47	24.085470		0.0047*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.2091761	0.116922	44.55	<.0001*
RefOil_NoReblend[RO434X]	0.3179025	0.131612	2.42	0.0203*
RefOil_NoReblend[RO435X]	0.2113512	0.127835	1.65	0.1059
LTMSLAB[A]	-0.410065	0.216916	-1.89	0.0658
LTMSLAB[B]	0.1880647	0.192259	0.98	0.3337
LTMSLAB[D]	0.1307657	0.186092	0.70	0.4862
LTMSLAB[E]	0.1448509	0.360896	0.40	0.6902

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	6.8705754	9.0465	0.0006*
LTMSLAB	4	4	1.7884626	1.1774	0.3349

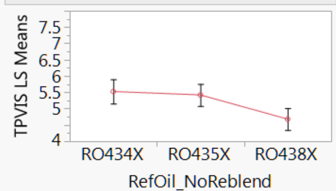
RefOil_NoReblend

Leverage Plot

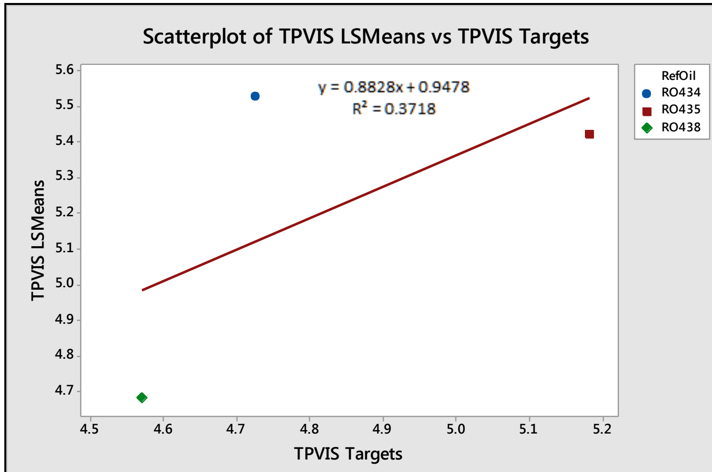
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	5.5270786	0.18532601	5.49121
RO435X	5.4205273	0.16839049	5.43769
RO438X	4.6799224	0.16596992	4.68208

LS Means Plot



LTMSLAB



RefOil	TPVIS Targets	TPVIS LSMeans
RO434	4.7269	5.527
RO435	5.1838	5.4205
RO438	4.5706	4.68

Is a correction factor warranted? If so, what kind?

- TPVIS LSMeans for piston sizes 9-10 are significantly higher than piston sizes 5-6. A correction factor could be created for this piston size grouping.

Response TPVIS

Whole Model

Effect Summary

Actual by Predicted Plot

Summary of Fit

RSquare	0.352451
RSquare Adj	0.329269
Root Mean Square Error	0.462749
Mean of Response	4.88482
Observations (or Sum Wgts)	435

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	15	48.83499	3.25567	15.2037
Error	419	89.72326	0.21414	Prob > F
C. Total	434	138.55825		<.0001*

Lack Of Fit

Source	DF	Sum of Squares	Mean Square	F Ratio
Lack Of Fit	93	25.315403	0.272209	1.3778
Pure Error	326	64.407855	0.197570	Prob > F
Total Error	419	89.723258		0.0221*
				Max RSq
				0.5352

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
LTMSLAB	5	5	1.560695	1.4577	0.2026
PISTSIZE	4	4	2.737453	3.1959	0.0133*
RefOil	6	6	40.777039	31.7376	<.0001*

Residual by Predicted Plot

LTMSLAB

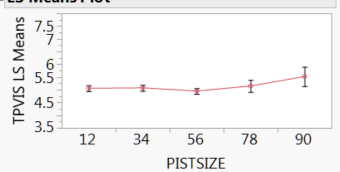
PISTSIZE

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
12	5.0589920	0.05899114	4.87652
34	5.0756423	0.06008406	4.93115
56	4.9510266	0.05775599	4.78533
78	5.1480862	0.12077542	5.16012
90	5.5214224	0.19394245	5.65200

LS Means Plot



LSMeans Differences Tukey HSD

α= 0.050 Q= 2.73971

LSMean[j]

LSMean[i]	Mean[i]-Mean[j] / Std Err Dif / Lower CL Dif / Upper CL Dif	12	34	56	78	90
12	Mean[i]-Mean[j]	0	-0.0167	0.10797	-0.0891	-0.4624
	Std Err Dif	0	0.05677	0.0557	0.12567	0.19978
	Lower CL Dif	0	-0.1722	-0.0446	-0.4334	-1.0098
	Upper CL Dif	0	0.13889	0.26057	0.25522	0.08492
34	Mean[i]-Mean[j]	0.01665	0	0.12462	-0.0724	-0.4458
	Std Err Dif	0.05677	0	0.05731	0.12589	0.19926
	Lower CL Dif	-0.1389	0	-0.0324	-0.4174	-0.9917
	Upper CL Dif	0.17219	0	0.28163	0.27247	0.10013
56	Mean[i]-Mean[j]	-0.108	-0.1246	0	-0.1971	-0.5704
	Std Err Dif	0.0557	0.05731	0	0.12506	0.19882
	Lower CL Dif	-0.2606	-0.2816	0	-0.5397	-1.1151
	Upper CL Dif	0.04464	0.03239	0	0.14558	-0.0257

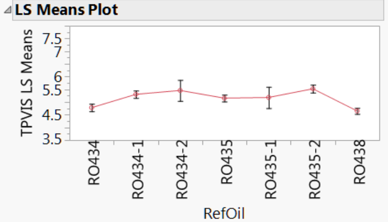
RefOil

Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434	4.7812561	0.07413796	4.67590
RO434-1	5.3056349	0.07302670	5.20721
RO434-2	5.4580505	0.21023648	5.47578
RO435	5.1546281	0.06785922	5.04748
RO435-1	5.1827181	0.21334616	5.05362
RO435-2	5.5236198	0.07936214	5.45138
RO438	4.6513298	0.05961752	4.54609

LS Means Plot



Is a correction factor warranted? If so, what kind?

- How does WPD severity differ from the target values?
  - LSMean summary below for WPD with LTMS data dates ≥ 01/01/14
  - Relationship between WPD targets and LSMeans suggests a linear trend could be used as a correction factor.

Response WPD

Whole Model

Actual by Predicted Plot

Summary of Fit

RSquare	0.556915
RSquare Adj	0.492074
Root Mean Square Error	0.416196
Mean of Response	3.461875
Observations (or Sum Wgts)	48

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	6	8.926535	1.48776	8.5889
Error	41	7.101997	0.17322	Prob > F
C. Total	47	16.028531		<.0001*

Lack Of Fit

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
RefOil_NoReblend	2	2	5.9792217	17.2591	<.0001*
LTMSLAB	4	4	3.2082246	4.6303	0.0035*

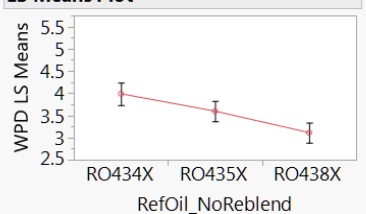
RefOil_NoReblend

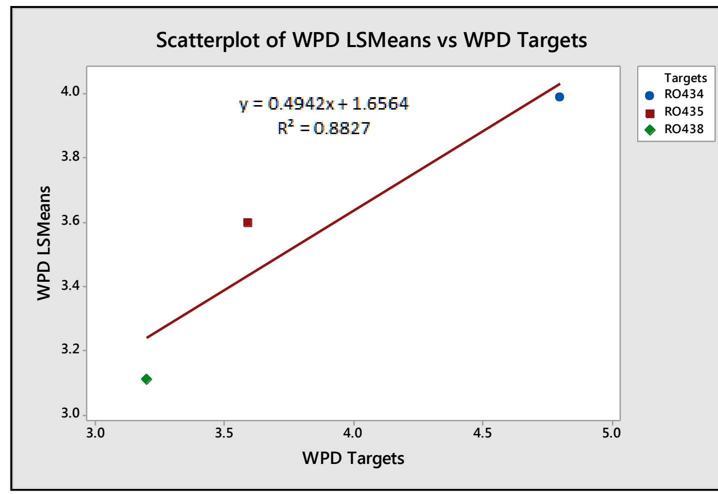
Leverage Plot

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
RO434X	3.9881717	0.12516774	3.87733
RO435X	3.5966902	0.11372963	3.52375
RO438X	3.1124582	0.11209480	3.03706

LS Means Plot





RefOil	WPD Targets	WPD LSMeans
RO434	4.80	3.99
RO435	3.59	3.60
RO438	3.20	3.11

Is a correction factor warranted? If so, what kind?

- Conclusions / Highlights:
  - Relationship between TPVIS LSMeans and Targets is not a constant or linear. As such, it may be difficult to develop a suitable linear/constant correction factor with this approach.
  - It may be possible to based a TPVIS correction approach which is based on the difference in LSMeans for piston sizes 9-10.
    - With current data set, it may be difficult to ascertain that the severity shift is due to piston sizes exclusively - because there have been other hardware changes, reference oil blend changes, a potential time related shift, and a potential blow-by effect.
  - Difference between WPD LSMeans and Targets tends to be linear. With this data, it is technically feasible to develop a linear correction factor.

Is the Pooled S we currently use for severity adjustments still appropriate?

Is the Pooled S we currently use for severity adjustments still appropriate?

- Relative magnitude of the pooled standard deviations have changed over time for the TPVIS and WPD parameter

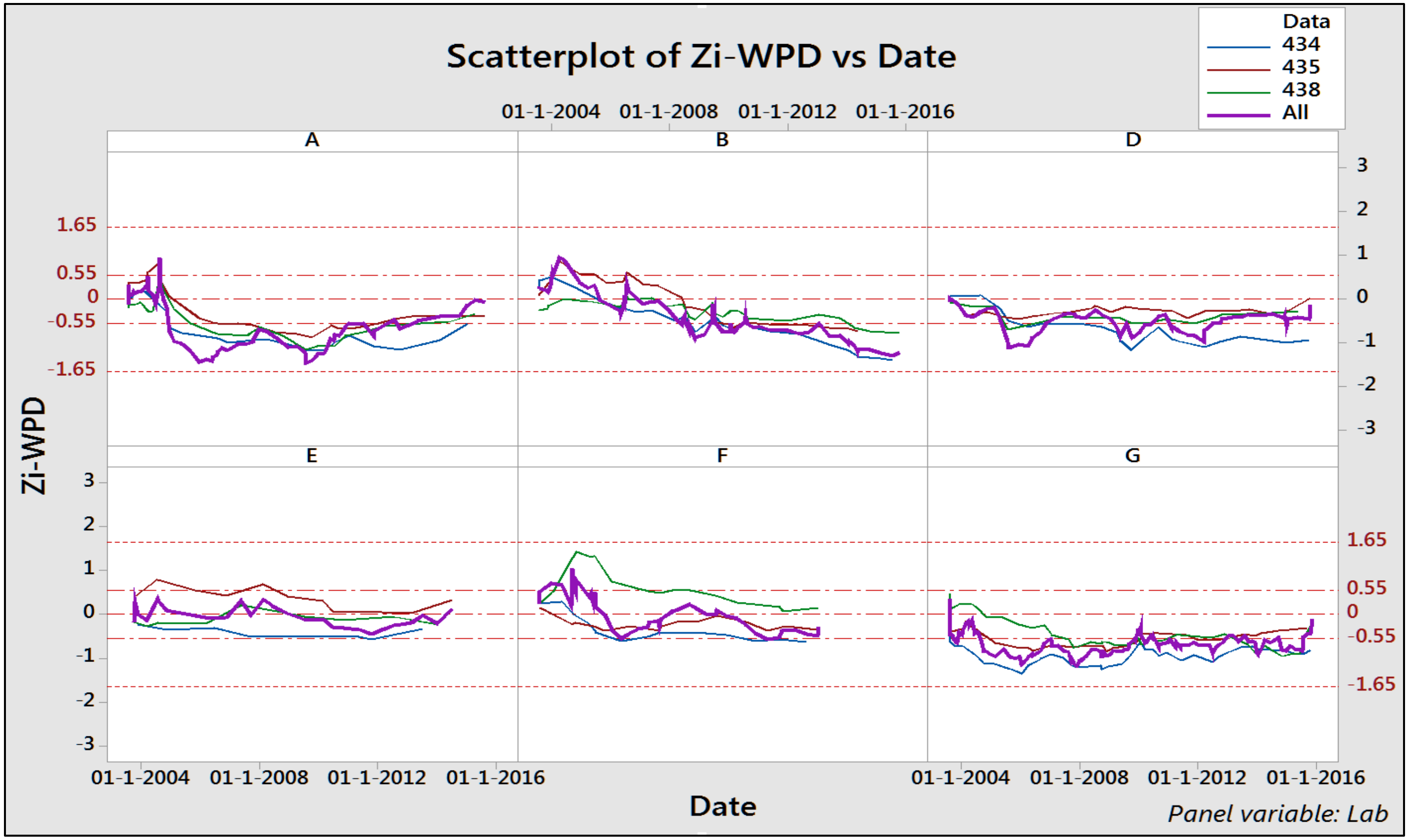
RefOil	S_p (Targets)	S_p (All Data)	S_p (Date>01/01/14)
TPVIS	0.2919	0.4675	0.624
WPD	0.6000	0.5208	0.412
Sample Size		435	48

- Changes to S_p will affect severity adjustment corrections
  - Increases in the actual S_p will under correct candidate test results
  - Decreases in the actual S_p will over correct candidate test results

Consider adopting Continuous SAs?

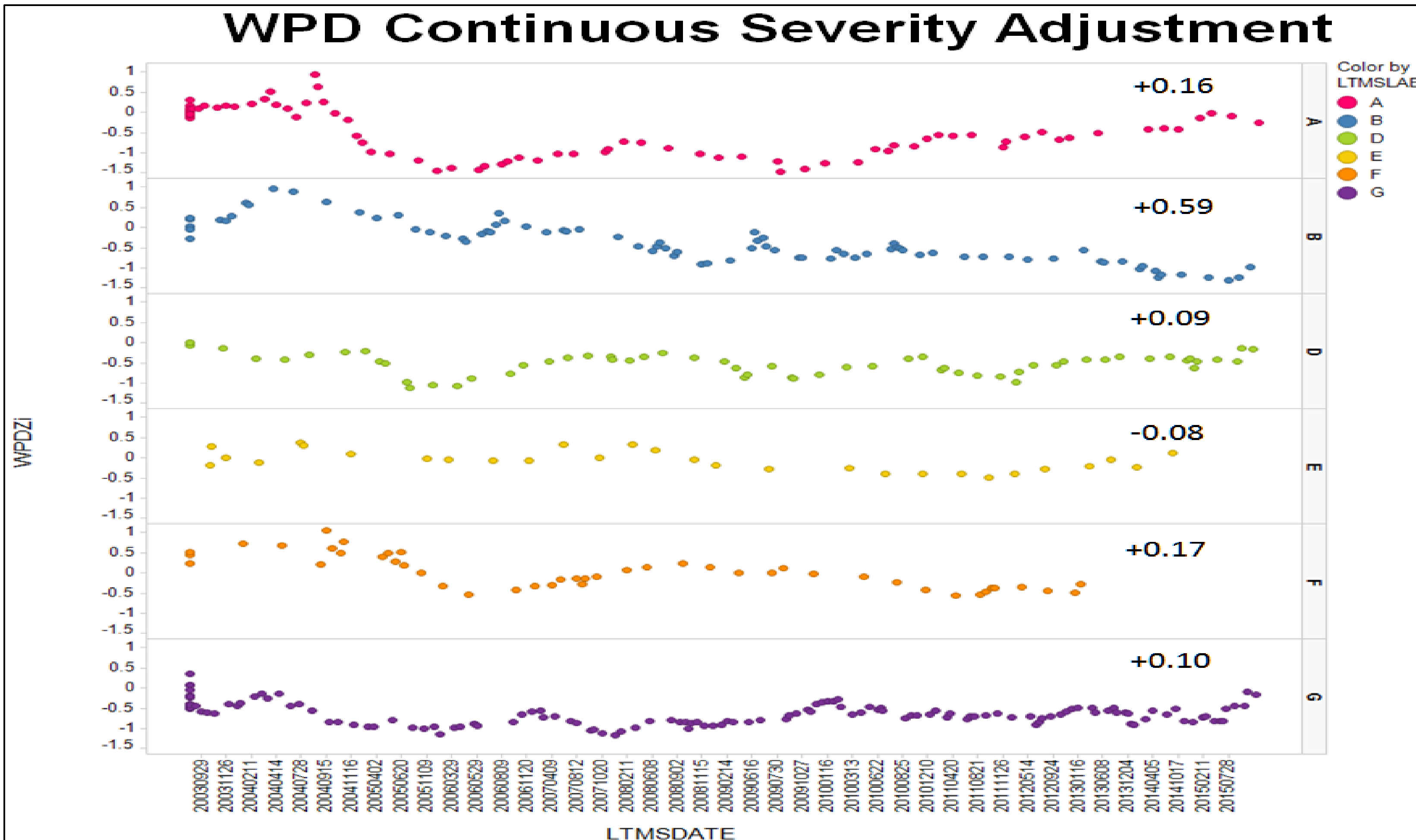
Consider adopting Continuous SAs?

- WPD parameter is currently running severe of target. Only 1 of the 4 calibrated labs (A, B, D, & G) have a severity adjustment.



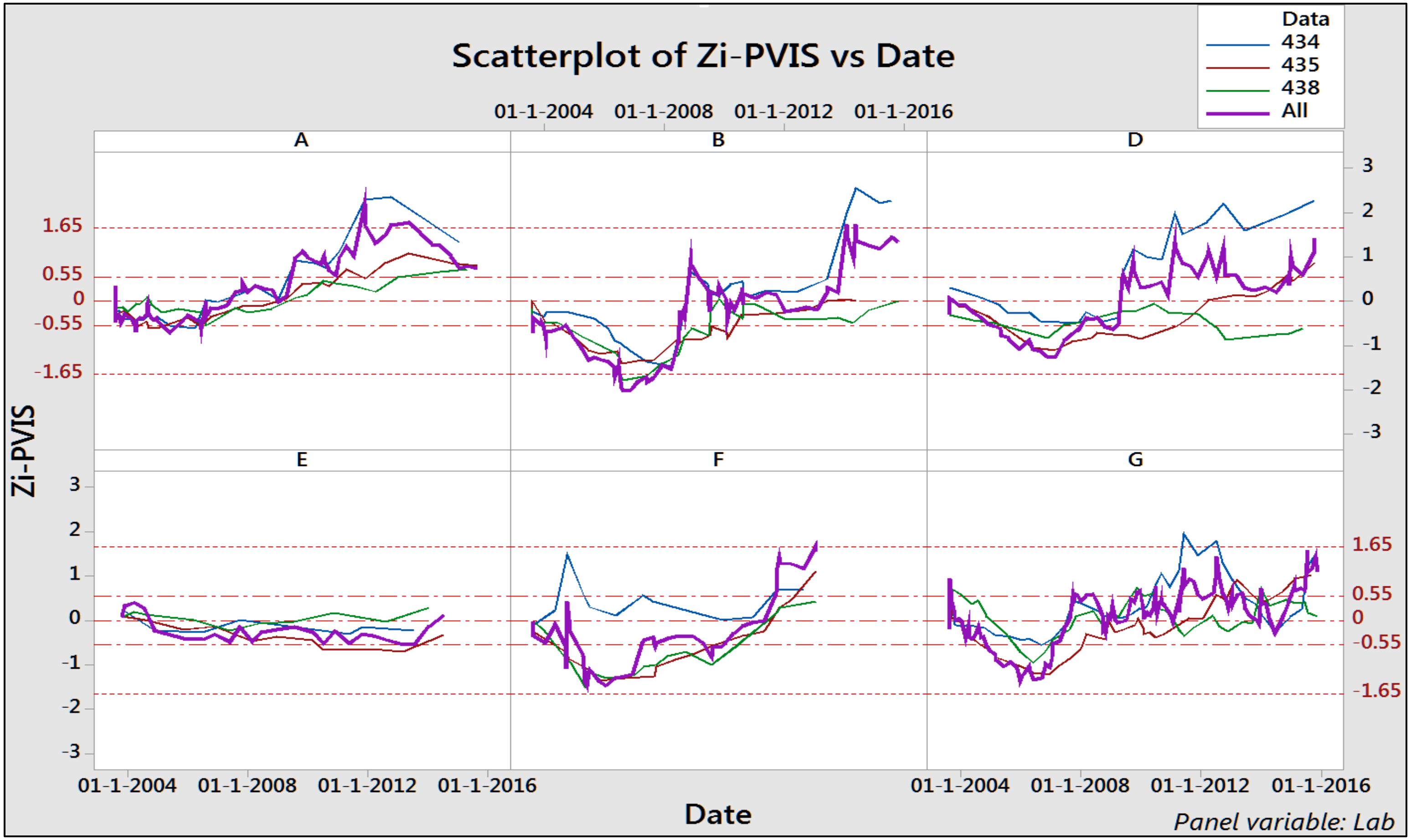
Consider adopting Continuous SAs?

- Summary by lab if continuous (WPD) SAs were adopted across all labs



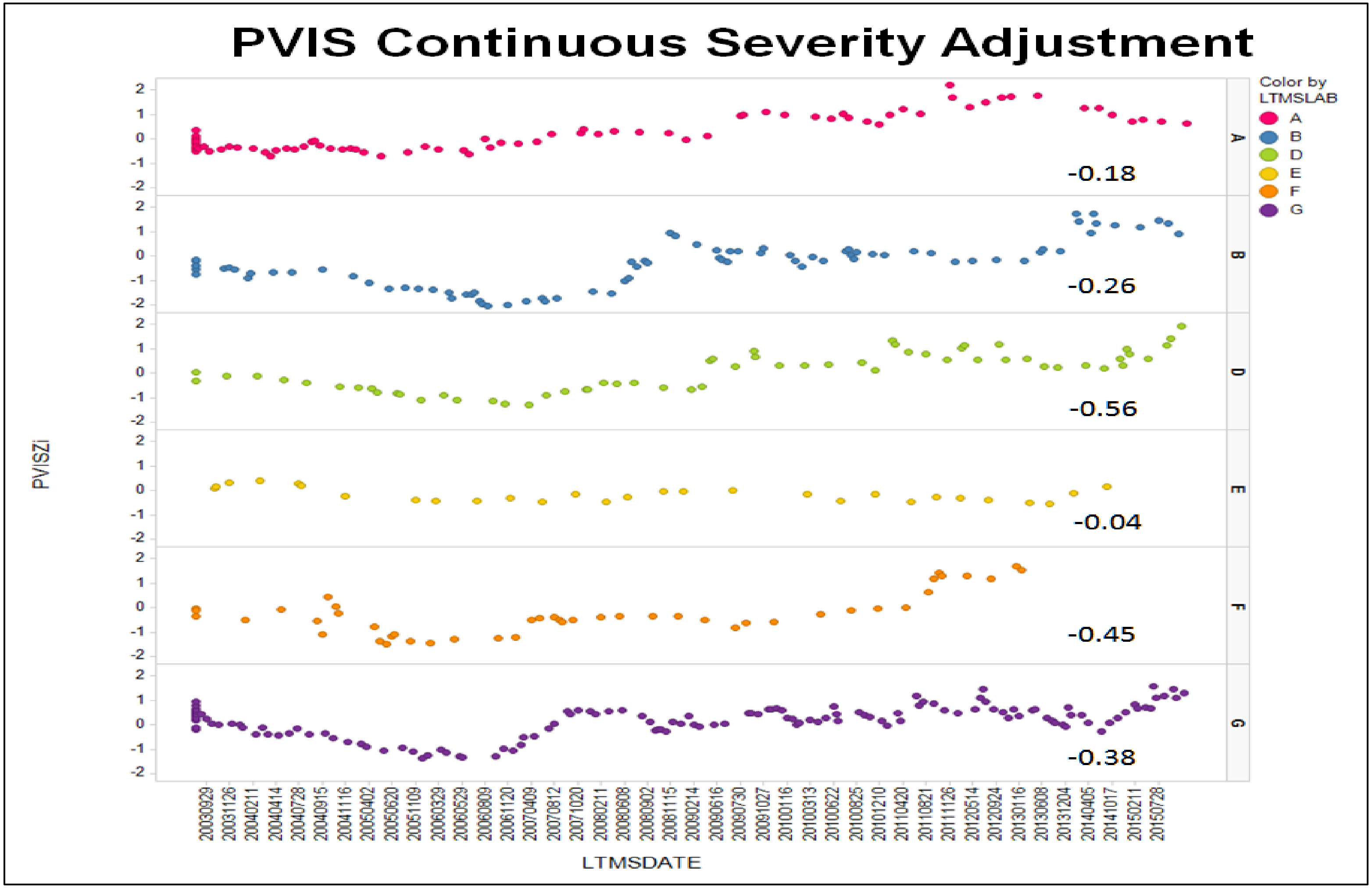
Consider adopting Continuous SAs?

- PVIS parameter is currently running severe of target. All 4 of the calibrated labs (A, B, D,& G) have a severity adjustment.



Consider adopting Continuous SAs?

- Summary by lab if continuous (PVIS) SAs were adopted across all labs



Consider adopting Continuous SAs?

- Conclusions / Highlights:
  - Data suggests that WPD parameter is running severe of target. Yet, only 1 of the 4 labs have a severity adjustment. Continuous SAs would provide some benefit to the labs – for those who do not currently have an SA.
  - All 4 of the calibrated labs have a PVIS severity adjustment. As such, adopting a continuous SAs would have no impact on the PVIS parameter.
  - Continuous SAs are a way to bring labs to parity and ensure equitable assessment of candidate oils across the industry. There is general consensus among the industry statisticians to implement continuous SAs where applicable.

Seq IIIH crankcase ventilation system standardization

3/4/2016

Objectives

The presumption is that the primary consideration is how the design impacts oil consumption.

The objective is therefore to standardize the configuration of the blowby ventilation system such that there is consistency in:

A. The balance of flow between left and right sides
B. The amount of oil trapped in the system
C. The tendency of the oil to coalesce and drain back, or escape the system

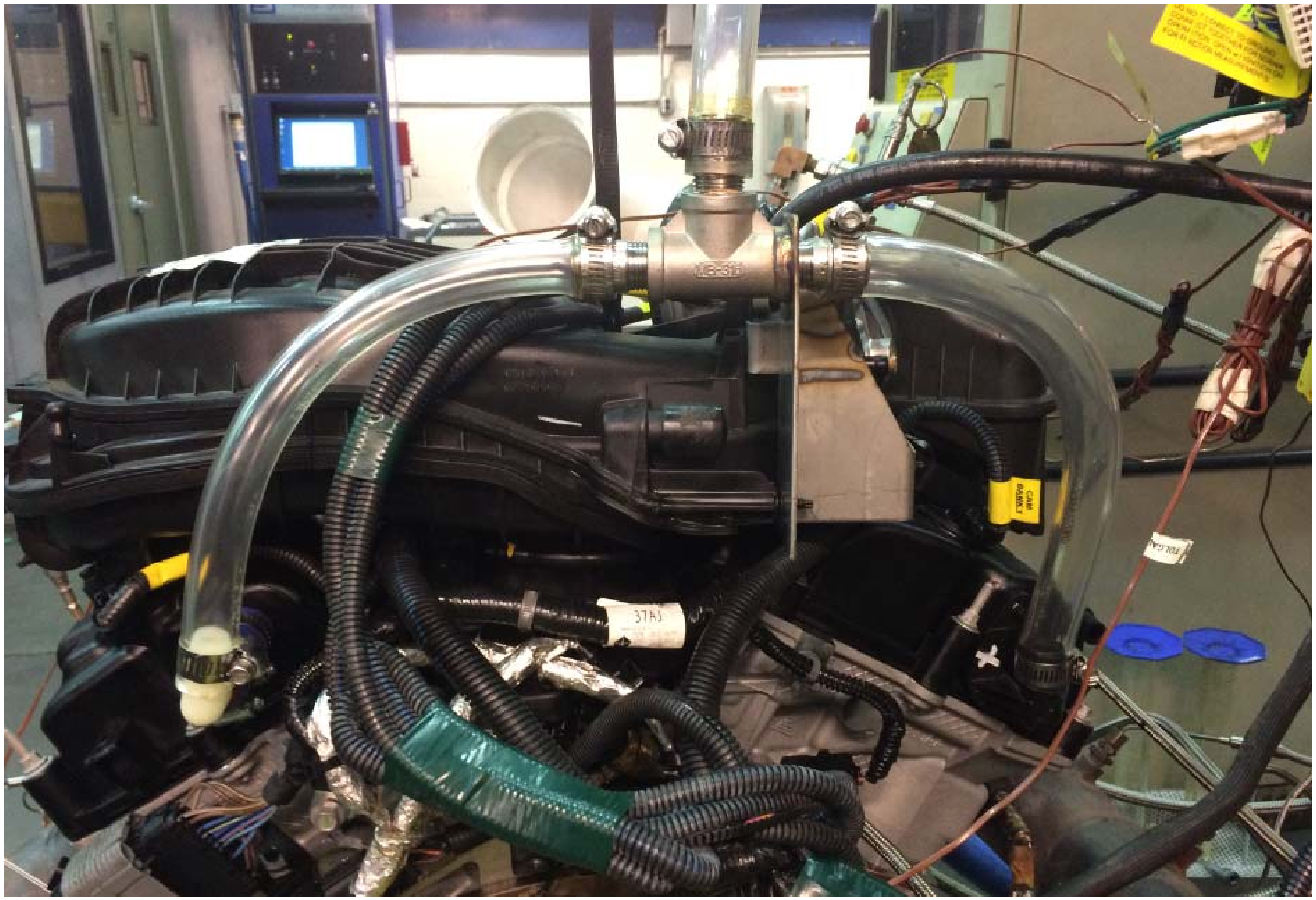
Practical considerations

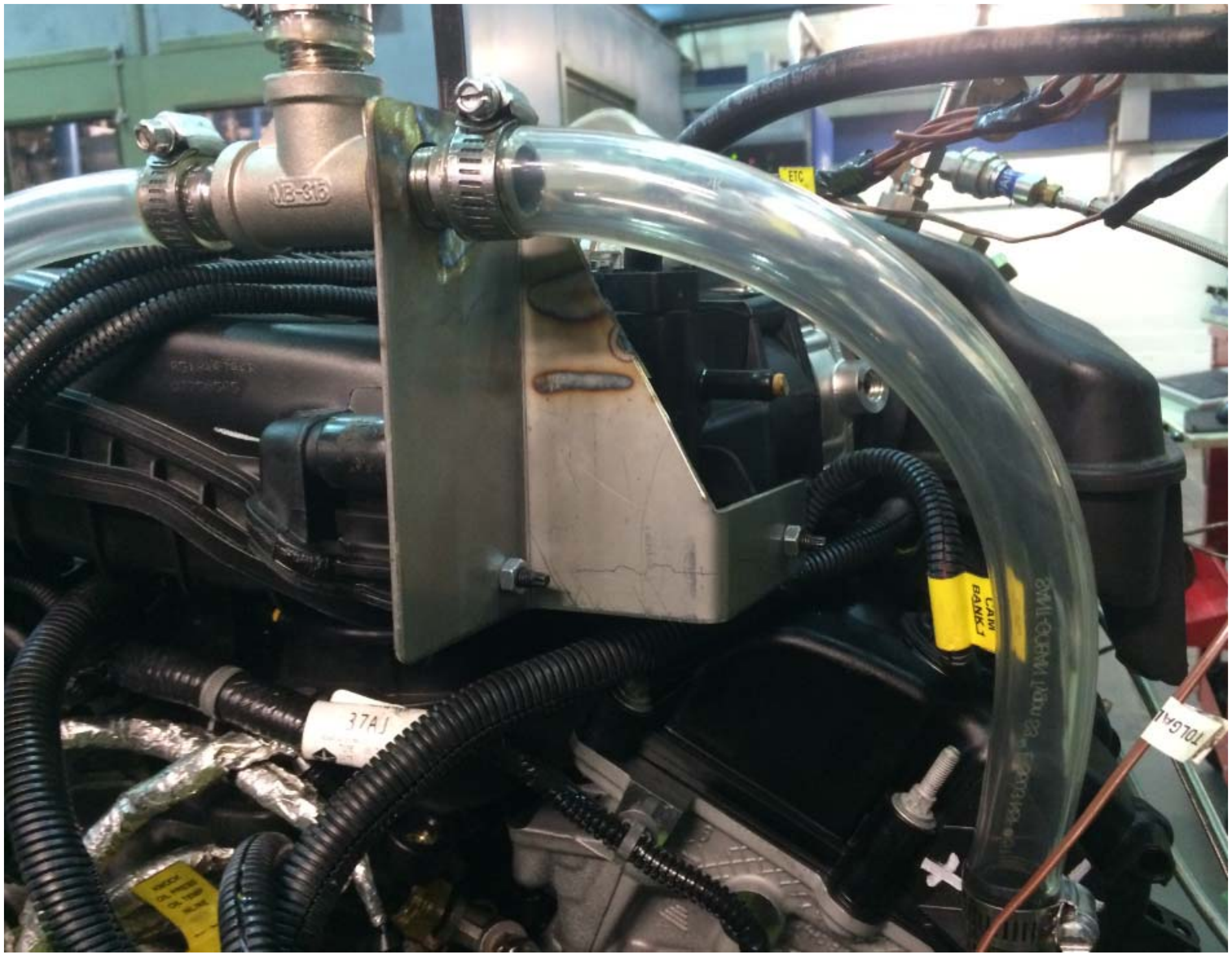
- Hose material that’s suitable for the application (temperature and oil resistance)
- Robust, positive connections that won’t leak or become disconnected
- Easily cleaned and maintained
- Cost effective to manufacture

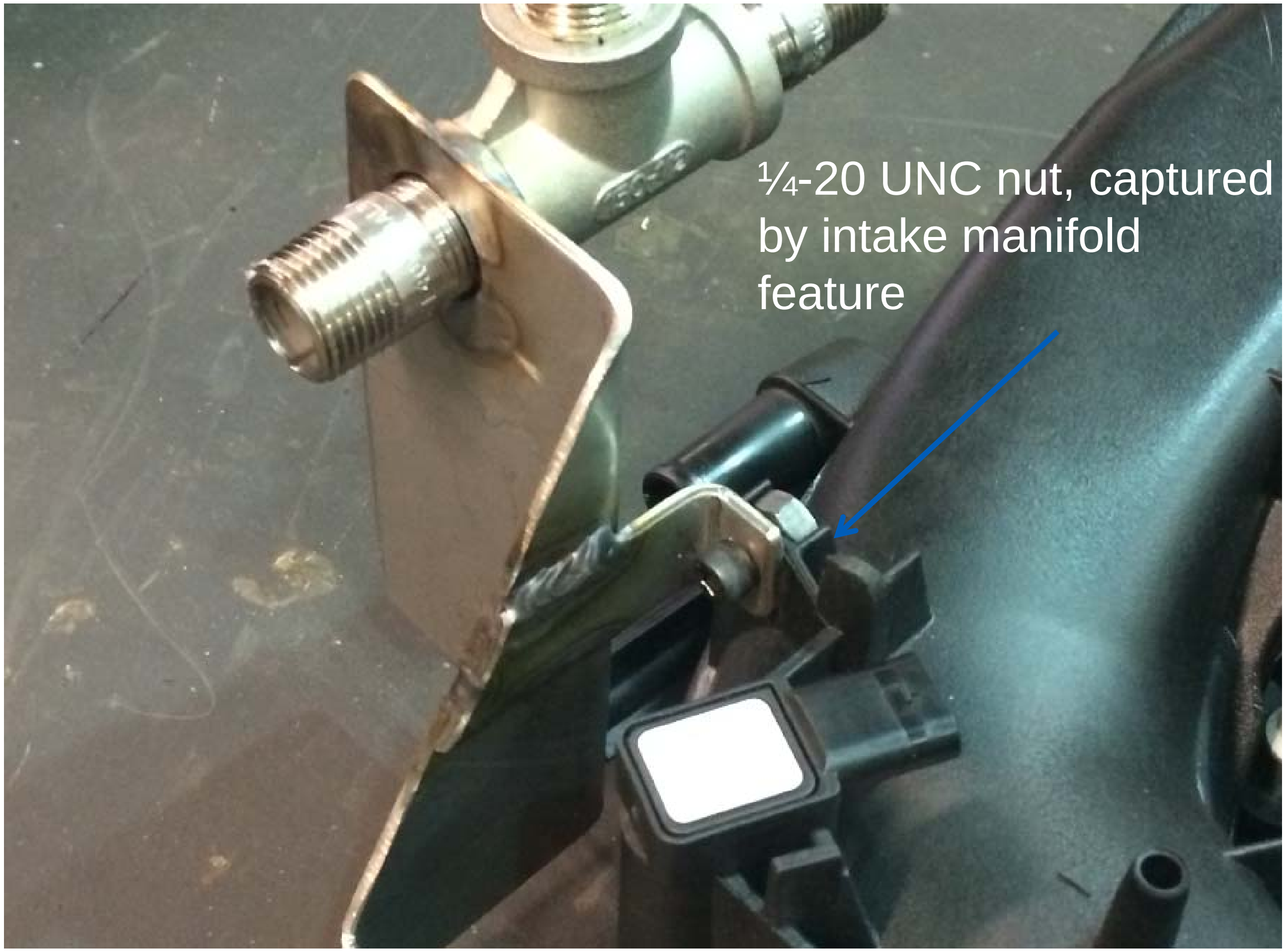
Secondary considerations

- The temperature of the oil / vapor mixture in the hoses might impact tendency of oil to coalesce
  - Standardized hose material
  - No insulation on hose
- Total restriction of the system, and thus the resulting crankcase pressure
  - Although testing has shown that the impact may be negligible on oil consumption, and minimum and maximum pressure should be set
  - This can be impacted by
    - Downstream hose length
    - Downstream hardware (3-way valve, JTEC, etc)
    - Vacuum draw from Aercology system

Support bracket (shown with non-reinforced hoses)



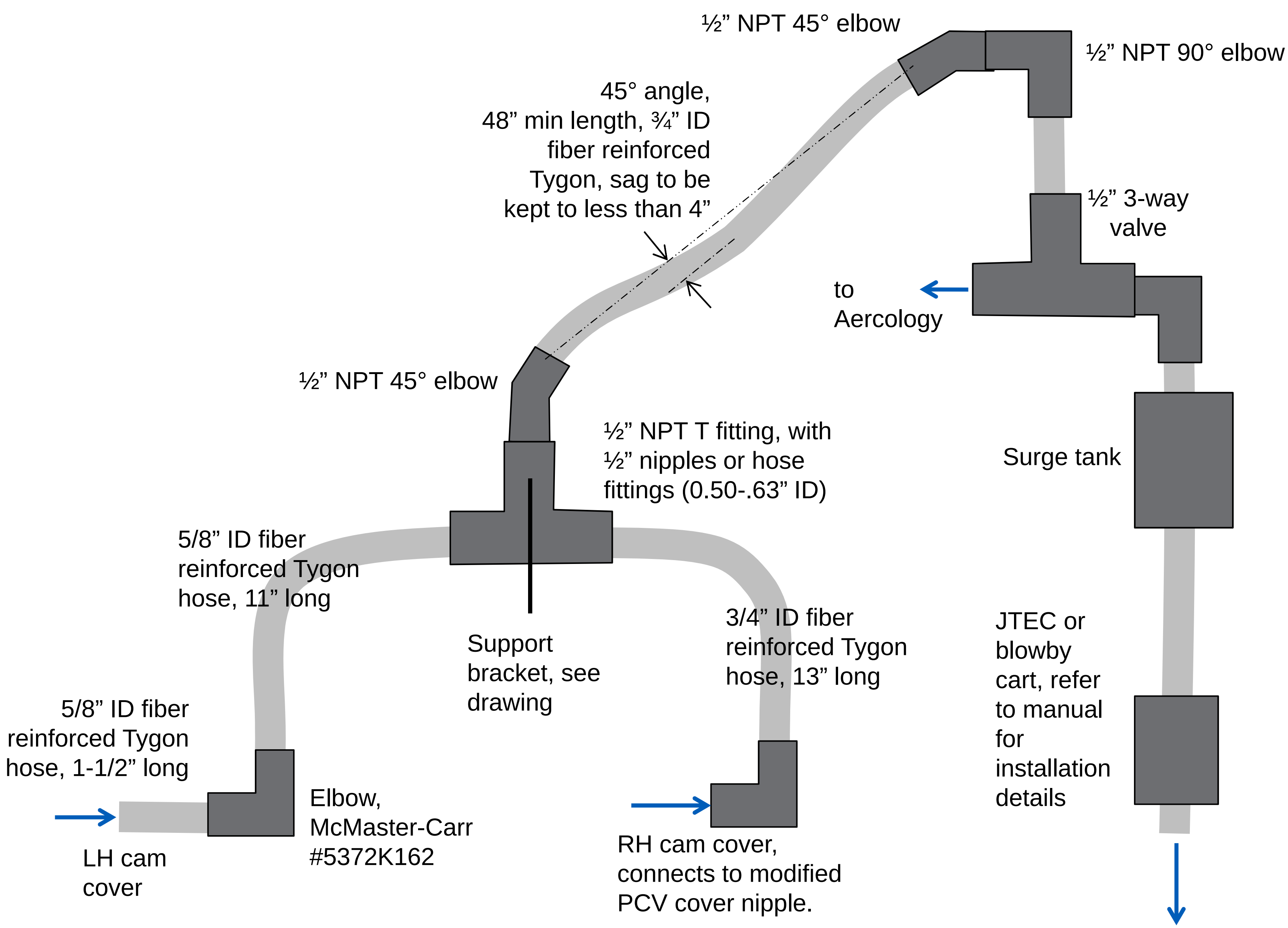



¼-20 UNC nut, captured
by intake manifold
feature

Design summary

- 5/8” ID x 11” long “Tygon” hose on LH
  - To match elbow and nipple size
- 3/4“ ID x 13” long “Tygon” hose on RH
  - To match PCV separator nipple size
- ½” NPT stainless steel “T” (0.50” ID)
- ½” NPT barbs or machined close nipples to accept the hoses
- ¾” hose from T going 45° vertically, with no droops or horizontal runs
- Installation of 3-way valve optional

Figure xx Chrysler IIIH Crankcase Ventilation



Correction factor

To standardize the measured LPM flow, two measures are required:

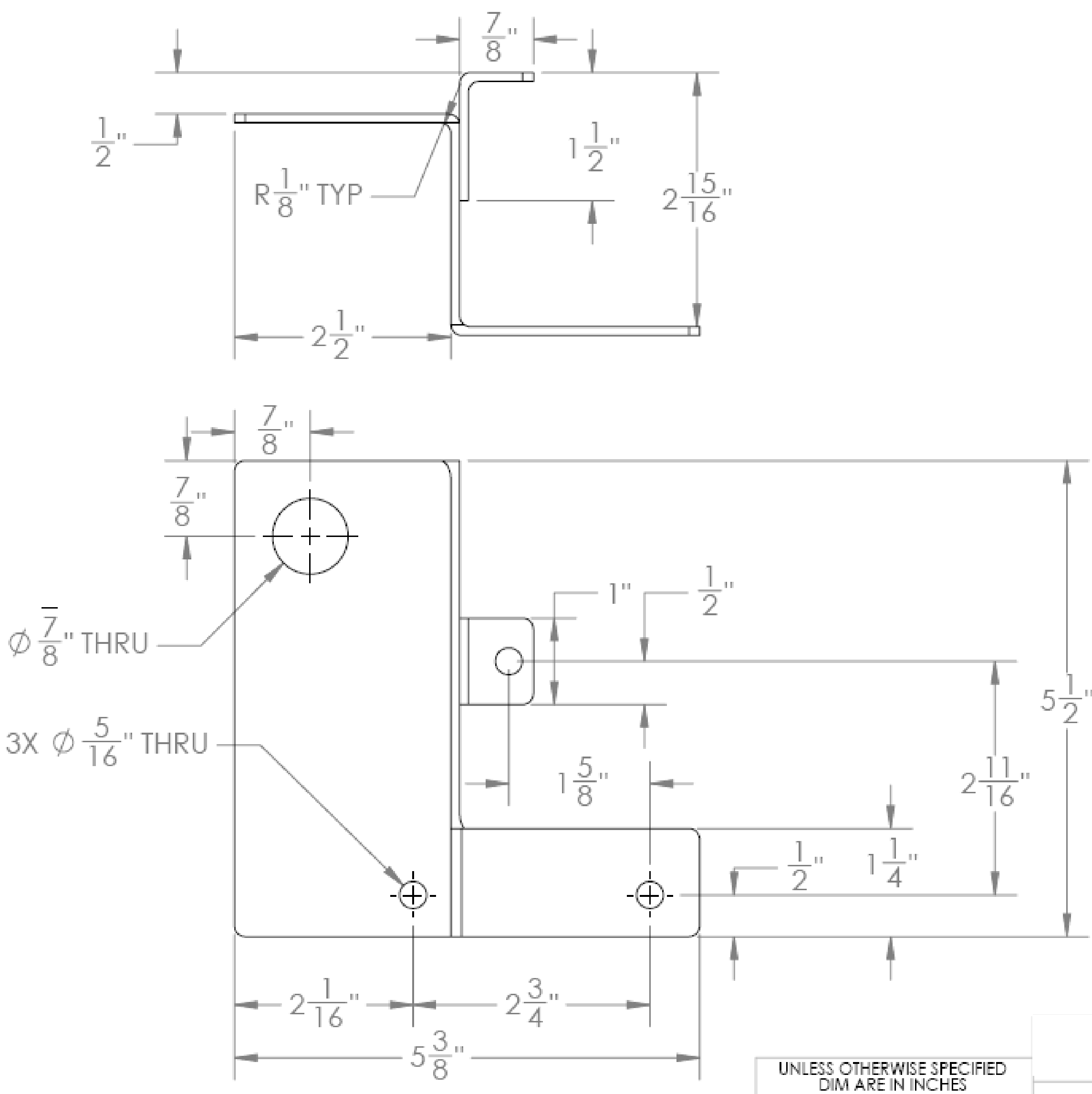
Blowby gas temp (TC installed just prior to the JTEC)
Absolute pressure at meter (gauge pressure measurement prior to the JTEC + local barometric pressure)

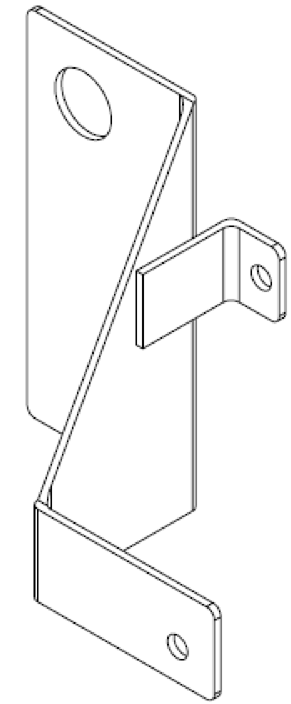
The correction factor is already in many ASTM procedures (and GMOD) for correcting sharp edge orifice flow, and is actually missing from the IIIH draft procedure –

Record the uncorrected blowby flow rate in liters per minute and correct it for an atmospheric pressure of 100 kPa and a temperature of 37.8 °C.
Use the following equation to correct the blowby flow rate:

CF=(3.1002*P/(273.15+T))^0.5

where:
CF = corrected blowby flow rate, L/min,
P = blowby pressure, kPa, absolute
T = temperature, °C





DATE	REVISION

UNLESS OTHERWISE SPECIFIED
DIM ARE IN INCHES
TOL ON ANGLE ±.10°
.XX ±.010 .XXX ±.005
FRACTIONAL± 1/32
INTERPRET DIM AND TOL PER ASME
Y14.5M-1994 GENERAL TOL LAW
ISO 2768 - c L

THIRD ANGLE PROJECTION

CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

MATERIAL
10GA STAINLESS STEEL

FINISH

NEXT ASSY

TITLE:
BRACKET, 3H BLOWBY

SIZE	DWG. NO.	REV
A	100133	

SCALE: 1:2 WEIGHT: SHEET 1 OF 1

5 4 3 2 1

JTEC Installation

J-TEC Model VF563AA Setup and Maintenance

INSTALLATION INSTRUCTIONS

The J-TEC Model VF563AA flow meter should be installed with a minimum of 20 pipe diameters of straight pipe upstream and 10 pipe diameters downstream from the flow meter. For example, a one-inch tube or hose should have 20 inches of straight length immediately before the flow meter inlet tube. This condition provides a more symmetrical flow profile, which is necessary to obtain accurate and repeatable results.

A typical connection to the flow meter is made by placing flexible hose onto the outside of the inlet tube and outlet tube.

Install the flow meter vertical with flow into the top and out the bottom to encourage liquids to drain out of the flow meter.

Install a CCV6000 filter canister (or buffer chamber) in the pipe between the crankcase and the flow meter to minimize the effect of pulsating flows, and collect oil and water droplets to keep the flow meter cleaner.

A typical J-TEC Model VF563AA flow meter and CCV6000 filter canister with three-way valve is shown below in Figure B:

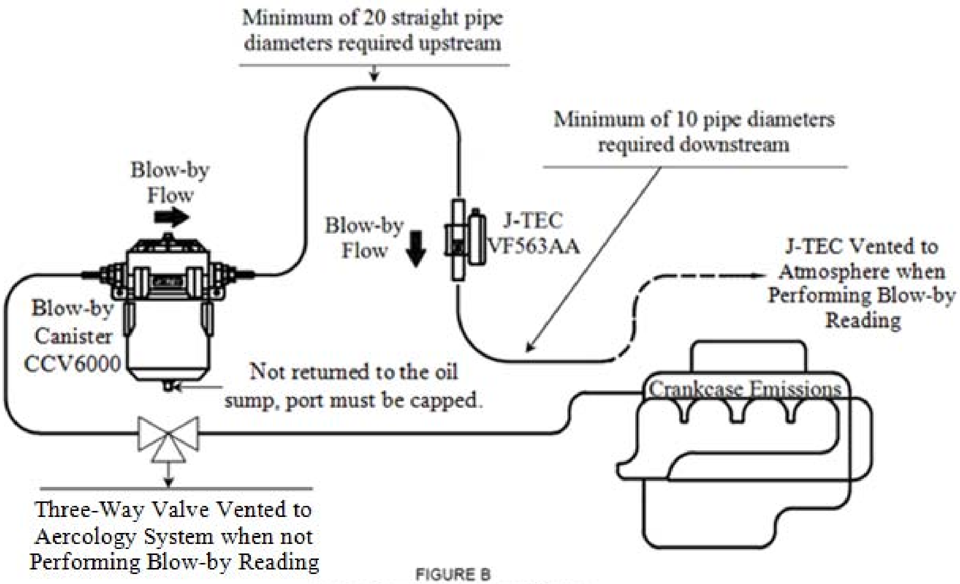


FIGURE B
Engine Blow-By Measurement System

CLEANING AND MAINTENANCE

The inside of the flow tube and strut must be kept clean. This cleaning procedure is to be completed prior to every test start.

To clean the flow tube and strut, gently brush the inside of the tube with a soft brush or cotton swab. A solvent cleaner, such as a brake parts cleaner that degreases and leaves no residue, may be used to loosen deposits. Ensure the solvent is compatible with aluminum, viton, and Teflon.

DO NOT use wire brushes or use high-pressure liquids. These may cause damage to the transducers.