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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

Originally Issued: November 16, 2015

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Unapproved Minutes of the Seq. III Surveillance Panel held on October 29, 2015
Sequence III Surveillance Panel Meeting held in Southfield, MI

Agenda **(Attachment 1)**

Membership / Attendance **(Attachment 2)**

Gordon Farnsworth, Jerry Brys, Andy Ritchie and Matt Bowden are on conference call.

The following voting membership changes have been recorded:

Cliff Salvesen will be replacing Mark Mosher
Addison Schweitzer will be replacing Charlie Leverette
Marty Heimrich will be replacing Pat Lang
Dan Lanctot will be replacing Zack Bishop

Jason Bowden-Secretary
Bill Buscher-Motion and Action Items Recorder

Chairman's Comments were provided by Dave Glaenzer

There have been a few items resolved by e-ballot since our last meeting.

- Sequence IIIF TCR form change has been approved.
- Sequence IIIGB LTMS has been updated.
- Sequence IIIF/IIIG Build manual has been updated for size 7 & 8 pistons/rings.
- Alternate chemical for use in Ultra-Sonic parts cleaner approved. **(Attachment 3)**

Approval of Prior Minutes

06/02/2015, San Antonio, TX.

08/24/2015 Teleconference

Motion: Jason Bowden / Rich Grundza- Motion passed unanimous.

Previous Action Item Review

The following previous action item was open: GM Performance to provide an update on the availability of non-modified heads in inventory. Additionally, they will try to determine if they will be able to install new seats in used heads.

GM Performance notified the Seq. III Surveillance Panel that they will not accept used heads for valve seat replacement. This item is closed.

They have also ordered 1,200 additional connecting rods.

All previous action items are closed.

Old Business

Equivalency of IIIF/IIIG results when using size 7 & 8 pistons/rings as compared to all other sizes. Sizes 9 & 10 have been approved for use in IIIF/IIIG. The stats group will be reviewing this as additional reference data is generated.

Part # 17120601 fuel injectors for Sequence IIIF/IIIG tests
Bruce Matthews reported that the current fuel injectors are no longer available and cannot be purchased. There is a cleaning procedure that worked on the current injector that stopped the dripping and made the spray pattern better. Labs estimated that we need an additional 200 injectors to meet the end of the IIIG. All labs currently flow the injectors. The same rig that is used for flow checking current injectors can be used for cleaning injectors. Ron Romano stated that in the Seq. VG they tried to look at a large quantity of aftermarket injectors and there were large differences and batch variability in the aftermarket material. He recommended that we conduct a very thorough review of the current flow procedure against the manufactures spec for the fuel injectors.

Review of remaining critical hardware for Sequence III tests.
Dave Glaenzer reviewed the latest industry inventory summary. **(Attachment 4)**

Labs obtain 2-3 uses out of he heads and are saving them as well.
Summary of prior period testing was provided:
38 ACC IIF
164 IIIG ACC
202 Total tests in prior period.
Total of approximately 436 each tests per year would give us 8-10 months' worth of remaining hardware.

New Business
Update on IIIH Precision Matrix provided by Karin Haumann **(Attachment 5)**

The two outstanding tests are complete, Lab E and Lab G reran oil 436.

Joe Martinez Presented the Seq. IIIH Precision Matrix Results **(Attachment 6)**

There have been 26 out of 28 tests validated from the matrix. The two additional 436 tests have not been included in this analysis. Joe provided the summary and supporting data for the matrix tests. With regards to PVIS, the data shows statistically significant differences for both lab and stand affect. Lab D is significantly lower than lab A and E. Stand A2 is significantly lower than stand A1 and stand G1 is significantly lower than stand G2. One result from Lab D is influential on the 434-2 PVIS data. Oil 434-2 and oil 438 shown a larger range on PVIS than oil 436.

IIIH PVIS precision, based upon the Seq. III Precision, is 150%-689% for IIIH and 150%-337% for IIIG. The 150% is an arbitrary number that was selected. If the number turns out to be lower the range will decrease as well.

With regards to WPD, the oils discriminate and there are no lab or stand differences.

MRV shows oil 436 is significantly lower than 434-2, 438-1 is significantly lower than 434-2. There are statistically significant lab differences for MRV. Lab D is significantly lower than A, E and G. There are significant stand differences, as stand A2 is lower than stand A1.

Phosphorus retention shows that oil 436 is significantly higher than oil 438-1 and 434-2. There are no significant differences between labs or stands. There is also a correlation between PVIS and MRV.

Based upon the current matrix data, Joe recommends a stand based LTMS as being appropriate for the Seq. IIIH, but the last two results need to be included and the stats group needs to talk more about this topic.

Joe presented the calculated targets for IIIH based off of the matrix data. She also presented concerns based off of this data.

-PVIS Concern1 (slide 43) - Labs do not Discriminate the same for PVIS. Lab D and Lab B do not discriminate the same as Labs A, E and G at this time.
-PVIS Concern2 (slide 44)- If 434-2 is meant to be a failing oil, then will PVIS and/or MRV be adequate parameters to ensure failing oil won't pass and passing oil won't fail? Is the test severe enough to ensure that poor oils do not pass?

Ron Romano asked if the labs have looked at this data to determine why the PVIS is so different. The task force has looked at operational data and believe that at least the stand to stand difference could be influenced by the variability of 438-1. Oil pressure dips with viscosity. Bob Campbell stated there is a concern as well that we may not be using the correct metric to look at oxidation. Kevin O'Malley stated that we need to be measuring %PVIS at increased intervals in order to capture the change. Chrysler and Oronite stated that oil 438-1 was only added to the matrix to show discrimination on WPD only. Bob C. commented that oil 438-1 is the most well behaved oil in the IIIG and concerned with this data because it may be very real and allow candidates to pass that should not. Teri Kowalski is concerned as well with regards to this problem. She is concerned that once limits are applied based off of this matrix data, candidates that should not pass may pass.

Karin Haumann asked if Phosphorus retention can be reviewed. Jim Linden said that this does not have any correlation with oxidation, so we should not be discussing this. Ron Romano agreed that we should focus on PVIS.

Dave Glaenzer asked Joe if a different transformation would help this situation. Joe M. stated that the Ln transformation is the most suitable for this. Dave G. commented that there is something fundamentally wrong with allowing labs to run in the range that this data shows. Bob Campbell commented that here is a passing result from Lab D when the oil broke. This should not happen. Teri K. and Ron R. agree.

Bob Campbell asked for the group to look at the oxidation data and determine if there is a different parameter we should be looking at that does not show the dip in viscosity.

Ron R. commented that we had a large data range for 434 in the matrix. If we use the data as presented, we will have to set the PVIS limit very low in order to protect the industry. Haiying Tang stated that we have good repeatability and reproducibility. Ron R. disagreed, stating that if you look at these charts, there is not good repeatability or reproducibility and the AOAP will never accept the low limit that ILSAC would have to put in place for PVIS.

Action Item 1- Precision matrix labs to provide the FTIR peak height oxidation and nitration data from all Sequence IIIH precision matrix tests, and all oil samples (i.e. 80 hours, 90 hours…) to the Sequence IIIH Task Force and the industry statisticians group.

Karin-we looked at hours to PVIS in the spring, but there was not a model that fit. It may not be as easy to take the same methodology as the diesel because the specter is different. We also need to make sure the processes are standardized at the labs. Bob C. informed the group that the T13 looks at the EOT oxidation and they did increase the sample frequency at the end of these to make sure they are seeing the correct curve. Pat Lang mentioned that we need to look at the nitration as well as oxidation because it is a pretty good predictor on the IIIG as it will change about 24 hours before oxidation.

Michael Conrad wants to caution about not accepting the test if we do not show any additional data that can tighten precision because we are only trying to replace the IIIG and this has shown relatively the same precision as the IIIG. Ron R. and Teri K. replied that they do not want bad oils passing and good oils failing.

Action Item 2- Sequence IIIH Task Force, along with the industry statisticians group, to evaluate all alternate suggestions for possible replacement for PVIS as the Sequence IIIH oxidation pass/fail parameter. Suggestions include hours to a certain PVIS value, hours to a certain FTIR oxidation and/or nitration value, including both peak height and area under the curve data, an FTIR area under the curve oxidation and/or nitration limit and an FTIR peak height oxidation and/or nitration limit.

Action Item 3- At some point, yet to be determined, the precision matrix labs to provide the FTIR spectra curves to a single lab, yet to be determined, to interpret all FTIR spectra curves the same for peak height and area under the curve.

Action Item 4- A sub-group of the Sequence IIIH Task Force, led by Kevin OMalley to closely evaluate all data from the precision matrix tests which produced influential observations to see if anything can be learned about influences on the test results.

CPD Report

Jason Bowden from OH Technologies, Inc presented the CPD Report **(Attachment 7)** and commented that the wrist pin supply is at approximately 150 each engine sets. The labs should be retaining this inventory.

TMC Report

Rich Grundza from Test Monitoring Center discussed the TMC Report for the prior period and reported that the IIIF has successfully referenced Run 7 & 8 rings in two labs. Pat Lang asked if there are any trends with the higher runs. Rich commented that there is not enough data to draw any conclusions.

Extending specification for cylinder head reuse:

Addison Schweitzer provided a presentation **(Attachment 8)** with regards to extending the life of the cylinder heads by widening the specifications to obtain additional runs. Intertek recommendation to gain additional uses on the head, increase tolerance for recession from .005” to .010”, allow different stones to be used as well. Modify rebuild manual sections shown in the presentation. E&E was able to remove the Stellite seat material without heat and is able to grind these surfaces. The CPD would handle the grinding of this material. Pat Lang commented that he does not agree with lab grinding seat as they have never done this. He would only recommend that a CPD conduct this. Bruce Matthews is also opposed to having labs grind heads.

A discussion with regards to the injectors also occurred and an action item was formed.

Action Item 5- Afton (Ed Altman) to document a cleaning procedure for the Sequence IIIF/G fuel injectors, which will be reviewed and added to the Sequence IIIF/G engine assembly manuals.

With regards to the cylinder heads, it was determined that further work would need to be required before any motions could be made and approved. Dave Glaenzer would like to determine why we selected .005” as the maximum. Sid Clark stated there was a concern with the combustion chamber volume and you will change the valve stem tip clearance. You would account for the spring load with the shimming, but this would change the valve stem clearance.

Addison commented that the valve stems used in this effort are .010” oversize inserts, but it is not Stellite material. Robert Stockwell recommends that we just increase the valve recession limit at this time before we start replacing seats.

Bruce Matthews commented that there are enough heads to support the testing for GF5, but they are not necessarily at the independent labs. We may have to look at a redistribution of heads.

Action Item 6- Form a Sequence IIIF/G Cylinder Head Reuse Task Force, chaired by Addison Schweitzer.

Action Item 7- Labs to start capturing valve seat width data on Sequence IIIF/G engine builds, using a measurement procedure defined by the Sequence IIIF/G Cylinder Head Reuse Task Force.

Action Item 8- Once data is available, the Sequence IIIF/G Cylinder Head Reuse Task Force will analyze the valve seat width data and make recommendations to the Sequence III Surveillance Panel on revisions to the Sequence IIIF/G engine assembly manuals to allow for additional runs to be obtained on the Stellite seat cylinder heads (P/N 24502260S).

<u>Discussion on use of Sequence IIIH test to replace IIIF & IIIG tests for current and prior categories:</u>
There was limited discussion with regards to this topic, based on the discussion with regards to the IIIH precision matrix data that occurred earlier. There is a presentation showing the Seq. IIIG and IIIH oil discrimination that was also provided to the AOAP **(Attachment 9)**

<u>Sequence IIIG piston ring chamfers</u>
An additional agenda item was added to the agenda at this time. George Szappanos provided a presentation with regards to piston ring chamfers **(Attachment 10)**. George mentioned during his presentation that Lubrizol began measuring piston ring chamfers after they noticed variability with the way they were gapping lab gapped IIIH rings during development of the IIIH. The presentation summarizes observations made at Lubrizol with regards to chamfers on the gap and also a test that was run using a ring package not used in Seq. III testing.

The group inquired as to whether any blowby data was collected and if it would be presented.

Jason Bowden recommended that, in the future, George contact the supplier of this material immediately when there are any questions relating to the products they supply, so that the supplier can help answer any questions they may have prior to the Surveillance Panel meeting.

Jason Bowden also commented that all rings supplied throughout the life of the Seq. III have been manufactured under print tolerances for machining the gap edge due to burs or chips that may occur from the gapping process. These are well established manufacturing tolerances and practices. There is a maximum allowable tolerance to break the gap edge.

Jason Bowden offered to have sample material from the CPD inventory inspected and confirm that the material meets print. He also offered to determine if tolerances can be tightened on the Seq. IIIF and IIIG material.

Action Item 9- OH Technologies will inspect their inventory of Sequence IIIF/G/H piston rings to insure that the ring chamfers are within the current specifications/tolerances.

Action Item 10- OH Technologies will review the ring chamfer specifications/tolerances with their suppliers of the Sequence IIIF/G/H piston rings to see if the specifications/tolerances can be tightened.

The Panel did not review the Scope and Objectives. Motion and Action Items were reviewed. **(Attachment 11)**

Next Meeting will be a conference call the week of November 16^{th}.

Meeting Adjourned

Sequence III Surveillance Panel
October 29, 2015 09:00 EDT
Southfield, MI
Call-in Number is: (712) 432-0927
Participant Passcode: 976140

Agenda

1.0) Attendance

1.1) Any change to voting member status?

2.0) Chairman's Comments

There have been a few items resolved by eballot since our last meeting.

Sequence IIIF TCR form change has been approved.
Sequence IIIGB LTMS has been updated.
Sequence IIIF/IIIG Build manual has been updated for size 7 & 8 pistons/rings.
Alternate chemical for use in Ultra-Sonic parts cleaner approved.

3.0) Approval of minutes

3.1) 06/02/2015, San Antonio, TX.
08/24/2015 Teleconference

4.0) Action Item Review

4.1) 06/24, DLG to contact Thom Smith of PCEOCP to notify him that Karin Haumann is Seq. III SP contact for IIIH equivalency determinations. Done. 06/16/2015.
4.2) 06/24, DLG to contact PCEOCP chair and CLOG for input on what is required to show equivalency. Done. 06/16/2015. New business agenda item.
4.3) GM Performance to provide an update on the availability of non-modified heads in inventory. Additionally, they will try to determine if they will be able to install new seats in used heads.
4.4) DLG to report to AOAP when each lab expects hardware to run out. Done. 06/16/2015.

5.0) Old Business

5.1) Equivalency of IIIF/IIIG results when using size 7 & 8 pistons/rings as compared to all other sizes. Sizes 9 & 10 have been approved for use in IIIF/IIIG. Stats Group.
5.2) Part # 17120601 fuel injectors for Sequence IIIF/IIIG tests. Matthews.
5.3) Review of remaining critical hardware for Sequence III tests. Glaenzer.

6.0) New Business

6.1) Update on IIIH Precision Matrix. Haumann.

6.2) CPD Report OH Technologies.
6.3) TMC Report Grundza.
6.4) Extending specification for cylinder head re-use. Schweitzer.
6.5) Discussion on use of Sequence IIIH test to replace IIIF & IIIG tests for current and prior categories. All.
6.6) Update on GMOD test. Matthews.
6.7) IIIG Piston Ring Chamfers. Szapponos.

7.0) Review Scope and Objectives

7.1) All

8.0) Next Meeting

8.1) TBD

9.0) Meeting Adjourned

SOUTHFIELD, MICH.

ASTM Sequence III Surveillance Panel (22 Voting members) date: 10/29/15

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Tom Wingfield Chevron Phillips Chemical Co. USA	wingftm@cpchem.com	Non-Voting Member Present________

10/29/15

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Brulin US Solution Sequence III

815 GD and 815 QR-DF

Overview

- Brulin donated US Solutions for a Demonstration at IAR on 8/19/2015.
- TierraTech MOT-500NS Concentration:
  - 815 GD (10 gallons)
  - 815 QR-DF (10 gallons)
    - Approximately 12.5% concentration
- IAR Cleaned an EOT IIIG Engine and Disassembled a GMOD Shakedown Engine for the Demonstration of the Brulin US Solutions.

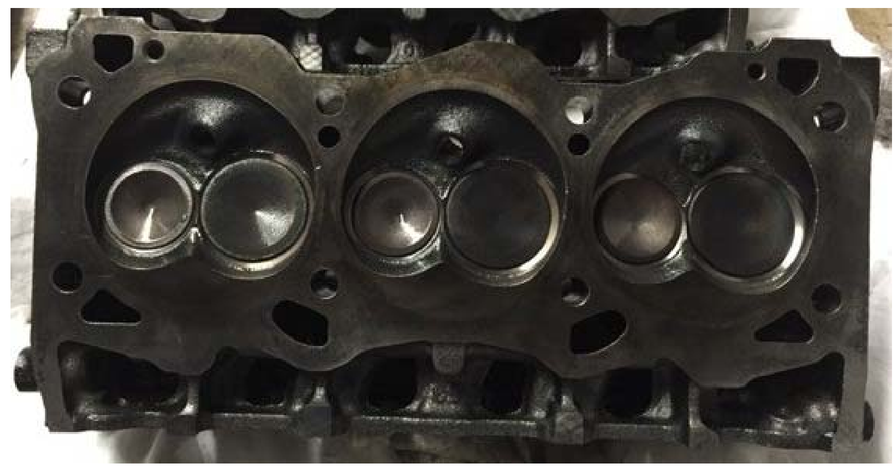
IIIG Hardware and Clean Times

- Cylinder Heads w/ Valves Installed
  - 30 minutes
- Engine Block
  - 60 minutes

Cylinder Heads Before

Cylinder Heads After 30 Mins



Engine Block Before

Engine Block After 60 Mins

GMOD Hardware and Clean Times

- Cylinder Heads w/ Valves Installed
  - 15 minutes
  - 30 minutes
- Oil Pan
  - 15 minutes
  - 30 minutes
- Engine Block
  - 30 minutes

Cylinder Heads Before

Cylinder Heads After 15 Mins

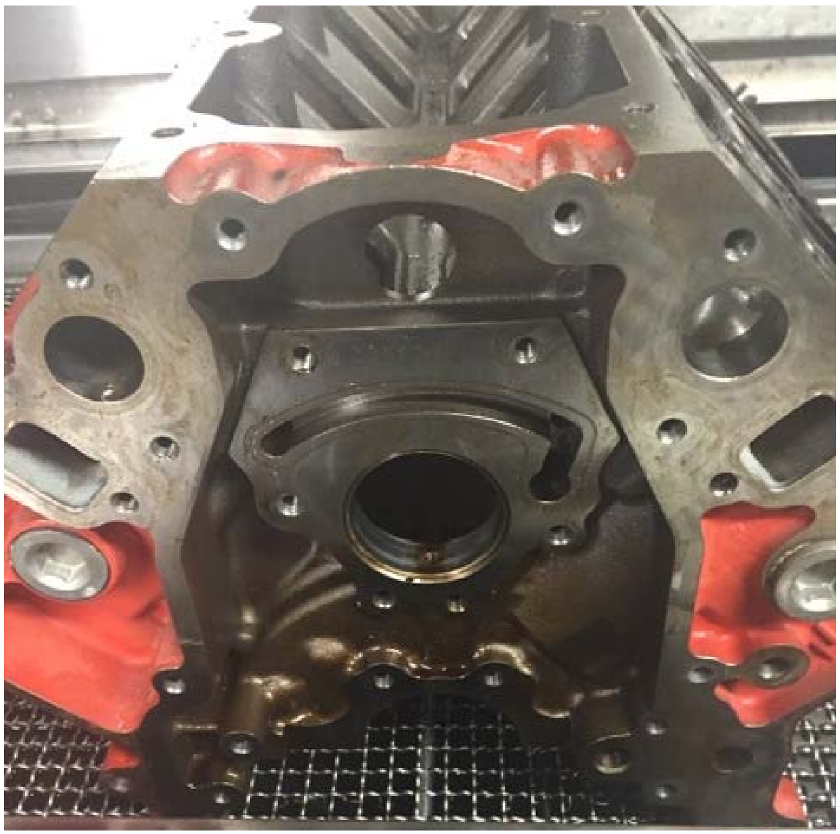
Cylinder Heads After 30 Mins

Oil Pan Before

Oil Pan After 15 Mins

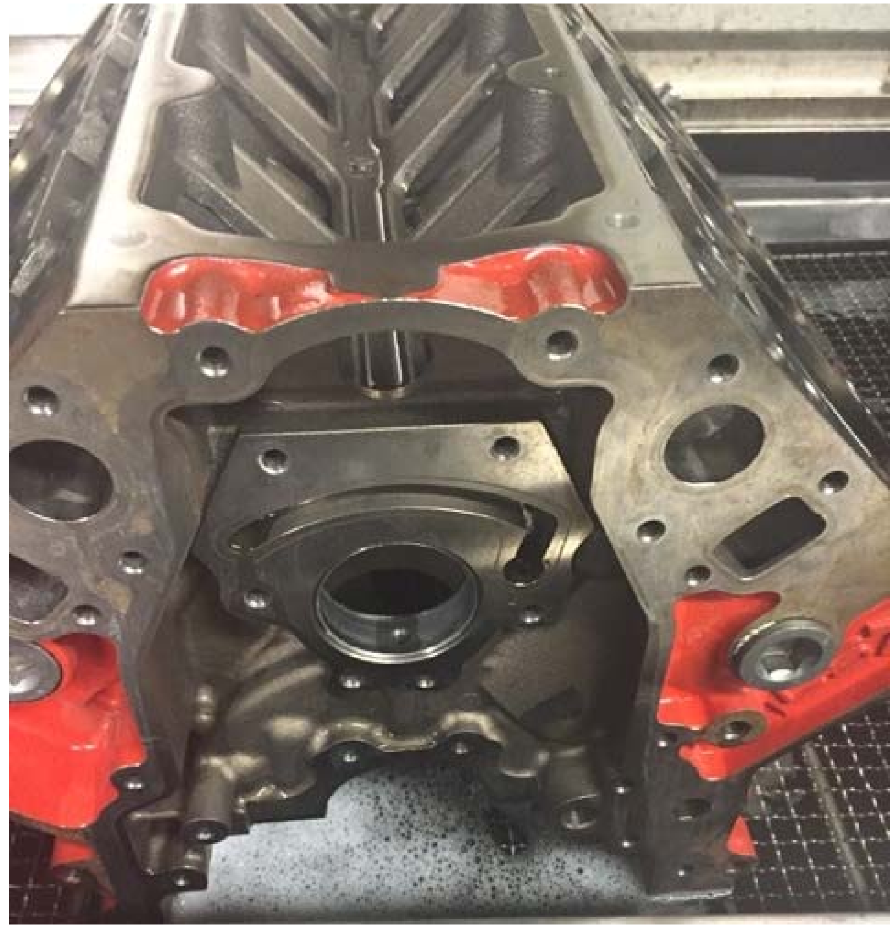
Oil Pan After 30 Mins

Engine Block Before



Engine Block Before

Engine Block After 30 Mins



Engine Block After 30 Mins

Conclusions

- Brulin US Solutions 815 GD and 815 QR-DF Clean Equivalent or Better than TierraTech US 7 and US B Solutions.
- Post Cleaning One Minute Hot Water Spray and 50/50 EF411 and Solvent Spray will not be altered in the Current Procedure.
- Brulin US Solutions are Manufactured Domestically here in the U.S. and are Available Throughout the U.S. at Local Vendors.

Recommendation

- MOTION:
  - IAR recommends that a 50/50 Brulin US Solution of 815 GD and 815 QR-DF be utilized in a 12.5% concentration and allowed as an alternate ultrasonic solution for Sequence III non-reference testing provided that the laboratory has conducted a successful reference oil test.

Questions

- Addison J. Schweitzer
  - Office: (210)-706-1586
  - Mobile: (210)-215-1370

Estimation of Remaining Sequence III Parts

Sequence IIIF & Sequence IIIG

David L. Glaenzer
Sequence III Surveillance Panel Chairman
October 1, 2015

Laboratories and Chevy Performance Surveyed

- As of October 1, 2015
  - Enough Connecting Rods for 263 tests
    - Chevy Performance ordering 1200 (200 runs)
  - Enough Crankshafts for 294 tests
    - Based on 6 uses per unit; Labs are getting more than six
    - Does not account for "in use" material
    - May become a problem area
  - Enough Cylinder Blocks for 776 tests
    - Includes use for runs 9&10
  - Enough Cylinder Heads for 439 tests
    - Heads that are unused or may be used for additional runs

Estimation of Usage

- April 1, 2015 through September 30, 2015
  - 38 Sequence IIIF tests completed with ACC registration
  - 164 Sequence IIIG tests completed with ACC registration
  - 202 Total ACC tests

  - 5 Sequence IIIF reference oil calibration tests
  - 11 Sequence IIIG reference oil calibration tests
  - 16 Total Calibration tests

  - Six month period
  - Annualized to 436 tests per year

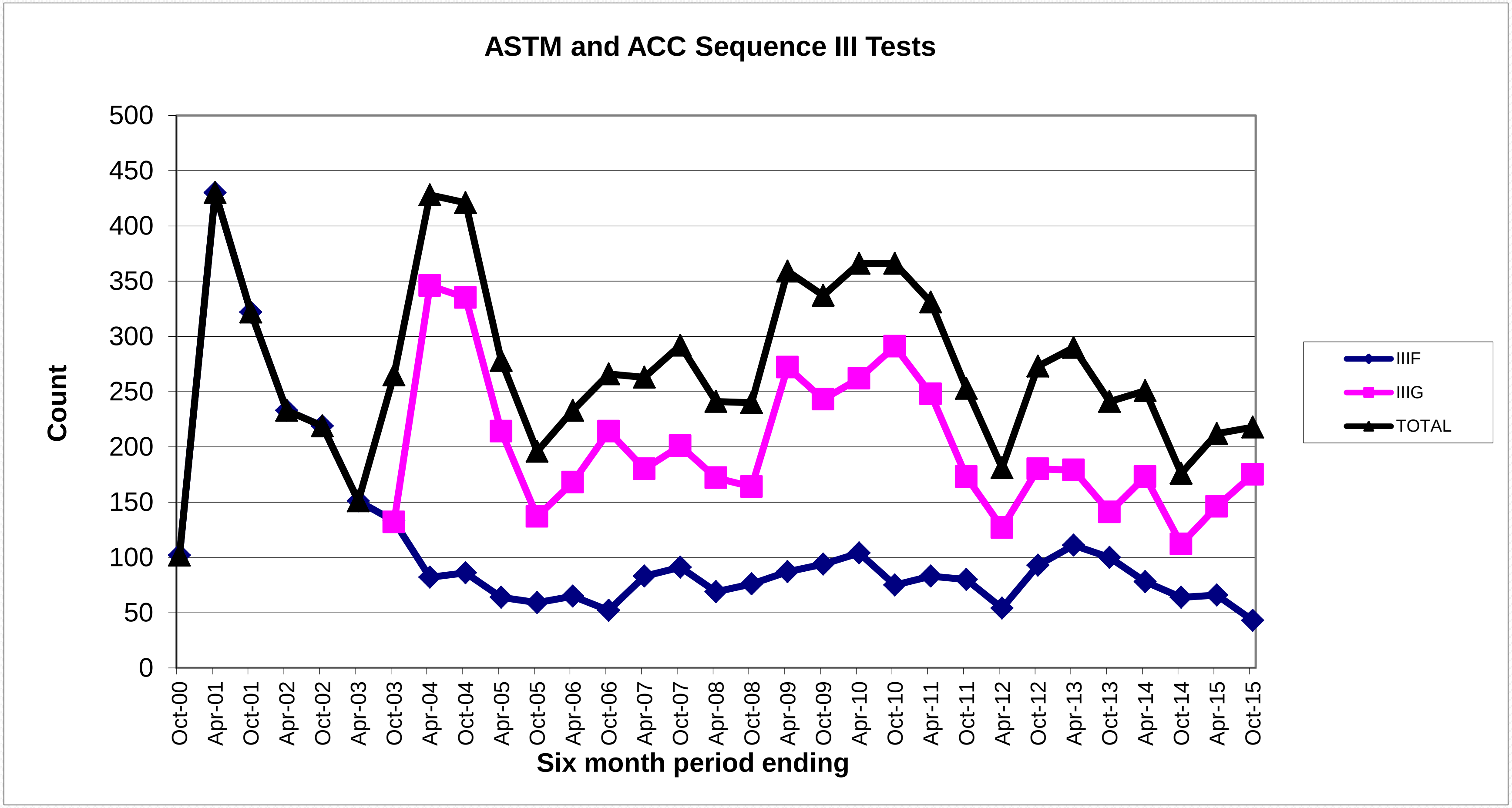
When Will We Run Out of Parts??

- At Current usage rate, 8 to 10 months (August, 2016)
- If usage continues to diminish, later
- Test labs have started to run size 9 & 10 pistons/rings
- Additional supply of connecting rods being secured by Chevy Performance

The Survey Numbers

On or about October 1, 2015		Sum	Runs	
				Rod Runs
#12593374 connecting rods (unused)		1575	263	263
#24502168 crankshaft (unused)		49	294	Crank Runs
				294
#24502286 cylinder block NEVER UNUSED		17	170	
#24502286 cylinder block USED W/ 1 RUN		0	0	
#24502286 cylinder block USED W/ 2 RUNS		0	0	
#24502286 cylinder block USED W/ 3 RUNS		3	21	
#24502286 cylinder block USED W/ 4 RUNS		2	12	
#24502286 cylinder block USED W/ 5 RUNS		2	10	
#24502286 cylinder block USED W/ 6 RUNS		58	232	
#24502286 cylinder block USED W/ 7 RUNS		51	153	
#24502286 cylinder block USED W/ 8 RUNS		86	172	
#24502286 cylinder block USED W/ 9 RUNS		3	3	Block Runs
				773
#24502260B cylinder heads		0		
#24502260S cylinder heads NEVER USED		370	370	
#24502260S cylinder heads USED ONCE, still serviceable		20	10	
#24502260S cylinder heads USED TWICE, still serviceable		102	51	
#24502260S cylinder heads USED THRICE, still serviceable		16	8	Head Runs
				439
cylinder heads NEVER USED	.Assumes two uses. May be more			
cylinder heads USED ONCE, still serviceable	Assumes one more use possible, may be more			
cylinder heads USED TWICE, still serviceable	Assumes one more use possible, may be more			

Estimation of Usage



Usage Numbers

6 Month	IIIF			IIIG				GRAND
Ending	ACC	REF	TOTAL	ACC	REF	TOTAL	TOTAL	TOTAL
Oct-00	71	31	102				102	102
Apr-01	366	64	430				430	532
Oct-01	275	47	322				322	854
Apr-02	202	31	233				233	1087
Oct-02	191	28	219				219	1306
Apr-03	112	39	151				151	1457
Oct-03	105	28	133	75	57	132	265	1722
Apr-04	70	12	82	312	34	346	428	2150
Oct-04	76	10	86	308	27	335	421	2571
Apr-05	54	10	64	195	19	214	278	2849
Oct-05	43	16	59	119	18	137	196	3045
Apr-06	56	9	65	147	21	168	233	3278
Oct-06	44	8	52	190	24	214	266	3544
Apr-07	68	15	83	165	15	180	263	3807
Oct-07	80	11	91	174	27	201	292	4099
Apr-08	61	8	69	155	17	172	241	4340
Oct-08	65	11	76	145	19	164	240	4580
Apr-09	79	8	87	253	19	272	359	4939
Oct-09	81	13	94	220	23	243	337	5276
Apr-10	104	15	104	262	27	262	366	5642
Oct-10	75	9	75	291	27	291	366	6008
Apr-11	83	31	83	236	24	248	331	6339
Oct-11	80	12	80	175	23	173	253	6592
Apr-12	56	9	54	130	16	127	181	6773
Oct-12	77	16	93	164	16	180	273	7046
Apr-13	88	23	111	158	21	179	290	7336
Oct-13	87	13	100	127	14	141	241	7577
Apr-14	66	12	78	154	19	173	251	7828
Oct-14	56	8	64	94	18	112	176	8004
Apr-15	57	9	66	132	14	146	212	8216
Oct-15	38	5	43	164	11	175	218	8434
	Period ends 03/31 & 09/30							

Attachment 5

IIIH Task Force Update to the Surveillance Panel

October 29, 2015

Matrix Update

- All but two tests have been reported to the TMC.
- The two outstanding tests are being rerun to ensure a more accurate data set.
- Both tests have completed, but are not included in this analysis.

	Lab-Stand	D-1	E-1	B-1	G-1	G-2	A-1	A-2
Run Order	1	434-2 106788-IIIH ✓	438-1 106784-IIIH Low MAP and Fuel Flow 438-1 106785-IIIH ✓	438-1 106796-IIIH Oil Leak 438-1 106797-IIIH ✓	436 106763-IIIH ✓	436 106764-IIIH Low MAP & Erratic Fuel Flow 436 111422-IIIH	438-1 106774-IIIH ✓	434-2 106778-IIIH ✓
	2	434-2 106789-IIIH Loss of Oil Pressure 434-2 106789A-IIIH ✓	436 106782-IIIH Low MAP & Fuel Flow 436	436 106792-IIIH ✓	438-1 106767-IIIH ✓	434-2 107873-IIIH ✓	438-1 107869-IIIH ✓	438-1 107870-IIIH ✓
	3	436 106786-IIIH ✓	434-2 106781-IIIH ✓	436 106793-IIIH ✓	438-1 106768-IIIH ✓	434-2 110227-IIIH ✓	434-2 106779-IIIH ✓	436 106775-IIIH ✓
	4	438-1 106791-IIIH ✓	434-2 106780-IIIH ✓	434-2 106795-IIIH ✓	434-2 110228-IIIH ✓	438-1 107872-IIIH ✓	436 106777-IIIH ✓	436 106776-IIIH ✓

✓ Indicates operation task force has reviewed operational data and found the test to be operationally valid.
* Indicates operations task force is still discussing operational validity of test.

Test Reported (green) Invalid (red)

Test Development Objectives

- The Chrysler test results show repeatability, reproducibility, and discrimination on PVIS and WPD. The precision matrix performed similarly to the prove-out matrix as expected.
- The Chrysler test meets the test development objectives:

Status	Criteria	Remark
Yes	Stand to stand repeatability	Demonstrated
Yes	Discrimination	Demonstrated
Yes	0W-16 viable	Demonstrated
Yes	Field Correlation	REO 2/3
Yes	Procedure and final hardware available and released	90 hours, 6 oz oil addition every 20 hours
Yes	Long term engine supply and readiness	3800 engines to last through 2022, other parts through CPD
Yes	Lab to lab reproducibility and prove-out matrix	2 independent labs and 2-3 dependent labs

Objectives for Reference Oils

- ✓ Include:
  - ✓ Borderline oils to identify shifts in test severity over time
  - ✓ An oil that performs poorly on WPD to maintain test discrimination (438-1)
  - ✓ An oil that performs poorly on pVis to maintain test discrimination (434-2)
  - ✓ An oil that performs well on both WPD and pVis (436)

Expectations of Reference Oils

✓ 434-2 would discriminate on pVis as a failing oil

✓ 436 would perform well on both pVis and WPD

✓ 438-1 would discriminate on WPD as a failing oil

Trade-Offs:

- Potentially high variability on pVis for 438-1
- Potentially high variability on WPD for 434-2

Task Force Recommendation

On October 23, 2015 the IIIH Task Force voted on the following motion:

The Task Force as a technical group has vetted the precision matrix data reported to date, and determined the tests included are operationally valid. Based on the matrix data the test is capable of measuring PVis and WPD. We recommend to the Surveillance Panel that the matrix data be used to consider the test to be used as an ASTM standardized test.

The motion passed with 9 approves and 3 waives.

Conclusions

The Precision Matrix Stats Group has analysed the data to be reviewed by the Surveillance Panel.

The precision matrix data collected have met the objectives established by the selection of the reference oils.

The Task Force has fulfilled the goal of providing a test that is capable of measuring PVis and WPD while showing discrimination, repeatability and reproducibility.

Stats Group Analysis

A HUGE thank you to Jo Martinez and the entire stats group for an expedited analysis of the matrix data.

Sequence IIIH Precision Matrix Statistical Analysis (Preliminary)

Statistics Group

October 26, 2015

Preliminary

Statistics Group

- Arthur Andrews, ExxonMobil
- Doyle Boese, Infineum
- Jo Martinez, Chevron Oronite
- Ricardo Affinito, Chevron Oronite
- Kevin O'Malley, Lubrizol
- Martin Chadwick, Intertek
- Richard Grundza, TMC
- Lisa Dingwell, Afton
- Todd Dvorak, Afton
- Travis Kostan, SwRI

Preliminary

IIIH Matrix Status:
26 out of 28 tests validated

	Lab-Stand	D-1	E-1	B-1	G-1	G-2	A-1	A-2
Run Order	1	434-2 106788-IIIH ✓	438-1 106784-IIIH Low MAP and Fuel Flow 438-1 106785-IIIH ✓	438-1 106796-IIIH Oil Leak 438-1 106797-IIIH ✓	436 106763-IIIH ✓	436 106764-IIIH Low MAP & Erratic Fuel Flow 436 111422-IIIH	438-1 106774-IIIH ✓	434-2 106778-IIIH ✓
	2	434-2 106789-IIIH Loss of Oil Pressure 434-2 106789A-IIIH ✓	436 106782-IIIH Low MAP & Fuel Flow 436	436 106792-IIIH ✓	438-1 106767-IIIH ✓	434-2 107873-IIIH ✓	438-1 107869-IIIH ✓	438-1 107870-IIIH ✓
	3	436 106786-IIIH ✓	434-2 106781-IIIH ✓	436 106793-IIIH ✓	438-1 106768-IIIH ✓	434-2 110227-IIIH ✓	434-2 106779-IIIH ✓	436 106775-IIIH ✓
	4	438-1 106791-IIIH ✓	434-2 106780-IIIH ✓	434-2 106795-IIIH ✓	434-2 110228-IIIH ✓	438-1 107872-IIIH ✓	436 106777-IIIH ✓	436 106776-IIIH ✓

✓ Indicates operation task force has reviewed operational data and found the test to be operationally valid.

* Indicates operations task force is still discussing operational validity of test.

Test Reported (green)   Invalid (red)

A Program of ASTM International

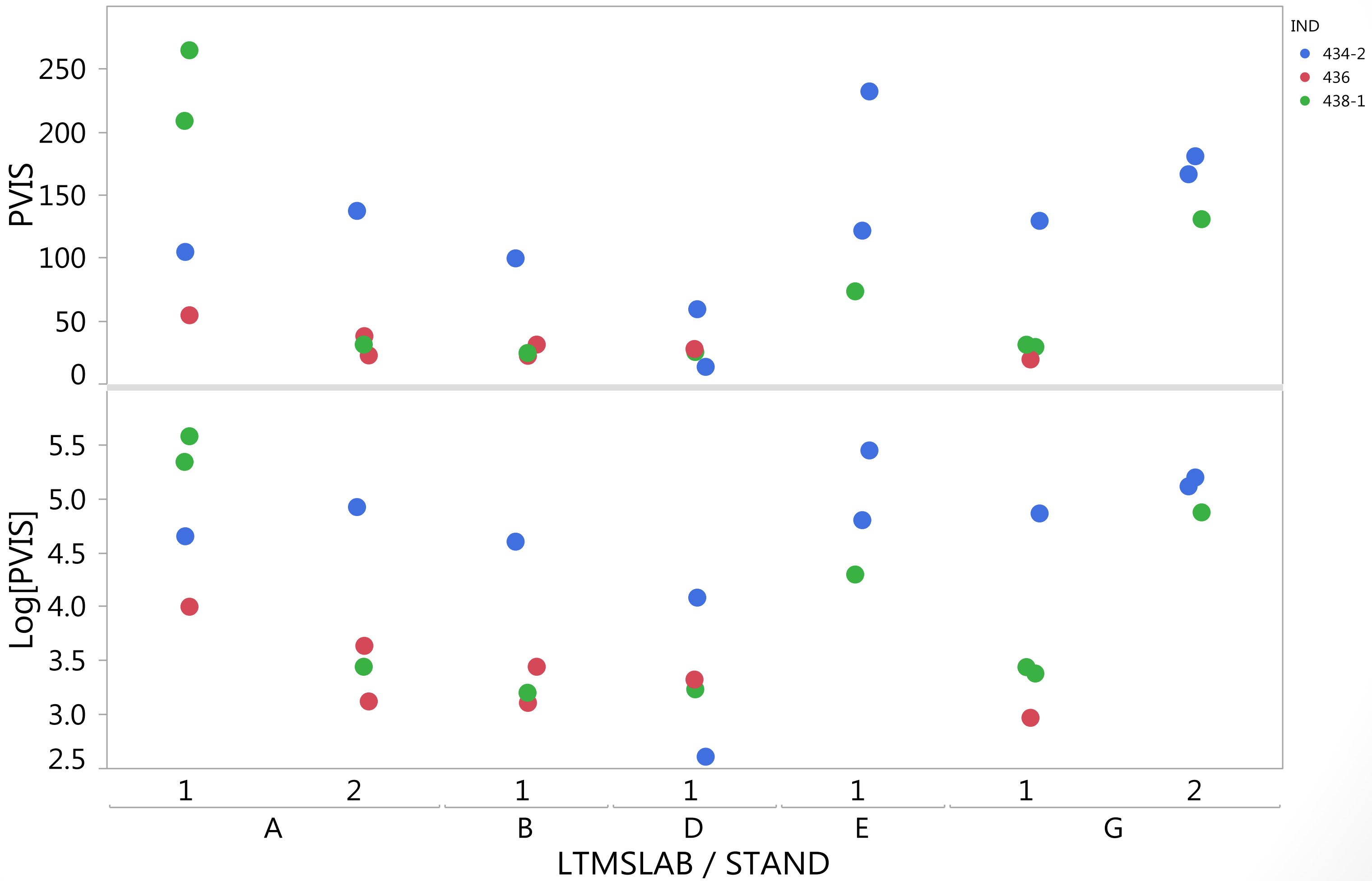
Preliminary

Summary

	LnPVIS	WPD	LnMRV	Phos
Lab Difference	D < A, E	No significant difference	D < E, A, G	No significant difference
Stand(Lab) Difference	G1<G2, A2<A1	No significant difference	A2 < A1	No significant difference
Oil Discrimination	436 < 434-2	436 > 438-1	436, 438-1 < 434-2	436 > 434-2, 438-1
Precision, s, RMSE	0.5500	0.48	0.4478	1.60

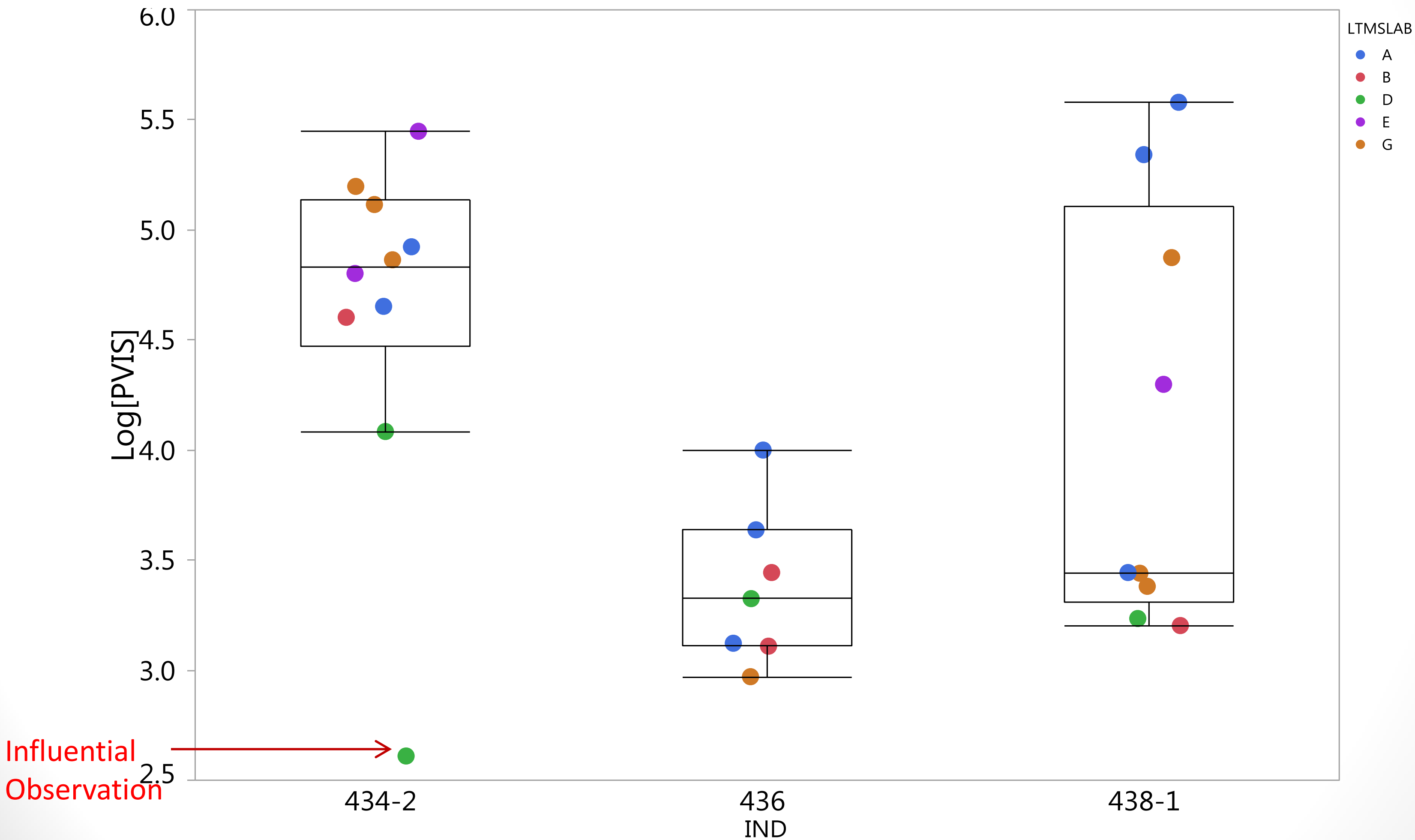
Preliminary

Percent Viscosity Increase n=26



Preliminary

LnPVIS



Preliminary

LnPVIS ANOVA

Summary of Fit

RSquare	0.7475
RSquare Adj	0.628676
Root Mean Square Error	0.550034
Mean of Response	4.104198
Observations (or Sum Wgts)	26

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	15.225695	1.90321	6.2908
Error	17	5.143141	0.30254	**Prob > F**
C. Total	25	20.368836		0.0007*

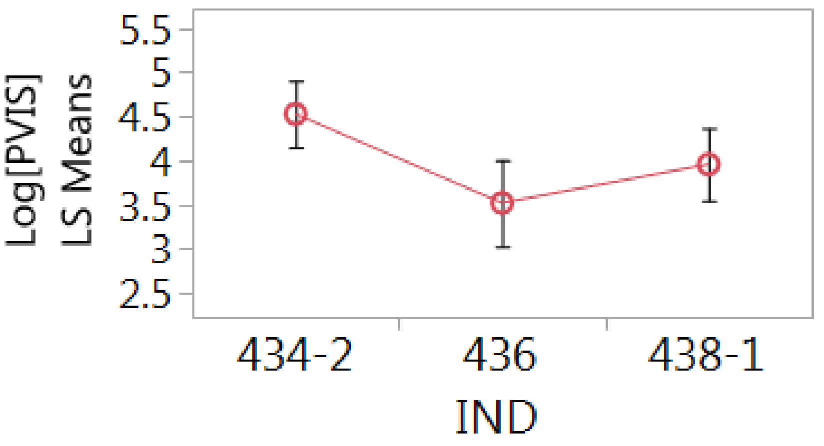
Effect Tests

Source	DF	Sum of Squares	F Ratio	Prob > F
IND	2	3.5572927	5.8791	0.0115*
LTMSLAB	4	5.1937339	4.2918	0.0140*
LTMSAPP[LTMSLAB]	2	3.6832092	6.0872	0.0101*

Preliminary

LnPVIS Oil Discrimination

436 is significantly lower than 434-2



Oil1	Oil2	Difference	p-Value
434-2	436	1.0095	0.01
434-2	438-1	0.5708	0.10
438-1	436	0.4388	0.32

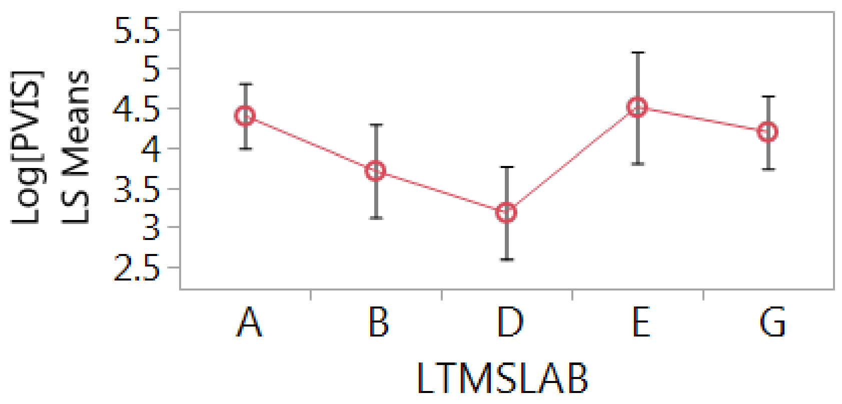
Oil	LnPVIS LS Mean	PVIS LS Mean
434-2	4.5287	93
436	3.5192	34
438-1	3.9580	52

Preliminary

LnPVIS Lab Difference

Lab D is significantly lower than Lab A

Lab D is significantly lower than Lab E



Lab1	Lab2	Difference	p-Value
E	D	1.3315	0.04
A	D	1.2218	0.02
G	D	1.0188	0.06
E	B	0.803	0.40
A	B	0.6933	0.29
B	D	0.5285	0.67
G	B	0.4903	0.66
E	G	0.3127	0.92
A	G	0.2031	0.96
E	A	0.1096	1.00

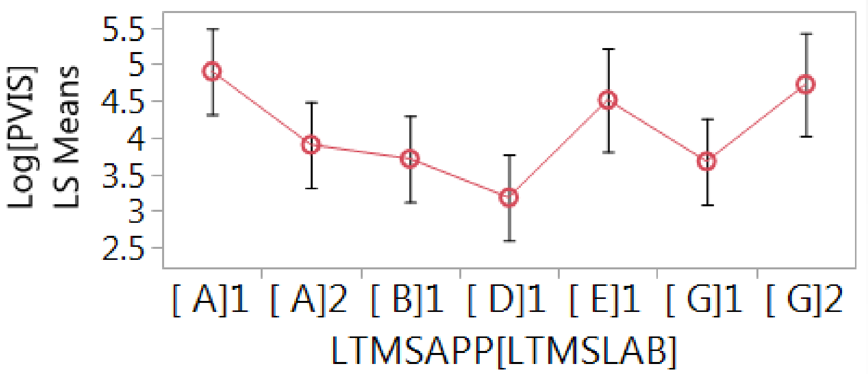
Lab	LnPVIS LS Mean	PVIS LS Mean
A	4.4037	82
B	3.7103	41
D	3.1818	24
E	4.5133	91
G	4.2006	67

Preliminary

LnPVIS Stand(Lab) Difference

Stand G1 is significantly lower than Stand G2

Stand A2 is significantly lower than Stand A1



Lab/Stand1	Lab/Stand2	Difference	p-Value
[G]2	[G]1	1.0511	0.03
[A]1	[A]2	1.0024	0.02

Lab/Stand	LnPVIS LS Mean	PVIS LS Mean
[A]1	4.9049	135
[A]2	3.9025	50
[G]1	3.6751	39
[G]2	4.7262	113

Preliminary

LnPVIS Precision

Model: Oil, Lab, Stand(Lab)

Model RMSE

- s = 0.5500
- IIIH Prove-out s=0.61
- IIIG Precision Matrix s=0.2919
- IIIG recent data s=0.54-0.63

Repeatability

- s = 0.5500
- r = 1.5245

Reproducibility

- s = 0.7761
- R = 2.1512

Preliminary

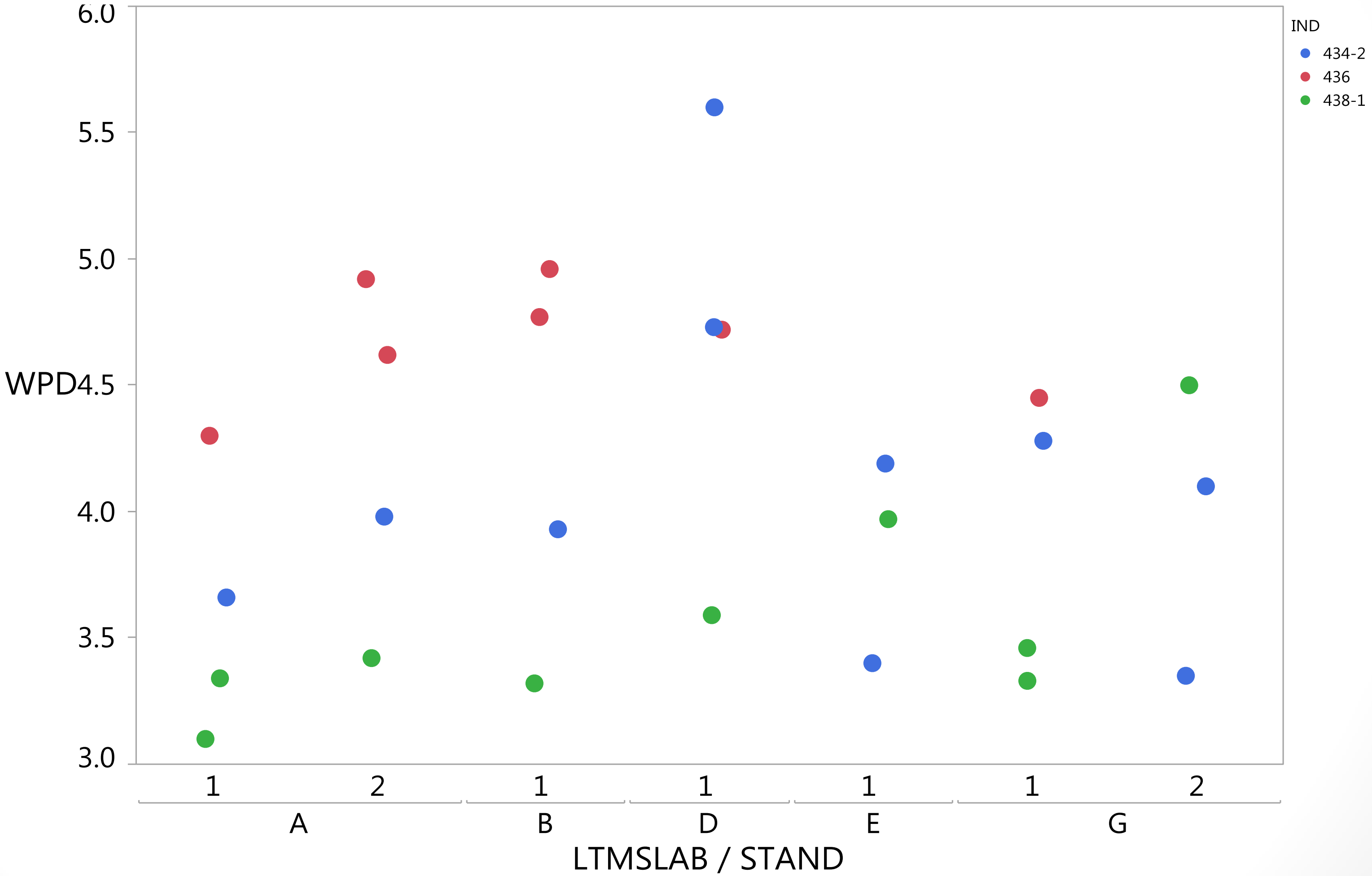
PVIS Precision

Based upon the Seq. III pooled standard deviations (s_r) and ASTM's repeatability (r) definition for the *maximum allowable difference between successive test results*, there is no significant difference between a PVIS result[1] of *150% - 689%* for the IIIH and *150% - 337%* for the IIIG.

Preliminary

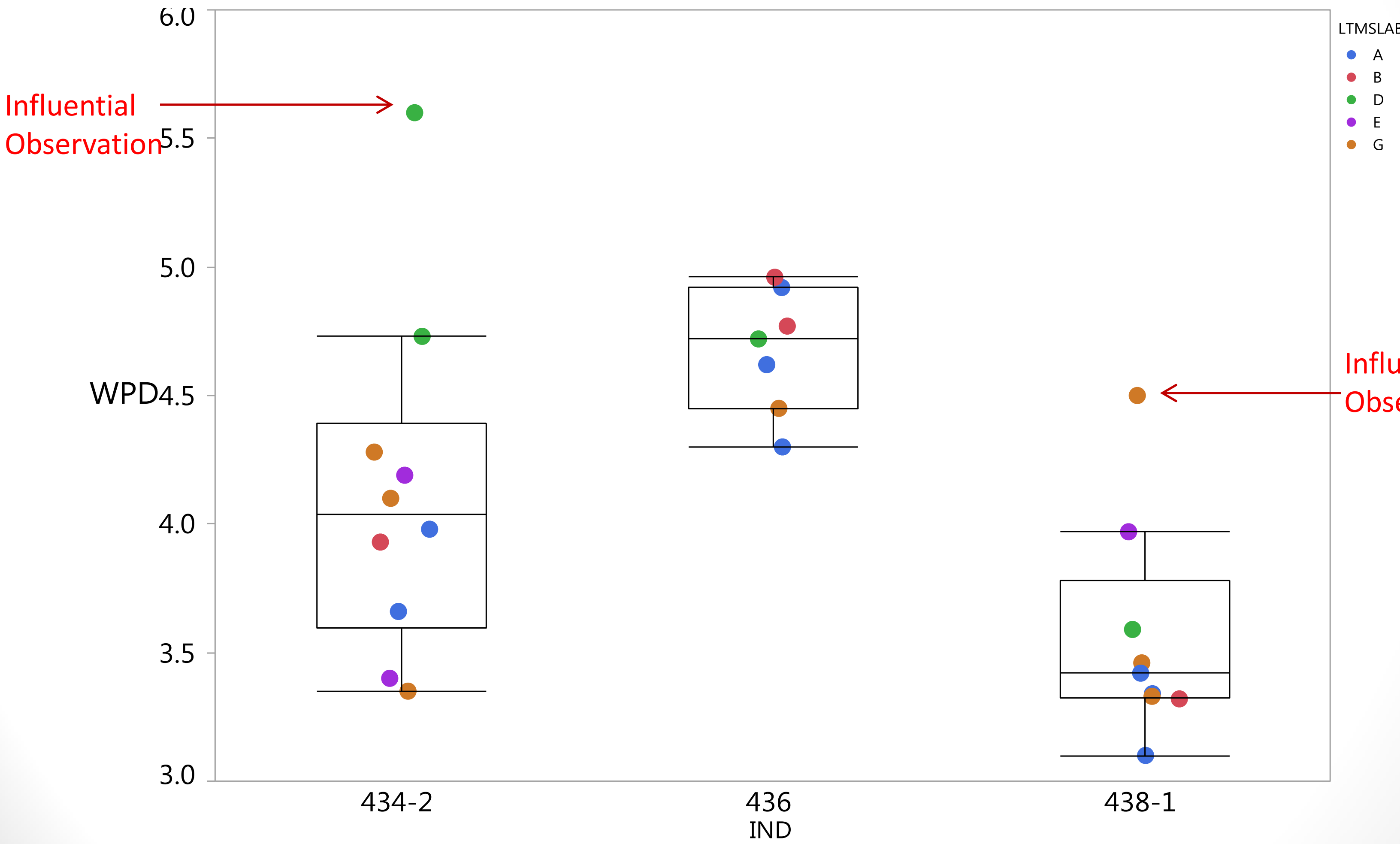
Note 1: A PVIS of 150% was arbitrarily selected in the calculations as the lower pass/fail limit.

Weighted Piston Deposit n=26



Preliminary

WPD



Preliminary

WPD ANOVA

Summary of Fit

RSquare	0.636043
RSquare Adj	0.464769
Root Mean Square Error	0.479261
Mean of Response	4.076538
Observations (or Sum Wgts)	26

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	6.823846	0.852981	3.7136
Error	17	3.904743	0.229691	**Prob > F**
C. Total	25	10.728588		0.0110*

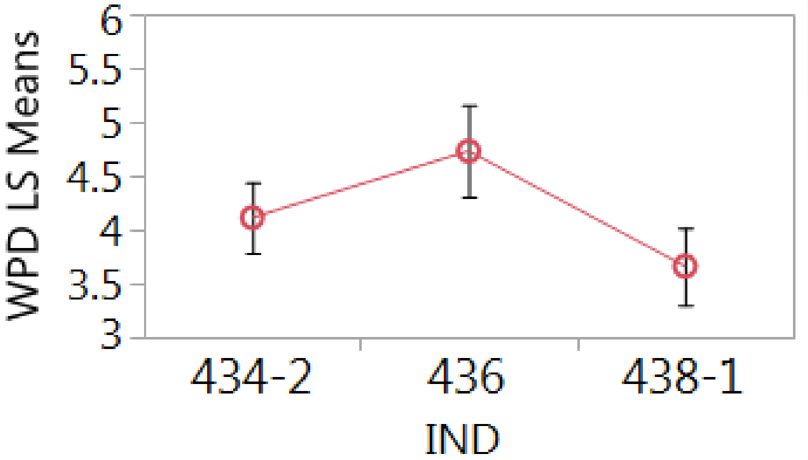
Effect Tests

Source	DF	Sum of Squares	F Ratio	Prob > F
IND	2	4.0097905	8.7287	0.0025*
LTMSLAB	4	1.5619090	1.7000	0.1963
LTMSAPP[LTMSLAB]	2	0.3181248	0.6925	0.5139

Preliminary

WPD Oil Discrimination

436 is significantly higher than 438-1



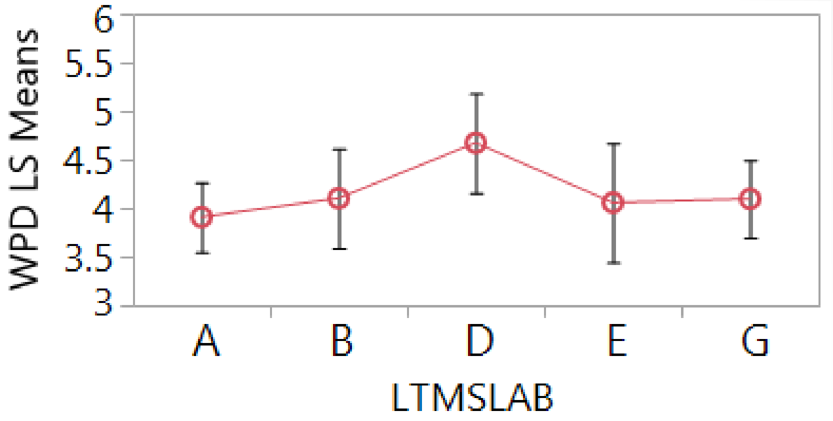
Preliminary

Oil1	Oil2	Difference	p-Value
436	438-1	1.07	0.00
436	434-2	0.62	0.07
434-2	438-1	0.45	0.15

Oil	WPD LS Mean
434-2	4.11
436	4.73
438-1	3.66

WPD Lab Difference

No significant lab difference



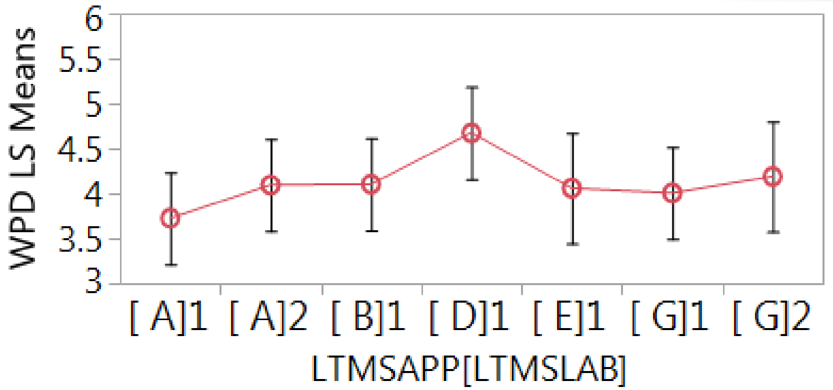
Lab1	Lab2	Difference	p-Value
D	A	0.76	0.12
D	E	0.61	0.48
D	G	0.58	0.36
D	B	0.57	0.49
B	A	0.19	0.96
G	A	0.19	0.95
E	A	0.15	0.99
B	E	0.05	1.00
G	E	0.04	1.00
B	G	0.01	1.00

Lab	WPD LS Mean
A	3.91
B	4.10
D	4.67
E	4.06
G	4.10

Preliminary

WPD Stand(lab) Difference

No significant stand(lab) difference



Lab/Stand1	Lab/Stand2	Difference	p-Value
[A]2	[A]1	0.37	0.30
[G]2	[G]1	0.18	0.63

Lab/Stand	WPD LS Mean
[A]1	3.73
[A]2	4.09
[G]1	4.01
[G]2	4.19

Preliminary

WPD Precision

Model: Oil, Lab, Stand(Lab)

Model RMSE

- s = 0.48
- IIIH Prove-out s=0.40
- IIIG Precision Matrix s=0.60
- IIIG recent data s=0.39-0.43

Repeatability

- s = 0.48
- r = 1.33

Reproducibility

- s = 0.50
- R = 1.39

Preliminary

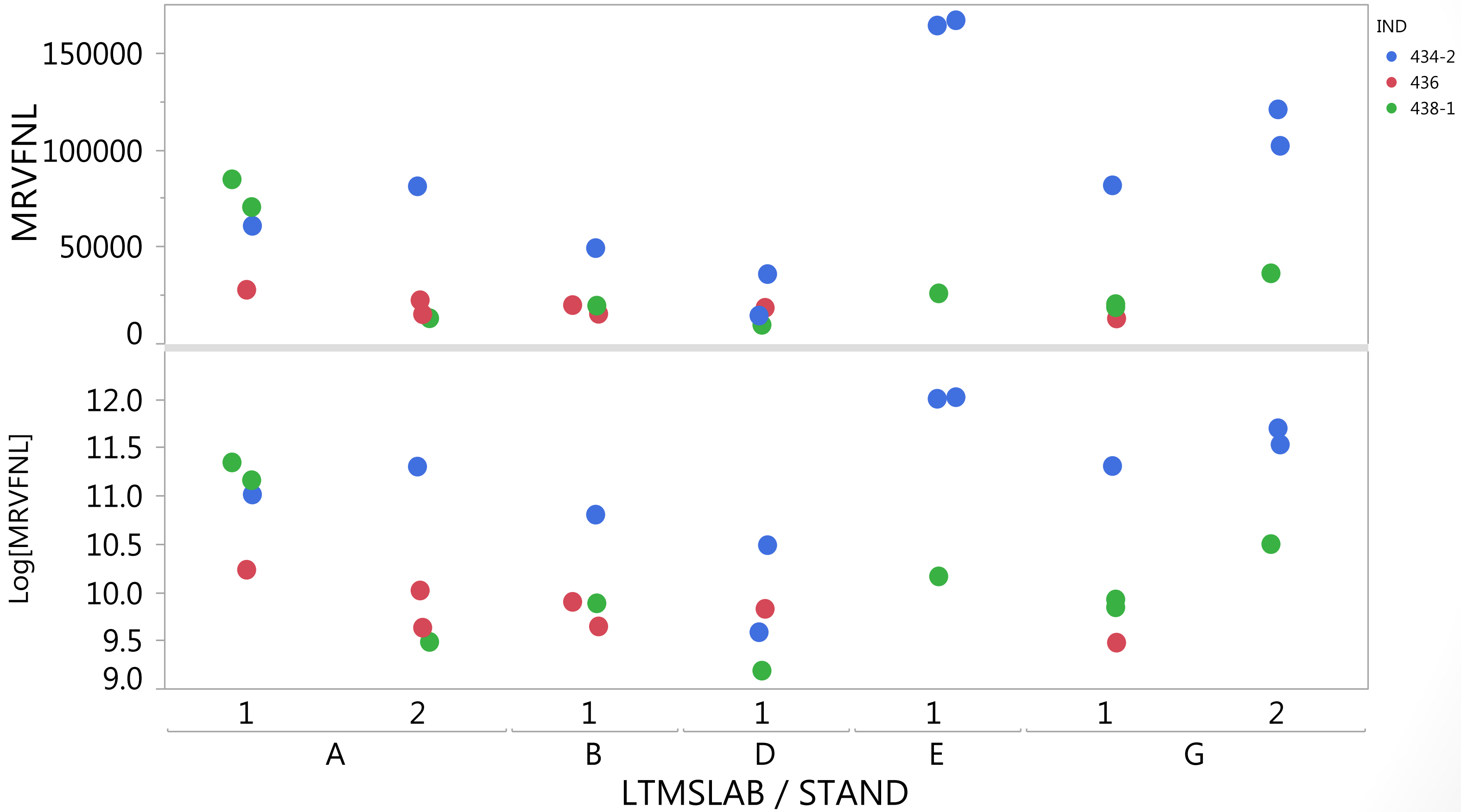
WPD Precision

Based upon the Seq. III pooled standard deviations (s_r) and ASTM's repeatability (*r*) definition for the *maximum allowable difference between successive test results*, there is no significant difference between a WPD result[1] of *2.7 – 4.0* for the IIIH and *2.3 – 4.0* for the IIIG.

Preliminary

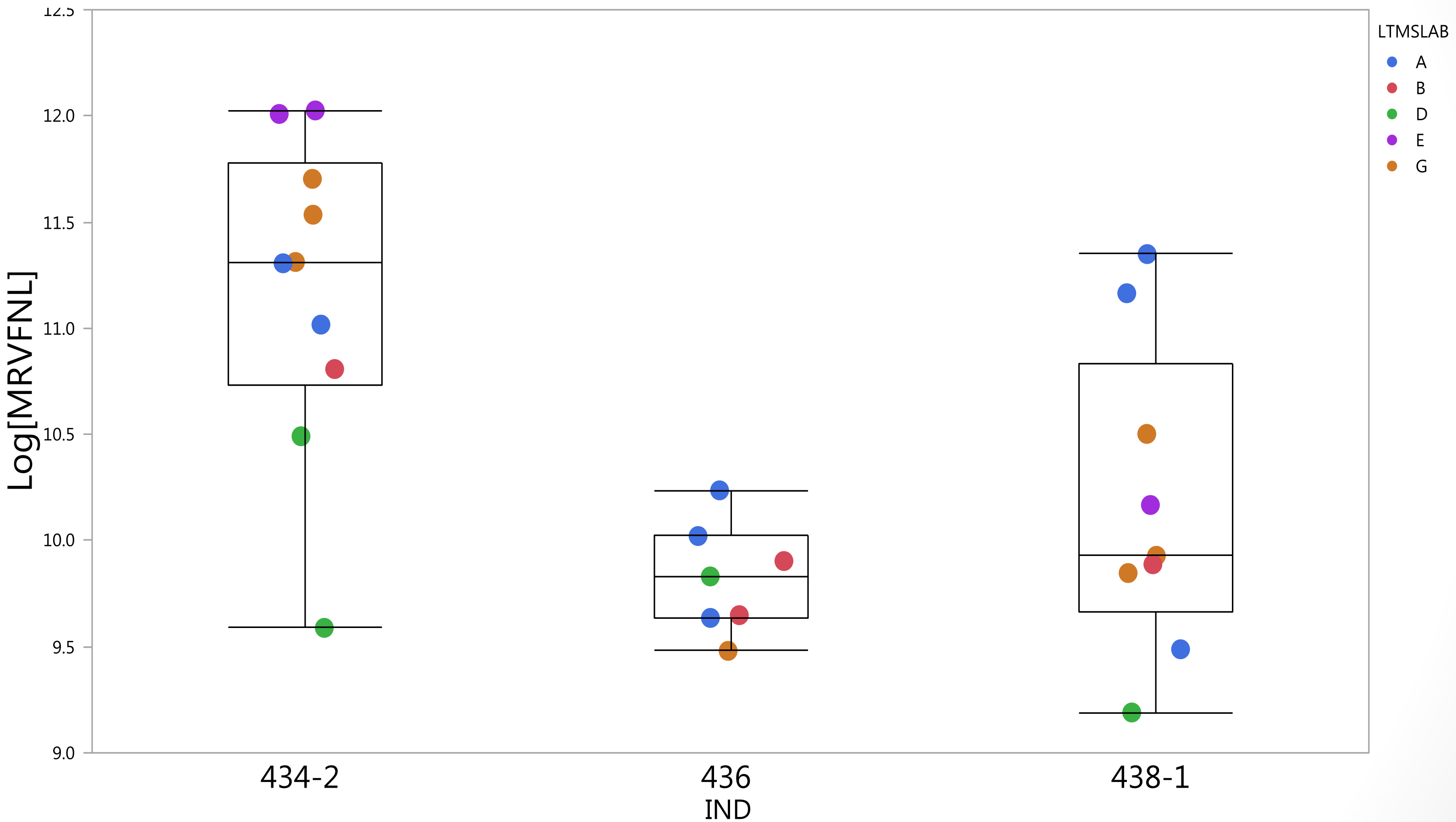
Note 1: A WPD of 4.0 was arbitrarily selected in the calculations as the upper pass/fail limit.

MRV Viscosity n=26



Preliminary

LnMRV



Preliminary

LnMRV ANOVA

Summary of Fit

RSquare	0.814225
RSquare Adj	0.726802
Root Mean Square Error	0.447787
Mean of Response	10.46454
Observations (or Sum Wgts)	26

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	14.939972	1.86750	9.3136
Error	17	3.408722	0.20051	**Prob > F**
C. Total	25	18.348694		<.0001*

Effect Tests

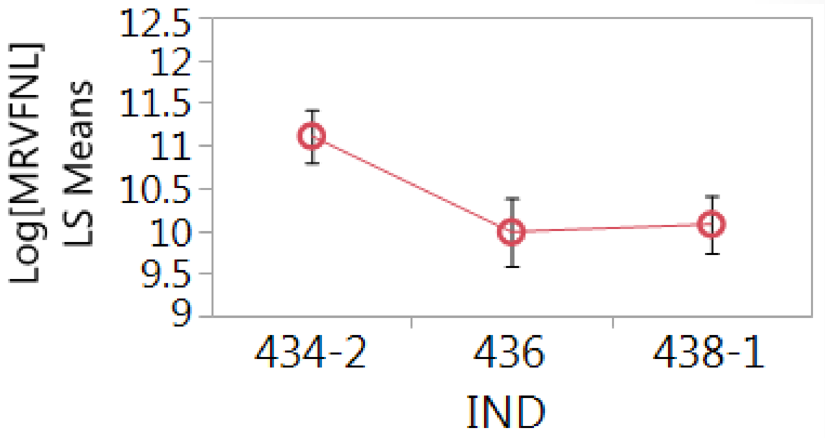
Source	DF	Sum of Squares	F Ratio	Prob > F
IND	2	6.1027395	15.2178	0.0002*
LTMSLAB	4	4.4179947	5.5084	0.0050*
LTMSAPP[LTMSLAB]	2	1.9212981	4.7910	0.0224*

Preliminary

LnMRV Oil Discrimination

436 is significantly lower than 434-2

438-1 is significantly lower than 434-2



Preliminary

Oil1	Oil2	Difference	p-Value
434-2	436	1.1239	0.00
434-2	438-1	1.0332	0.00
438-1	436	0.0907	0.92

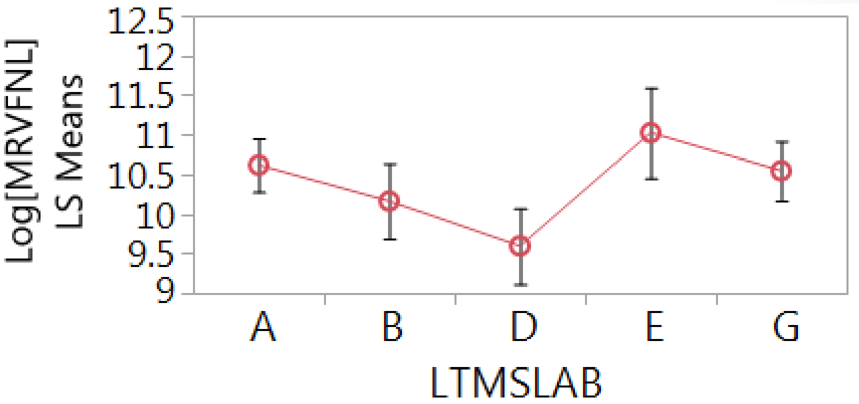
Oil	LnMRV LS Mean	MRV LS Mean
434-2	11.1087	66749
436	9.9848	21694
438-1	10.0755	23754

LnMRV Lab Difference

Lab D is significantly lower than Lab E

Lab D is significantly lower than Lab A

Lab D is significantly lower than Lab G



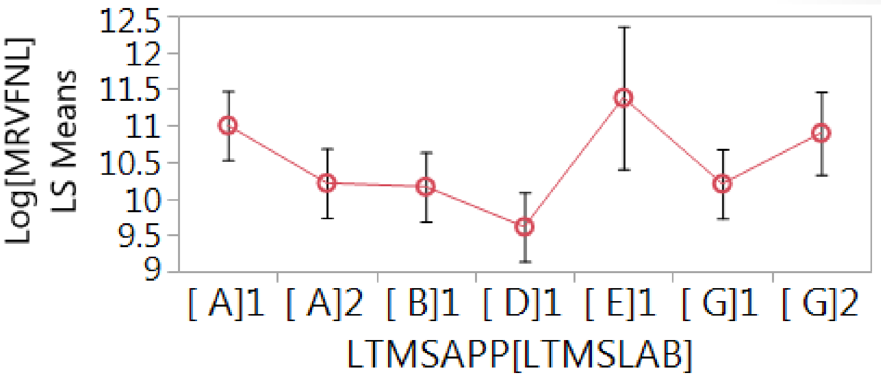
Lab1	Lab2	Difference	p-Value
E	D	1.4307	0.01
A	D	1.0216	0.01
G	D	0.9508	0.03
E	B	0.8629	0.17
B	D	0.5677	0.43
E	G	0.4799	0.56
A	B	0.4539	0.49
E	A	0.4091	0.70
G	B	0.3831	0.69
A	G	0.0708	1.00

Lab	LnMRV LS Mean	MRV LS Mean
A	10.6171	40827
B	10.1633	25934
D	9.5955	14698
E	11.0262	61464
G	10.5463	38036

Preliminary

LnMRV Stand(Lab) Difference

Stand A2 is significantly lower than Stand A1



Lab/Stand1	Lab/Stand2	Difference	p-Value
[A]1	[A]2	0.8065	0.02
[G]2	[G]1	0.6518	0.08

Lab/Stand	LnMRV LS Mean	MRV LS Mean
[A]1	11.0204	61108
[A]2	10.2139	27280
[G]1	10.2204	27458
[G]2	10.8722	52691

Preliminary

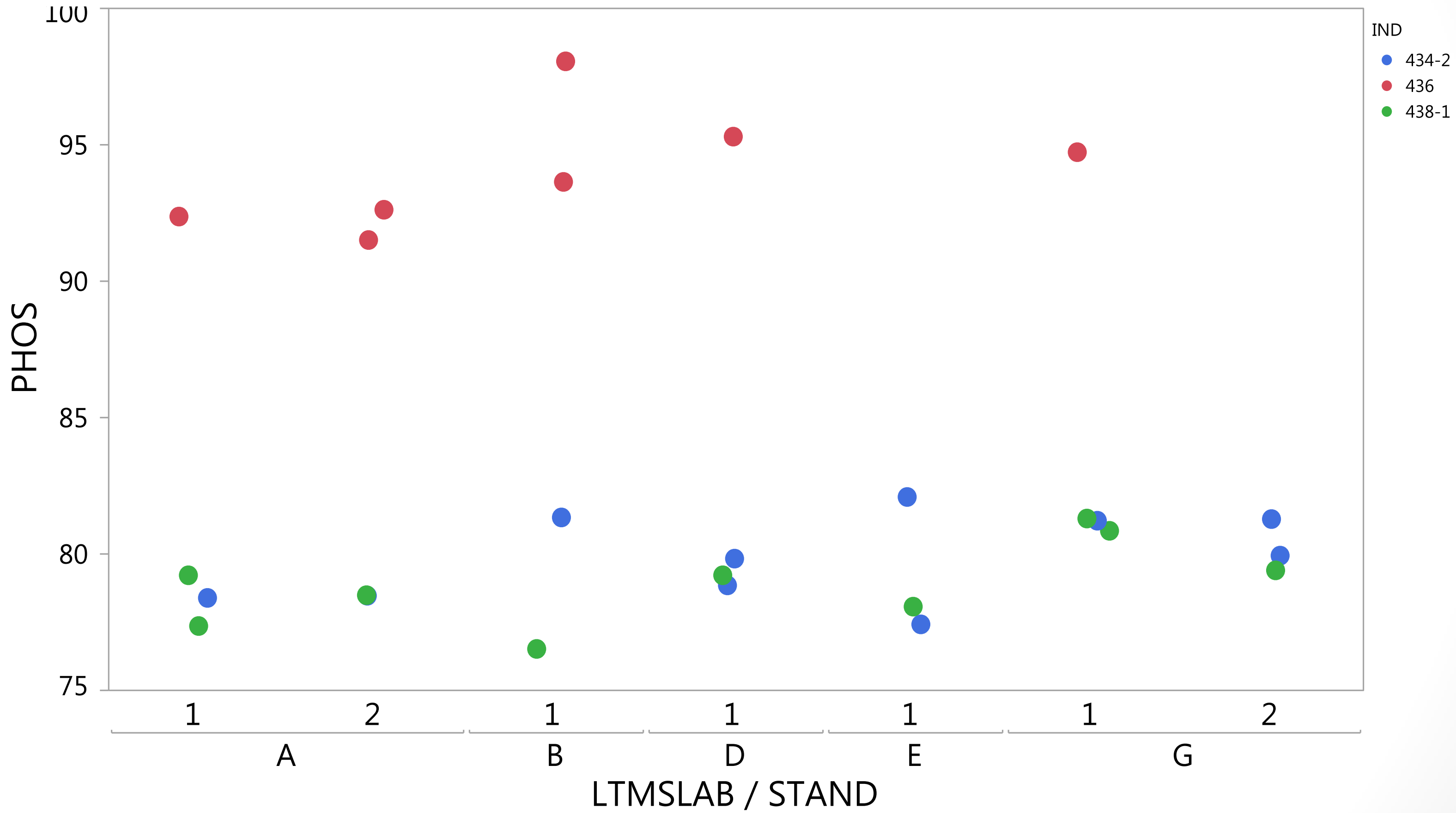
LnMRV Precision

Model: Oil, Lab, Stand(Lab)

Model RMSE	Repeatability	Reproducibility
• s = 0.4478 • No IIIGA s	• s = 0.4385 • r = 1.2412	• s = 0.6449 • R = 1.7876

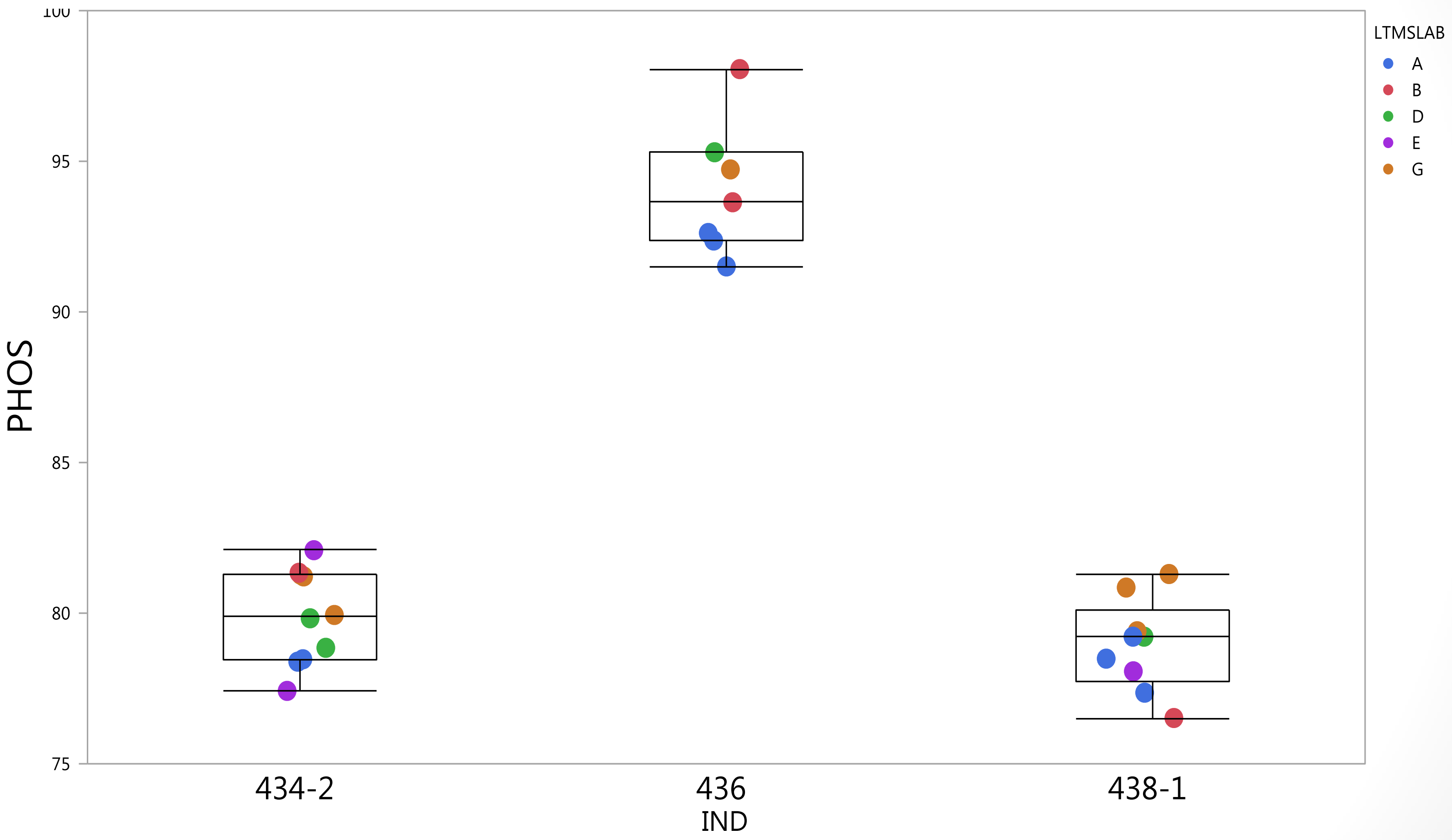
Preliminary

Phosphorus Retention n=26



Preliminary

PHOS



Preliminary

PHOS ANOVA

Summary of Fit

RSquare	0.962598
RSquare Adj	0.944998
Root Mean Square Error	1.600934
Mean of Response	83.365
Observations (or Sum Wgts)	26

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	8	1121.3720	140.172	54.6907
Error	17	43.5708	2.563	**Prob > F**
C. Total	25	1164.9429		<.0001*

Effect Tests

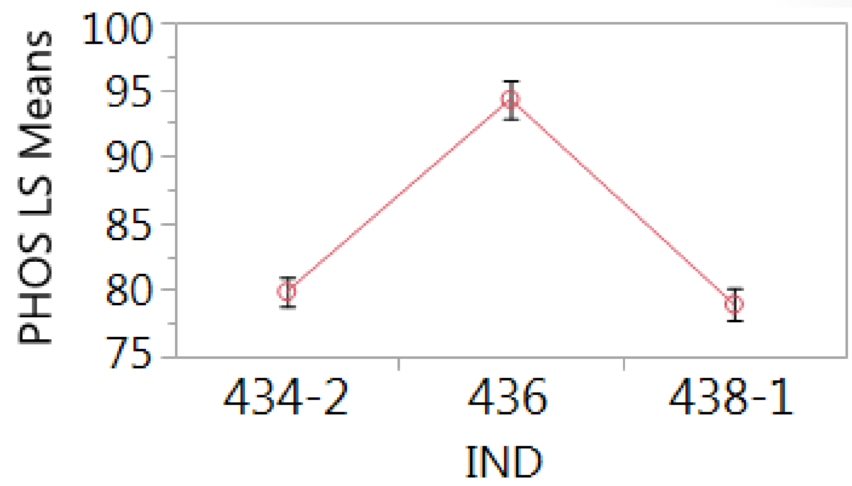
Source	DF	Sum of Squares	F Ratio	Prob > F
IND	2	945.11881	184.3783	<.0001*
LTMSLAB	4	23.88424	2.3297	0.0976
LTMSAPP[LTMSLAB]	2	1.57303	0.3069	0.7397

Preliminary

PHOS Oil Discrimination

436 is significantly higher than 438-1

436 is significantly higher than 434-2



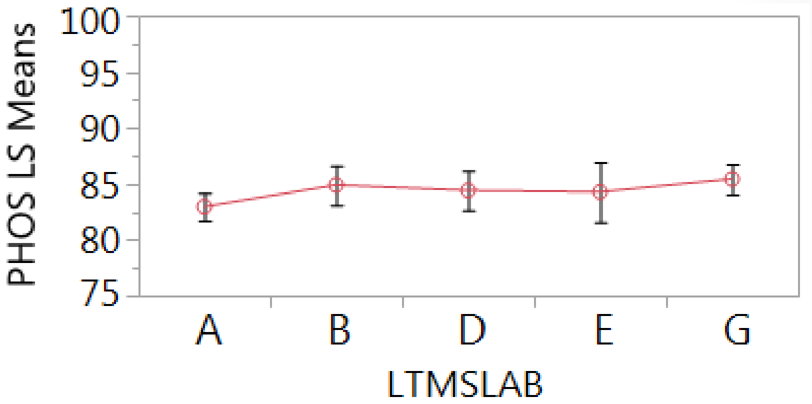
Preliminary

Oil1	Oil2	Difference	p-Value
436	438-1	15.33	0.00
436	434-2	14.38	0.00
434-2	438-1	0.95	0.45

Oil	PHOS LS Mean
434-2	79.87
436	94.25
438-1	78.93

PHOS Lab Difference

No significant lab difference



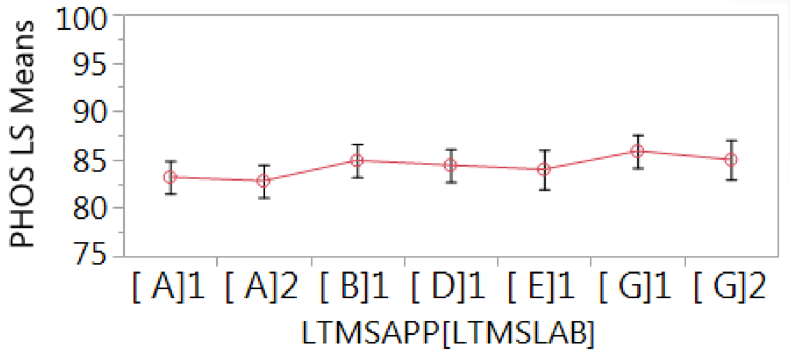
Lab1	Lab2	Difference	p-Value
G	A	2.45	0.07
B	A	1.92	0.33
G	E	1.45	0.69
D	A	1.42	0.62
G	D	1.02	0.85
E	A	0.99	0.90
B	E	0.93	0.95
G	B	0.53	0.99
B	D	0.50	0.99
D	E	0.43	1.00

Lab	PHOS LS Mean
A	82.99
B	84.91
D	84.42
E	83.99
G	85.44

Preliminary

PHOS Stand(Lab) Difference

No significant stand(lab) difference



Lab/Stand1	Lab/Stand2	Difference	p-Value
[G]1	[G]2	0.88	0.49
[A]1	[A]2	0.39	0.74

Lab/Stand	PHOS LS Mean
[A]1	83.19
[A]2	82.80
[G]1	85.88
[G]2	85.00

Preliminary

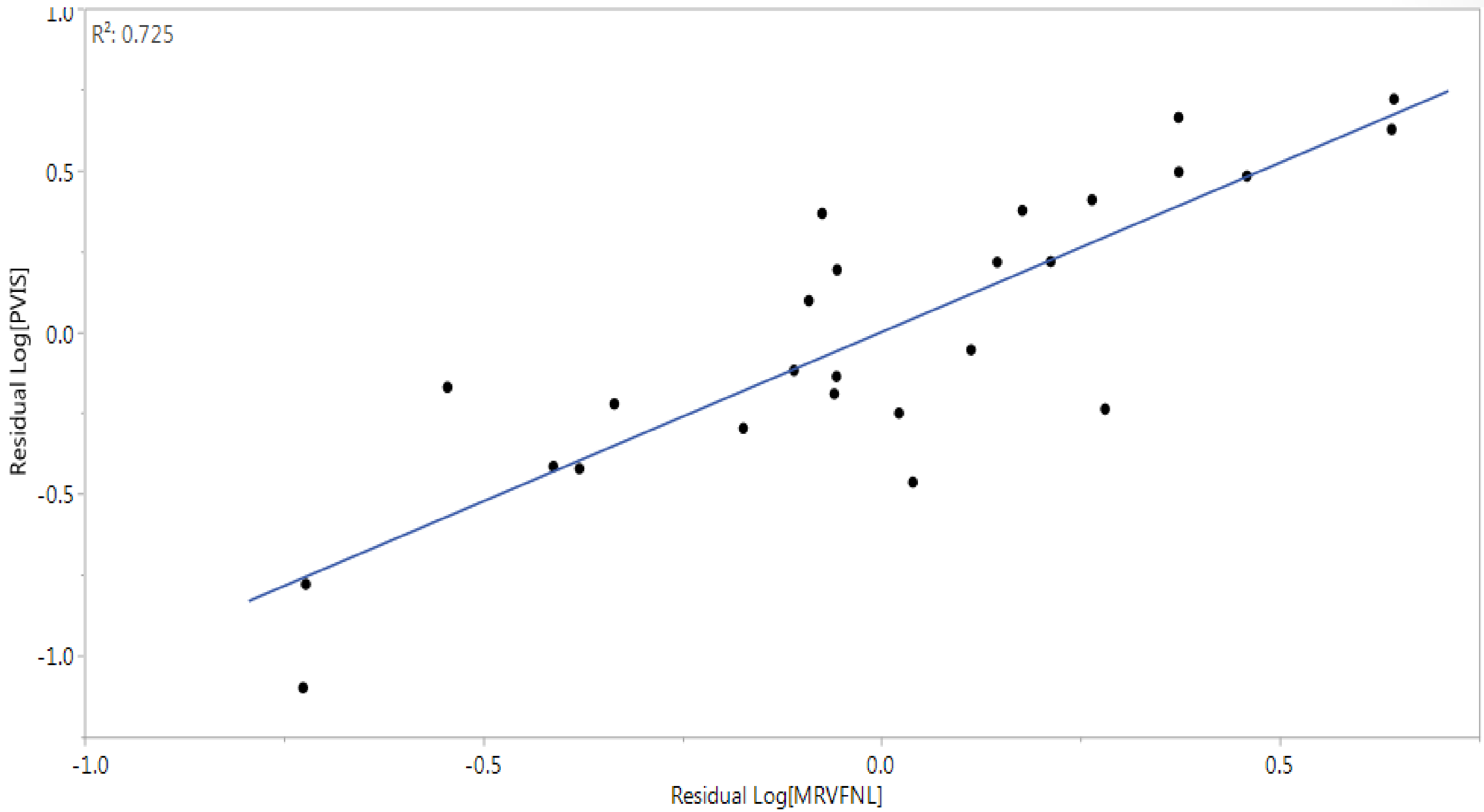
PHOS Precision

Model: Oil, Lab, Stand (Lab)

Model RMSE	Repeatability	Reproducibility
• s = 1.60 • IIIGB s=2.33	• s = 1.60 • r = 4.43	• s = 1.75 • R = 4.85

Preliminary

Correlation



PVIS and MRV are correlated

Preliminary

LTMS

ANOVA Factor	P-value			
	LnPVIS	WPD	LnMRV	PHOS
IND	0.01	0.00	0.00	0.00
LTMSLAB	0.01	0.20	0.01	0.10
LTMSAPP[LTMSLAB]	0.01	0.51	0.02	0.74

Looks like a Stand-based LTMS is appropriate for Sequence IIIH based on the Stand(Lab) factor being significant but a more detailed analysis of LTMS is needed to confirm this.

Preliminary

Reference Oil Targets (Preliminary)

PERCENT VISCOSITY INCREASE

Unit of Measure: LN(PVIS)

IIIH			IIIG		
Reference Oil	LSMean	Standard Deviation	Reference Oil	Mean	Standard Deviation
434-2	4.5287	0.8013	434	4.7269	0.3859
436	3.5192	0.3571			
438-1	3.9580	0.9558	438	4.5706	0.1768

WEIGHTED PISTON DEPOSITS

Unit of Measure: Merits

IIIH			IIIG		
Reference Oil	LSMean	Standard Deviation	Reference Oil	Mean	Standard Deviation
434-2	4.11	0.66	434	4.80	0.96
436	4.73	0.24			
438-1	3.66	0.43	438	3.20	0.33

Preliminary

Reference Oil Targets (Preliminary)

MRV VISCOSITY

Unit of Measure: LN(MRV)

IIIH			IIIGA		
Reference Oil	LSMean	Standard Deviation	Reference Oil	Mean	Standard Deviation
434-2	11.1087	0.74593	434	10.7881	0.45550
436	9.9848	0.25809			
438-1	10.0755	0.72094	438	9.8277	0.16646

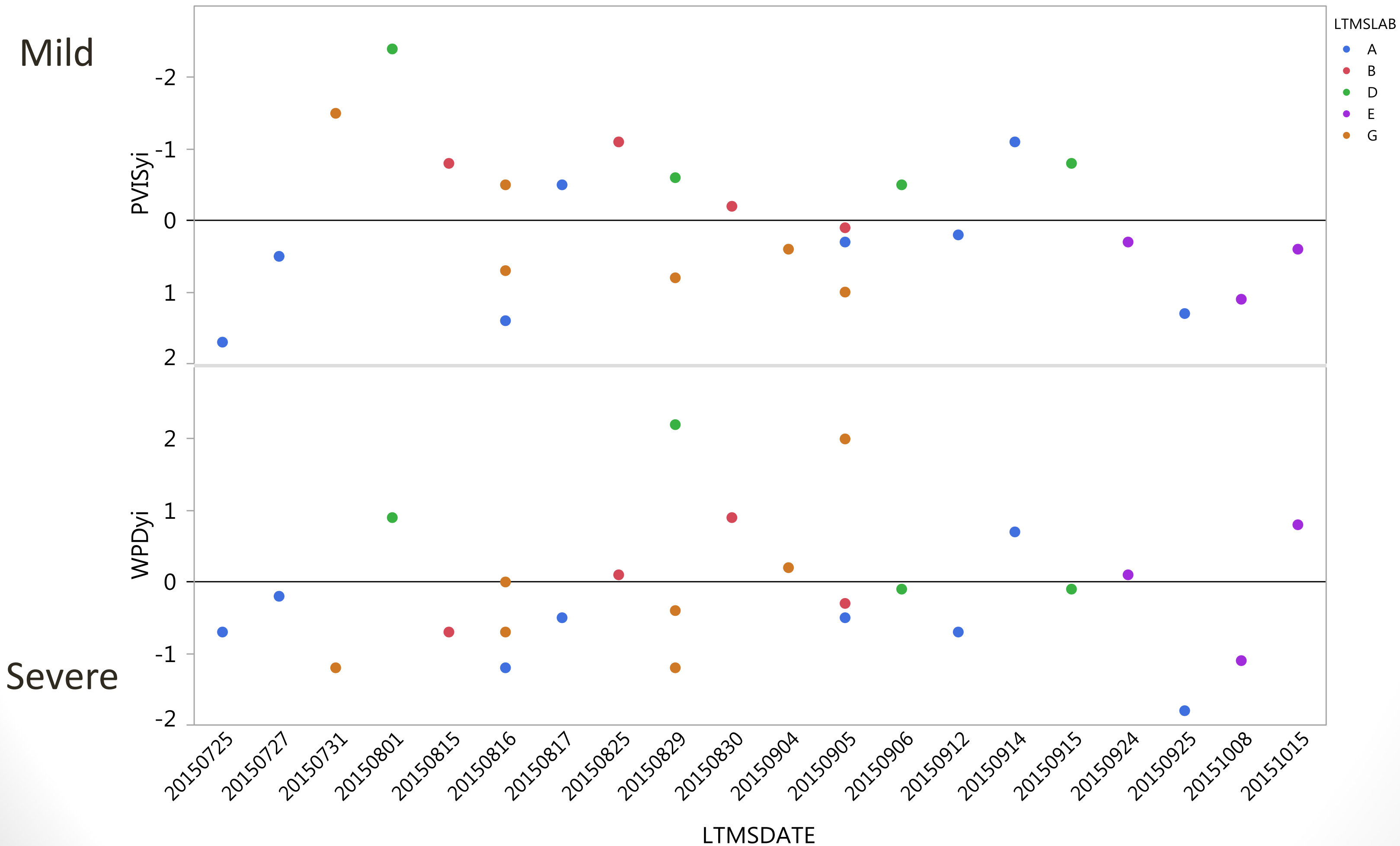
PHOSPHORUS RETENTION

Unit of Measure: Percent

IIIH			IIIGB		
Reference Oil	LSMean	Standard Deviation	Reference Oil	Mean	Standard Deviation
434-2	79.87	1.57	434	76.00	2.02
436	94.25	2.22			
438-1	78.93	1.54	438	78.20	2.56

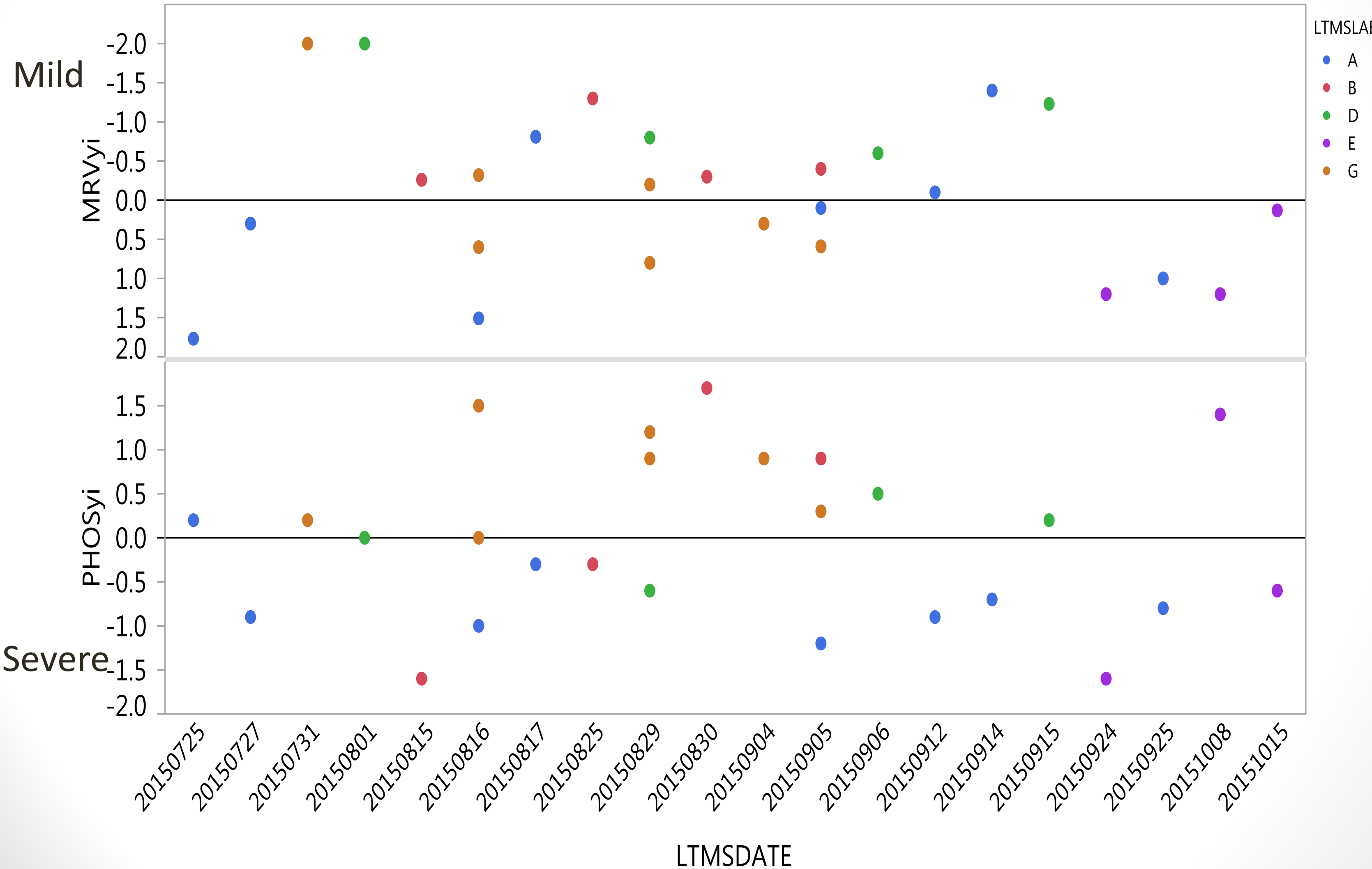
Preliminary

Industry Yi (Preliminary)



Preliminary

Industry Yi (Preliminary)

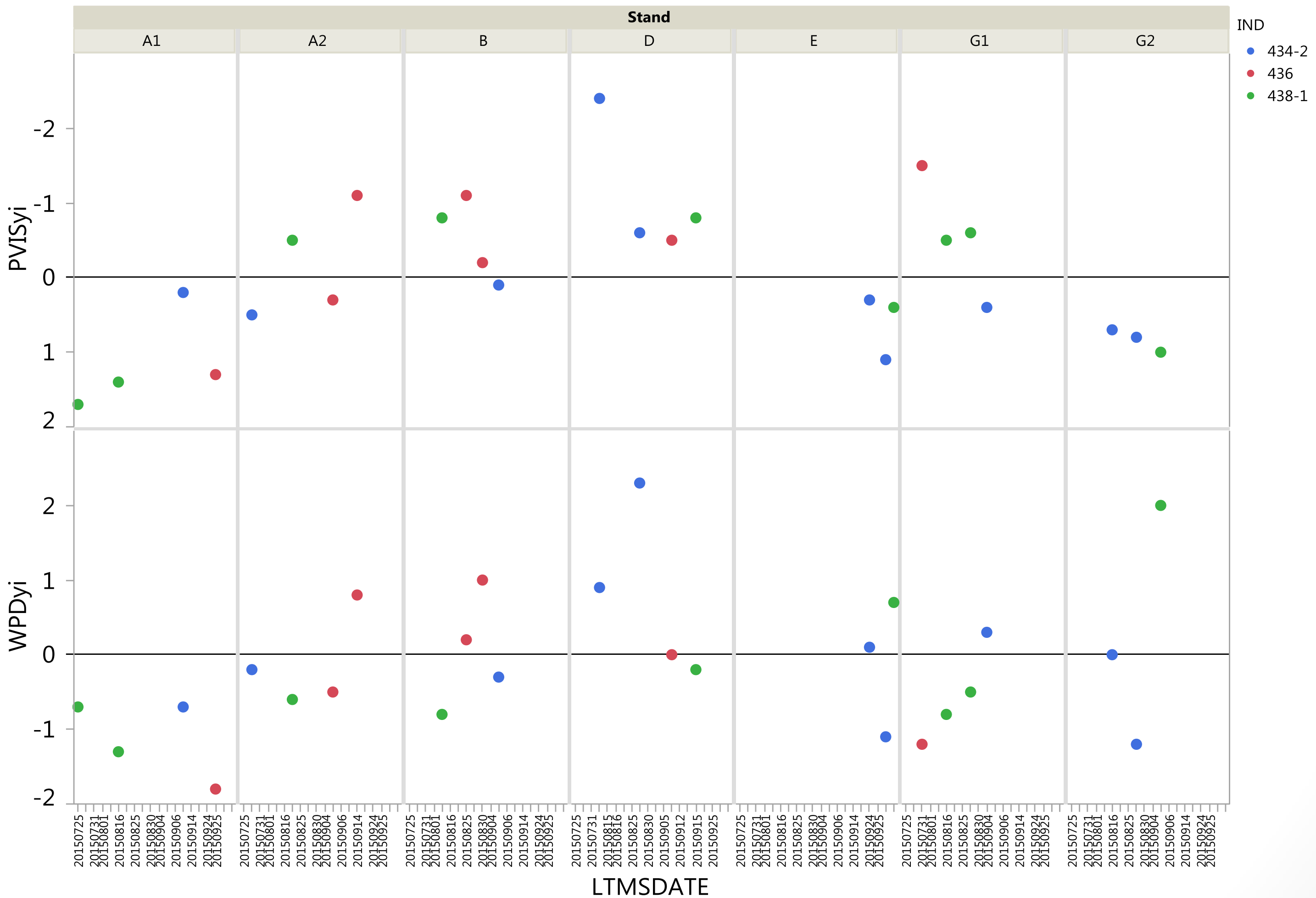


Preliminary

Stand Yi (Preliminary)

Mild

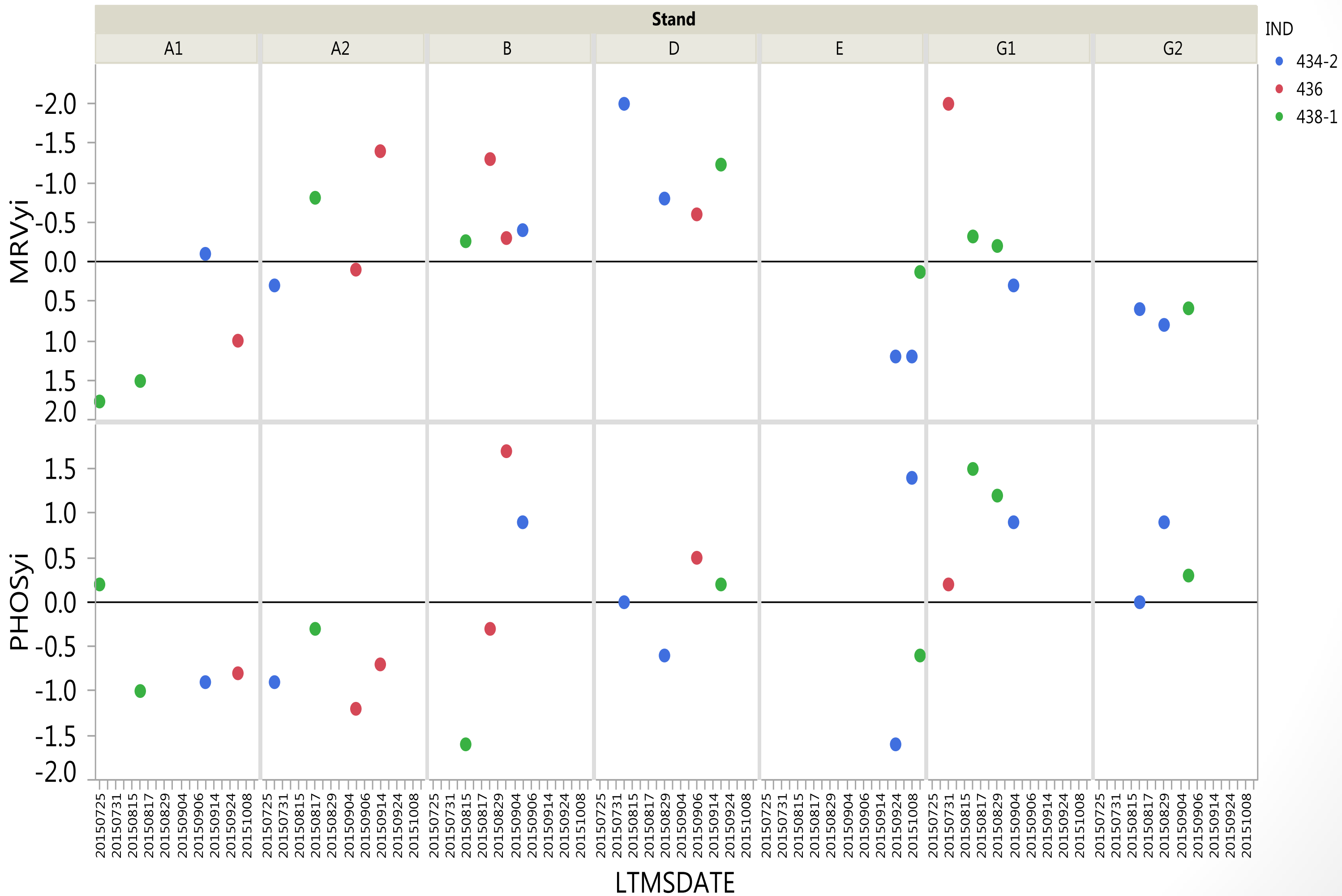
Severe



Preliminary

Stand Yi (Preliminary)

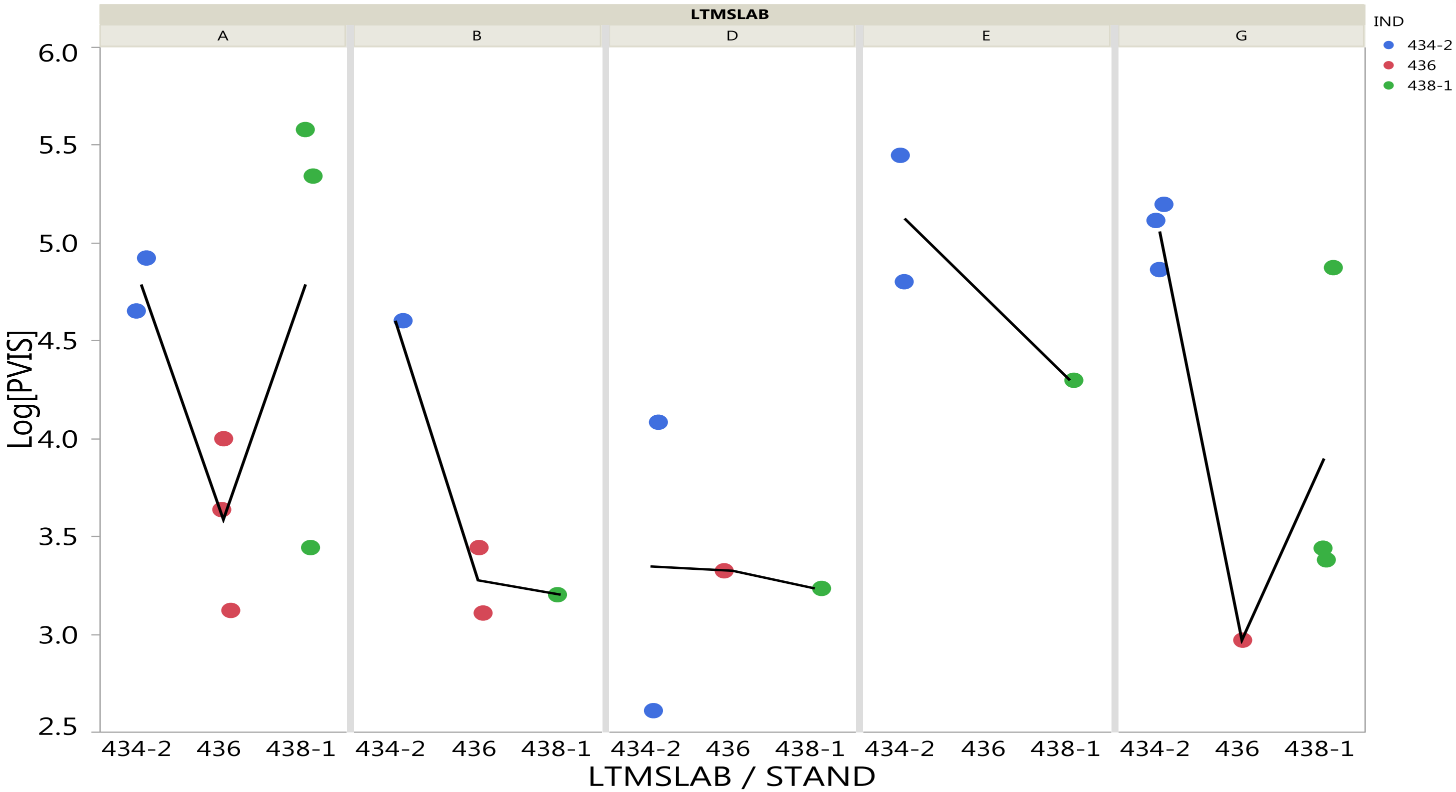
Mild



Severe

Preliminary

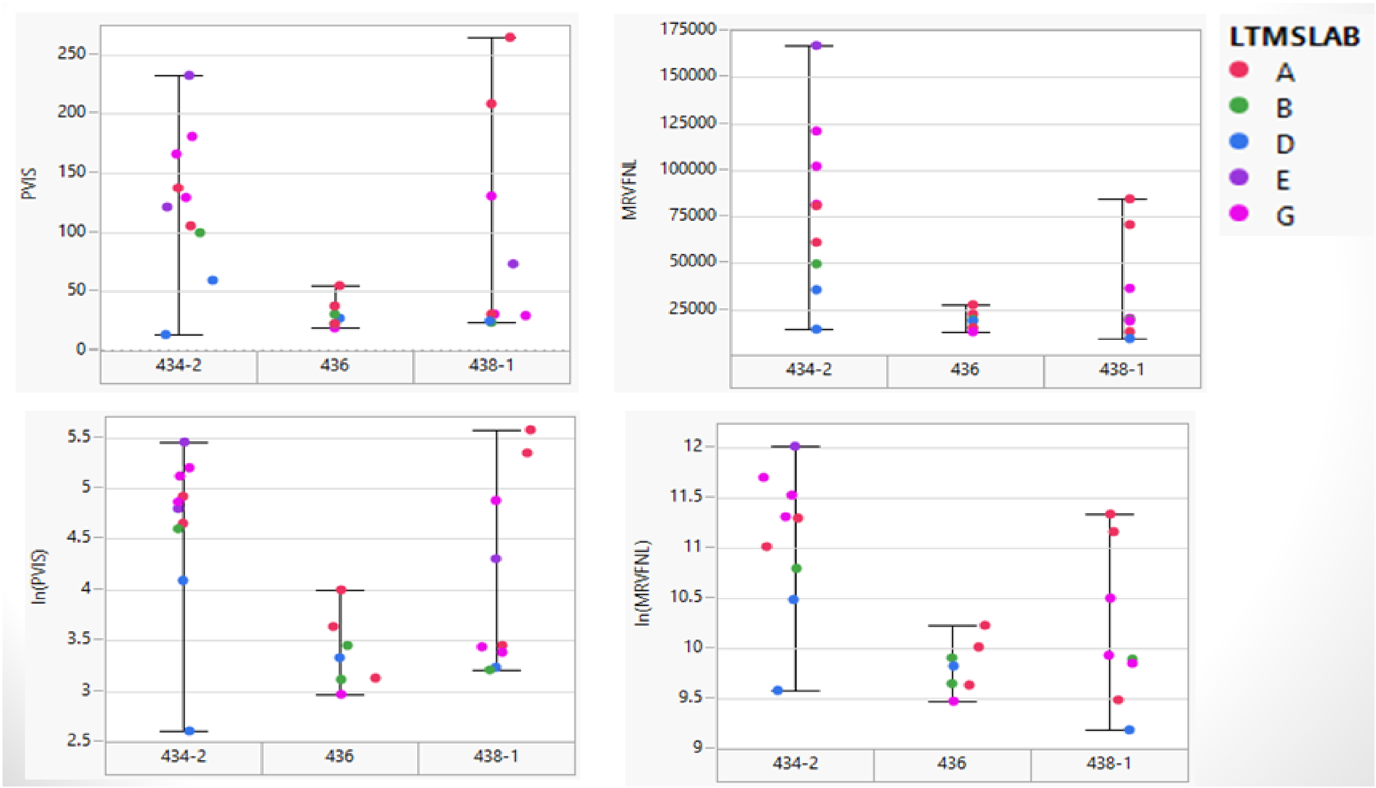
PVIS Concern 1



Preliminary

Labs do not discriminate the same way for PVIS

PVIS Concern 2



If 434-2 is meant to be a failing oil, then will PVIS and/or MRV be adequate parameters to ensure failing oils won't pass and passing oils won't fail?
Is the test severe enough for PVIS to consistently reflect that 434-2 "breaks"?

Preliminary

CENTRAL PARTS DISTRIBUTOR REPORT

SEQUENCE III SURVEILLANCE PANEL MEETING

SOUTHFIELD, MI

OCTOBER 29, 2015

PARTS REJECTION REPORT

(5 MONTH PERIOD (5/28/15 – 10/23/15)

DATE PREPARED: 10/23/15					
REPORTING PERIOD: 5 Months (5/28/15 - 10/23/15)					
ITEM	**DESCRIPTION**	**REASON REJECTED**	**QTY**	**REPLACED**	**DATE REPLACED**
OHT3F-008-8	CAMSHAFT, IIIG	PHOSPHATE COATING SCUFF	2	YES	7/23/2015
OHT3F-078-1	PISTON, GRADE 78	2 EXTRA DRAIN BACK HOLES	1	YES	8/11/2015

BATCH CODE CHANGE REPORT

(5 MONTH PERIOD (5/28/15 – 10/23/15)

IIIF	**Batch Code**	**Date Introduced**
PUSHROD	12	7/28/15
PISTON, GR. 78	2	8/19/15
PISTON, GR. 90	1	10/01/15
RINGS, RUN 7	1	8/19/15
RINGS, RUN 9	1	10/01/15
IIIG	**Batch Code**	**Date Introduced**
PUSHROD	12	8/07/15
PISTON GR. 90	1	7/21/15
RINGS, RUN 9	1	7/21/15

ADDITIONAL ITEMS

Reminder:

OHT has previously notified the testing laboratories and the Surveillance Panel to retain the following material:

OHT3F-014-1 PIN, WRIST (~150 engine sets in stock)
OHT3G-080-1 BRACKET, OIL FILTER

If testing volumes were to increase significantly, the following items would need to be retained as well:

OHT3F-058-1 ARM, ROCKER W/ BOLTS

All other items are in stock.

QUESTIONS

If you have any questions please do not hesitate to contact OHT.

Thank you.

Multiple Runs on Seq III Cylinder Heads

Part Number: 24502260S

Overview

- Original expectation was to get multiple runs on the Stellite seat cylinder heads from GM Performance (Part Number: 24502260S).
- Current IIIF/G critical hardware inventory shows that something needs to be done about head shortage in the industry to extend the life of the Seq III. The current options are:
  - Machining used 24502260B heads by Schwartz
  - Re-work of used 24502260S heads by Schwartz
  - Third party machine shop re-work of head material
  - Increasing the max valve recession specification and allowing the labs to re-work the current inventory of head material.

Cylinder Head Re-Use

- IAR developed a plan for additional uses on the cylinder heads and propose the following revisions to the IIIF/G EAM.
  - Increasing the maximum valve recession from 0.005” → 0.010”
  - Allowing the use of grinding stones (30°, 45°, and 60°) for valve seat preparation.


new Head
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50


New Head
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Description of Operation
When reusing cylinder head part number 240502260S, Clean cylinder head by automated parts washer or ultrasound bath and spray with 50/50 solution of EF-411 and degreasing solvent. Remove excess solution using compressed air. Do not use sndpaper, scotchbrite pads or other abrasives to clean heads. Visually inspect seats for wear. Measure Valve recession using procedure in 5a, sheet 1. Reject any heads where valve recession exceeds ~~0.005"~~ 0.010" Measure valve guide clearances at top nd bottom of guides. Reject any heads which do not meet clearance of 0.0015 to 0.0032 inch.

Specification

REV	Date	Revision History

View
Initial Prep, reusing Head 24052260S

		Section	Sheet
Head Assembly	**Sequence IIIG**	5a	2

Recommend the allowance of grinding stones (30°, 45°, 60°) for valve seat preparation. ←

Description of Operation

Lap valves using a water based valve grinding compound. Use Permatex Valve Grinding Compound, water mixed, item #80036.

Thoroughly clean lapping compound from valves and seats using water and a lint free rag. Be sure all lapping compound is removed. After cleaning lapping compound, spray entire head with degreasing solvent. Spray with, with 50-50 mixture of degreasing solvent and EF411 then blow dry with compressed air.

Apply bluing to each valve and install. Visually inspect for proper seating. The bluing ring should be a consistent width around the entire valve circumference and be positioned toward the middle of the face.If valves show proper seating appearance, repeat "Pre Test Measurement Procedure". If Valve seat wear does not exceed ~~.005~~", heads are acceptable for re-use. 0.010"

Specification

REV	Date	Revision History

View

Head Preparations (continued)

Head Assembly	Sequence IIIG	Section	Sheet
		5a	4

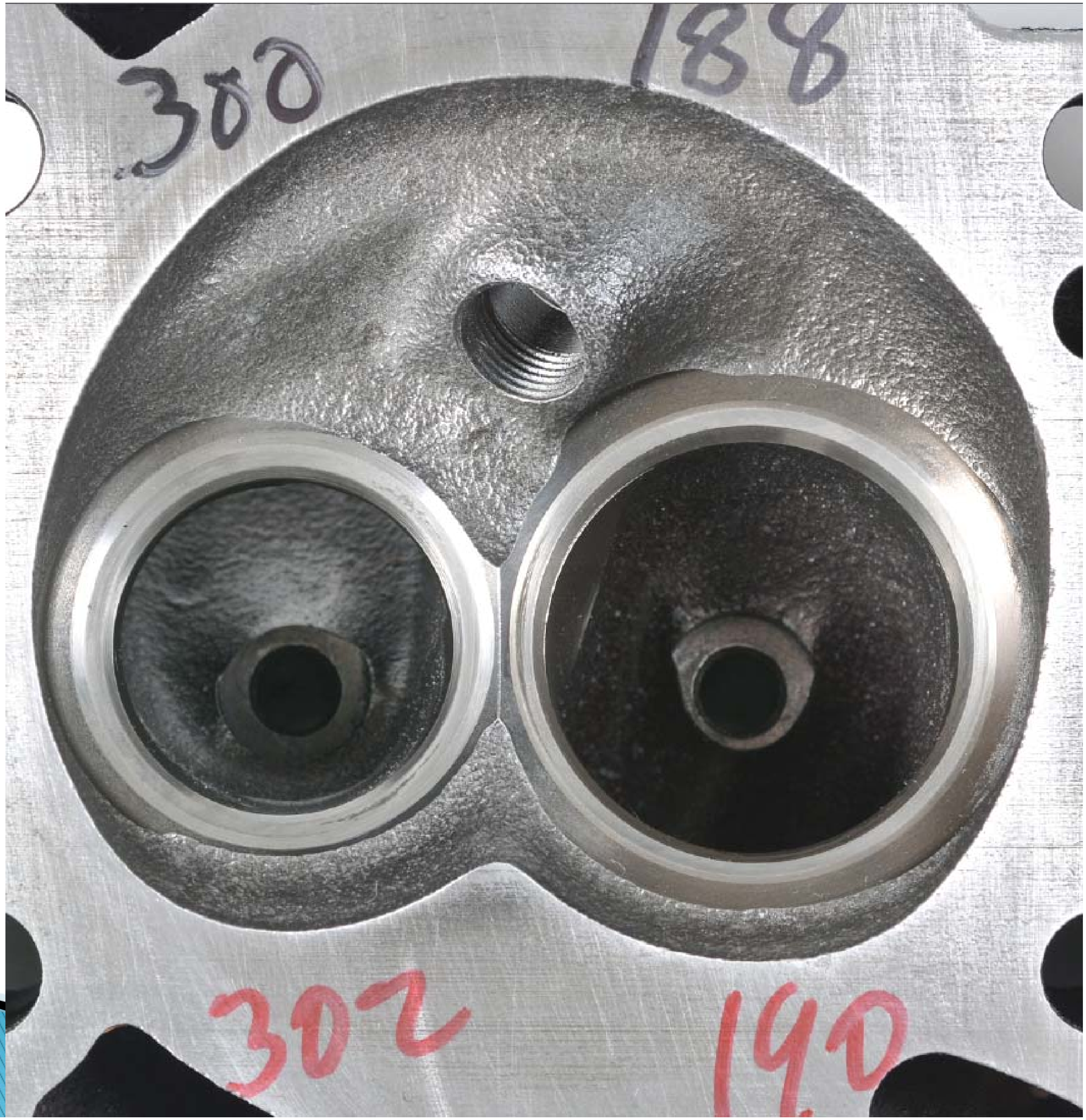
Recommendation

- MOTION:
  - IAR recommends that the maximum valve recession in the IIIF/G EAM be increased to 0.010" and allow the usage of grinding stones (30°, 45°, and 60°) for valve seat preparation on Sequence III non-reference testing provided that the laboratory has conducted a successful reference oil test.

Questions

- Addison J. Schweitzer
  - Office: (210)-706-1586
  - Mobile: (210)-215-1370

Supplemental Slides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AOAP
IIIG and IIIH Oil 434-1 Variability
IIIG and IIIH Oil Discrimination and Precision

Statisticians Group

Janet Buckingham, SwRI

Doyle Boese, Infineum

Jo Martinez, Oronite

Kevin O'Malley, Lubrizol

3/18/15

Variability of Oil 434-1 Conclusions

- Variability of 434-1, oil that is common to both tests, is not significantly different between IIIH and IIIG.
  - LnPVIS is estimated to have a standard deviation of 0.78 for the IIIH and from 0.44 to 1.23 for the IIIG.
  - WPD is estimated to have a standard deviation of 0.40 for the IIIH and from 0.69 to 0.88 for the IIIG.

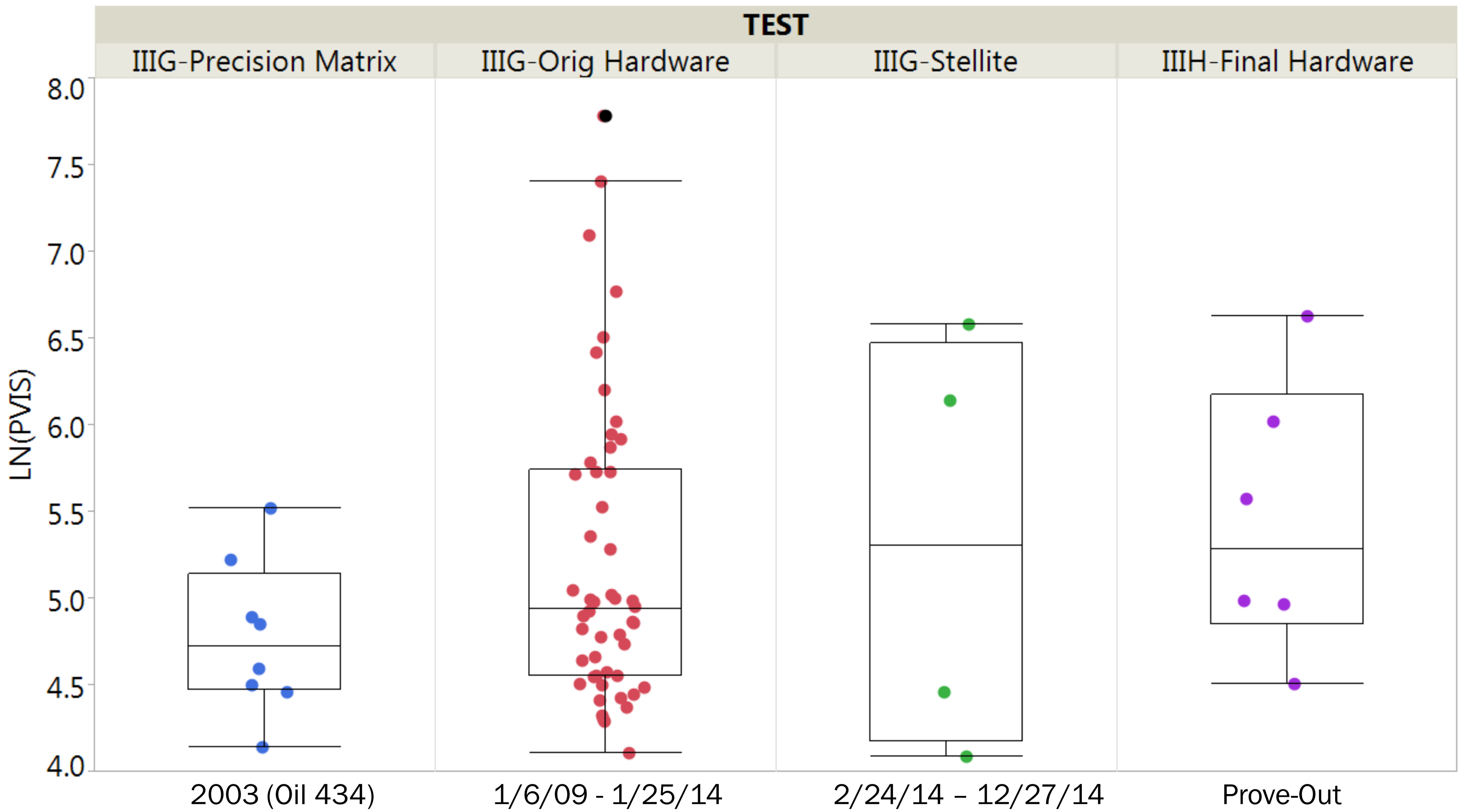
How does the variability in Oil 434-1 compare between the IIIG and IIIH tests?

Seq IIIG and Seq IIIH Oil 434-1 Data				
Test	Oil	Time Period	Hardware	# Tests
IIIG Precision Matrix	434	2003	Original	8
IIIG Since 2009	434-1	1/6/09 - 1/25/14	Original	50
IIIG Since 2014	434-1	2/24/14 – 12/27/14	Stellite	4
IIIH Prove-Out	434-1	2014-15	Final	6

LN(PVIS) Data – Oil 434-1

by Test Type and Hardware

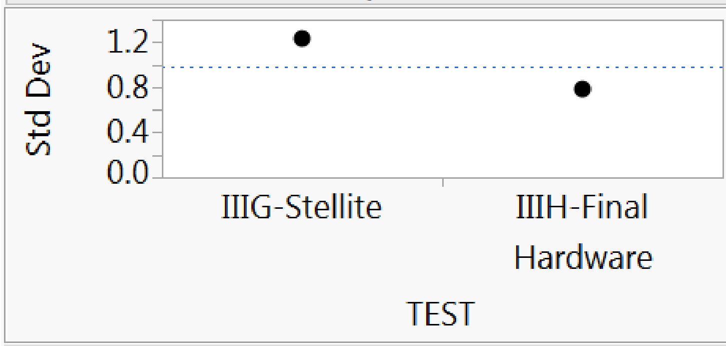
IIIG 434-1 LN(PVIS) Targets: Mean = 4.7269 Stdev = 0.3859



Concerns: IIIG PVIS has shifted over time.

Compare LN(PVIS) Variances IIIG Stellite vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Stellite	4	1.230539	1.046089	1.046089
IIIH-Final Hardware	6	0.782742	0.627110	0.627110

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	3.4755	1	8	0.0993
Brown-Forsythe	3.2631	1	8	0.1085
Levene	3.8772	1	8	0.0845
Bartlett	0.7049	1	.	0.4011
F Test 2-sided	2.4715	3	5	0.3534

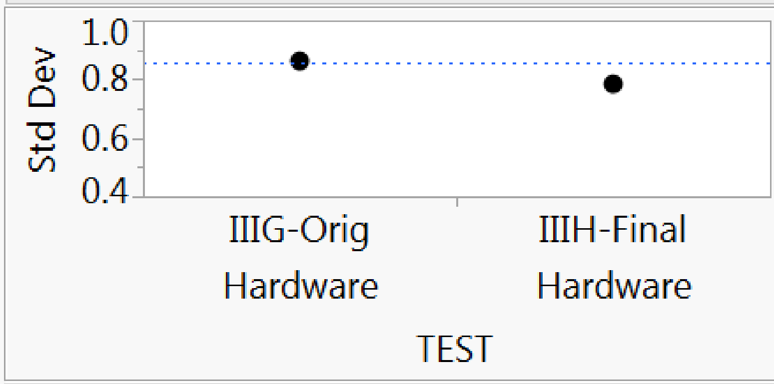
Warning: Small sample sizes. Use Caution.

Conclusion:

No significant difference in the LN(PVIS) variances between the IIIG Stellite and IIIH Prove-out based on the 434-1 results.

Compare LN(PVIS) Variances IIIG (since 2009) vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Orig Hardware	50	0.8626669	0.6923676	0.6330114
IIIH-Final Hardware	6	0.7827415	0.6271097	0.6271097

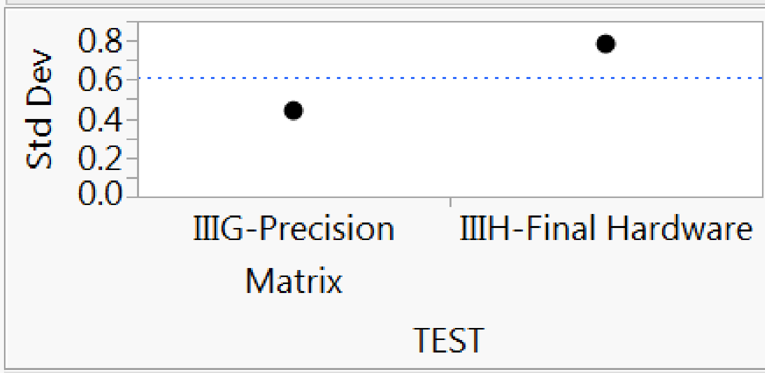
Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	0.0620	1	54	0.8044
Brown-Forsythe	0.0005	1	54	0.9826
Levene	0.0933	1	54	0.7612
Bartlett	0.0762	1	.	0.7824
F Test 2-sided	1.2146	49	5	0.9216

Conclusion:

No significant difference in the LN(PVIS) variances between the IIIG (since 2009) and IIIH Prove-out based on the 434-1 results.

Compare LN(PVIS) Variances
IIIG Precision Matrix vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Precision Matrix	8	0.4446734	0.3483561	0.3483561
IIIH-Final Hardware	6	0.7827415	0.6271097	0.6271097

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	2.4252	1	12	0.1454
Brown-Forsythe	2.4601	1	12	0.1428
Levene	2.8617	1	12	0.1165
Bartlett	1.7347	1	.	0.1878
F Test 2-sided	3.0985	5	7	0.1726

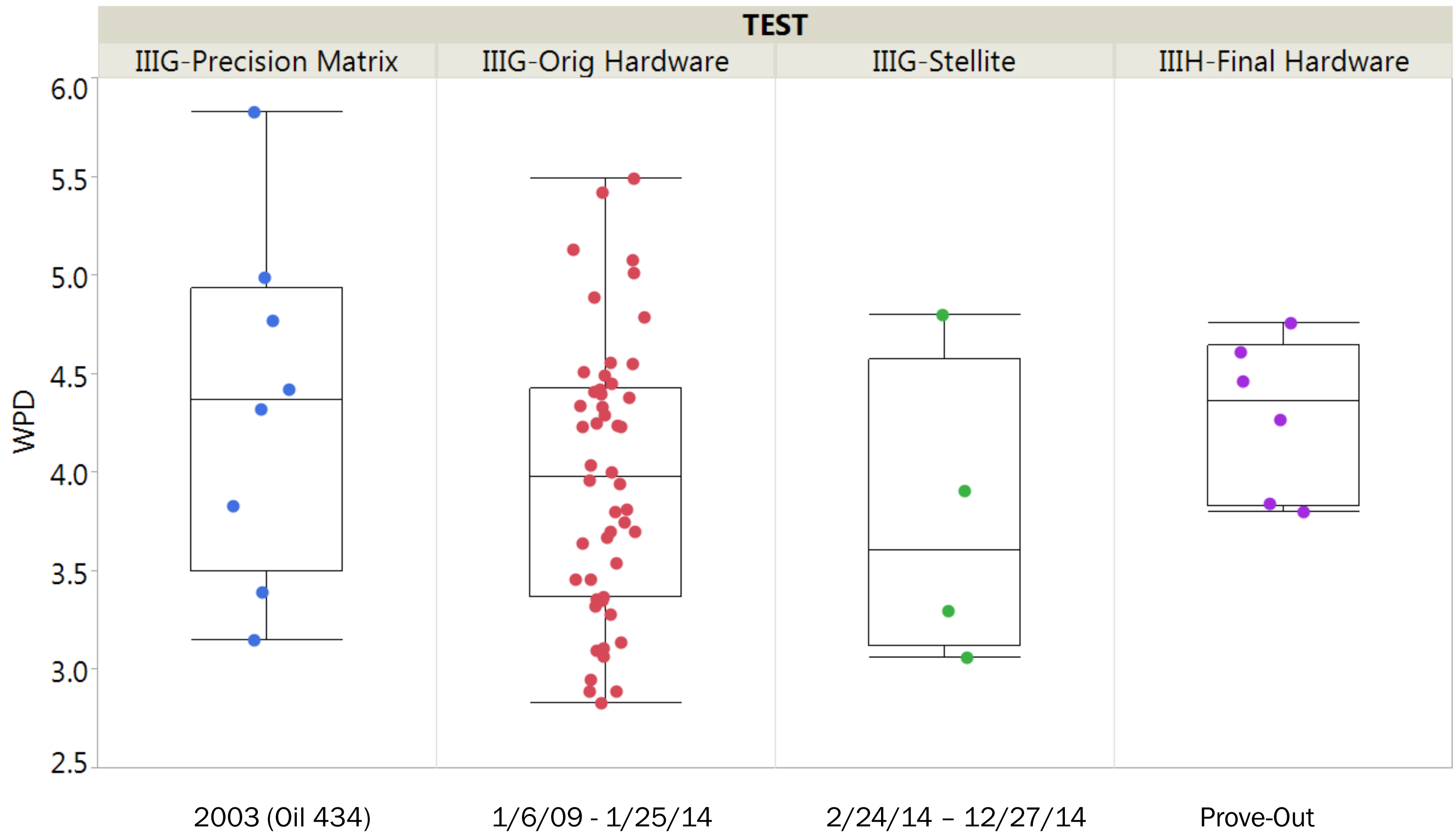
Conclusion:

No significant difference in the LN(PVIS) variances between the IIIG PM and IIIH Prove-out based on the 434 and 434-1 results.

WPD Data – Oil 434-1

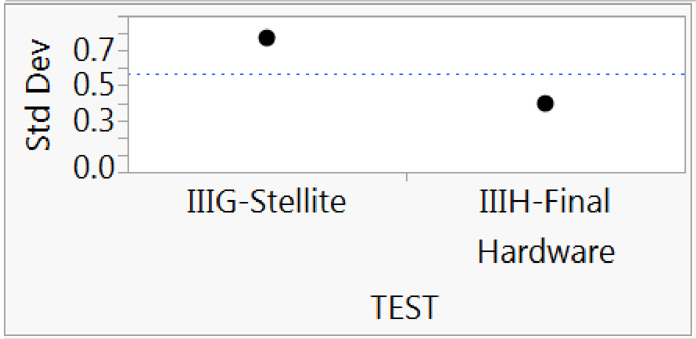
by Test Type and Hardware

IIIG 434-1 WPD Targets: Mean = 4.80 Stdev = 0.96



Compare WPD Variances
IIIG Stellite vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Stellite	4	0.7757738	0.5875000	0.5875000
IIIH-Final Hardware	6	0.3987982	0.3200000	0.3200000

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	2.0680	1	8	0.1884
Brown-Forsythe	1.8441	1	8	0.2115
Levene	2.2684	1	8	0.1705
Bartlett	1.5201	1	.	0.2176
F Test 2-sided	3.7841	3	5	0.1861

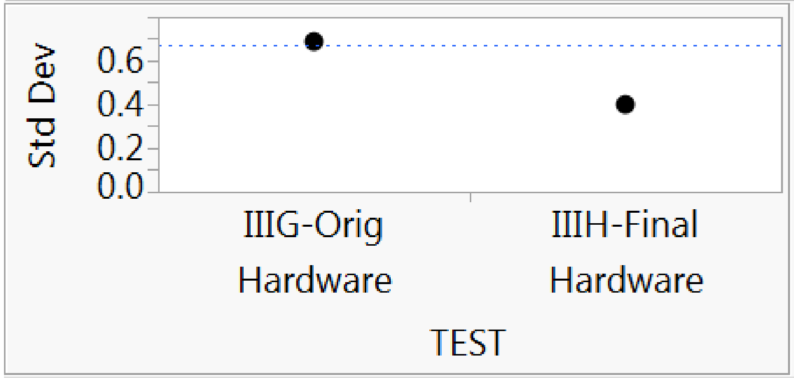
Warning: Small sample sizes. Use Caution.

Conclusion:

No significant difference in the WPD variances between the IIIG Stellite and IIIH Prove-out based on the 434-1 results.

Compare WPD Variances
IIIG (since 2009) vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Orig Hardware	50	0.6897174	0.5768000	0.5768000
IIIH-Final Hardware	6	0.3987982	0.3200000	0.3200000

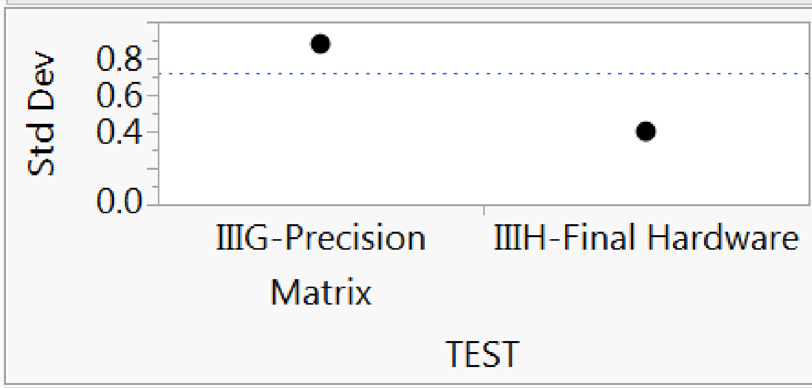
Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	1.9597	1	54	0.1673
Brown-Forsythe	2.7691	1	54	0.1019
Levene	2.7827	1	54	0.1011
Bartlett	1.9141	1	.	0.1665
F Test 2-sided	2.9911	49	5	0.2205

Conclusion:

No significant difference in the WPD variances between the IIIG (since 2009) and IIIH Prove-out based on the 434-1 results.

Compare WPD Variances
IIIG Precision Matrix vs. IIIH Prove-out

Tests that the Variances are Equal



Level	Count	Std Dev	MeanAbsDif to Mean	MeanAbsDif to Median
IIIG-Precision Matrix	8	0.8793626	0.6650000	0.6650000
IIIH-Final Hardware	6	0.3987982	0.3200000	0.3200000

Test	F Ratio	DFNum	DFDen	p-Value
O'Brien[.5]	2.2807	1	12	0.1569
Brown-Forsythe	2.3340	1	12	0.1525
Levene	2.3819	1	12	0.1487
Bartlett	2.8387	1	.	0.0920
F Test 2-sided	4.8622	7	5	0.1006

Conclusion:

No significant difference in the WPD variances between the IIIG PM and IIIH Prove-out based on the 434 and 434-1 results.

IIIG and IIIH Oil Discrimination and Precision Conclusions

- The current IIIH data shows statistical discrimination among the oils for both LnPVIS and WPD.
- The IIIH precision is estimated to be within the range of the precision of the IIIG.

LnPVIS:

The IIIH standard deviation is estimated to be 0.59 to 0.61*.

The IIIG standard deviation ranges from 0.29 to 0.63* for the different subsets of data considered in the analysis.

WPD:

The IIIH standard deviation is estimated to be 0.40 to 0.42*.

The IIIG standard deviation ranges from 0.39 to 0.60* for the different subsets of data considered in the analysis.

* Ranges of estimates, not confidence intervals.

Comparing IIIG and IIIH Precision Using Lab-based Models

- Compared IIIG and IIIH with models using only two effects:
  - Oil
  - Lab
- Combined all 435 oil blends as they were not significantly different from one another in the various models
- Statistical outliers were not removed from the models
  - Very small data sets

- Concerns:
  - The standard deviations of the oils in the IIIG and IIIH are not the same; however, the range of the quality of the oils is similar
  - The IIIG PVIS data has shifted over time

PVIS Summary

- Lab-based Model included only Oil and Lab effects
- Used 5% level of significance
- No statistical outliers were removed

Test	Data	Oil Discrimination	RMSE
IIIG	Precision matrix (n=24) 2003 Oils: 434, 435, 438	(438, 434) < 435	0.2919
IIIG	#A (n=154)* 1/6/09 – 2/2/14 Original cylinder heads Oils: 434-1, 435blends, 438	438 < (435blends, 434-1)	0.54
IIIG	#B (n=75)* 1/24/11 – 2/2/14 Original cylinder heads Oils: 434-1, 435-2, 438	438 < (435-2, 434-1)	0.63
IIIG	#C (n=23) 2/24/14 – 2/18/15 Stellite seats Oils: 434-1, 434-2, 435-2, 438	438 < 435-2	0.56
IIIH	#D (n=22) Prove-out Final hardware Oils: 434-1, REO2, REO3, 438-1	(REO2, 438-1, REO3) < 434-1	0.59
IIIH	#E (n=20) Prove-out Final hardware Oils: 434-1, REO2, 438-1	(438-1, REO2) < 434-1	0.61

* Statistical outliers identified but not removed

WPD Summary

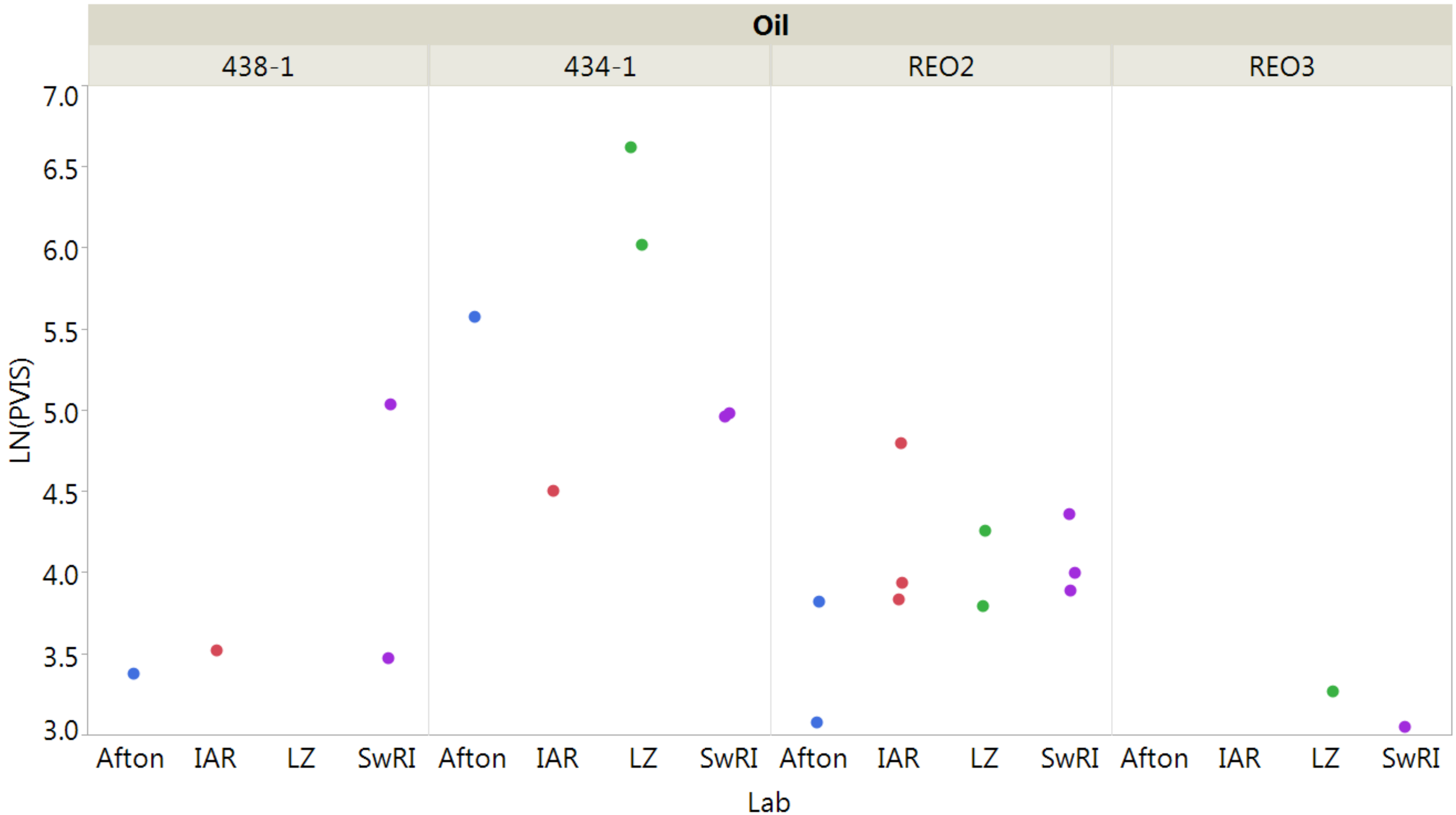
- Lab-based model included only Oil and Lab effects
- Used 5% level of significance
- No statistical outliers were removed

Test	Data	Oil Discrimination	RMSE
IIIG	Precision matrix (n=24) 2003 Oils: 434, 435, 438	(438, 435) < 434	0.60
IIIG	#A (n=154)* 1/6/09 – 2/2/14 Original cylinder heads Oils: 434-1, 435blends, 438	438 < 435blends < 434-1	0.43
IIIG	#B (n=75) * 1/24/11 – 2/2/14 Original cylinder heads Oils: 434-1, 435-2, 438	438 < 435-2 < 434-1	0.39
IIIG	#C (n=23) 2/24/14 – 2/18/15 Stellite seats Oils: 434-1, 434-2, 435-2, 438	(438, 435-2) < 434-2 438 < 434-1	0.40
IIIH	#D (n=22)* Prove-out Final hardware Oils: 434-1, REO2, REO3, 438-1	(REO2, 434-1, 438-1) < REO3 438-1 < REO2	0.42
IIIH	#E (n=20)* Prove-out Final hardware Oils: 434-1, REO2, 438-1	438-1 < (REO2, 434-1)	0.40

* Statistical outliers identified but not removed

LN(PVIS) – IIIH Prove-Out

by Oil and Lab



Model #A: IIIG LN(PVIS)

Original cylinder heads, 1/6/09 – 2/2/14, n=154

Summary of Fit

RSquare	0.288193
RSquare Adj	0.254065
Root Mean Square Error	0.542634
Mean of Response	5.032369
Observations (or Sum Wgts)	154

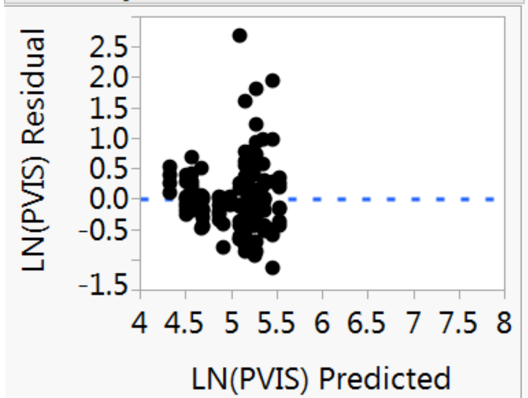
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
INDx	2	2	13.767153	23.3776	<.0001*
LTMSLAB	5	5	2.723646	1.8500	0.1067

Residual by Predicted Plot



- Oil Discrimination
  - 438 < (435blends, 434-1)
- RMSE = 0.54

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.3679

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
435	438	0.6678567	0.1067865	0.414997	0.9207160	<.0001*
434-1	438	0.5864287	0.1071977	0.332596	0.8402618	<.0001*
435	434-1	0.0814280	0.1081393	-0.174635	0.3374906	0.7323

Model #B: IIIG LN(PVIS)

Original cylinder heads, 1/24/11 – 2/2/14, n=75

Summary of Fit

RSquare	0.359715
RSquare Adj	0.292819
Root Mean Square Error	0.632663
Mean of Response	5.174737
Observations (or Sum Wgts)	75

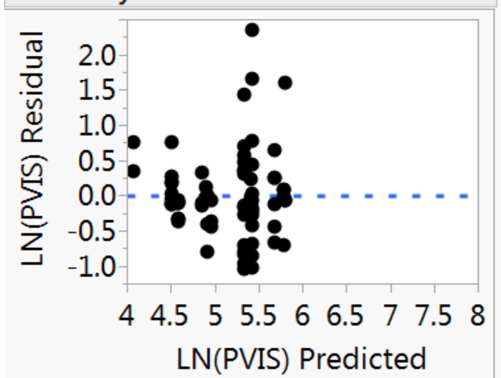
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	2	2	10.942534	13.6692	<.0001*
LTMSLAB	5	5	3.980907	1.9891	0.0915

Residual by Predicted Plot



- Oil Discrimination
  - 438 < (435-2, 434-1)
- RMSE = 0.63

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.39689

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-1	438	0.8374931	0.1840148	0.396430	1.278556	<.0001*
435-2	438	0.8283850	0.1803166	0.396186	1.260584	<.0001*
434-1	435-2	0.0091081	0.1766911	-0.414401	0.432617	0.9985

Model #C: IIIG LN(PVIS)

Stellite seats, 2/24/14 – 2/18/15, n=23

Summary of Fit

RSquare	0.477831
RSquare Adj	0.234152
Root Mean Square Error	0.564695
Mean of Response	5.076853
Observations (or Sum Wgts)	23

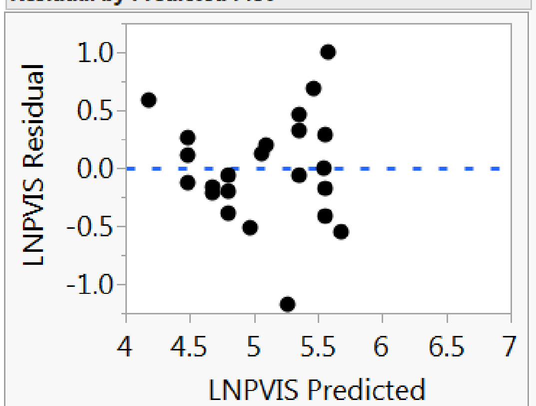
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	3	3	3.4160230	3.5709	0.0396*
LTMSLAB	4	4	0.8287706	0.6498	0.6358

Residual by Predicted Plot



- Oil Discrimination
  - 438 < 435-2
- RMSE = 0.56

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.88215

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
435-2	438	0.8787650	0.2861176	0.05413	1.703399	0.0349*
434-1	438	0.7829486	0.3486176	-0.22182	1.787716	0.1558
434-2	438	0.6111640	0.4710501	-0.74647	1.968800	0.5783
435-2	434-2	0.2676009	0.4715850	-1.09158	1.626779	0.9402
434-1	434-2	0.1717846	0.5066402	-1.28843	1.631997	0.9860
435-2	434-1	0.0958163	0.3517378	-0.91794	1.109577	0.9926

Model #D: IIIH LN(PVIS)

Final hardware, n=22

Summary of Fit

RSquare	0.724694
RSquare Adj	0.614571
Root Mean Square Error	0.591196
Mean of Response	4.284474
Observations (or Sum Wgts)	22

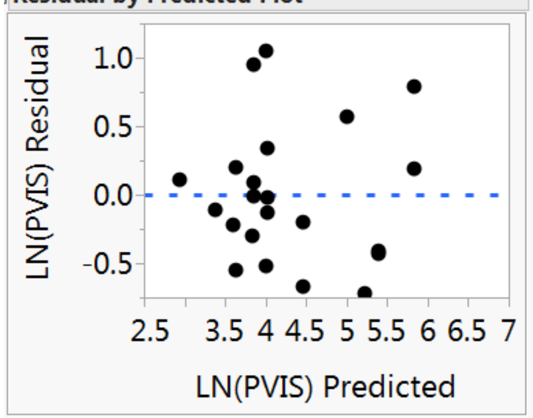
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Oil	3	3	11.927602	11.3755	0.0004*
Lab	3	3	1.521118	1.4507	0.2677

Residual by Predicted Plot



Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-1	REO3	2.451258	0.4913439	1.03513	3.867385	0.0008*
434-1	438-1	1.395351	0.3961808	0.25350	2.537203	0.0146*
434-1	REO2	1.372278	0.3101316	0.47843	2.266123	0.0025*
REO2	REO3	1.078980	0.4794411	-0.30284	2.460801	0.1546
438-1	REO3	1.055907	0.5417127	-0.50539	2.617204	0.2501
REO2	438-1	0.023073	0.3572543	-1.00659	1.052733	0.9999

- Oil Discrimination
  - (REO2, 438-1, REO3) < 434-1
- RMSE = 0.59

Model #E: IIIH LN(PVIS)

Final hardware, n=20, removed REO3 tests

Summary of Fit

RSquare	0.679321
RSquare Adj	0.564792
Root Mean Square Error	0.610199
Mean of Response	4.396553
Observations (or Sum Wgts)	20

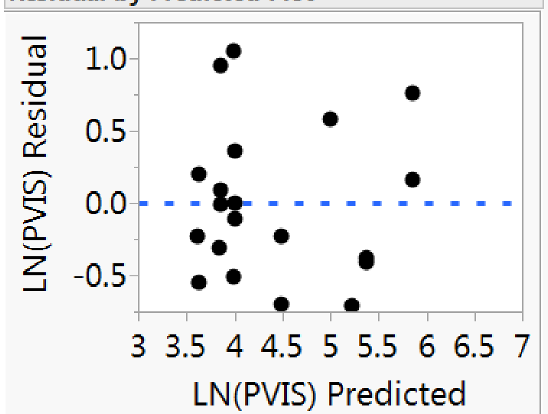
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Oil	2	2	7.4921150	10.0608	0.0020*
Lab	3	3	1.5269488	1.3670	0.2935

Residual by Predicted Plot

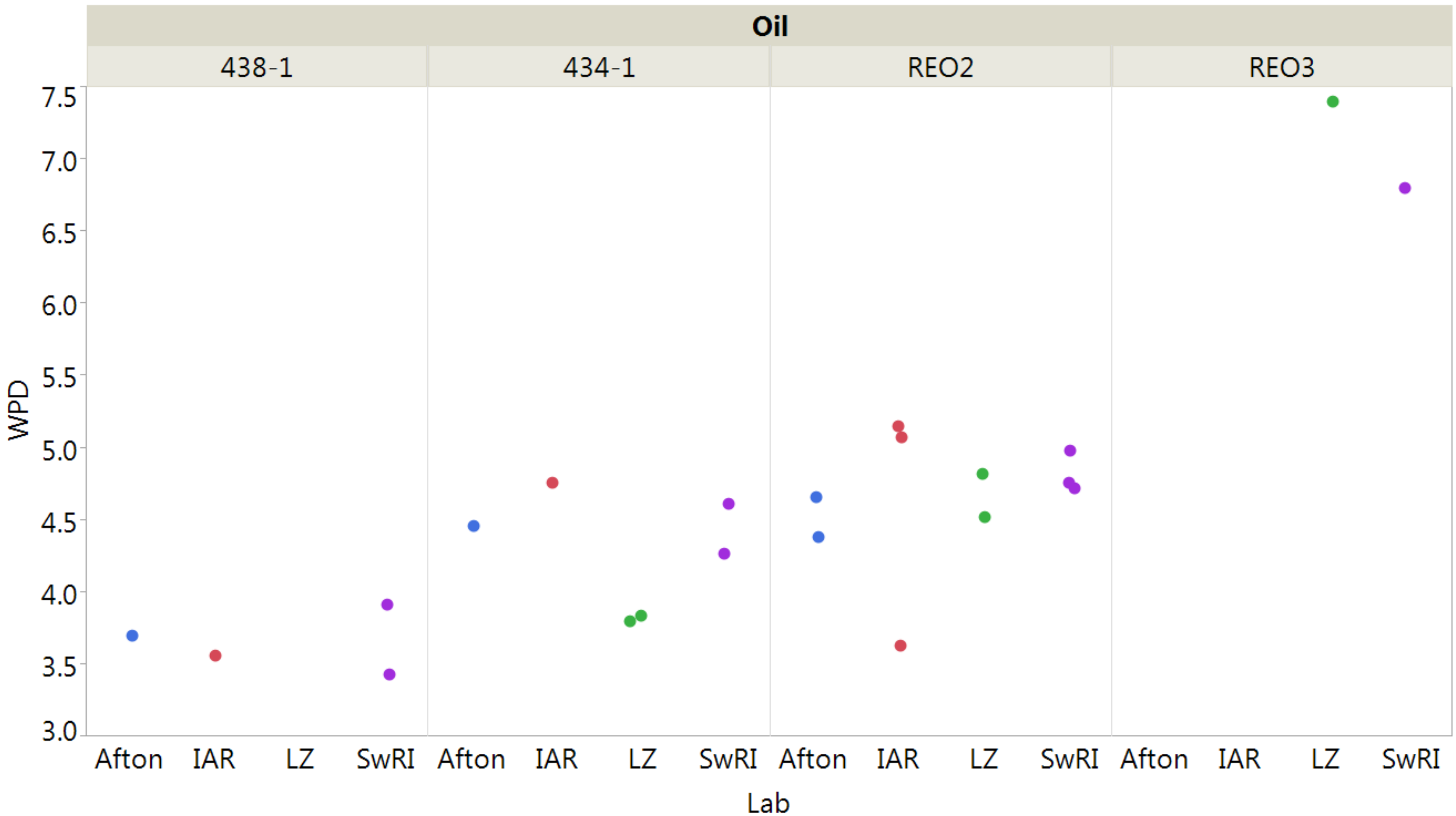


- Oil Discrimination
  - (438-1, REO2) < 434-1
- RMSE = 0.61

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-1	438-1	1.382360	0.4114778	0.305408	2.459313	0.0122*
434-1	REO2	1.368718	0.3203467	0.530281	2.207156	0.0021*
REO2	438-1	0.013642	0.3702370	-0.955372	0.982656	0.9993

WPD – IIIH Prove-Out

by Oil and Lab



Model #A: IIIG WPD

Original cylinder heads, 1/6/09 – 2/2/14, n=154

Summary of Fit

RSquare	0.482397
RSquare Adj	0.45758
Root Mean Square Error	0.431488
Mean of Response	3.436753
Observations (or Sum Wgts)	154

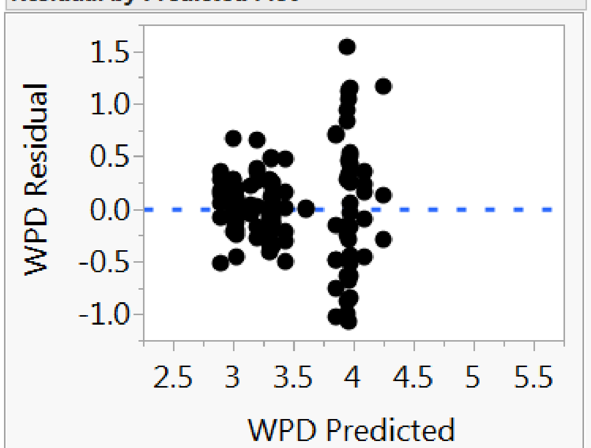
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
INDx	2	2	24.143856	64.8394	<.0001*
LTMSLAB	5	5	1.272489	1.3669	0.2401

Residual by Predicted Plot



- Oil Discrimination
  - 438 < 435blends < 434-1
- RMSE = 0.43

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.3679

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-1	438	0.9521892	0.0852407	0.7503480	1.154030	<.0001*
434-1	435	0.6520206	0.0859894	0.4484065	0.855635	<.0001*
435	438	0.3001686	0.0849137	0.0991018	0.501236	0.0016*

Model #B: IIIG WPD

Original cylinder heads, 1/24/11 – 2/2/14, n=75

Summary of Fit

RSquare	0.498179
RSquare Adj	0.44575
Root Mean Square Error	0.389044
Mean of Response	3.4224
Observations (or Sum Wgts)	75

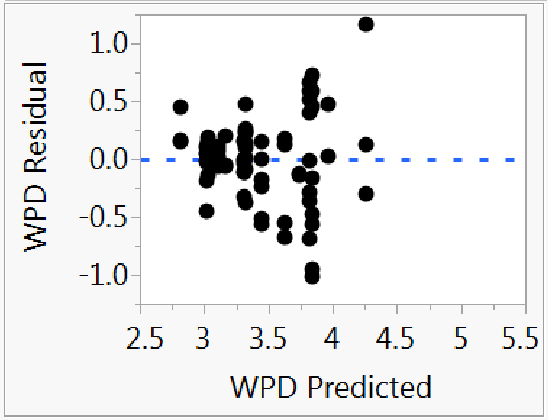
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	2	2	8.0254868	26.5122	<.0001*
LTMSLAB	5	5	1.8641520	2.4633	0.0414*

Residual by Predicted Plot



- Oil Discrimination
  - 438 < 435-2 < 434-1
- RMSE = 0.39

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.39689

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-1	438	0.8095061	0.1131562	0.5382832	1.080729	<.0001*
434-1	435-2	0.5170667	0.1086526	0.2566383	0.777495	<.0001*
435-2	438	0.2924395	0.1108820	0.0266674	0.558212	0.0277*

Model #C: IIIG WPD

Stellite seats, 2/24/14 – 2/18/15, n=23

Summary of Fit

RSquare	0.780577
RSquare Adj	0.678179
Root Mean Square Error	0.403545
Mean of Response	3.470435
Observations (or Sum Wgts)	23

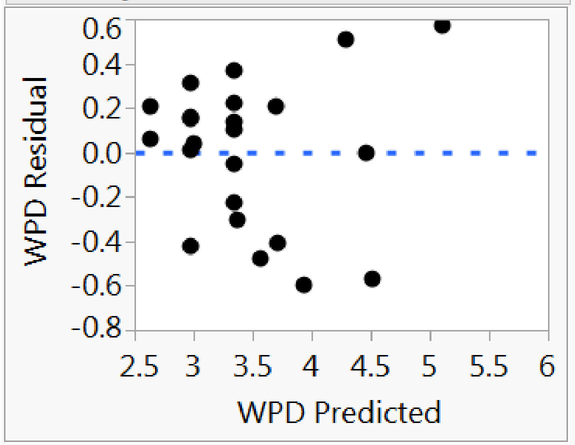
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
IND	3	3	3.9406460	8.0661	0.0020*
LTMSLAB	4	4	2.6953057	4.1377	0.0187*

Residual by Predicted Plot



- Oil Discrimination
  - (438, 435-2) < 434-2
  - 438 < 434-1
- RMSE = 0.54

LSMeans Differences Tukey HSD

α= 0.050 Q= 2.88215

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
434-2	438	1.540290	0.3366242	0.570089	2.510491	0.0018*
434-2	435-2	1.171070	0.3370065	0.199767	2.142373	0.0160*
434-2	434-1	0.807733	0.3620578	-0.235771	1.851238	0.1597
434-1	438	0.732557	0.2491308	0.014524	1.450589	0.0448*
435-2	438	0.369220	0.2044668	-0.220084	0.958524	0.3088
434-1	435-2	0.363337	0.2513606	-0.361122	1.087796	0.4922

Model #D: IIIH WPD

Final hardware, n=22

Summary of Fit

RSquare	0.863102
RSquare Adj	0.808343
Root Mean Square Error	0.422336
Mean of Response	4.601364
Observations (or Sum Wgts)	22

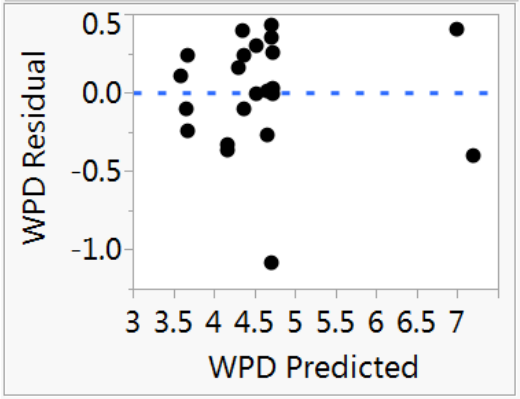
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Oil	3	3	15.931929	29.7736	<.0001*
Lab	3	3	0.134179	0.2508	0.8596

Residual by Predicted Plot



- Oil Discrimination
  - (REO2, 434-1, 438-1) < REO3
  - 438-1 < REO2
- RMSE = 0.42

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
REO3	438-1	3.530643	0.3869859	2.41529	4.645994	<.0001*
REO3	434-1	2.829531	0.3510037	1.81789	3.841176	<.0001*
REO3	REO2	2.473734	0.3425006	1.48660	3.460872	<.0001*
REO2	438-1	1.056909	0.2552134	0.32135	1.792472	0.0043*
434-1	438-1	0.701112	0.2830215	-0.11460	1.516823	0.1047
REO2	434-1	0.355797	0.2215501	-0.28274	0.994337	0.4048

Model #E: IIIH WPD

Final hardware, n=20, removed REO3 tests

Summary of Fit

RSquare	0.594512
RSquare Adj	0.449696
Root Mean Square Error	0.403771
Mean of Response	4.3515
Observations (or Sum Wgts)	20

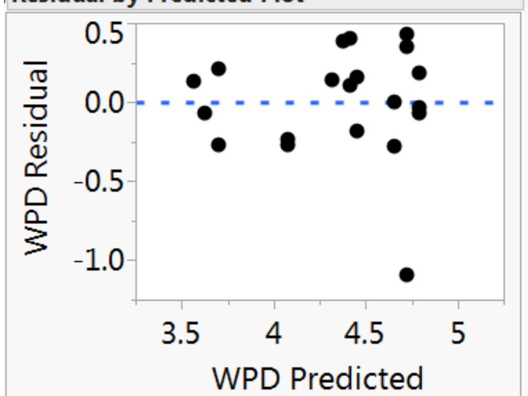
Analysis of Variance

Parameter Estimates

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Oil	2	2	3.2495325	9.9660	0.0020*
Lab	3	3	0.3472596	0.7100	0.5620

Residual by Predicted Plot



- Oil Discrimination
  - 438-1 < (434-1, REO2)
- RMSE = 0.40

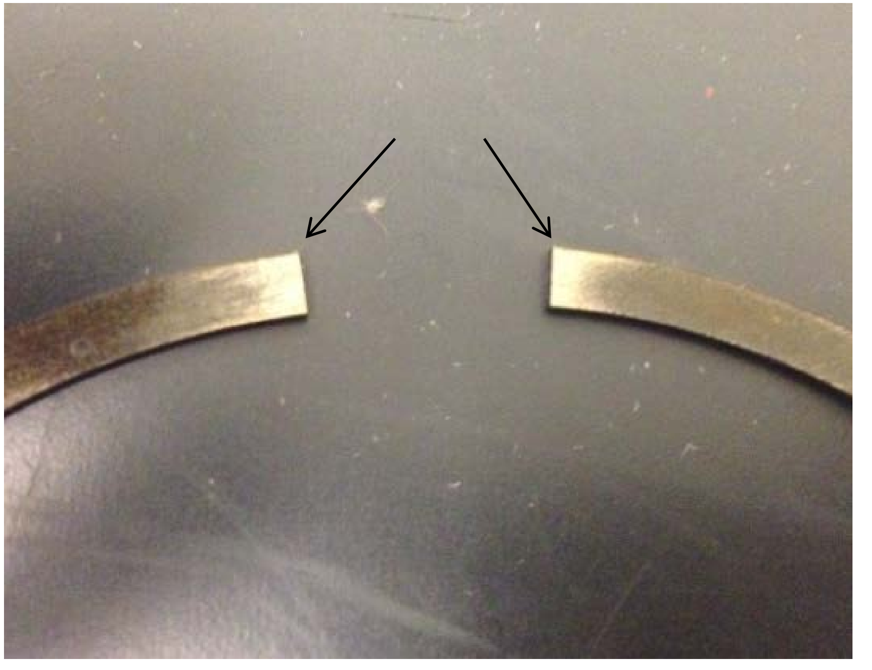
Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
REO2	438-1	1.091110	0.2449869	0.449911	1.732310	0.0015*
434-1	438-1	0.748222	0.2722761	0.035599	1.460845	0.0392*
REO2	434-1	0.342888	0.2119744	-0.211908	0.897685	0.2710

Sequence IIIG Piston Ring Chamfers

09/28/2015

Background

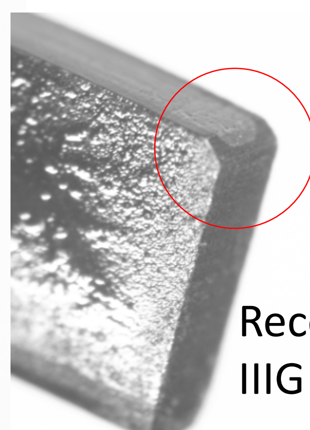
- Industry has been concerned about Seq. III Piston Deposit Severity
- LZ discovered on Chrysler IIIH test that even a slight chamfer or excessive deburring of the edge/corner of the piston ring gap will cause dramatic shifts in WPD and PVIS severity
- Led to investigation of IIIG piston rings



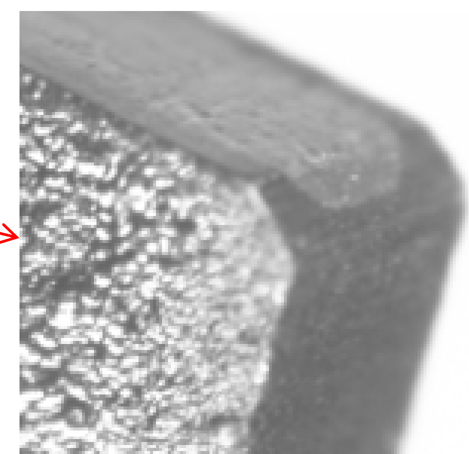
IIIG Ring Gap

- Inspection of current batch of rings revealed a vertical chamfer along both outside corners of the ring gap
- Spot checks of batches 8, 9, and the most recent batches 1 and 2 for run 7/8 and 9/10 also indicate the chamfer is present
- Measurements of the chamfers vary in the width (0.14-0.34 mm avg.)
- OHT rings for the IIIH and IIIF do not appear to have this chamfer
- Early, batch 4 IIIG rings (BC4) do not have this chamfer
- Production, dealer purchased rings also do not show chamfered vertical edges
- General industry knowledge is that the edge should be sharp and un-chamfered

Chamferless rings

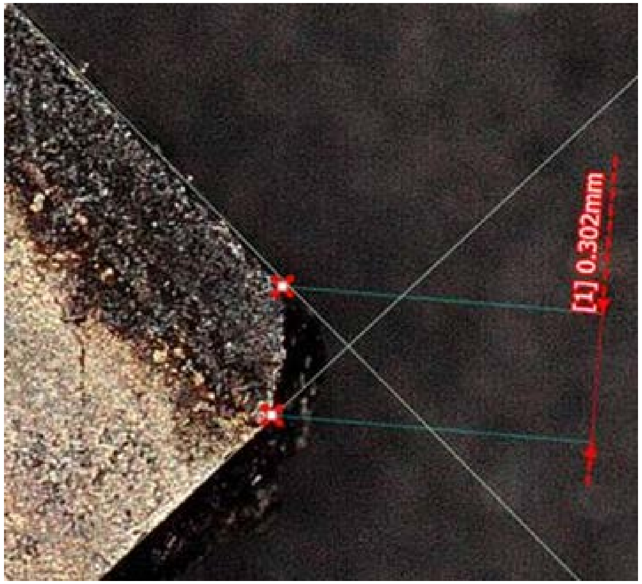


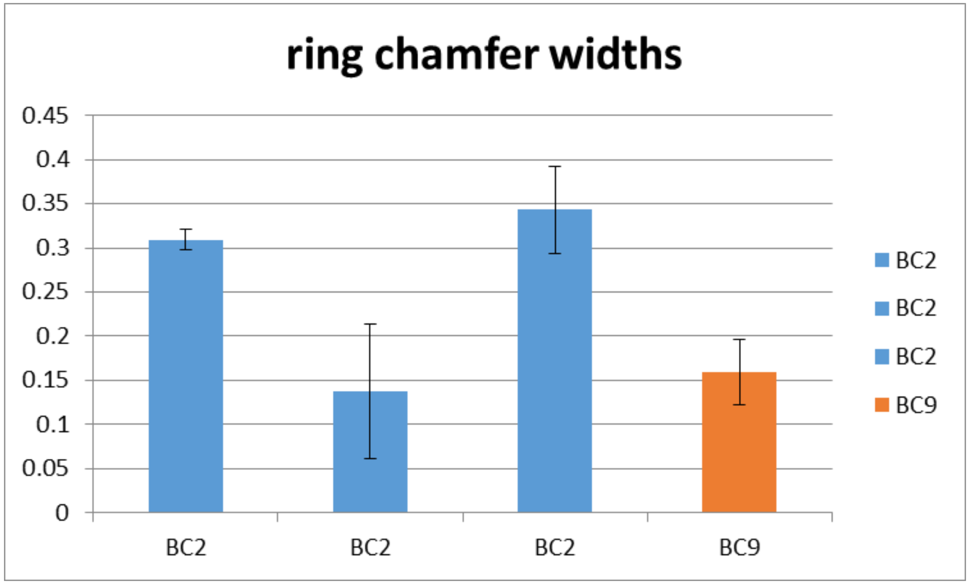
Recent batch IIIG rings



Inspection of rings

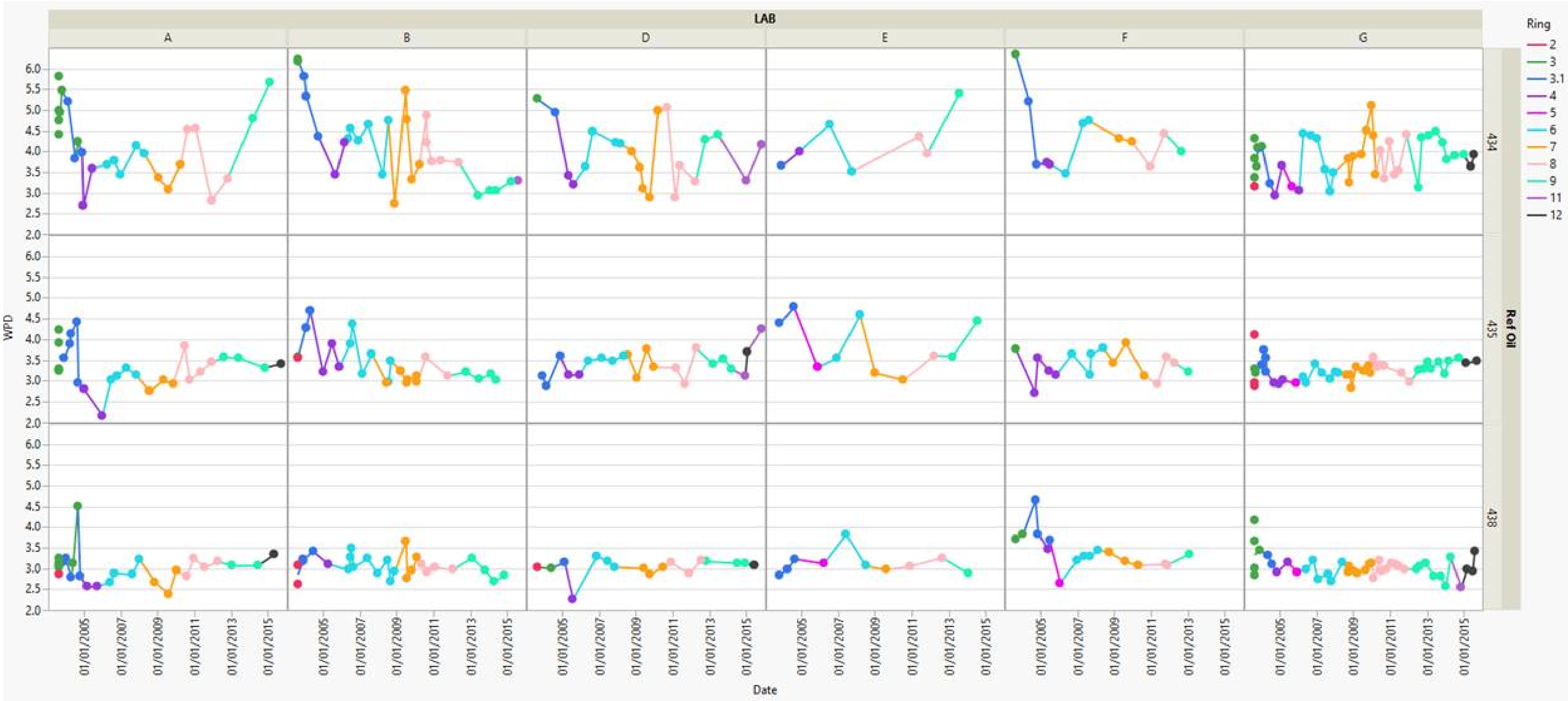
- Measured with Kayence machine (IVB)
- LH and RH chamfer of each ring measured
- Fairly large variability even between batches





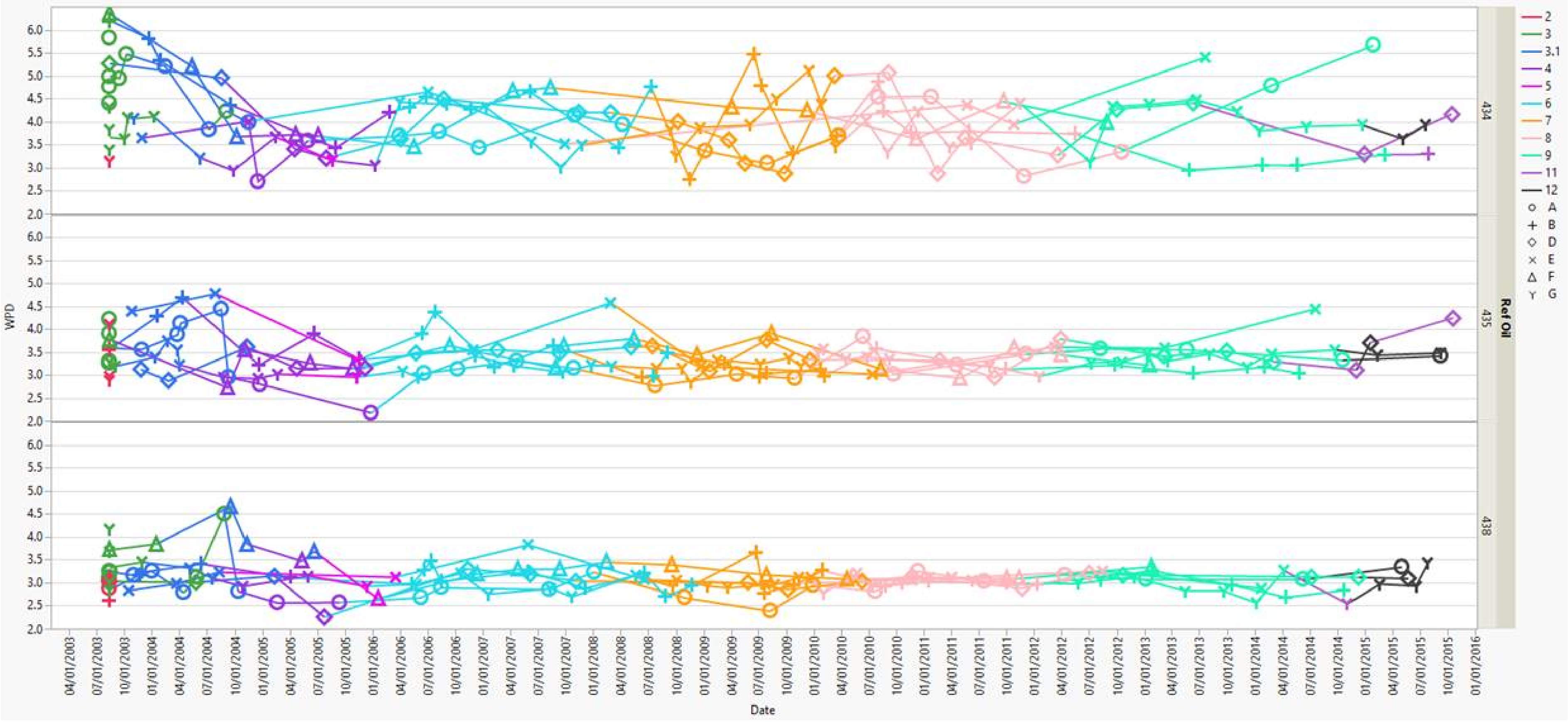
WPD by batch

- By lab



WPD by batch

- By oil

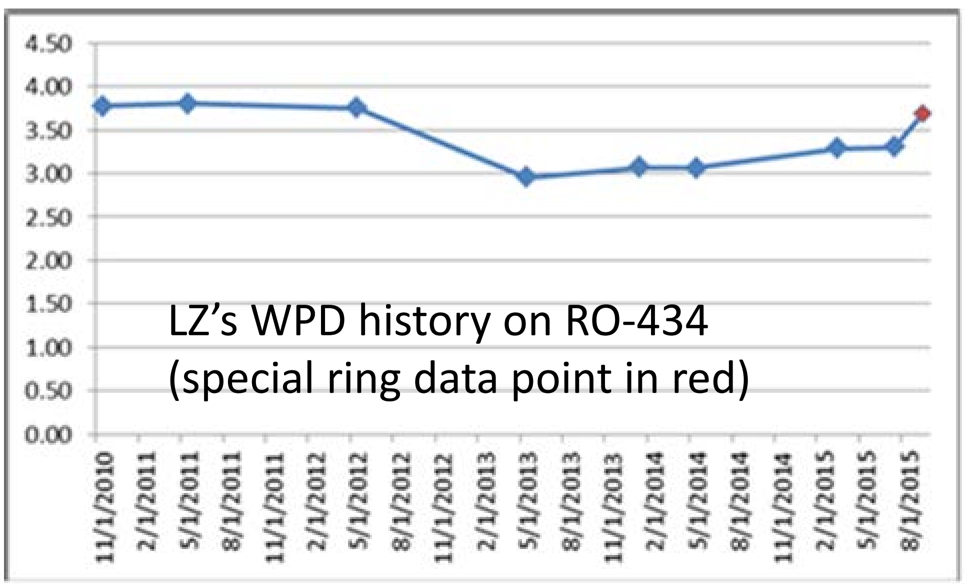


LZ Experiments

- A set of “chamferless” production rings were fitted in a run 7/8 block
- The resulting gap was approx 0.001” larger than the allowable tolerance (0.025” ±0.002”), which should translate to more severity
- A recent LZ candidate was re-run with these production rings
- An improvement of 0.9 merits was achieved

LZ Experiments

- The previous experiment was repeated with industry reference oil RO-434
- An improvement of 0.5 merits was achieved



Questions left…

- Why does the industry data not show a batch effect?
  - Is there variability within batches?
  - Is there variability between block run #s?
  - Does the variability span batches?
  - Is there another characteristic responsible?
- Should there be follow-up work done?
  - Can rings be remade without chamfers and tested?
  - Should other test types adopt a more thorough inspection of their rings?

appendix

Background (provided by Sid Clark)

- Sid Clark searched back in old STP 315 Sequence III Test Procedures
  - Seq. II & III A through D Test Procedures all state….

D.9 <u>End Ring Gap</u>

It is recommended that a top and 2nd end ring gap(36) of 0.034 and 0.032 in. respectively, be used on a new engine. If light viscosity oils, such as 5W-20 are to be evaluated, the end ring gap should be decreased from 1 to 2 thousands per ring. The compression ring gaps can be modified on subsequent tests as necessary to assist in controlling blowby rates. The engine speed and load may be varied within the specified limits to further assist in controlling blowby rates. A ring grinder, prints RX-116728 thru 33, 116933 thru 49, 116951 thru 57, and 117052, 117506 and 117507, is helpful in grinding the rings to obtain a square-edged gap. All burrs must be removed from the rings with a fine stone prior to installation.

Excerpt from Multicylinder Test Sequences for Evaluating Automotive Engine Oils STP 315F

Background Cont.

- The aforementioned tests used 0.005” oversized piston rings supplied through Muskegon Piston Ring Co.
- The labs cut their ring gaps with the focus on “Square Cut Gaps”
- Technicians would de-burr gap edges, but never to the extent there was a notable chamfer. Actually, build technicians very seldom used any stones on the outer edge of the gap areas as checking the ring gap in the cylinder removed any fine burrs.
- Fine stoning was focused on the flat surfaces to assure proper ring rotation.

Background Cont.

- During the Sequence IIIE Test period, OHT,(then Bowden Manufacturing) was recommended by General Motors as the approved Central Parts Distributor for piston rings.
- GM worked with Muskegon Piston Ring and the CPD to assure all pre-gapped piston rings were square cut and free of any chamfers.
- The technical directions in the Sequence IIIE Procedure were changed to require the use of the CPD supplied materials and labs were no longer allowed to modify ring gaps.
- It has been ~ Twenty Years since this change and the CPD has been through numerous suppliers as the gapping process is very labor intensive and suppliers change, along with Engineers and Technicians.

Background & Conclusion

- In the past, any change in piston ring suppliers / specifications, was always approved through GM
- Prints and specifications were spelled out and all rings met the print.
- I'm concerned there may be some degree of miscommunication between the CPD and the current supplier doing the actual gapping procedures.
- George is correct, this was identified through IIIH Test Development as the newer build technicians were not necessarily aware of the importance of the "Square Cut" at the ring gap and soon realized its effect on testing.

Background respectfully submitted by Sid Clark as Consultant to SwRI and our Lubrizol Customer.

LTMS cleaned data

RINGCODE	first use	renamed	count
BC-2	6-Nov-02	2	2
BC-8	7-Nov-02	8	18
2	26-May-03	2	19
3	10-Jun-03	3	18
2/9	12-Aug-03	2	4
BC-3	12-Aug-03	3	20
3/10	12-Aug-03	3	12
	12-Aug-03	unk	31
BC3	17-Sep-03	3	1
BC-3A	14-Oct-03	3.1	15
3A	23-Oct-03	3.1	30
BC 3A	26-Nov-03	3.1	2
BC3A	20-Mar-04	3.1	5
4	22-Aug-04	4	26
BC4	16-Nov-04	4	2
BC-4	16-Dec-04	4	6
BC 4	4-Jul-05	4	1
5	18-Aug-05	5	4
BC5	9-Nov-05	5	1
6	18-Feb-06	6	71
BC-6	20-Feb-06	6	18
BC-5	15-Mar-06	5	1
BC6	3-Jul-06	6	6
BC 6	26-Nov-06	6	1
7	8-Jun-08	7	62
BC-7	22-Jul-08	7	9
BC7	23-Dec-08	7	5
8	16-Jan-10	8	64
BC12	9-Mar-10	unk	1
BC8	6-Oct-10	8	7
9	23-May-12	9	68
BC-9	31-Jul-12	9	2
BC9	20-Feb-13	9	6
10	30-Dec-13	10	3
1	2-Jul-14	11	10
BC1	11-Aug-14	11	1
FACTO	13-Sep-15	unk	1

Sequence III Surveillance Panel
October 29, 2015
9:00AM – 12:00PM
USCAR
Southfield, MI

Motions and Action Items
As Recorded at the Meeting by Bill Buscher

1. Action Item – Precision matrix labs to provide the FTIR peak height oxidation and nitration data from all Sequence IIIH precision matrix tests, and all oil samples (i.e. 80 hours, 90 hours…) to the Sequence IIIH Task Force and the industry statisticians group.

2. Action Item – Sequence IIIH Task Force, along with the industry statisticians group, to evaluate all alternate suggestions for possible replacement for PVIS as the Sequence IIIH oxidation pass/fail parameter. Suggestions include hours to a certain PVIS value, hours to a certain FTIR oxidation and/or nitration value, including both peak height and area under the curve data, an FTIR area under the curve oxidation and/or nitration limit and an FTIR peak height oxidation and/or nitration limit.

3. Action Item – At some point, yet to be determined, the precision matrix labs to provide the FTIR spectra curves to a single lab, yet to be determined, to interpret all FTIR spectra curves the same for peak height and area under the curve.

4. Action Item – A sub-group of the Sequence IIIH Task Force, led by Kevin OMalley to closely evaluate <u>all</u> data from the precision matrix tests which produced influential observations to see if anything can be learned about influences on the test results.

5. Action Item – Afton (Ed Altman) to document a cleaning procedure for the Sequence IIIF/G fuel injectors, which will be reviewed and added to the Sequence IIIF/G engine assembly manuals.

6. Action Item – Form a Sequence IIIF/G Cylinder Head Reuse Task Force, chaired by Addison Schweitzer.

7. Action Item – Labs to start capturing valve seat width data on Sequence IIIF/G engine builds, using a measurement procedure defined by the Sequence IIIF/G Cylinder Head Reuse Task Force.

8. Action Item: Once data is available, the Sequence IIIF/G Cylinder Head Reuse Task Force will analyze the valve seat width data and make recommendations to the Sequence III Surveillance Panel on revisions to the Sequence IIIF/G engine assembly manuals to allow for additional runs to be obtained on the Stellite seat cylinder heads (p/n 24502260S).

9. Action Item – OH Technologies will inspect their inventory of Sequence IIIF/G/H piston rings to insure that the ring chamfers are within the current specifications/tolerances.

10. Action Item – OH Technologies will review the ring chamfer specifications/tolerances with their suppliers of the Sequence IIIF/G/H piston rings to see if the specifications/tolerances can be tightened.