IIIH Task Force Conference Call January 6, 2015

Attendees:
Chrysler: Haiying Tang, Jeff Betz
Intertek: Adison Schweitzer, Charlie Leverett, Bill Buscher
Lubrizol: George Szappanos, Michael Conrad, Kevin OMalley
Afton: Ed Altman, Dave Glaenzer
SwRI: Karin Haumann, Sid Clark, Pat Lang
Ashland: Amol Savant
Infineum: Mike McMillan, Andy Ritchie, Gordon Farnsworth
Shell: Scott Lindholm
Oronite: Jerry Wang, Kaustav Sinha
IMTS: Dave Passmore
OHT: Matt Bowden, Jason Bowden
TMC: Rich Grundza
Halterman: Tracey King

Karin opened the call explaining the group has a few issues to discuss Today and she wanted everyone on understand these issues will not be resolved during this call.

The first order of business was discussion about cylinder head seed inventory and labs responsibility to order enough materials to comfortably move into the cylinder head core exchange plan for supply of Cylinder Heads. The group discussed inventory levels for testing requirements for both the Precision Matrix and support of the first reference period. The group discussed inventory guidelines as outlined in the old information letter 62 which established basic guidelines for the industry back in the Sequence IIIE test period (Early 1990's). Jason reviewed some of the guidelines and the group discussed inventory levels at 90 and 180 day levels for both labs and suppliers. The group also understood the requirement for a six month industry inventory of cylinder heads at the supplier level had earlier been agreed that IMTS would satisfy that requirement by maintaining a six month inventory of valve seat inserts.

Additional comments from both Karin and Dave Glaenzer suggested labs hold post-test cylinder heads and blocks pending decision on usage guidelines for possible additional testing.

The group discussed inventory tracking of core materials at IMTS with Dave Passmore providing an explanation of the processing plans at IMTS.

Action Item #1: IMTS will forward information on the order process to the labs.

The group then discussed the status of the Test Procedure and the Chrysler IIIH Engine Assembly Manual

Action Item #2: Jeff Betz and Sid Clark will perform the final review and forward the latest Draft Copy of the manual to the TMC for uploading to the TMC Website.

Karin started her review of the presentation she sent for the call (IIIH 434-1 Run With New Thermocouple Location) See Attachment #1

Karin explained the location of the thermocouple in the main oil gallery and the group walked through each slide discussing the data. George Szappanos commented on how the important point is once the oil breaks around 80 hours, we do see the temperature response through the cooler, best represented by the directional indications or Delta between the purple line on the plot indicating we are controlling the temperature better and the aqua colored line now showing more response through the cooler to maintain the set point. (See slide 3 Attachment #1).

The group also discussed possibly using an alternate point of temperature measurement based on what happened on two of the five tests positioning the thermocouple in the main gallery. Addison explained Intertek did not crack the main oil gallery. Due to concerns about cracking the gallery the fitting was not sufficiently tightened.

Addison explained the problem was caught during the initial run in and the group decided to re-start the test and make up the lost oil which was such a small amount the group figured it would not have an effect on the test. Addison will record the volume of oil required to bring the test back to the start level.

Addison said they used Loctite 565 PST sealant and Jeff Betz agreed that should be the sealer to use, cautioning he would suggest at least one diameter of the fitting below the top of the sealing area on the main oil gallery to resist cracking the aluminum.

The group discussed alternate methods of tapping into the gallery and suggestions about using an alternate point of measurement and control some place in the engine oil gallery system. The groups discussed concerns about oil leaks and safety concerns about leaks in this area. Afton and Intertek discussed how their oil leaks presented themselves and George agreed the group should look at alternate areas for temperature monitoring and control.

Amol commented about concerns over temperature differences between the cooler and the oil gallery and the group discussed thermocouple insertion depths and procedural guidelines indicating sensor tips in the middle of the stream or flow. George expressed concerns about finding an area that would position the sensing tip exactly at each lab without possibility of contacting internal gallery walls or undesirable control areas on external plumbing fixtures.

Intertek agreed to record some temperatures in alternate areas of the oil galleries on their test, moving and switching thermocouples to record temperatures to gather additional data. This would also involve moving the sample valve configuration. This would involve moving the sample valve to the other side of the engine. Addison will study the oil flow schematic looking

for potential alternate temperature control connections. Everyone agreed with Karin commenting a lot of this data and answers to these questions could be gathered from existing data plots.
Karin switched back to her presentation and continued explaining each slide. Karin commented about oil pump pressure deltas commenting the interesting thing in the SwRI data is the difference in PVIS between the high and low pressure tests were only 3% difference in final results. The group also discussed piston cooling jets and differences in WPD related to running pressures. Pat Lang commented it would be tough to make this conclusion on two data points and the group agreed.

The group again discussed alternate oil gallery pressure, sample, and temperature instrumentation on the Intertek run ultimately agreeing the test would be controlled at the oil gallery tap just below the cooler and filter adaptor assembly with data collection on the alternate temperature sensing areas.

Charlie responded to questions about how they would run the test and indicated if they found one of the areas that replicated the new location they would then focus on that point.

Karin suggested controlling to the pump temperature and see what the new location showed in temperature response. The group continued discussion and Charlie reiterated that if they found good correlation they were not going to continue changing positions and run the test as configured. Addison agreed to calibrate their thermocouples and confirm their data for this test.

Karin expressed concern about possible oil influence on temperatures across the engine. Again the group discussed concerns with Amol commenting about chemical effects on operating temperatures.

The group agreed we are an hour into the call and decided to move forward with review of Haiying Tang's Presentation; (Chrysler Oxidation and Deposit Engine Test Development for GF-6 Task Force meeting January 6, 2015) See Attachment #2

The group reviewed Haiying's presentation slide by slide, commenting on the data and suggesting changes which would be incorporated prior to presenting to the Surveillance Panel for discussion on January 9, 2015 and at the AOAP meeting on January 15, 2015.

The group discussed reasons for missing data points, tests run to 90 and 100 hours, tests run with lab gapped rings and what is now called Final Hardware using supplier gapped rings, and general questions about prove-out vs matrix planned test parameters. Karin explained the differences in many of these points such as engine exhaust back pressure setting during Prove-out runs and planned Matrix set-points. The group discussed reference oil selections with Kevin OMalley commenting the final selection of oils and design of the matrix is pending final meetings between ILSAC and the Matrix Design Group. Scott Lindholm indicated oils could still

be added to the Matrix. The aforementioned discussion was prompted by earlier discussions about possibly using REO3 as a WPD discriminatory (High Performing Reference Oil).

After additional discussion, Haiying Tang made the following motion;

Motion: Haiying Tang / Scott Lindholm

Haiying Tang requested the Task Force Team to approve support for the Chrysler IIIH Test indicating its readiness for the Precision Matrix at the upcoming AOAP meeting.

Discussion:

The group discussed numerous concerns one of which led to an additional action item;

Action Item #4: Lubrizol will try to run Reference Oil 3 (REO3) prior to the AOAP meeting scheduled for January 15, 2015.

The group requested the motion also capture the fact that actual testing would start after final determination of the efforts currently underway to make a final determination of the oil control temperature control point.

Dave Glaenzer recommended saying "Pending resolution of oil temperature control point".

Haiying and Scot both agreed to that modification.

Recommended wording now becomes;

"Haiying Tang, Seconded by Scott Lindholm requested the IIIH Task Force approve support of the Chrysler IIIH Test indicating its readiness for Precision Matrix Testing pending final resolution of the oil temperature control point."

Karin called the question and the tally was,

Approve 7, Wave 4, Abstain 1.

The group agreed Karin would prepare a presentation for the Surveillance Panel Conference Call on January 9, 2015.

Haiying would prepare the presentation for the combined PCEOCP and AOAP Meetings for January 15, 2015.

Action Items:

1) IMTS will forward information on the order process to the labs.

2) Jeff Betz and Sid Clark will perform the final review and forward the latest Draft Copy of the manual to the TMC for uploading to the TMC Website.

3) Haiying will update her presentation for presentation to the Surveillance Panel on January 9, 2015 and the AOAP on January 15, 2015.

4) Lubrizol will try to run Reference Oil 3 (REO3) prior to the AOAP meeting scheduled for January 15, 2015.

This is a compilation from notes recorded during the call, with comments from member participants during the Draft Review. Certain subjects may not necessarily be in exact order; however, they are believed to represent an accurate account of the call. If anyone feels changes or additional content may be necessary, please contact Sid Clark @ 586-873-1255 or Sidney.Clark@swri.org

Thanks, Sid

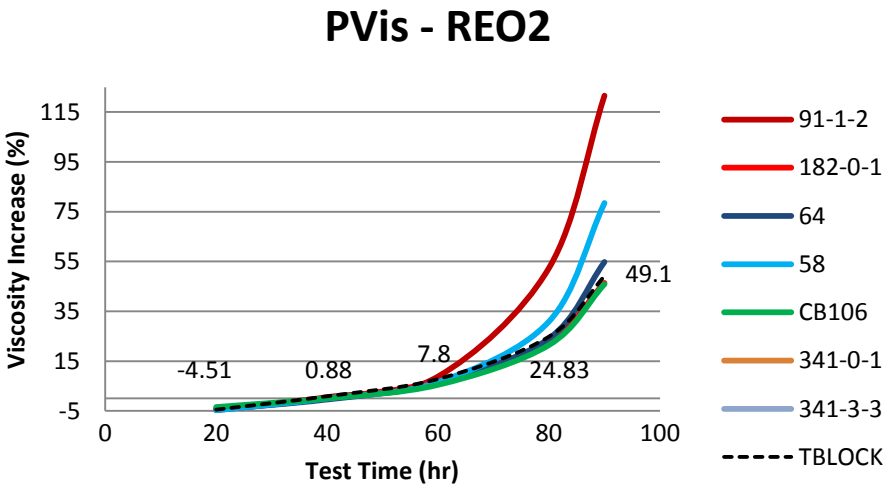
IIIH 434-1 Run With New Thermocouple Location

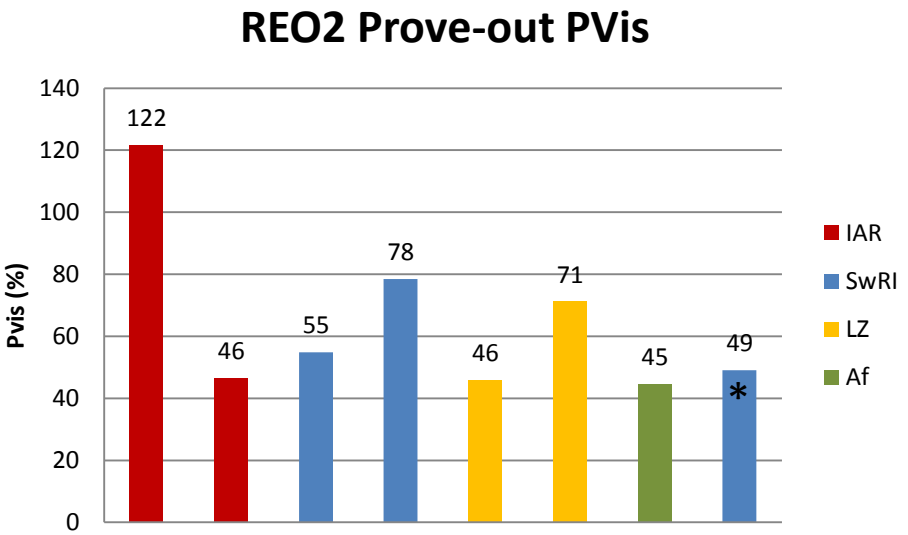
January 6, 2015

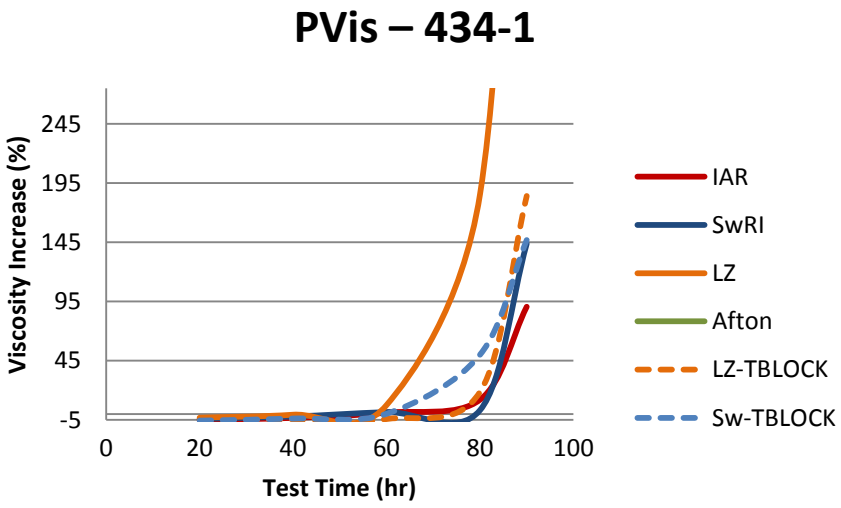
Test Summary

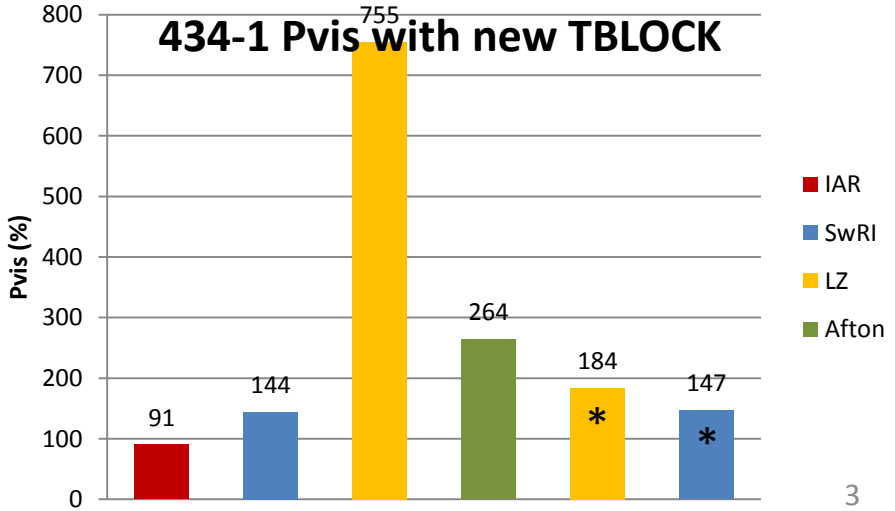
- Controlled oil temperature to the new thermocouple location in the block to 151 deg C
- Ran test at 4.5 kPa exhaust back pressure
- Final Pvis was 146.8%
- WPD is 4.61 merits

PVis Results



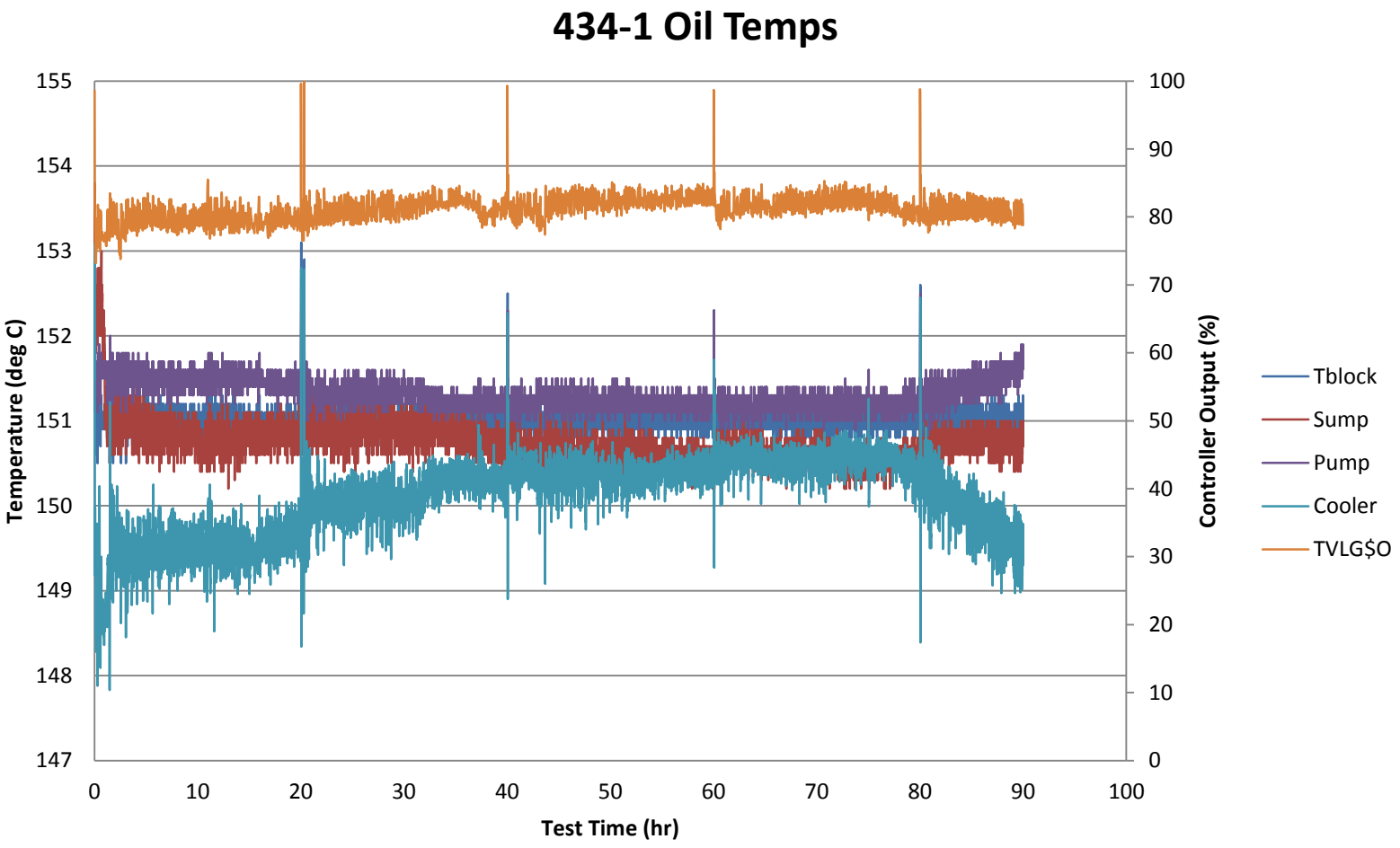




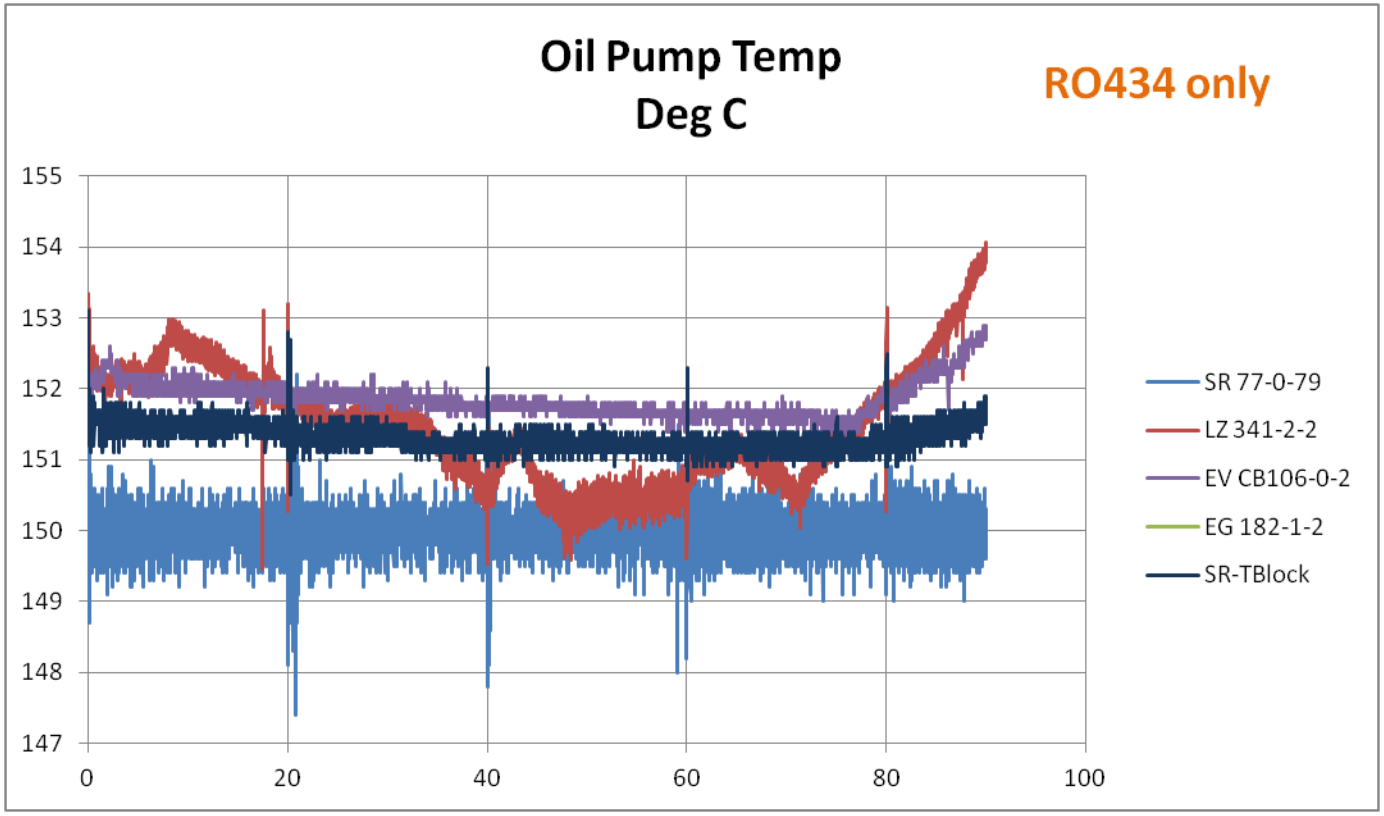


*New TC control location

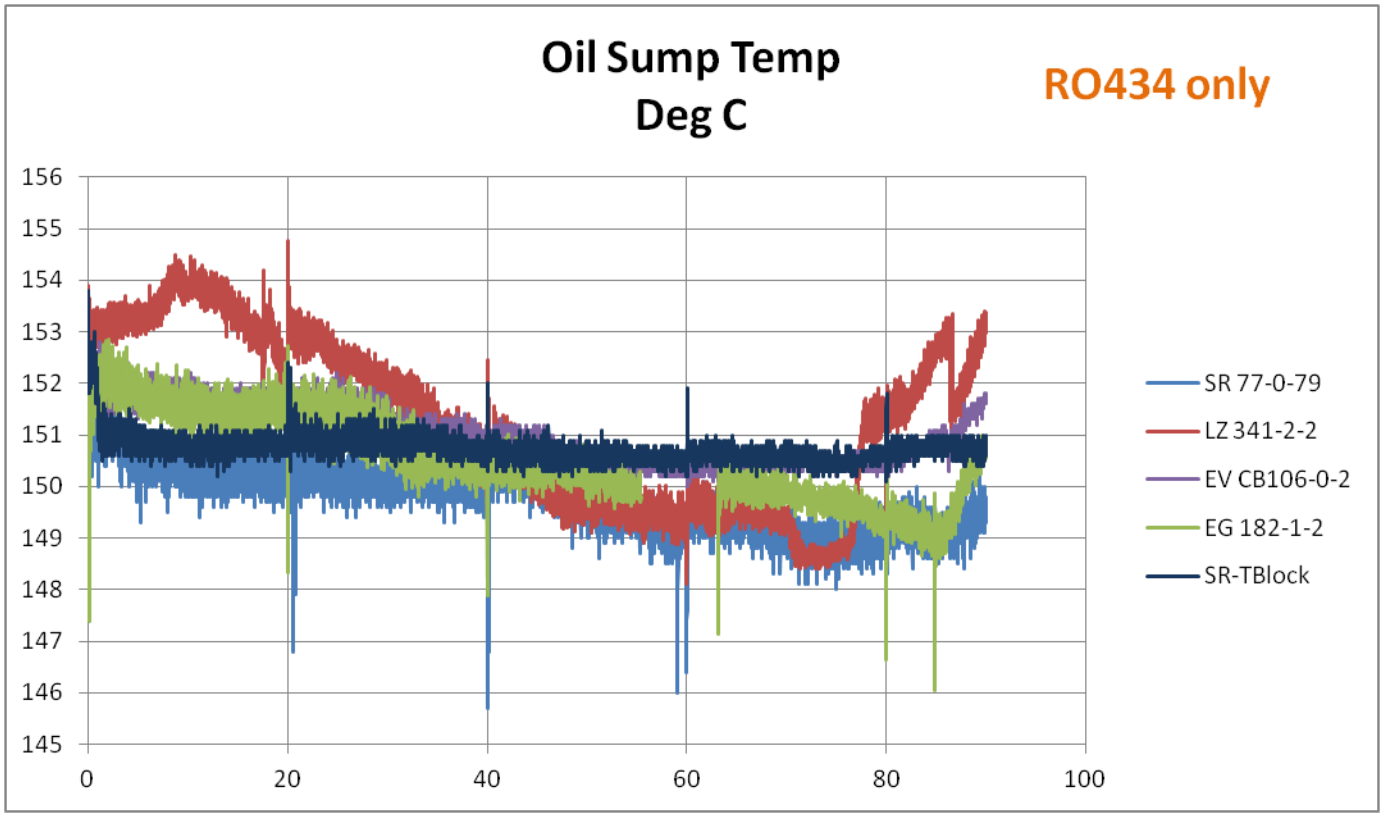
Oil Temperatures



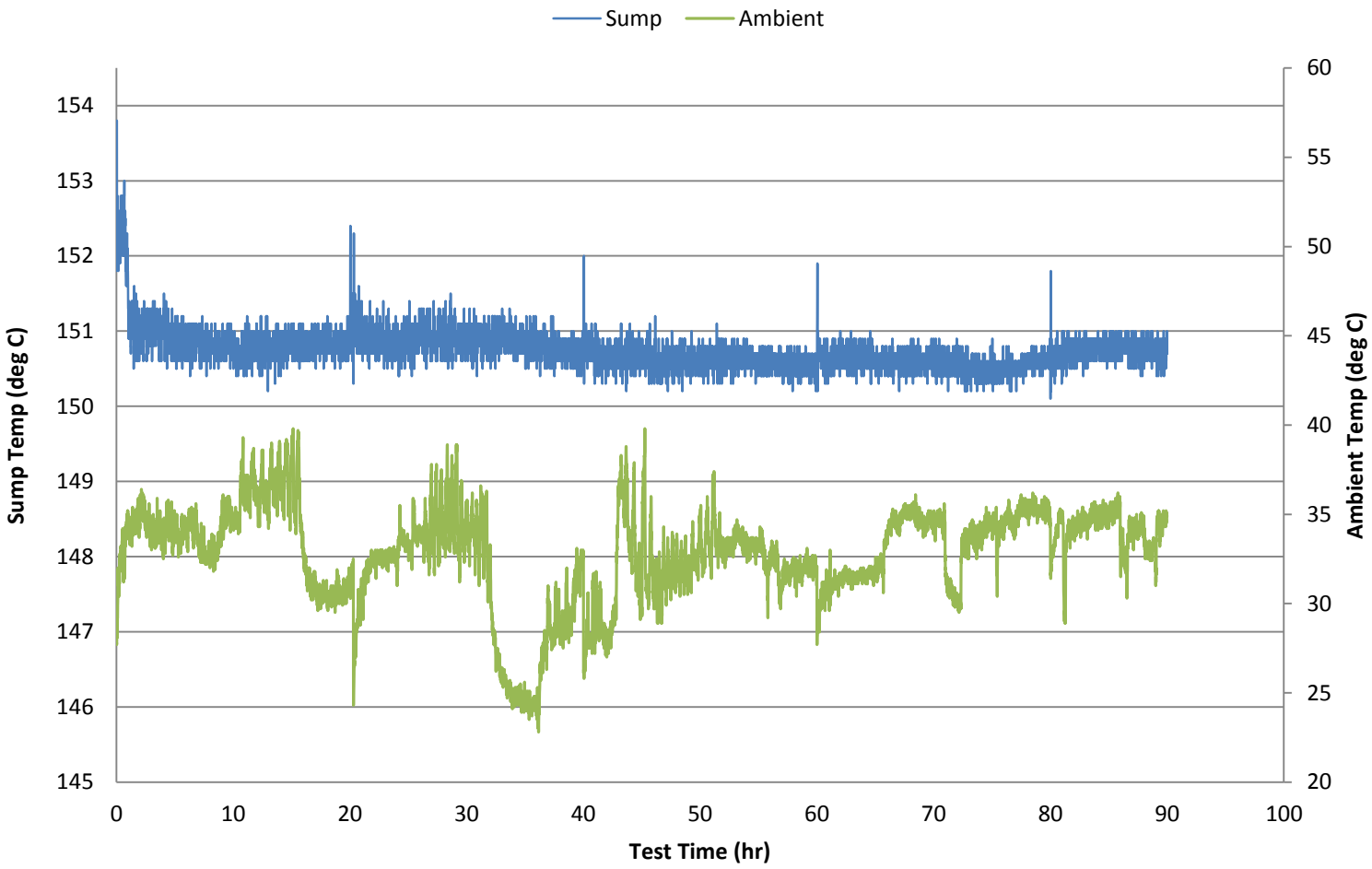
REO2 Oil Pump Temps



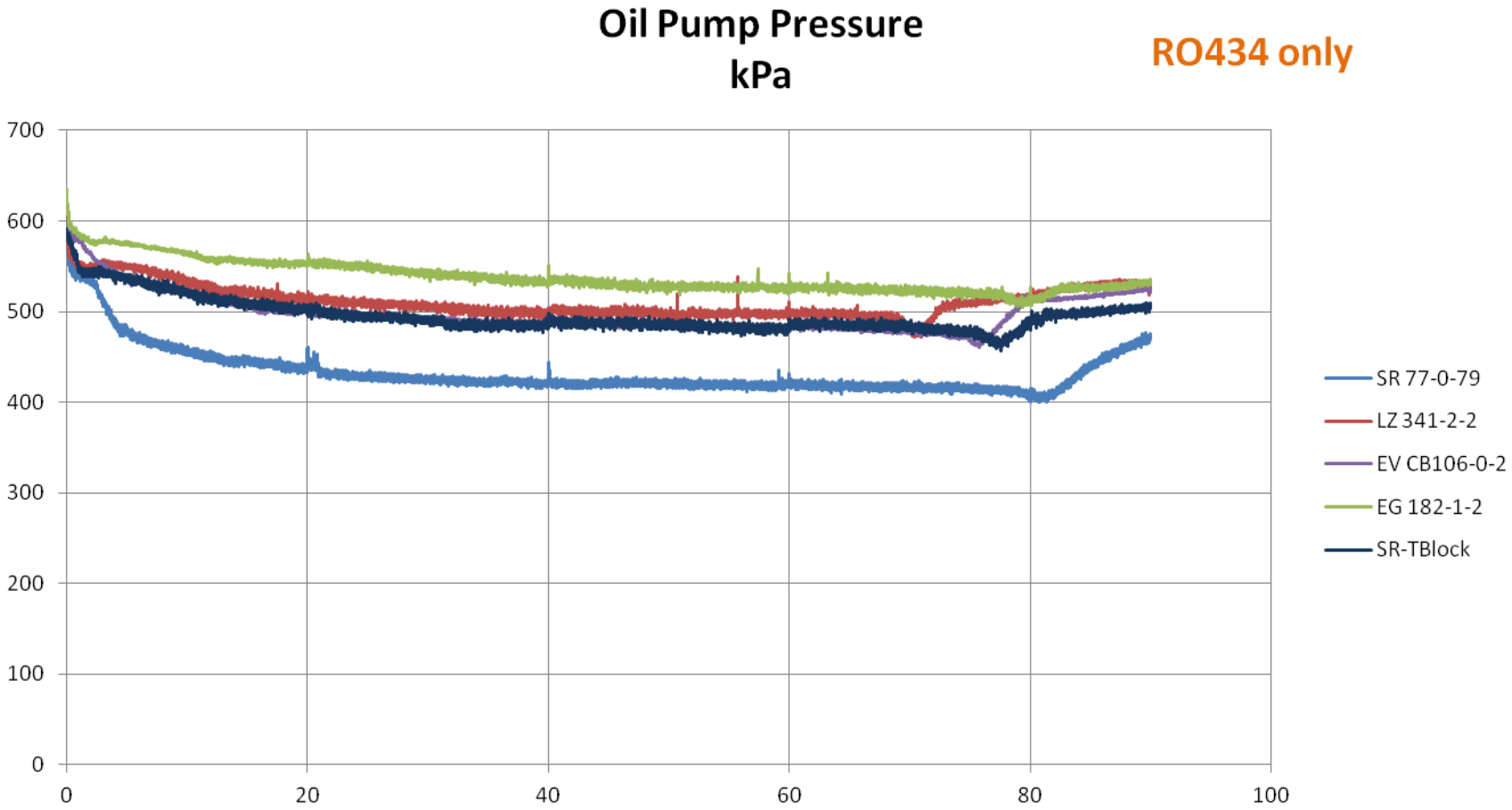
REO2 Sump Temps



Ambient Temperature Influence



Oil Pressure



Conclusion

- Uncontrolled temps do not differ from tests with the original control point.
- Pvis results did not vary with new control point.

Chrysler Oxidation and Deposit Engine Test Development for GF-6

Task Force meeting

January 6, 2015

Prove-Out Matrix

- All labs are using the final hardware and hone procedure
- The results are repeated and correlated between the labs.

Prove out Matrix								
	SwRI		**IAR**		**Lubrizol**		**Afton**	
	pVis, %	WPD	pVis, %	WPD	pVis, %	WPD	pVis, %	WPD
REO2	78.5	4.76	121.6**	3.63	71.1	4.52	45.9	4.38
REO2	54.8	4.72	46.4	5.15	44.6	4.82		
REO2	49.1*	4.98						
434-1	143.7	4.27	90.5	4.76	754.7***	3.8	264.3	4.46
434-1	146.8*	4.61			184*	3.84		
REO3	21.2	6.8						

*New Oil Thermocouple Location
**Test was conducted using lab cut rings and exhibited high blowby
***Anomaly in engine cooling strategy during oil level was identified

Repeatability & Reproducibility
Prove-Out Data

REO2

LAB	N tests	PVIS Mean %	PVIS Range %	WPD Mean (merits)	WPD Range (merits)
SwRI	3	60.8	49.1 - 78.5	4.82	4.72 - 4.98 (Δ0.26)
LZ	2	57.9	44.6 - 71.1	4.67	4.52 - 4.82 (Δ0.30)
IAR	2	84.0	46.4 - 121.6	4.39	3.63 – 5.15 (Δ1.52)
Afton	1		45.9	4.38	

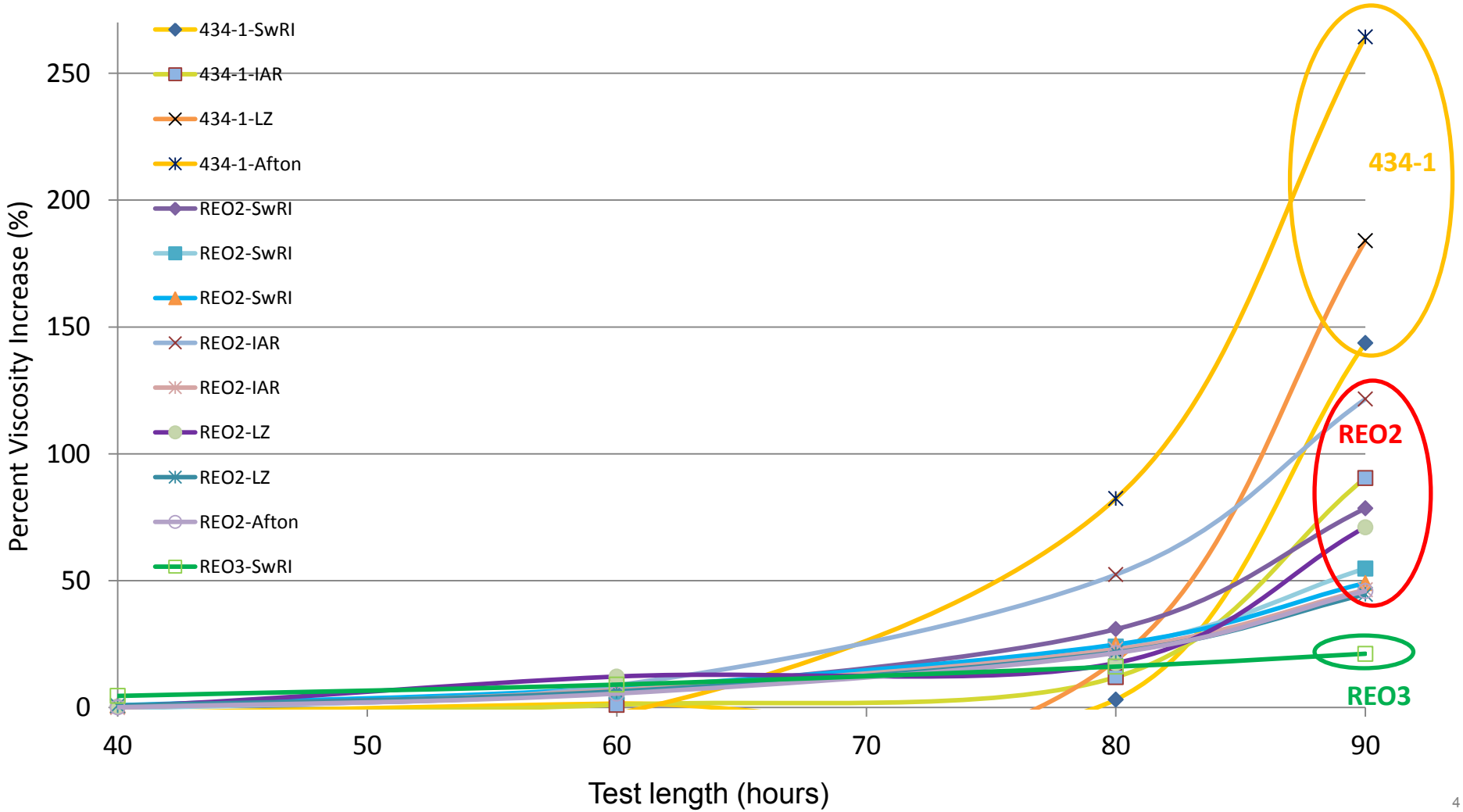
434-1

LAB	N tests	PVIS Mean %	PVIS Range %	WPD Mean (merits)	WPD Range (merits)
SwRI	2	145.3	143.7 – 146.8	4.44	4.27 – 4.61 (Δ0.34)
LZ	2	469.4	184.0 – 754.7	3.82	3.80 – 3.84 (Δ0.04)
Afton	1		264.3	4.46	

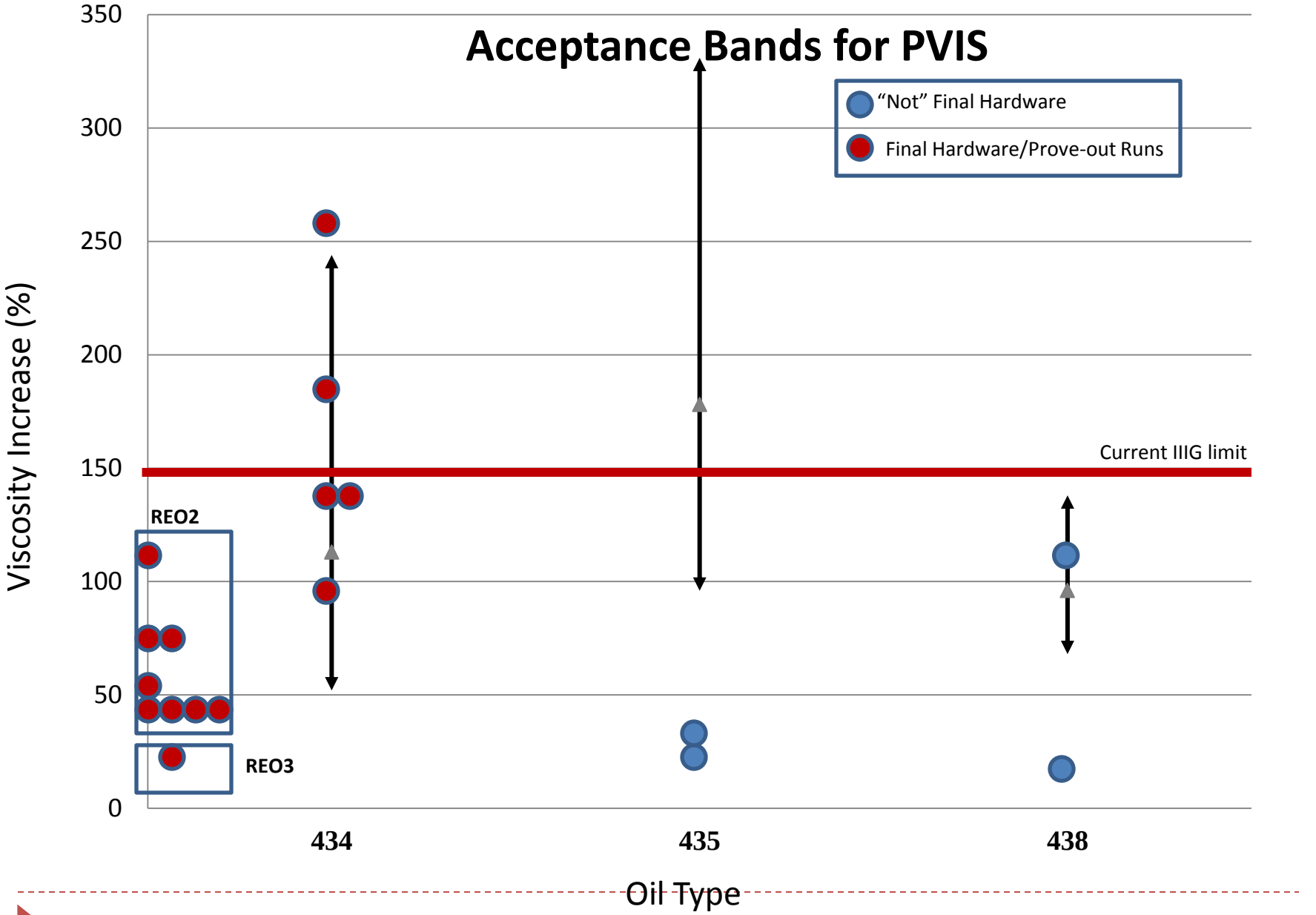
IIIG target for 434-1: 52.20 – 244.37 % (mean 112.94 ± 2σ of precision matrix results)
2.88 – 6.72 merits (mean 4.8 ± 2σ of precision matrix results)

Repeatability and discrimination on PVIS

- TMC reference oils and two Vegas field test oils were run in duplicate with final procedure and final hardware



Compared with IIIG PVIS

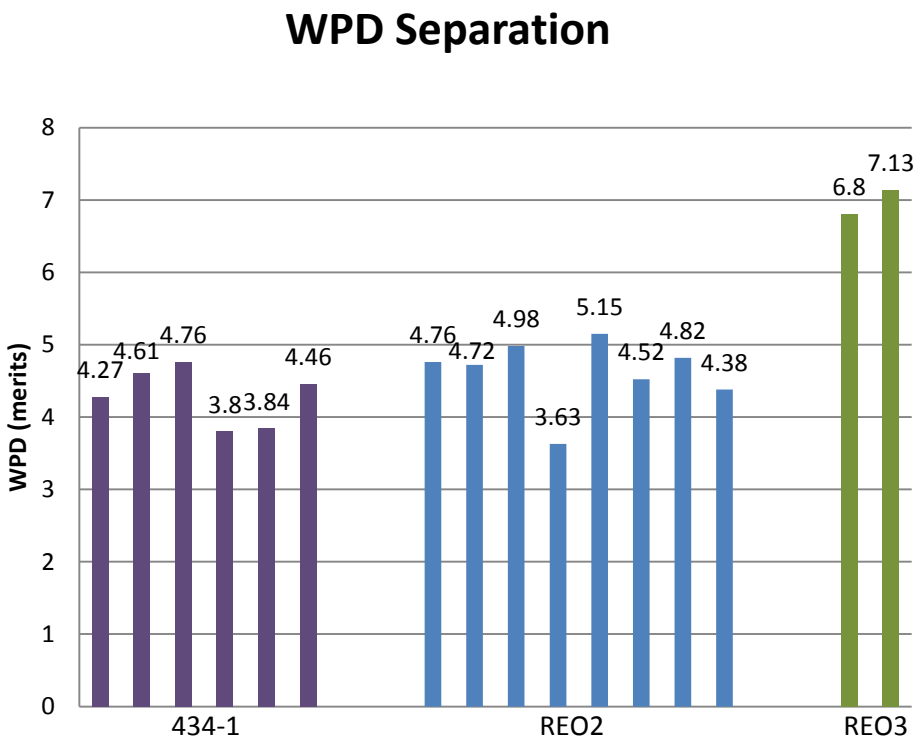


Vertical lines represent current IIIG acceptance bands based on original precision matrix data.

Discrimination on WPD

- TMC reference oils and two Vegas field test oils were run with final procedure and final hardware
- WPD results demonstrated discrimination on WPD with the separation of REO3 from TMC reference oil 434-1 and REO2

Oil	pVis, %	WPD
434-1-SwRI	143.7	4.27
434-1- SwRI	146.8	4.61
434-1-IAR	90.5	4.76
434-1-LZ	754.7	3.8
434-1-LZ	184	3.84
434-1-Afton	264.4	4.46
435-SwRI	38.6	4.84
438-SwRI	113.9	3.91
REO2-SwRI	78.5	4.76
REO2-SwRI	54.8	4.72
REO2-SwRI	49.1	4.98
REO2-IAR	121.6	3.63
REO2-IAR	46.4	5.15
REO2-LZ	71.1	4.52
REO2-LZ	44.6	4.82
REO2-Afton	45.9	4.38
REO3-SwRI	21.2	6.80

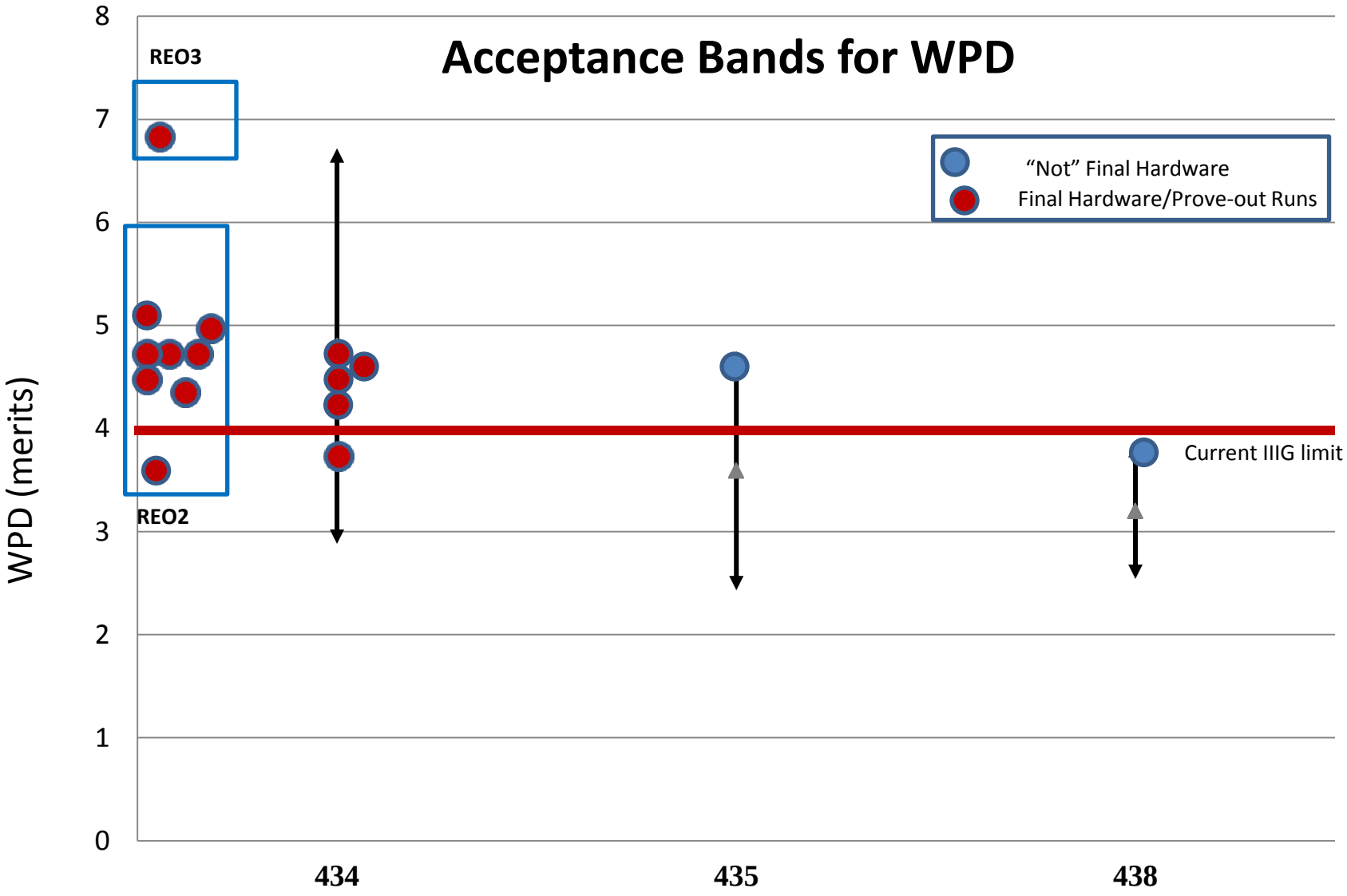


Further WPD Discrimination on REO3

- Early in the development several conditions were varied in an effort to dial in an appropriate severity level that was recognizable relative to the IIIG.
- As the severity increased REO3 was run periodically to ensure discrimination of both Pvis and WPD were maintained.

	Test 20	Test 23	Test 26
Test Length (hr)	110	120	110
WPD @ specified test length	6.06	5.19	5.44
Pvis @ 100 hours (%)	36.80	34.05	37.24
Ring Gaps (top/bottom; 0.001”)	25/35	30/40	30/40
Intake Air Temp (deg C)	35	38	38
Oil Add	none	none	none

Compared with IIIG WPD



Vertical lines represent current IIIG acceptance bands based on original precision matrix data.

Development Data

Development Data on Final Hardware

Oil	PVIS (%)	WPD (merits)
TMC 434-1 SwRI	143.7	4.27
TMC 434-1 SwRI	146.8	4.61
TMC 434-1 IAR	90.5	4.76
TMC 434-1 Afton	264.3	4.46
TMC 434-1 LZ	754.7	3.8
TMC 434-1 LZ	184.0	3.84
REO2 SwRI	78.5	4.76
REO2 SwRI	54.8	4.72
REO2 SwRI	49.1	4.98
REO2 IAR	121.6	3.63
REO2 IAR	46.4	5.15
REO2 Lubrizol	71.1	4.52
REO2 Lubrizol	44.6	4.82
REO2 Afton	45.9	4.38
REO3 SwRI	21.2	6.80
REO3 SwRI	17.9	7.13*

*100 hour

Test Status Summary

- Test Development is complete and all work has been transferred to the Task Force

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

Summary

- The Chrysler test results show repeatability, reproducibility, and discrimination on PVIS and WPD
- The Chrysler test meets the test development objectives
- A prove-out matrix using final procedure and final hardware has been designed and data is in agreement with development data
- Six stands are ready for Matrix in two independent labs and two dependent labs

Thank You!