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COMMITTEE **D02** ON **PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS**

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Originally Issued: April 04, 2016

Reply to:

Unapproved Minutes of the March 29, 2016
Sequence III Surveillance Panel Meeting.

1.0) Attendance

A list of attendees is included as Attachment 1.

2.0) Chairman Comments

Chairman Glaenzer discussed the recent Sequence IIIG LTMS changes and labs have been provided with updated test confirmations from the TMC. Dave also asked that the members review the membership list and advise if there are any members who no longer participate in the panel so they can be removed.

3.0) Approval of minutes

3.1) Minutes from 03/16/2016 Conference Call Motion Jason Bowden, Second Matt, unanimous

4.0) Action Item Review

4.1) Solicit labs to determine critical hardware remaining for Sequence IIIF/IIIG testing. Dave Glaenzer's report is shown as Attachment 2. As of March 15, crankshafts may be a problem. Dave estimates hardware will be available for the next 6-8 months or about the end of the year.

4.2) Review change implemented to IIIG LTMS at March 09, 2016 meeting. Review after four months. Due 07/23/2016. **Glaenzer**

5.0) Old Business

5.1) Test Improvement Task Force report; cylinder bore surface finish, Quality Index limits, monitoring of ECU parameters.

George Szappanos reviewed his presentation (Attachment 3) during the meeting. Discussion on "limp home mode". Afton had an ECU that had an issue, which was swapped out on a test at Lubrizol, which experienced the same condition. Chrysler thinks the coolant sensor trick may be at the root cause of the ECU going into the failure mode. Chrysler has been reluctant to disable the limp home mode for testing purposes. Jeff Betz will have the ECU re-calibrated to remove limp home mode for several parameters to address this issue. George presented a number of ECU parameters to be recorded/monitored (see Attachment 3). George also discussed the influence of temperature and loads impact on the variability of when the low pressure mode of the oil pump initiates during ramp up. ECU programming was also reviewed. Chrysler indicated that the ECU supply won't be a problem and Chrysler will investigate flashing a build out of these ECU's or allowing the IBOX to be used by labs to flash their own ECU. George's recommendations are listed as a summary in Attachment 3. Cylinder bore finish parameters and associated limits were discussed. Ed Altman presented Precision Matrix data analysis of surface finish parameters which is included as Attachment 4. Attachment 4 summarizes the current limits and reviewed the limits based on the changes made to the honing procedure. Considerable discussion took place regarding setting of surface finish limits. The panel agreed to review the limits once additional data is obtained. The panel agreed to suspend the limits for Rvk and Rz, and bore diameter, until new limits can be established. After three months the data will be analyzed and new limits set. These items are addressed under Action Item #4, collection of post workshop data, in Attachment 5, Motions and Action Items recorded by Mr. Bill Buscher. A motion was made and is recorded as Item #5 in Attachment 5. Motion was approved 13-0-0.

5.2) Test Procedure update. **Haumann.** Posted to TMC site 03/22/2016
5.3) Engine Build Manual update. **Clark.** Posted to TMC site 03/22/2016

6.0) New Business

6. 1) IIIG Equivalent Limit in IIIH. CLOG will be meeting next week to continue work on comparable IIIG/H limits and will advise the panel during next meeting.

6.2) LTMS plans for Sequence IIIH.

The chair elected to deviate from the proposed agenda and moved to presentations regarding LTMS for the IIIH. Kevin O'Malley proposed a number of items regarding LTMS for IIIH, delineated in Attachment 6. Discussions on the concept of "fast start" continuous SA and the philosophy of e_i were undertaken. Individual test results were reviewed with their impact using the proposed LTMS was conducted. A discrepancy was noted in that a result which was excluded from matrix analysis was included in the proposed LTMS. Ed Altman motioned that the any test result not used in the matrix analysis is not to be charted, seconded by Andy Ritchie, the motion was approved 11-0-0. Discussions were undertaken on e_i and Z_i limits. Rich Grundza moved to accept the proposed concept of the LTMS system as presented by the Stats Group, seconded by Robert Stockwell. Motion was unanimous. Todd Dvorak laid out the discussions we need to complete for LTMS, that is, review the standard deviation calculation, establish ei and Zi limits, determine lambda values for EWMA, establish undue influence limit, reference period, reference oil assignment, rotational or random, and implementation date for calibrations. Use arithmetic standard deviation for LTMS purposes (Motion #8 in Attachment 5). Ed

Altman, second Pat Lang. Reference period was agreed to as 6 months and 15 tests, Motion Grundza, second Altman, approved with one waive. Two operationally valid calibration tests with no alarms after the second test will result in calibration. The average of the first two tests will be used for Z_0, Addison Schweitzer motioned, Rich Grundza seconded, motion was approved with one waive. Reference oil assignment was addressed. Lambda, e_i, Level 2 alarm and Z_i limits were addressed. A lambda of 0.3, e_i Level 3 alarm of 2.066, level 2 alarm of 1.734 and Z_i of 1.8 were approved. The panel agreed to specify that Sequence IIIHA reference oil MRV be conducted at -30 deg C. A proposed LTMS document was reviewed. Discussions took place regarding the pooled s for severity adjustment calculation, and it was agreed to use RMSE standard deviation from the model used to calculate the reference oil target means for severity adjustments. The panel agreed to put forward a proposed LTMS document for all parameters. Attachments 7, 8 & 9. Kevin will send these documents to the TMC and the TMC will notify the chair once the TMC is ready to issue the documents, after which the chair will schedule a conference call to approve. The panel discussed what oil to use for the reference test conducted on the honing refinements.

6.3) <u>Determine calibration and referencing protocols</u>

Reference period was agreed to as 6 months and 15 tests as noted above. The panel discussed when calibrations can take place. It was agreed that calibrations will begin after the first successful reference test completed using draft procedure dated 3/22/2016 and build manual 3/22/2016. The panel agreed to start official stand calibration on 4/15/16.

6.4) <u>Determine if Precision Matrix stands can be considered calibrated based on their matrix tests in light of test procedure enhancements</u>. Discussed and included above in item 6.3.

6.5) <u>Appendix K Update</u>. **Martinez**. Will be reviewed at next meeting.

7.0) <u>Work Remaining</u>

7.1) Surveillance Panel recommendation regarding test readiness for the category. Dave will address this during a future call.

7.2) Publish research report No change on this item, Karin Haumann continues to work with Facilitator and Rich will provide precision statements.

8.0) <u>Review Scope and Objectives</u>

A review of the scope and objectives was conducted and is included as Attachment 10.

9.0) <u>Next Meeting</u> A conference is scheduled for 04/13/16 at 11:00 EDT.

10.0) <u>Meeting Adjourned at 17:10 CDT</u>

ASTM Sequence III Surveillance Panel (22 Voting members) Attachment 1 date: 03/29/2016

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

Is this correct? DT

haiying.tang@fcagroup.com ?

OK CORRECT

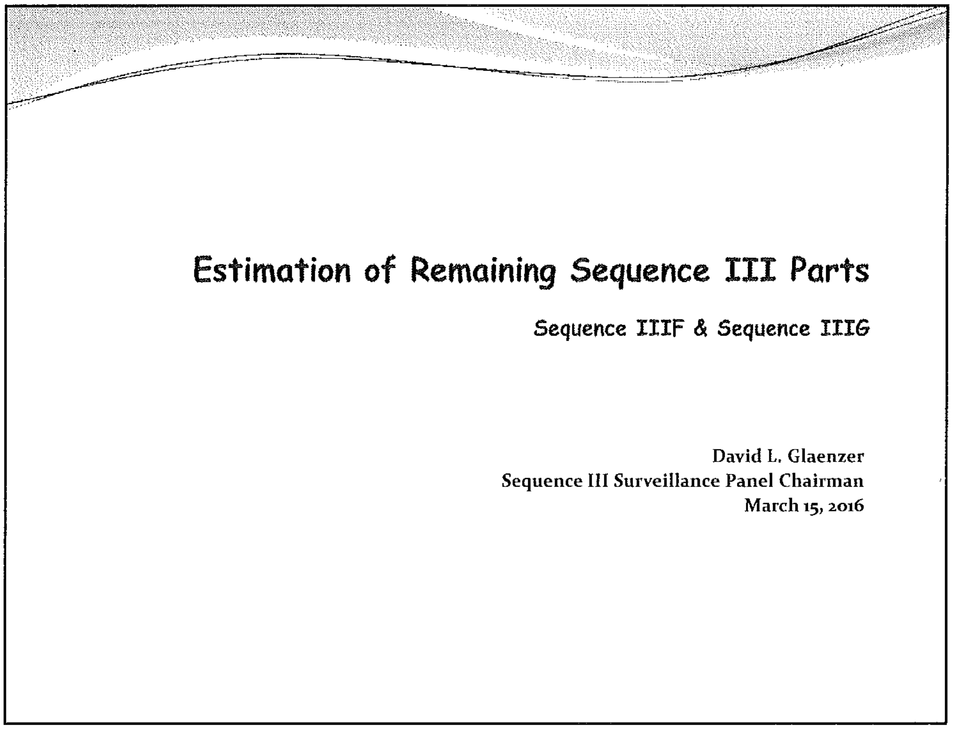
ASTM Sequence III Surveillance Panel (22 Voting members) date: 03/29/2016

Name	Email	Signature	
Ricardo Affinito	affinito@chevron.com	N-V Member	Present_____
Art Andrews	arthur.t.andrews@exxonmobil.com	N-V Member	Present_____
Robert Bacchi	robert.bacchi@basf.com	N-V Member	Present_____
Terry Bates	batesterryw@aol.com	N-V Member	Present_____
Doyle Boese	doyle.boese@infineum.com	N-V Member	Present ✓
Adam Bowden	adbowden@ohtech.com	N-V Member	Present_____
Dwight H. Bowden	dhbowden@ohtech.com	N-V Member	Present_____
Matt Bowden	mjbowden@ohtech.com	N-V Member	Present_____
Jerome A. Brys	jerome.brys@lubrizol.com	N-V Member	Present ✓
Jessica Buchanan	jessica.buchanan@lubrizol.com	N-V Member	Present_____
Bill Buscher III	william.buscher@intertek.com	N-V Member	Present WAB
Bob Campbell	bob.campbell@aftonchemical.com	N-V Member	Present_____
Chris Castanien	chris.castanien@nesteoil.com	N-V Member	Present_____
Martin Chadwick	martin.chadwick@intertek.com	N-V Member	Present ✓
Ankit Chaudhry	ankit.chaudhry@swri.org	N-V Member	Present ✓
Jeff Clark	jac@astmtmc.cmu.edu	N-V Member	Present_____
Sid Clark	sidney.clark@swri.org	N-V Member	Present_____
Phil Davies	daviesjp@bp.com	N-V Member	Present_____
Todd Dvorak	todd.dvorak@aftonchemical.com	N-V Member	Present ✓
Frank Farber	fmf@astmtmc.cmu.edu	N-V Member	Present_____
Joe Franklin	joe.franklin@intertek.com	N-V Member	Present_____
Gordon Farnsworth	gordon.farnsworth@infineum.com	N-V Member	Present_____
David L. Glaenzer	dave.glaenzer@aftonchemical.com	N-V Member	Present ✓
Karin E. Haumann	karin.haumann@shell.com	N-V Member	Present ✓
Martin Heimrich	martin.heimrich@swri.org	N-V Member	Present_____
Jason Holmes	jason.holmes@basf.com	N-V Member	Present_____
Walter Lerche	walt.lerche@gm.com	N-V Member	Present_____
Jim Linden	lindenjim@jlindenconsulting.com	N-V Member	Present_____

ASTM Sequence III Surveillance Panel (22 Voting members) date: 03/29/2016

Name	Email	Signature	
Scott Lindholm	scott.lindholm@shell.com	N-V Member	Present
Jo Martinez	jogm@chevrontexaco.com	N-V Member	Present ✓
James Matasic	james.matasic@lubrizol.com	N-V Member	Present ✓
Mike McMillan	mmcmillan123@comcast.net	N-V Member	Present
Bob Olree	olree@netzero.net	N-V Member	Present
Kevin O'Malley	kevin.omalley@lubrizol.com	N-V Member	Present ✓
Dave Passmore	dpassmore@imtsind.com	N-V Member	Present
Christian Porter	christian.porter@aftonchemical.com	N-V Member	Present
Phil Rabbat	phil.rabbit@basf.com	N-V Member	Present
Allison Rajakumar	allison.rajakumar@lubrizol.com	N-V Member	Present
Scott Rajala	srajala@ilacorp.com	N-V Member	Present
Jim Rutherford	jaru@chevrontexaco.com	N-V Member	Present
Bob Salgueiro	bob.salgueiro@infineum.net	N-V Member	Present
Elisa Santos	elisa.santos@infineum.com	N-V Member	Present
Hirano Satoshi	satoshi_hirano_aa@mail.toyota.co.jp	N-V Member	Present
Amol Savant	acsavant@ashland.com	N-V Member	Present ✓
Philip R. Scinto	prs@lubrizol.com	N-V Member	Present
Robert Stockwell	robert.stockwell@chevron.com	N-V Member	Present ✓
Chris Taylor	chris.taylor@vpracingfuels.com	N-V Member	Present
Ben Weber	bweber1@sat.rr.com	N-V Member	Present
Angela Willis	angela.p.willis@gm.com	N-V Member	Present
Tom Wingfield	wingftm@cpchem.com	N-V Member	Present
Travis Kostan	travis.Kostan@swri.org	N-V Member	✓
MARK SUTHERLAND	msutherland@tei-net.com	N-V Member	✓
Tim Cushing	timothy.cushing@gm.com	N-V Member	✓
Mike Raney	michael.p.raney@gm.com	N-V Member	✓
AL LOPEZ	al.lopez@intertek.com	NV member	✓

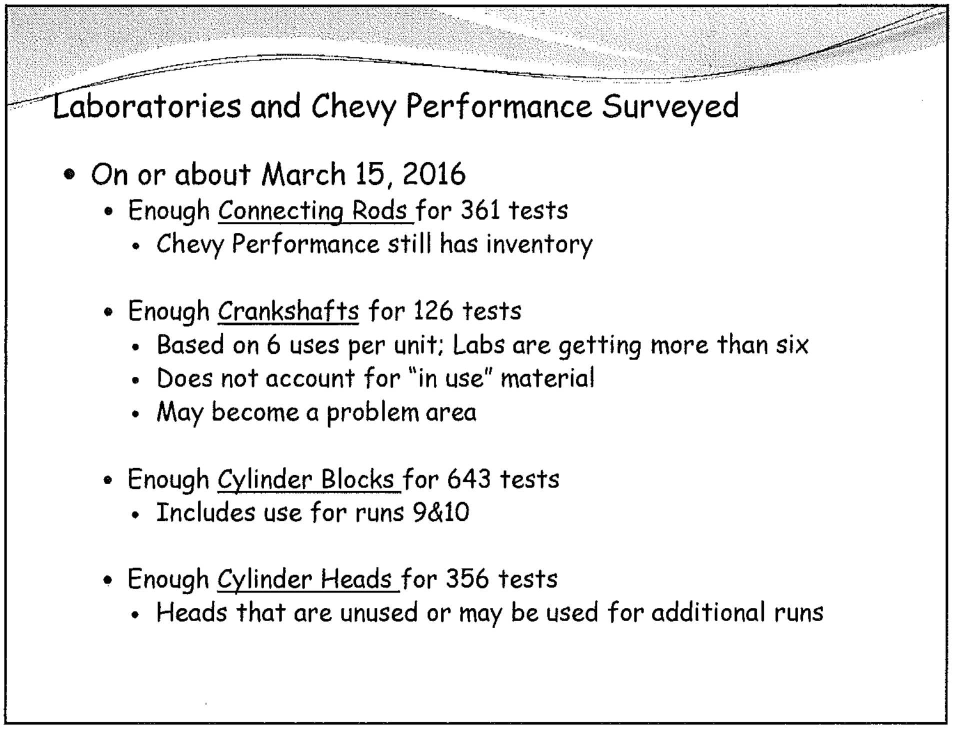
Attachment 2



Estimation of Remaining Sequence III Parts

Sequence IIIF & Sequence IIIG

David L. Glaenzer
Sequence III Surveillance Panel Chairman
March 15, 2016



Laboratories and Chevy Performance Surveyed

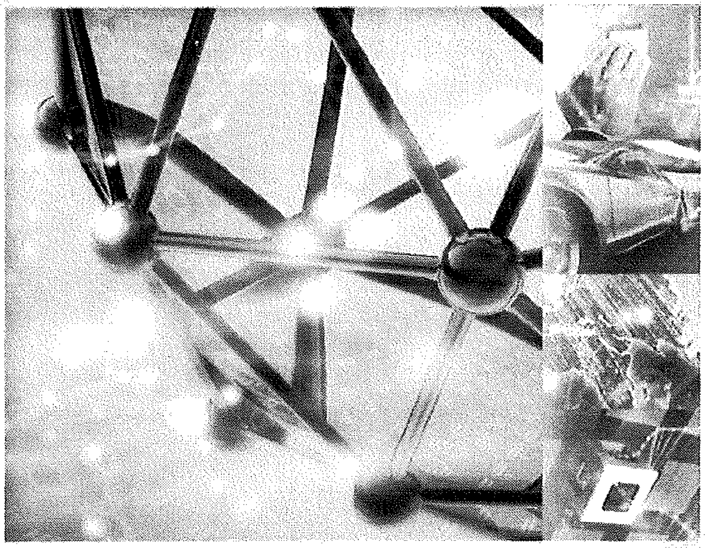
- On or about March 15, 2016
  - Enough Connecting Rods for 361 tests
    - Chevy Performance still has inventory
  - Enough Crankshafts for 126 tests
    - Based on 6 uses per unit; Labs are getting more than six
    - Does not account for "in use" material
    - May become a problem area
  - Enough Cylinder Blocks for 643 tests
    - Includes use for runs 9&10
  - Enough Cylinder Heads for 356 tests
    - Heads that are unused or may be used for additional runs

Estimation of Usage

- April 1, 2015 through September 30, 2015
  - 202 Total ACC tests
  - 16 Total Calibration tests
  - Six month period
- September 30, 2015 through February 29, 2016
  - 181 Total ACC tests
  - 21 Total Calibration tests
  - Five month period

When Will We Run Out of Parts??

- At Current usage rate, 6 to 8 months (end of 2016 ??)
- If usage continues to diminish, later



Attachment 3

Seq IIIH

ECU data collection

3/24/2016

Lubrizol

TF objectives, related to ECU

SUCCESS TOGETHER

1. Prevent the occurrence of "limp home" mode during engine ramping to test conditions

2. Collect ECU "CAN" parameters
   - To ensure consistent engine operation
   - To allow diagnostic troubleshooting

3. Better understand the oil pressure control logic related to the variable displacement oil pump

4. Investigate 3rd party programming of ECU

Lubrizol

1. "limp home" mode

- At 3500 rpm, the ECU begins to reduce throttle and the load setpoint can't be achieved
- Has occurred at multiple labs
- No check engine light or trouble codes
- Unknown cause
- Difficult to reproduce

Resolution

- Chrysler believes the issue is due to the ECU reacting to a difference between the modeled temperature and measured sensor temperatures, and derating the engine to protect it

- The trip limits have been widened for these values to prevent future recurrence

- An alternate option which was not implemented is to completely disable the "limp home" mode; Chrysler is investigating (concerns about dangerous operation)

2. ECU "CAN" parameter capture

Several parameters should be captured routinely to validate correct engine control:

Parameter	Usefulness	Value at test condition	Notes	PID	type	Bytes	scale	Offset	Units
Speed	Validates lab measurement	3900		0C	UWORD	2	.25	0	Rpm
Coolant temp	Insures resistor is installed and correct value	55	Resistor installed	05	UBYTE	1	1	-40	DegC
Intake air temp	Validates lab measurement	35		0F	UBYTE	1	1	-40	DegC
MAP	Redundant load indicator	86		0B	UBYTE	1	1	0	kPa
Throttle position	Redundant load indicator	27		45	UBYTE	1	.392156	0	%
MIL	Warns of potential sensor or operation issue	0	0=off	01	UBYTE	1	-	-	
Open loop flag	Indicates closed loop fuel control operation	514	257= open 514=closed loop	03	UWORD	2	1	0	
Spark	Verifies correct timing; Impacts consistent combustion efficiency	23	fixed	0E	UBYTE	1	.5	-64	Deg
Long term fuel trim	Can warn of unusual sensor inputs	0	Disabled	07	UBYTE	1	.78125	-128	%
Fuel injection timing	Consistent combustion efficiency	400	Stays constant	$06DB	UWORD	2	10	0	Deg
Cam timing, Exh1, Exh2, Int1, Int2	Verifies correct camshaft installation	112 112 110 110	Fixed cam phasers	$06D9 $06E2 $06DE $06DF	SWORD	2	10	0	Deg
Dual speed Oil pump	On/off	0	Changes from 3 as the engine ramps to test conditions	$081B	HEX 2 BYTES	2	-	-	On/off
VVT oil temperature	Validates lab measurement; troubleshooting	150	disabled	$03B7	UBYTE	2	1	-64	Deg C
VVT oil pressure	Validates lab measurement; troubleshooting	~500	disabled	$022A	UBYTE	2	4	-0	kPa

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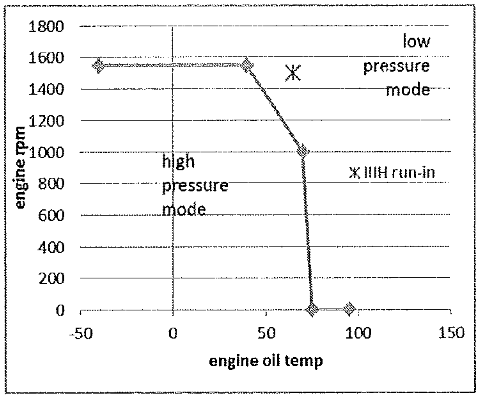
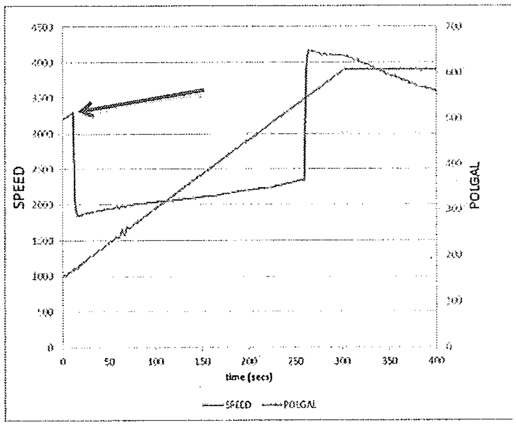
3. Dual speed oil pump operation

- Uses speed and load, but also coolant & oil temperature as inputs to turn on/off
- Table below summarizes control regime at low speed:
  - High pressure until speed and temp are achieved
- Switches to high pressure again at 3500 rpm

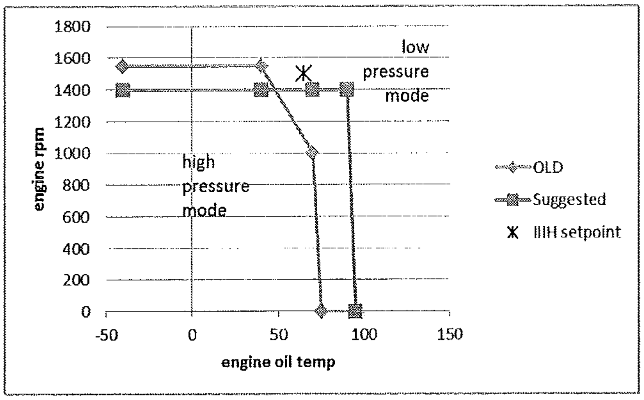


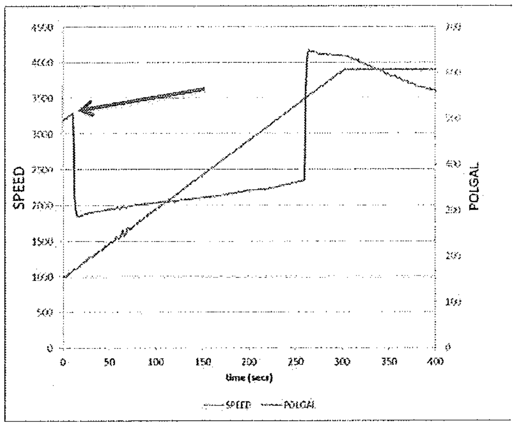


suggestion

SUCCESS TOGETHER

- Oil temperature is difficult to control during engine off and during ramp – this leads to inconsistent operation
- Switch point (blue arrow) is inconsistent, even in same stand
- Suggest moving the threshold to force strictly speed-dependent operation
- More consistent, easier to troubleshoot





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4. ECU programming

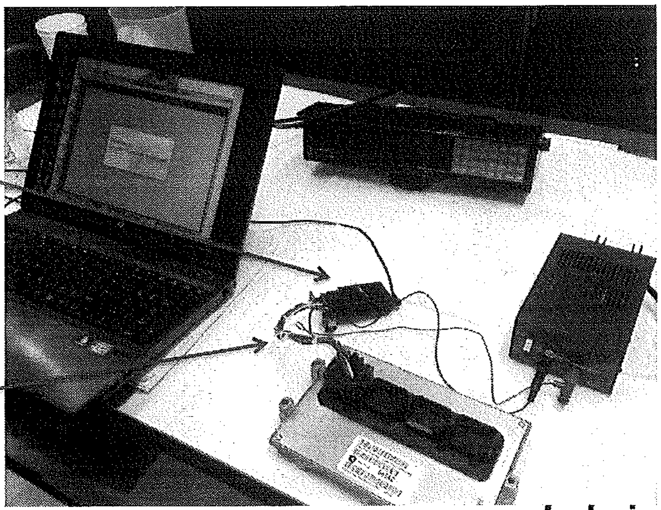
SUCCESS TOGETHER

- Faults with programming can cause “no start”
- 3rd party sourcing to insure sustainability
- Requires specialty tools from Chrysler

CDA software✓
Calibration file
MicroPod connector

(or alternately, iBox, shown in back)

laptop
ECU connector harness
12v power supply



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Next steps

SUCCESS TOGETHER

- A version of the calibration including the “limp home” fix and revised oil pump operating range has been tested at LZ
- Agree on revision to oil pump range
- Chrysler to update calibration
- Updated ECUs can be made available via Chrysler
  - (or 3rd party)
- Agree on requirement to record CAN data
- Set limits
- Update data dictionary and report forms

Lubrizol

Afton CHEMICAL

Surface Finish IIIH Capability Analysis

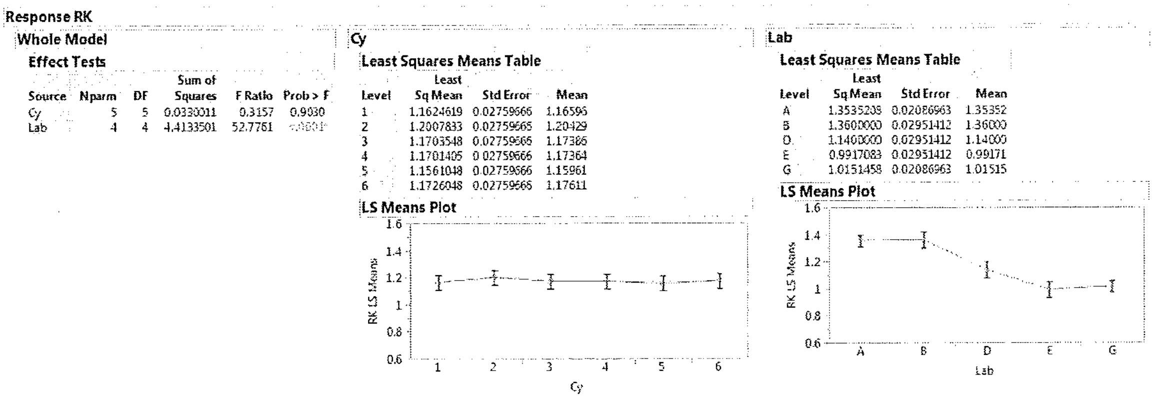
Date: March 9, 2016

Passion for Solutions™

Attachmt 4

Response RK

- Lab is significant in the model for RK, meaning lab has a significant affect on the value of RK.



Response RK

Whole Model

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Cy	5	5	0.0330011	0.3157	0.9030
Lab	4	4	4.4133501	52.7761	<.0001*

Cy

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1	1.1624619	0.02759666	1.16596
2	1.2007833	0.02759665	1.20429
3	1.1703548	0.02759665	1.17386
4	1.1701405	0.02759666	1.17364
5	1.1561048	0.02759666	1.15961
6	1.1726048	0.02759665	1.17611

LS Means Plot

Lab

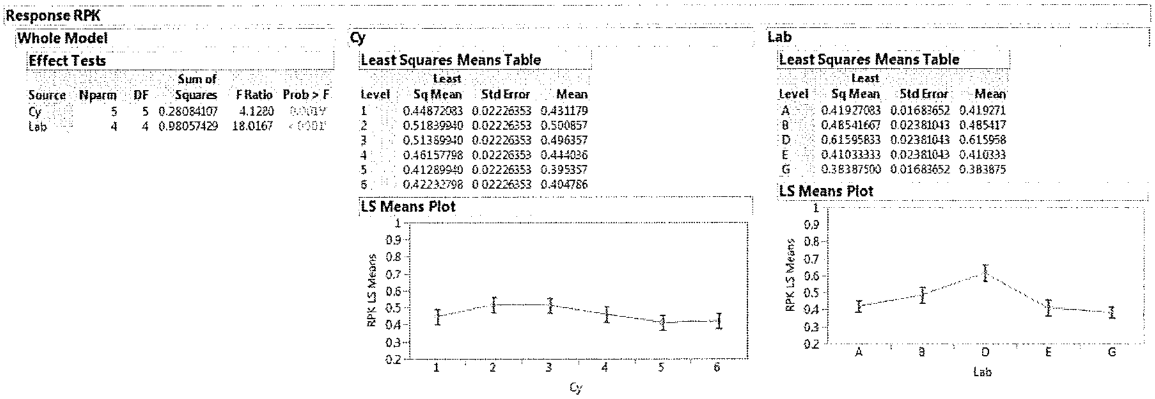
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	1.3535208	0.02086963	1.35352
B	1.3600000	0.02951412	1.36000
D	1.1400000	0.02951412	1.14000
E	0.9917083	0.02951412	0.99171
G	1.0151458	0.02086963	1.01515

LS Means Plot

Response RPK

- **Lab and Cylinder are significant in the model for RPK, meaning lab and cylinder number have a significant affect on the value of RPK.**



Response RPK

Whole Model

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Cy	5	5	0.28084107	4.1280	0.0019
Lab	4	4	0.98057429	18.0167	<.0001

Cy

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1	0.44872083	0.02226353	0.431179
2	0.51839940	0.02226353	0.500857
3	0.51389940	0.02226353	0.496357
4	0.46157798	0.02226353	0.444036
5	0.41289940	0.02226353	0.395357
6	0.42232798	0.02226353	0.404786

LS Means Plot

Lab

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
A	0.41927083	0.01683652	0.419271
B	0.48541667	0.02381043	0.485417
D	0.61595833	0.02381043	0.615958
E	0.41033333	0.02381043	0.410333
G	0.38387500	0.01683652	0.383875

LS Means Plot

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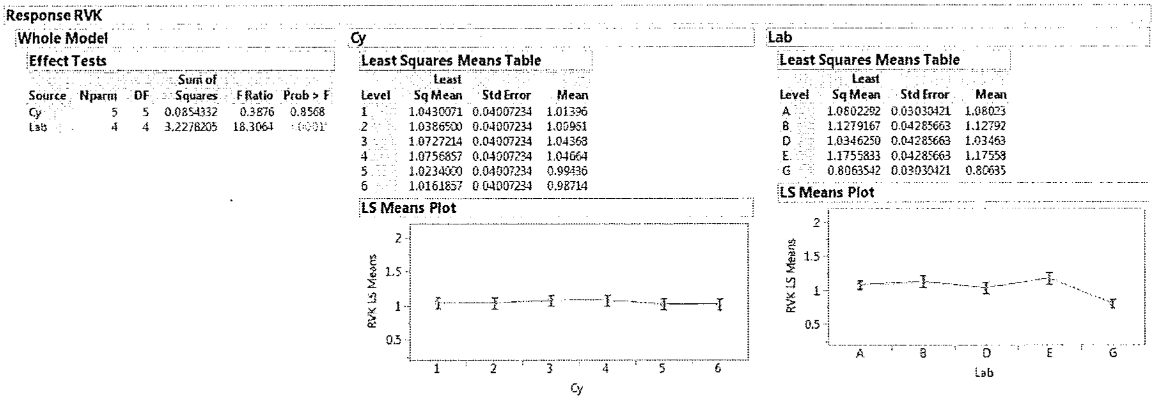
Response RVK

- **Lab is significant in the model for RVK, meaning lab has a significant affect on the value of RVK.**



Response RVK

Whole Model

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Cy	5	5	0.0854332	0.3876	0.8568
Lab	4	4	3.2278205	18.3064	<.0001

Cy

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1	1.0430071	0.04007234	1.01396
2	1.0386500	0.04007234	1.00951
3	1.0727214	0.04007234	1.04368
4	1.0756857	0.04007234	1.04664
5	1.0234000	0.04007234	0.99436
6	1.0161857	0.04007234	0.98714

LS Means Plot

Lab

Least Squares Means Table

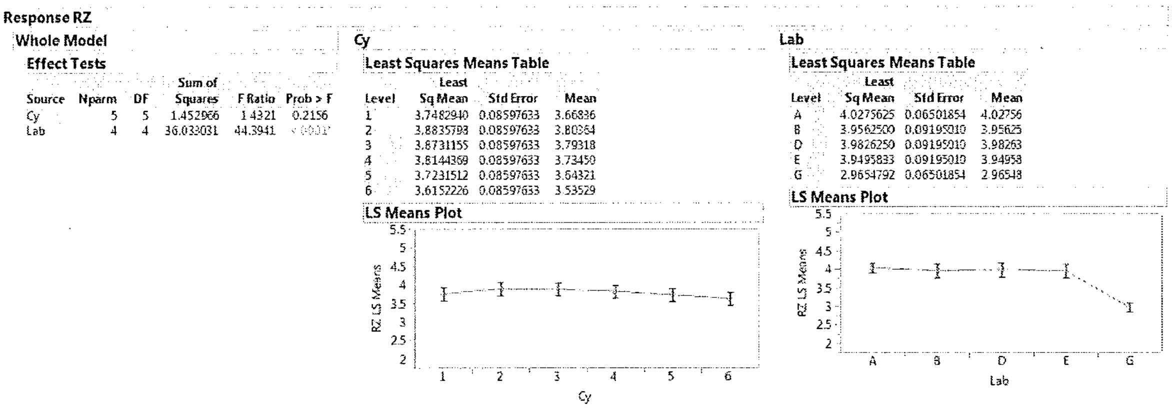
Level	Least Sq Mean	Std Error	Mean
A	1.0802292	0.03030421	1.08023
B	1.1279167	0.04285663	1.12792
D	1.0346250	0.04285663	1.03463
E	1.1755833	0.04285663	1.17558
G	0.8063542	0.03030421	0.80635

LS Means Plot

Passion for Solutions™

Response RZ

- **Lab is significant in the model for RZ, meaning lab has a significant affect on the value of RZ.**



Response RZ

Whole Model

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Cy	5	5	1.452966	1.4321	0.2156
Lab	4	4	36.033031	44.3941	<.0001

Cy

Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1	3.7482940	0.08597633	3.66836
2	3.8835793	0.08597633	3.80364
3	3.8731155	0.08597633	3.79318
4	3.8144369	0.08597633	3.73450
5	3.7231512	0.08597633	3.64321
6	3.6152226	0.08597633	3.53529

LS Means Plot

Lab

Least Squares Means Table

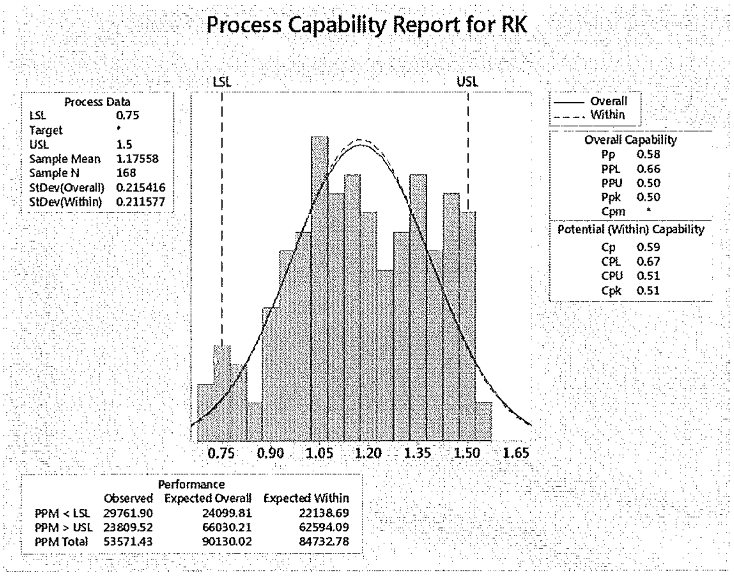
Level	Least Sq Mean	Std Error	Mean
A	4.0275625	0.06501854	4.02756
B	3.9562500	0.09195010	3.95625
D	3.9826250	0.09195010	3.98263
E	3.9495833	0.09195010	3.94958
G	2.9654792	0.06501854	2.96548

LS Means Plot

CAPABILITY ANALYSIS USING ALL DATA FROM EACH CYLINDER

Capability Analysis Using All Data for RK

- **RK seems to be on target since C_p and C_{pk} are approximately equal, but the spread for RK is too large since C_p is less than 1.**



Process Capability Report for RK

Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.17558
Sample N	168
StDev(Overall)	0.215416
StDev(Within)	0.211577

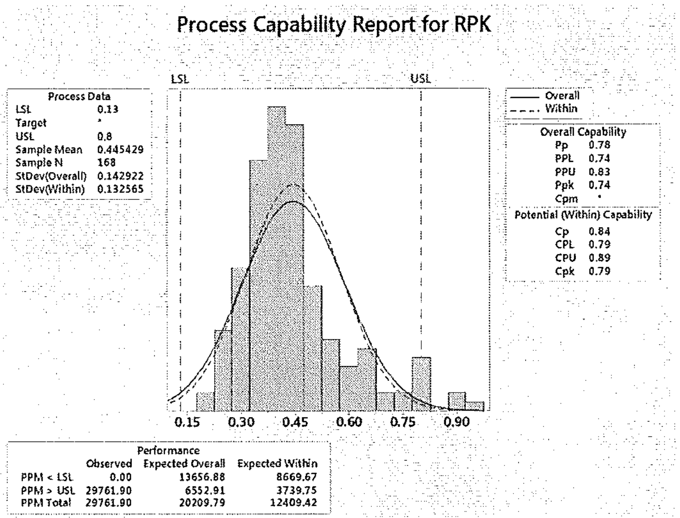
Overall Capability	
Pp	0.58
PPL	0.66
PPU	0.50
Ppk	0.50
Cpm	*

Potential (Within) Capability	
Cp	0.59
CPL	0.67
CPU	0.51
Cpk	0.51

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	29761.90	24099.81	22138.69
PPM > USL	23809.52	66030.21	62594.09
PPM Total	53571.43	90130.02	84732.78

Capability Analysis Using All Data for RPK

- **RPK seems to be on target since C_p and C_{pk} are approximately equal, but the spread for RPK is a little bit too large since C_p is less than 1 (this could be due to outliers in data).**



Process Capability Report for RPK

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.445429
Sample N	168
StDev(Overall)	0.142922
StDev(Within)	0.132565

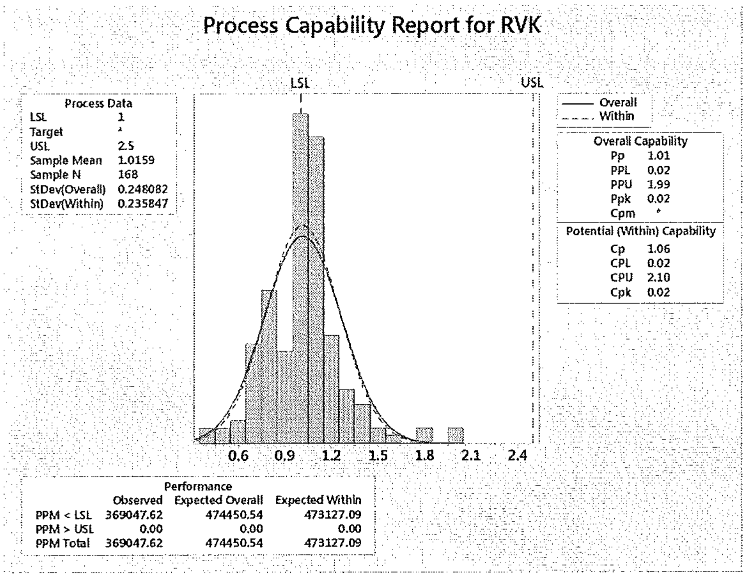
Overall Capability	
Pp	0.78
PPL	0.74
PPU	0.83
Ppk	0.74
Cpm	*

Potential (Within) Capability	
Cp	0.84
CPL	0.79
CPU	0.89
Cpk	0.79

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	13656.88	8669.67
PPM > USL	29761.90	6552.91	3739.75
PPM Total	29761.90	20209.79	12409.42

Capability Analysis Using All Data for RVK

- **RVK is extremely off target since C_p and C_{pk} are not equal, but the spread for RVK is not too large since C_p is greater than 1.**



Process Capability Report for RVK

Process Data

LSL	1
Target	*
USL	2.5
Sample Mean	1.0159
Sample N	168
StDev(Overall)	0.248082
StDev(Within)	0.235847

Overall Capability

Pp	1.01
PPL	0.02
PPU	1.99
Ppk	0.02
Cpm	*

Potential (Within) Capability

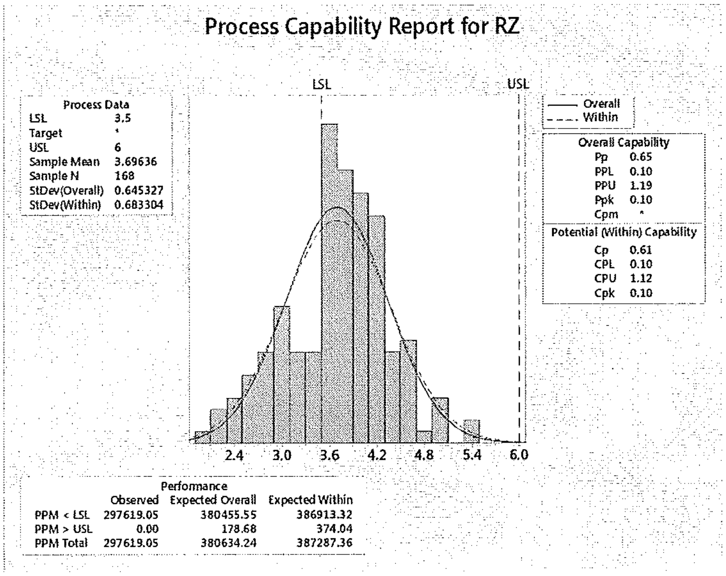
Cp	1.06
CPL	0.02
CPU	2.10
Cpk	0.02

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	369047.62	474450.54	473127.09
PPM > USL	0.00	0.00	0.00
PPM Total	369047.62	474450.54	473127.09

Capability Analysis Using All Data for RZ

- **RZis extremely off target since C_p and C_{pk} are not equal, and the spread for RZ is too large since C_p is less than 1.**



Process Capability Report for RZ

Process Data

LSL	3.5
Target	*
USL	6
Sample Mean	3.69636
Sample N	168
StDev(Overall)	0.645327
StDev(Within)	0.683304

Overall Capability

Pp	0.65
PPL	0.10
PPU	1.19
Ppk	0.10
Cpm	*

Potential (Within) Capability

Cp	0.61
CPL	0.10
CPU	1.12
Cpk	0.10

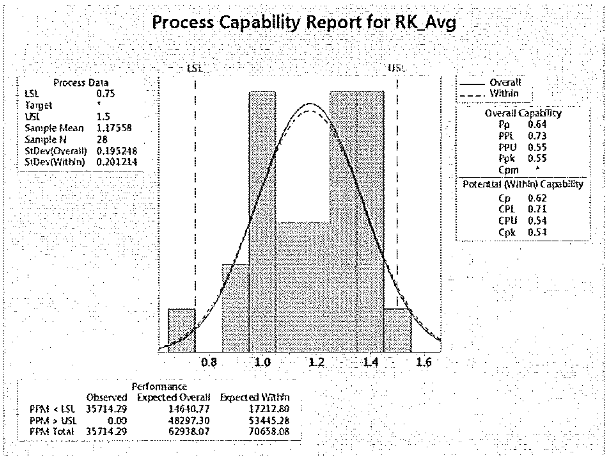
Perfomance

	Observed	Expected Overall	Expected Within
PPM < LSL	297619.05	380455.55	386913.32
PPM > USL	0.00	178.68	374.04
PPM Total	297619.05	380634.24	387287.36

CAPABILITY ANALYSIS USING THE BLOCK AVERAGE DATA

Capability Using Average Cylinder Data for RK and RPK

- **Using the average of all six cylinders gives extremely similar results, but for RPK the spread is no longer too large since the outliers are not as prominent.**



Process Capability Report for RK_Avg

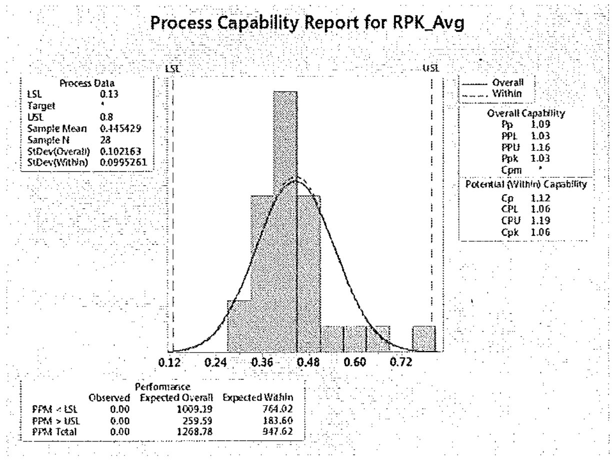
Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.17558
Sample N	28
StDev(Overall)	0.195248
StDev(Within)	0.201214

Overall Capability	
Pp	0.64
PPL	0.73
PPU	0.55
Ppk	0.55
Cpm	*

Potential (Within) Capability	
Cp	0.62
CPL	0.71
CPU	0.54
Cpk	0.54

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	35714.29	14640.77	17212.80
PPM > USL	0.00	48297.30	53445.28
PPM Total	35714.29	62938.07	70658.08



Process Capability Report for RPK_Avg

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.445429
Sample N	28
StDev(Overall)	0.102163
StDev(Within)	0.0995261

Overall Capability	
Pp	1.09
PPL	1.03
PPU	1.16
Ppk	1.03
Cpm	*

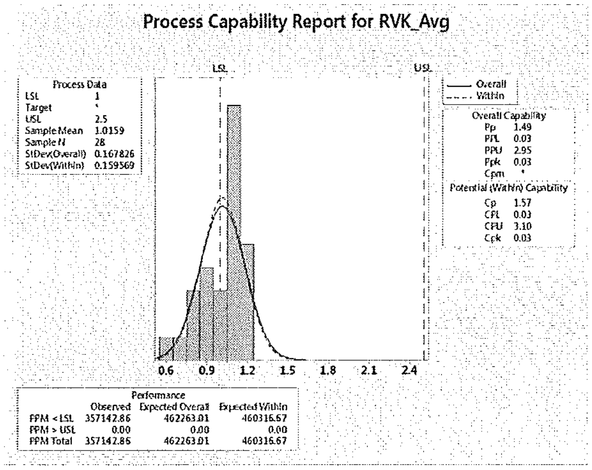
Potential (Within) Capability	
Cp	1.12
CPL	1.06
CPU	1.19
Cpk	1.06

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	1009.19	764.02
PPM > USL	0.00	259.59	183.60
PPM Total	0.00	1268.78	947.62

Capability Using Average Cylinder Data for RVK and RZ

- **Using the average of all six cylinders gives the same results for RVK and RZ as using all of the data.**



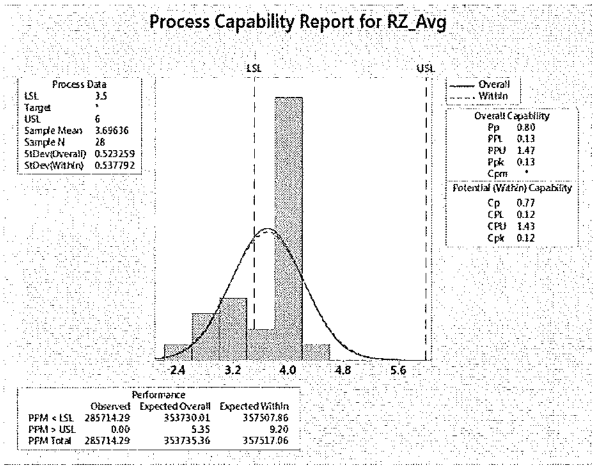
Process Capability Report for RVK_Avg

Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	1.0159
Sample N	28
StDev(Overall)	0.167826
StDev(Within)	0.159569

Overall Capability	
Pp	1.49
PPL	0.03
PPU	2.95
Ppk	0.03
Cpm	*

Potential (Within) Capability	
Cp	1.57
CPL	0.03
CPU	3.10
Cpk	0.03

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	357142.86	462263.01	460316.67
PPM > USL	0.00	0.00	0.00
PPM Total	357142.86	462263.01	460316.67



Process Capability Report for RZ_Avg

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	3.69636
Sample N	28
StDev(Overall)	0.523259
StDev(Within)	0.537792

Overall Capability	
Pp	0.80
PPL	0.13
PPU	1.47
Ppk	0.13
Cpm	*

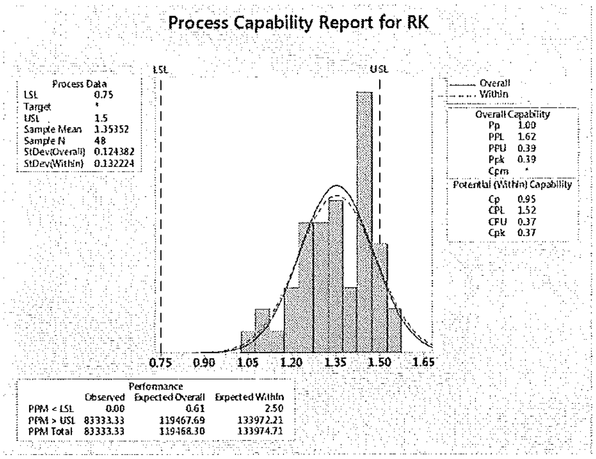
Potential (Within) Capability	
Cp	0.77
CPL	0.12
CPU	1.43
Cpk	0.12

Performance	Observed	Expected Overall	Expected Within
PPM < LSL	285714.29	353730.01	357507.86
PPM > USL	0.00	5.35	9.20
PPM Total	285714.29	353735.36	357517.06

CAPABILITY ANALYSIS FOR EACH INDIVIDUAL LAB

Capability Analysis of RK and RPK for Lab A

- For Lab A, RK is not on target since C_{pk} and C_p are not equal, and the spread is only a tiny bit large since C_p is less than 1.
- For Lab A, RPK is close to on target and has good spread.



Process Capability Report for RK

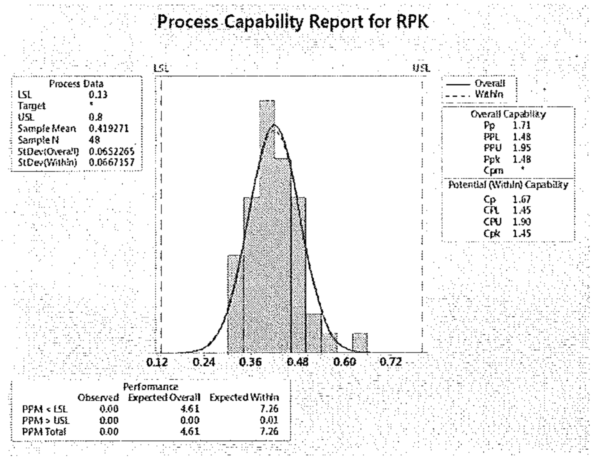
Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.35352
Sample N	48
StDev(Overall)	0.124382
StDev(Within)	0.132224

Overall Capability	
Pp	1.00
PPL	1.62
PPU	0.39
Ppk	0.39
Cpm	*

Potential (Within) Capability	
Cp	0.95
CPL	1.52
CPU	0.37
Cpk	0.37

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.61	2.50
PPM > USL	83333.33	119467.69	133972.21
PPM Total	83333.33	119468.30	133974.71



Process Capability Report for RPK

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.419271
Sample N	48
StDev(Overall)	0.0652265
StDev(Within)	0.0667157

Overall Capability	
Pp	1.71
PPL	1.48
PPU	1.95
Ppk	1.48
Cpm	*

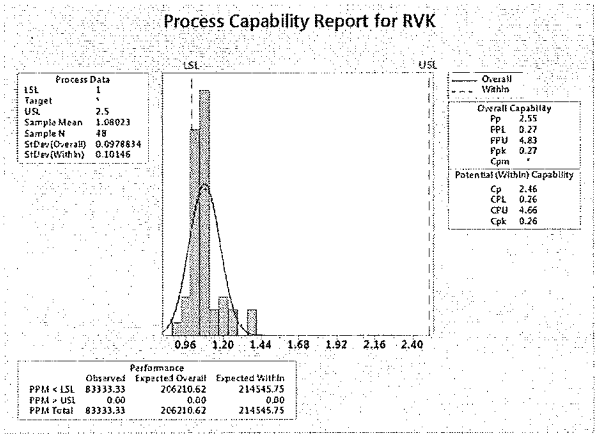
Potential (Within) Capability	
Cp	1.67
CPL	1.45
CPU	1.90
Cpk	1.45

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	4.61	7.26
PPM > USL	0.00	0.00	0.01
PPM Total	0.00	4.61	7.26

Capability Analysis for RVK and RZ for Lab A

- For Lab A, RVK is not on target, but there does not seem to be a lot of spread.
- For Lab A, RZ is not on target since C_{pk} is less than C_p, but the spread is not too large.



Process Capability Report for RVK

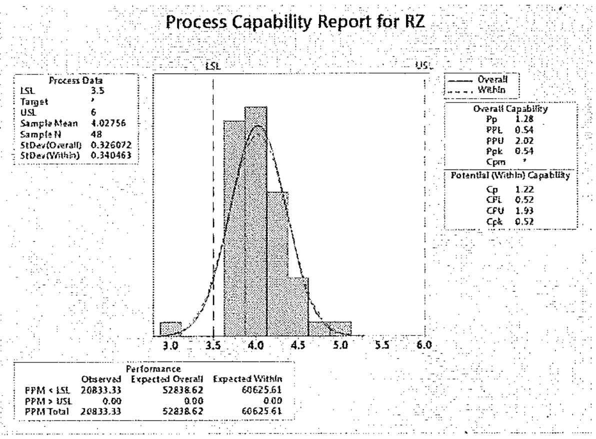
Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	1.08023
Sample N	48
StDev(Overall)	0.0978834
StDev(Within)	0.10146

Overall Capability	
Pp	2.55
PPL	0.27
PPU	4.83
Ppk	0.27
Cpm	*

Potential (Within) Capability	
Cp	2.46
CPL	0.26
CPU	4.66
Cpk	0.26

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	83333.33	206210.62	214545.75
PPM > USL	0.00	0.00	0.00
PPM Total	83333.33	206210.62	214545.75



Process Capability Report for RZ

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	4.02756
Sample N	48
StDev(Overall)	0.326072
StDev(Within)	0.340463

Overall Capability	
Pp	1.28
PPL	0.54
PPU	2.02
Ppk	0.54
Cpm	*

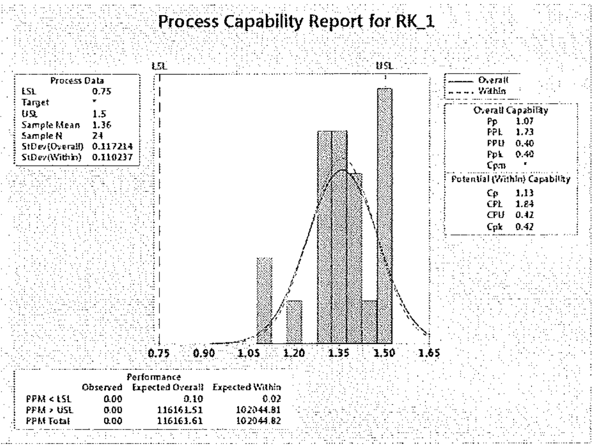
Potential (Within) Capability	
Cp	1.22
CPL	0.52
CPU	1.93
Cpk	0.52

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	20833.33	52838.62	60625.61
PPM > USL	0.00	0.00	0.00
PPM Total	20833.33	52838.62	60625.61

Capability Analysis for RK and RPK for Lab B

- For Lab B, RK is not on target since C_{pk} is less than C_p, but the spread is not too large since C_p is greater than 1.
- For Lab B, RPK is on target and the spread is not too large, but a few points are on the USL.



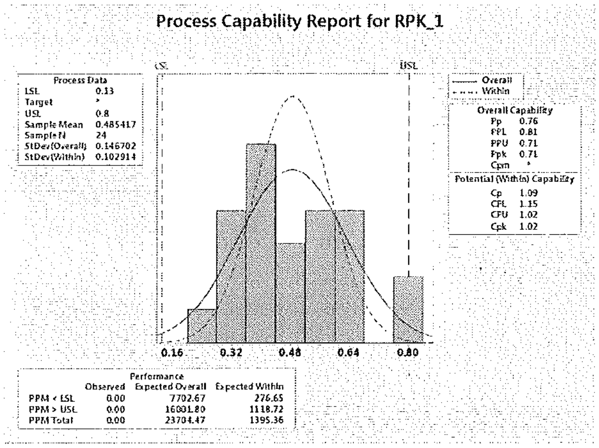
Process Capability Report for RK_1

Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.36
Sample N	24
StDev(Overall)	0.117214
StDev(Within)	0.110237

Overall Capability	
Pp	1.07
PPL	1.73
PPU	0.40
Ppk	0.40
Cpm	*
Potential (Within) Capability	
Cp	1.13
CPL	1.84
CPU	0.42
Cpk	0.42

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	0.10	0.02
PPM > USL	0.00	116161.51	102044.81
PPM Total	0.00	116161.61	102044.82



Process Capability Report for RPK_1

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.485417
Sample N	24
StDev(Overall)	0.146702
StDev(Within)	0.102914

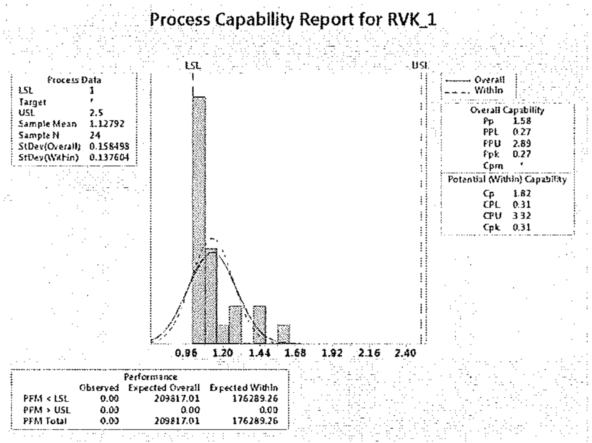
Overall Capability	
Pp	0.76
PPL	0.81
PPU	0.71
Ppk	0.71
Cpm	*
Potential (Within) Capability	
Cp	1.09
CPL	1.15
CPU	1.02
Cpk	1.02

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	7702.67	276.65
PPM > USL	0.00	16001.80	1118.72
PPM Total	0.00	23704.47	1395.36

Capability Analysis for RVK and RZ for Lab B

- For Lab B, RVK is not on target since C_p and C_{pk} are not equal, but there does not seem to be a lot of spread.
- For Lab B, RZ is not on target since C_{pk} is less than C_p and the spread is a bit too large for these specification limits.



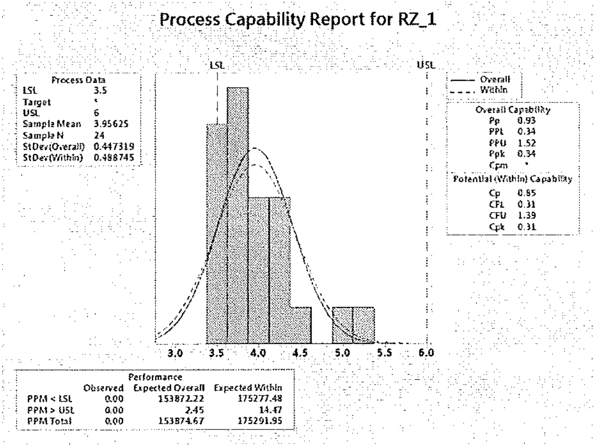
Process Capability Report for RVK_1

Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	1.12792
Sample N	24
StDev(Overall)	0.158498
StDev(Within)	0.137604

Overall Capability	
Pp	1.58
PPL	0.27
PPU	2.89
Ppk	0.27
Cpm	*
Potential (Within) Capability	
Cp	1.82
CPL	0.31
CPU	3.32
Cpk	0.31

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	209817.01	176289.26
PPM > USL	0.00	0.00	0.00
PPM Total	0.00	209817.01	176289.26



Process Capability Report for RZ_1

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	3.95625
Sample N	24
StDev(Overall)	0.447319
StDev(Within)	0.488745

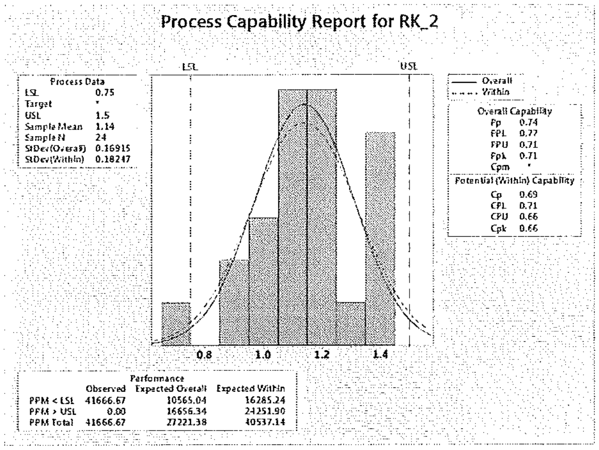
Overall Capability	
Pp	0.93
PPL	0.34
PPU	1.52
Ppk	0.34
Cpm	*
Potential (Within) Capability	
Cp	0.85
CPL	0.31
CPU	1.39
Cpk	0.31

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	153872.22	175277.48
PPM > USL	0.00	2.45	14.47
PPM Total	0.00	153874.67	175291.95

Capability Analysis for RK and RPK for Lab D

- **For Lab D, RK is on target since C_{pk} approximately equal to C_p, but the spread is too large for these specification limits.**
- **RPK has a large spread since C_p is less than one and is slightly off target.**


Process Capability Report for RK_2

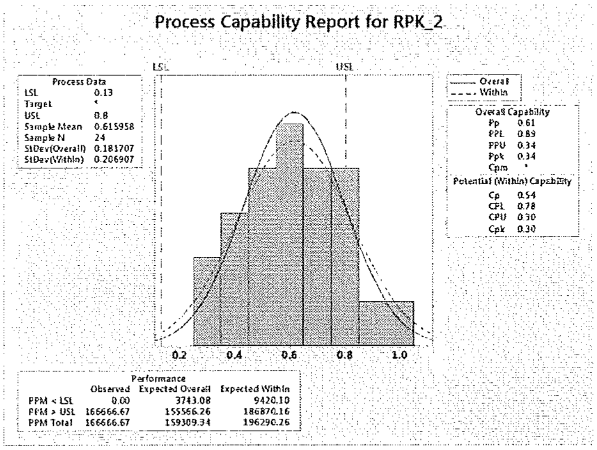
Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.14
Sample N	24
StDev(Overall)	0.16915
StDev(Within)	0.18247

Overall Capability	
Pp	0.74
PPL	0.77
PPU	0.71
Ppk	0.71
Cpm	*

Potential (Within) Capability	
Cp	0.69
CPL	0.71
CPU	0.66
Cpk	0.66

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	41666.67	10565.04	16285.24
PPM > USL	0.00	16656.34	24251.90
PPM Total	41666.67	27221.38	40537.14


Process Capability Report for RPK_2

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.615958
Sample N	24
StDev(Overall)	0.181707
StDev(Within)	0.206907

Overall Capability	
Pp	0.61
PPL	0.89
PPU	0.34
Ppk	0.34
Cpm	*

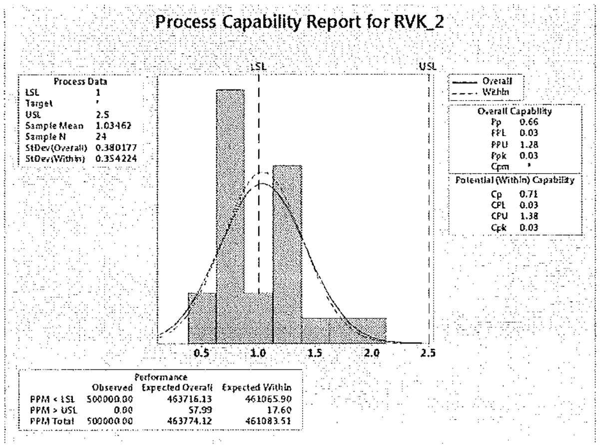
Potential (Within) Capability	
Cp	0.54
CPL	0.78
CPU	0.30
Cpk	0.30

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	3743.08	9420.10
PPM > USL	166666.67	155566.26	186870.16
PPM Total	166666.67	159309.34	196290.26

Capability Analysis for RVK and RZ for Lab D

- **For Lab D, RVK is not on target causing many of the points to be below the LSL, and the spread seems to be too large since C_p is less than 1.**
- **For Lab D, RZ is not on target since C_{pk} is less than C_p, and the spread is too large for these specification limits.**


Process Capability Report for RVK_2

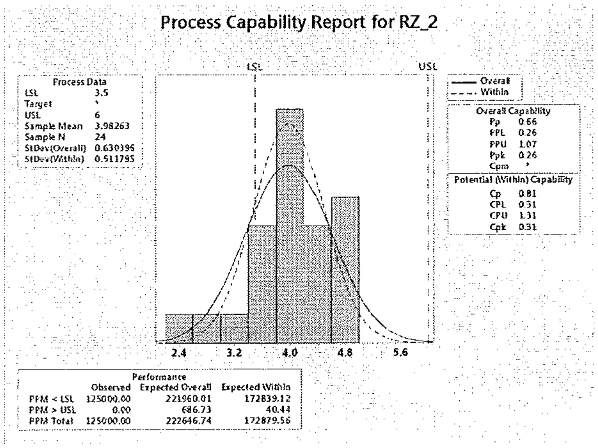
Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	1.03462
Sample N	24
StDev(Overall)	0.380177
StDev(Within)	0.354224

Overall Capability	
Pp	0.66
PPL	0.03
PPU	1.28
Ppk	0.03
Cpm	*

Potential (Within) Capability	
Cp	0.71
CPL	0.03
CPU	1.38
Cpk	0.03

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	500000.00	463716.13	461065.90
PPM > USL	0.00	57.99	17.60
PPM Total	500000.00	463774.12	461083.51


Process Capability Report for RZ_2

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	3.98263
Sample N	24
StDev(Overall)	0.630395
StDev(Within)	0.511795

Overall Capability	
Pp	0.66
PPL	0.26
PPU	1.07
Ppk	0.26
Cpm	*

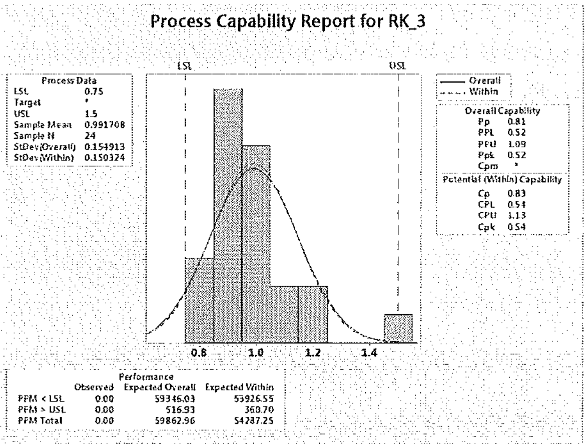
Potential (Within) Capability	
Cp	0.81
CPL	0.31
CPU	1.31
Cpk	0.31

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	125000.00	221960.01	172839.12
PPM > USL	0.00	686.73	40.44
PPM Total	125000.00	222646.74	172879.56

Capability Analysis for RK and RPK for Lab E

- **For Lab E, RK is not on target since C_{pk} is less than C_p and the spread is too large since C_p is less than 1, but only a few points seem to be on the USL.**
- **For Lab E, RPK has large spread, but seems to be close to the target. A few points fall above the USL.**



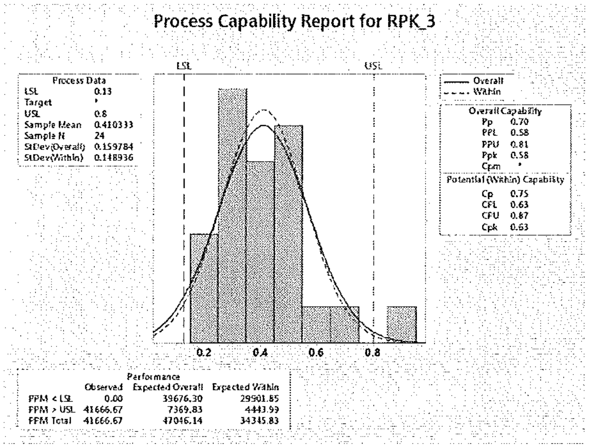
Process Capability Report for RK_3

Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	0.991708
Sample N	24
StDev(Overall)	0.154913
StDev(Within)	0.150324

Overall Capability	
Pp	0.81
PPL	0.52
PPU	1.09
Ppk	0.52
Cpm	*
Potential (Within) Capability	
Cp	0.83
CPL	0.54
CPU	1.13
Cpk	0.54

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	59346.03	53926.55
PPM > USL	0.00	516.93	360.70
PPM Total	0.00	59862.96	54287.25



Process Capability Report for RPK_3

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.410333
Sample N	24
StDev(Overall)	0.159784
StDev(Within)	0.148936

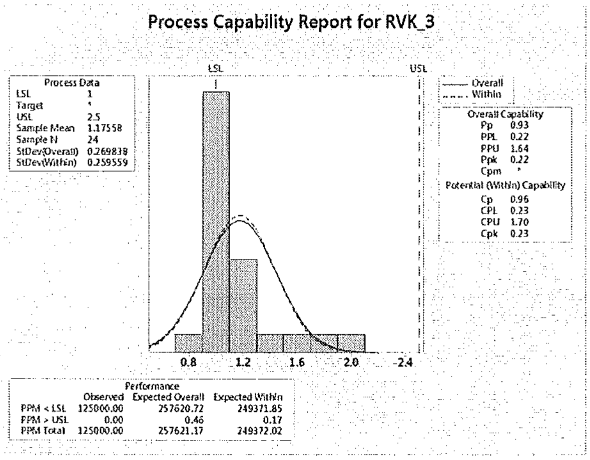
Overall Capability	
Pp	0.70
PPL	0.58
PPU	0.81
Ppk	0.58
Cpm	*
Potential (Within) Capability	
Cp	0.75
CPL	0.63
CPU	0.87
Cpk	0.63

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	39676.30	29901.85
PPM > USL	41666.67	7369.83	4443.99
PPM Total	41666.67	47046.14	34345.83

Capability Analysis for RVK and RZ for Lab E

- **For Lab E, RVK is not on target since C_p is less than C_{pk}, but the spread is only slightly large.**
- **For Lab E, RZ is not on target, and the spread is too large for these specification limits since C_p is less than 1.**



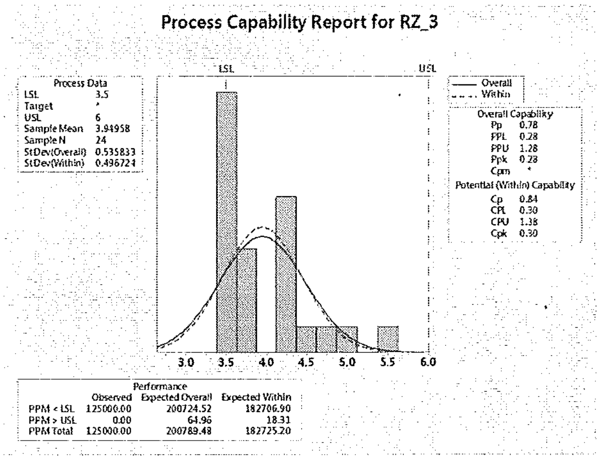
Process Capability Report for RVK_3

Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	1.17558
Sample N	24
StDev(Overall)	0.269838
StDev(Within)	0.259559

Overall Capability	
Pp	0.93
PPL	0.22
PPU	1.64
Ppk	0.22
Cpm	*
Potential (Within) Capability	
Cp	0.96
CPL	0.23
CPU	1.70
Cpk	0.23

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	125000.00	257620.72	249371.85
PPM > USL	0.00	0.46	0.17
PPM Total	125000.00	257621.17	249372.02



Process Capability Report for RZ_3

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	3.94958
Sample N	24
StDev(Overall)	0.535833
StDev(Within)	0.496724

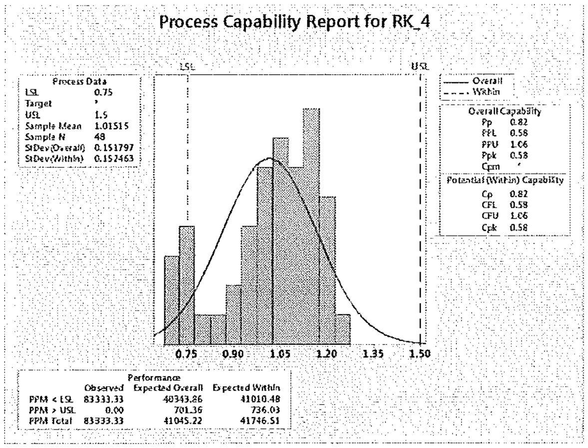
Overall Capability	
Pp	0.78
PPL	0.28
PPU	1.28
Ppk	0.28
Cpm	*
Potential (Within) Capability	
Cp	0.84
CPL	0.30
CPU	1.38
Cpk	0.30

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	125000.00	200724.52	182706.90
PPM > USL	0.00	64.96	18.31
PPM Total	125000.00	200789.48	182725.20

Capability Analysis for RK and RPK for Lab G

- For Lab G, RK is not on target since C_{pk} is less than C_p and the spread is too large.
- For Lab G, RPK meets the specification limits and has good spread, but seems to be slightly off target since C_p is less than 1.



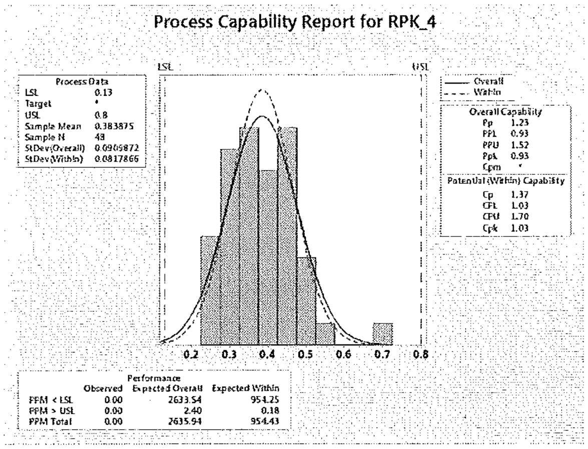
Process Capability Report for RK_4

Process Data	
LSL	0.75
Target	*
USL	1.5
Sample Mean	1.01515
Sample N	48
StDev(Overall)	0.151797
StDev(Within)	0.152463

Overall Capability	
Pp	0.82
PPL	0.58
PPU	1.06
Ppk	0.58
Cpm	*
Potential (Within) Capability	
Cp	0.82
CPL	0.58
CPU	1.06
Cpk	0.58

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	83333.33	40343.86	41010.48
PPM > USL	0.00	701.36	736.03
PPM Total	83333.33	41045.22	41746.51



Process Capability Report for RPK_4

Process Data	
LSL	0.13
Target	*
USL	0.8
Sample Mean	0.383875
Sample N	48
StDev(Overall)	0.0909872
StDev(Within)	0.0817866

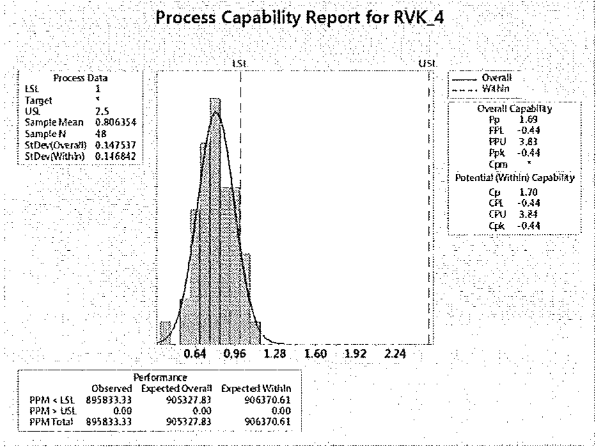
Overall Capability	
Pp	1.23
PPL	0.93
PPU	1.52
Ppk	0.93
Cpm	*
Potential (Within) Capability	
Cp	1.37
CPL	1.03
CPU	1.70
Cpk	1.03

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	0.00	2633.54	954.25
PPM > USL	0.00	2.40	0.18
PPM Total	0.00	2635.94	954.43

Capability Analysis for RVK and RZ for Lab G

- For Lab G, RVK is extremely off target since C_p is extremely less than C_{pk}, but the spread looks good.
- For Lab G, RZ is extremely off target, but the spread is only slightly large since C_p is close to 1.



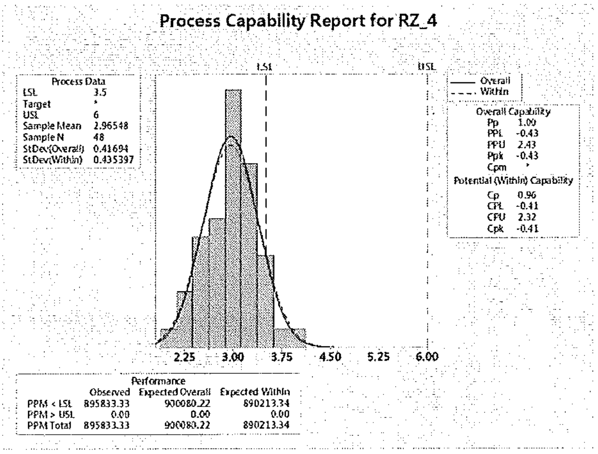
Process Capability Report for RVK_4

Process Data	
LSL	1
Target	*
USL	2.5
Sample Mean	0.806354
Sample N	48
StDev(Overall)	0.147537
StDev(Within)	0.146842

Overall Capability	
Pp	1.69
PPL	-0.44
PPU	3.83
Ppk	-0.44
Cpm	*
Potential (Within) Capability	
Cp	1.70
CPL	-0.44
CPU	3.84
Cpk	-0.44

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	895833.33	905327.83	906370.61
PPM > USL	0.00	0.00	0.00
PPM Total	895833.33	905327.83	906370.61



Process Capability Report for RZ_4

Process Data	
LSL	3.5
Target	*
USL	6
Sample Mean	2.96548
Sample N	48
StDev(Overall)	0.41694
StDev(Within)	0.435397

Overall Capability	
Pp	1.00
PPL	-0.43
PPU	2.43
Ppk	-0.43
Cpm	*
Potential (Within) Capability	
Cp	0.96
CPL	-0.41
CPU	2.32
Cpk	-0.41

Performance

	Observed	Expected Overall	Expected Within
PPM < LSL	895833.33	900080.22	890213.34
PPM > USL	0.00	0.00	0.00
PPM Total	895833.33	900080.22	890213.34

Conclusion

- **RK and RPK seem to have slightly large spread for specification limits of this distance apart, but overall they seem to be performing on target.**
  - The issue with the spread for these two parameters could be due to issues with a few outliers from certain Labs.
- **RVK and RZ seem to have issues with being on target, but their spread within specification limits of this distance apart does not seem to be as big of a problem.**
- **Lab does seem to have an effect on the severity of the responses, but the overall issues trend throughout each Lab.**
- **Recommended specification limits based on all of the data can be found on the next slide.**

Specification Limits

- **Current Specification Limits:**
  - RK: 0.75 to 1.5
  - RPK: 0.13 to 0.8
  - RVK: 1 to 2.5
  - RZ: 3.5 to 6
- **Recommended Specification Limits (based on all data, mean ± 3*standard deviation):**
  - RK: 0.53 to 1.82
  - RPK: 0.02 to 0.87
  - RVK: 0.27 to 1.76
  - RZ: 1.76 to 5.63

Attachment
5

Sequence III Surveillance Panel
March 29, 2016
8:00AM – 5:00PM
Southwest Research Institute
San Antonio, TX

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

1. Action Item – Chrysler to recalibrate the Sequence IIIH ECU to defeat the limp home mode for coolant and oil temperature inputs and to revise the oil pump operating range for engagement/disengagement of high pressure mode, one the range has been agreed upon.

2. Action Item – Chrysler and the Sequence IIIH Test Improvement Task Force to continue to explore options for long-term supply of ECUs flashed for the Sequence IIIH test.

3. Action Item – Labs to obtain and provide Sequence IIIH honing data (bore size (6 measurements for each cylinder), MR2, RK, RPK, RVK and RZ), post honing workshop, to Todd Dvorak (Afton) for analysis, review and possibly redefining the Sequence IIIH honing specifications.

4. Action Item – Addison Schweitzer to create a template for the Sequence IIIH honing data, will send it to Rich Grundza for posting on the TMC website. Labs to provide their data to Todd Dvorak using this template. Labs to provide currently available data by 4/1/16, and to continue to collect and provide data until further notice.

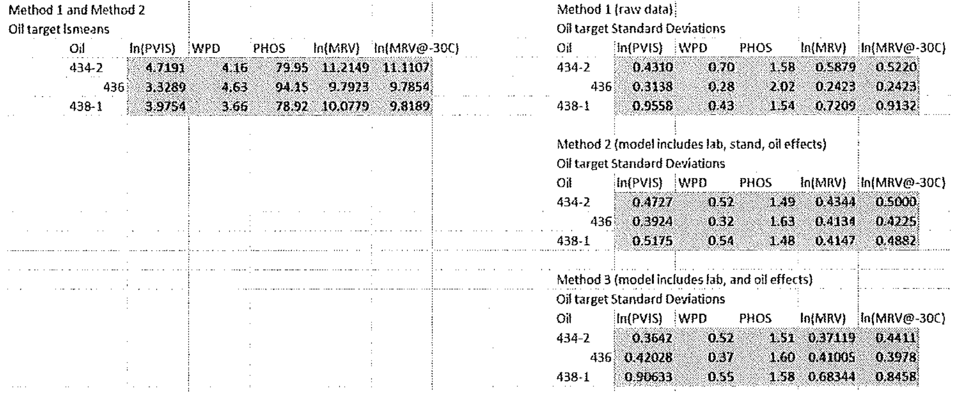
5. Motion – Temporarily suspend the following Sequence IIIH honing specifications; upper and lower limits for RVK and RZ. Also temporarily revise the Sequence IIIH target bore size calculation to be the average of the 6 measurements (longitudinal and transverse at top, middle and bottom) of each cylinder, until more honing data, post honing workshop, is available from the labs.
   Addison Schweitzer / Ed Altman / Passed Unanimously

6. Motion – Any Sequence IIIH precision matrix test result excluded in the precision matrix data analysis will not be charted in LTMS.

Ed Altman / Andy Ritchie / Passed Unanimously

7. Action Item – Adopt the concept of stand based LTMS control charts based on e_i and Z_i, fast start for Z_i, continuous SAs and excessive influence for the Sequence IIIH/IIIHA/IIIHB.
   Rich Grundza / Robert Stockwell / Passed Unanimously

8. Motion – Use arithmetic standard deviation (Method 1) for LTMS purposes for the Sequence IIIH/IIIHA/IIIHB. At some point in the future this will be reviewed for appropriateness.



Method 1 and Method 2
Oil target lsmeans

Oil	ln(PVIS)	WPD	PHOS	ln(MRV)	ln(MRV@-30C)
434-2	4.7191	4.16	79.95	11.2149	11.1107
436	3.3289	4.63	94.15	9.7923	9.7854
438-1	3.9754	3.66	78.92	10.0779	9.8189

Method 1 (raw data)
Oil target Standard Deviations

Oil	ln(PVIS)	WPD	PHOS	ln(MRV)	ln(MRV@-30C)
434-2	0.4310	0.70	1.58	0.5879	0.5220
436	0.3138	0.28	2.02	0.2423	0.2423
438-1	0.9558	0.43	1.54	0.7209	0.9132

Method 2 (model includes lab, stand, oil effects)
Oil target Standard Deviations

Oil	ln(PVIS)	WPD	PHOS	ln(MRV)	ln(MRV@-30C)
434-2	0.4727	0.52	1.49	0.4344	0.5000
436	0.3924	0.32	1.63	0.4134	0.4225
438-1	0.5175	0.54	1.48	0.4147	0.4882

Method 3 (model includes lab, and oil effects)
Oil target Standard Deviations

Oil	ln(PVIS)	WPD	PHOS	ln(MRV)	ln(MRV@-30C)
434-2	0.3642	0.52	1.51	0.37119	0.4411
436	0.42028	0.37	1.60	0.41005	0.3978
438-1	0.90633	0.55	1.58	0.68344	0.8458

   Ed Altman / Pat Lang / Passed w/ 1 waive

9. Motion – Define the reference period for the Sequence IIIH/IIIHA/IIIHB at 15 candidate tests or 6 months.
   Rich Grundza / Ed Altman / Passed w/ 1 waive

10. Motion – The introduction of a new Sequence IIIH/IIIHA/IIIHB stand will require two operationally valid reference oil calibration tests with no alarms following the second operationally valid test. The average of the first two operationally valid tests will be used for Z_0.
    Addison Schweitzer / Rich Grundza / Passed w/ 1 waive

11. Motion – Set the Sequence IIIH/IIIHA/IIIHB reference oil assignment protocol at equal proportion with random assignment for all three reference oils (434-2, 436 and 438-1).
    Pat Lang / Addison Schweitzer / Passed Unanimously

12. Motion – Define a new Sequence IIIH/IIIHA/IIIHB stand as any stand that has never been calibrated or has not conducted a calibration test within 18 months of the completion of its last acceptable calibration test.
    Jason Bowden / Ed Altman / Passed Unanimously

13. Motion – Adopt the LTMS constants included in the table below for the Sequence IIIH/IIIHA/IIIHB. At some point in the future this will be reviewed for appropriateness.

		EWMA Chart		Stand Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand	Level 1	0.3	0.000	Level 1	±0
	Level 2		±1.800	Level 2	±1.734
Industry	Level 1	0.2	±0.775	Level 3	±2.066
	Level 2		±0.859	--	--

Martin Chadwick / Jo Martinez / Passed w/ 1 waive

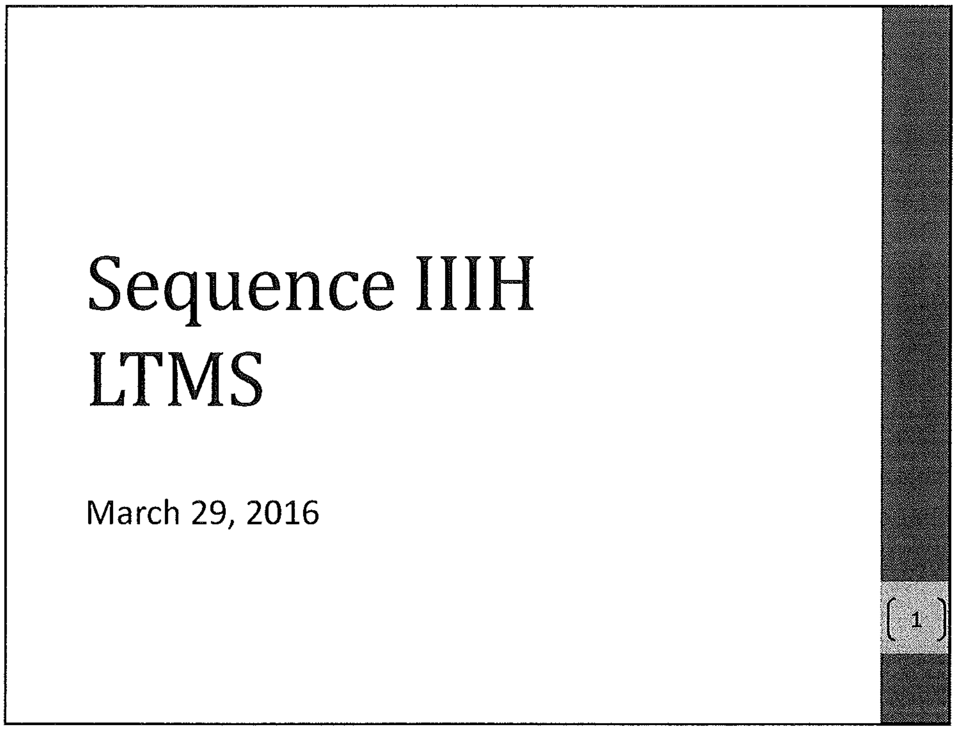
14. Motion – Update the Sequence IIIHA test procedure to specify that MRV is to be performed at -30°C, for Sequence IIIHA reference oil calibration tests.
Martin Chadwick / Robert Stockwell / Passed Unanimously

15. Motion – Adopt pooled S for the Sequence IIIH/IIIHA/IIIHB severity adjustments as the RMSE from the model used to calculate the LS means.
Jo Martinez / Amol Savant / Passed w/ 1 waive

16. Action Item – Kevin OMalley to provide the three Sequence IIIH/IIIHA/IIIHB LTMS documents to the TMC.

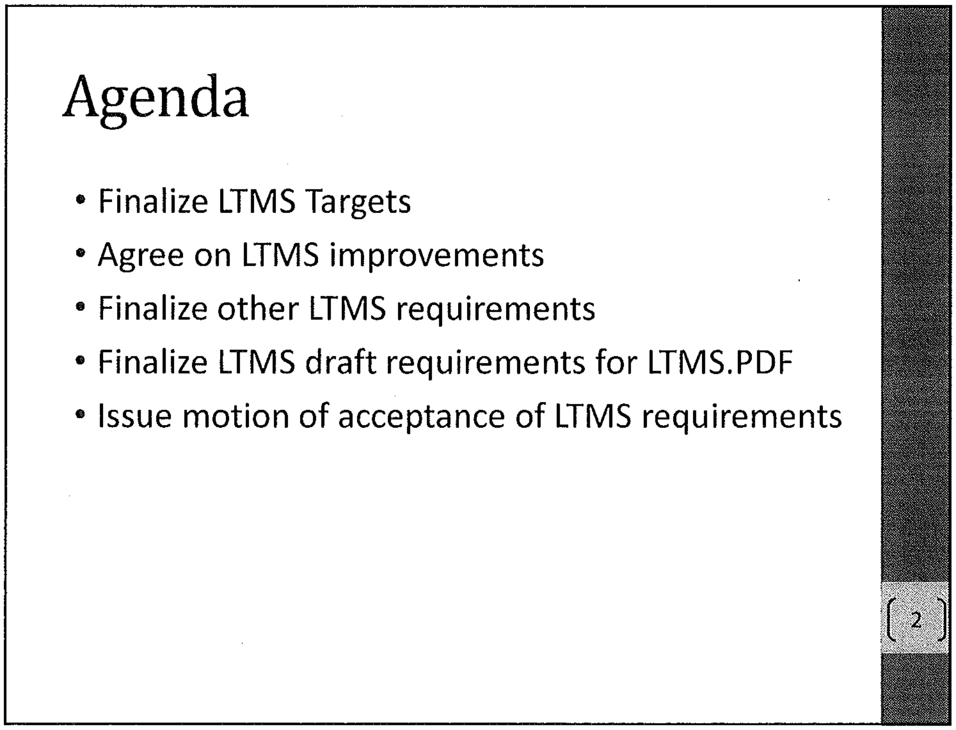
17. Motion – Official stand calibration will start on 4/15/16 for stands that have completed calibration testing following the criteria included in the Sequence IIIH/IIIHA/IIIHB LTMS documents and using the latest Sequence IIIH test procedure and engine assembly manual drafts, posted on 3/22/16 or later.
Bob Campbell / Andy Ritchie / Passed Unanimously

Attachment
6



Sequence IIIH LTMS

March 29, 2016



Agenda

- Finalize LTMS Targets
- Agree on LTMS improvements
- Finalize other LTMS requirements
- Finalize LTMS draft requirements for LTMS.PDF
- Issue motion of acceptance of LTMS requirements

LTMS Improvements

- Checklist
  - Fast Start for Z_i
  - Continuous severity adjustment
  - Excessive Influence and e_i (use of R_i & Q_i are discontinued)

Other Surveillance Panel Discussions

- Surveillance discussion of other LTMS requirements
  - Lab/stand calibration rules
  - Reference oil assignments including target for percent of time oils are tested
  - Removal of lab/stand (in IIIG)?
  - Introduction of reference oils (in IIIG)?

IIIH LTMS Requirements

Attachment 7

The following are the specific IIIH calibration test requirements.

A. Reference Oils and Critical Performance Criteria

The critical performance criteria are Percent Viscosity Increase (PVIS), and Weighted Piston Deposits (WPD). The reference oils required for test stand and test laboratory referencing are reference oils accepted by the ASTM Sequence III Surveillance Panel. The means and standard deviations for the current reference oils for each critical performance criterion are presented below.

Percent Viscosity Increase (PVIS)
Unit of Measure: ln(PVIS)

Reference Oil	Mean	Standard Deviation
434-2	4.7191	0.4727
436	3.3289	0.3924
438-1	3.9754	0.5175

Weighted Piston Deposits
Unit of Measure: Merits

Reference Oil	Mean	Standard Deviation
434-2	4.16	0.52
436	4.63	0.32
438-1	3.66	0.54

B. Acceptance Criteria

1. New Test Stands

   - A minimum of two (2) operationally valid calibration tests and/or matrix tests, with no Level 3 e_i alarms must be conducted in a new stand on any approved reference oils.

   - Note that industry matrix runs may be included, as well as reference runs, at the discretion of the surveillance panel.

   - Following the necessary tests, check the status of the control charts and follow the prescribed actions.

2. Existing Test Stands

- Test stands in an existing test lab that have not run an acceptable reference in the past two years, may calibrate with one test provided e_i Level 1 limits are not exceeded. Otherwise a second test is required for calibration.

- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

3. Reference Oil Assignment

Once test stands have been accepted into the system, the TMC will assign reference oils for continuing calibration according to the reference oil mix:

- Scheduled calibration tests should be conducted on reference oils 436, 434-2, and 438-1 or subsequent approved reblends on a 2:1:1 ratio basis (i.e., 50% of reference tests on 436; 25% of reference tests on 434-2; 25% of reference tests on 438-1).

4. Control Charts

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. For the IIIH, Z_0=Mean Y_i of first two operationally valid tests in the stand. The constants used for the construction of the control charts for the IIIH, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart		Stand Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand	Level 1	0.3	0.000	Level 1	±1.351
	Level 2		±1.800	Level 2	±1.734
Industry	Level 1	0.2	±0.775	Level 3	±2.066
	Level 2		±0.859	--	--

The following are the steps that must be taken in the case of exceeding control chart limits. The steps are listed in order of priority, although charts should be studied simultaneously to determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance. The laboratory always has the option of removing any stand from the system.

- Exceed Stand chart of Prediction Error (e_i)

  Level 3:

  – Immediately conduct one additional reference test in the stand that triggered the alarm. Do not update the control charts until the follow up reference test is completed and Excessive Influence (refer to Section 1.A.5) has been performed.

  Level 2:

  – The Level 2 limit applies in situations that have been pre-determined by the surveillance panel to have a potential impact on test results. These situations may include the introduction of new critical parts, fuel batches, reference oil reblends, or other test components. When these conditions have been met and a Level 2 alarm is triggered, immediately conduct one additional reference test in the stand that triggered the alarm.

  Level 1:

  – The Level 1 limit also applies to stand in an existing test lab that has not run an acceptable reference in the past two years. The stand can calibrate with one test if the Level 1 limits are not exceeded. Otherwise, immediately conduct another reference test in the stand.

☐ Exceed Stand EWMA of Standardized Test Result (Z_i)

Level 2:

– Immediately conduct one additional reference test in the stand that triggered the alarm. The stand that triggered the alarm is not qualified for non-reference tests until the Level 2 alarm is cleared.

– In instances where surveillance panel has deemed that industry-wide circumstances are impacting the Level 2 alarm, the TMC may be asked to review stand calibration status in accordance with the surveillance panel's findings.

Level 1:

- The Level 1 limit applies to all reference tests that are control charted, even when other alarms have been triggered. Level 1 uses Z_i to determine the stand severity adjustment (SA). Calculate the stand SA as follows and confirm the calculation with the TMC:

  Percent Viscosity Increase (ln(PVIS)): SA = $(-Z_i) \times (0.4641)$
  Weighted Piston Deposits (WPD): SA = $(-Z_i) \times (0.47)$

☐ Exceed Industry EWMA of Standardized Test Result (Z_i)

Level 2:

- TMC informs the surveillance panel that the limit has been exceeded. The surveillance panel then investigates and pursues resolution of the alarm.

Level 1:

- The TMC investigates whether severity adjustments are adequately addressing the trend, investigates the possible causes, and communicates as appropriate with industry.

Sequence IIIHA LTMS Requirements

Attachment 8

The following are the specific IIIHA calibration test requirements.

A. Reference Oils and Critical Performance Criteria

The critical parameter is MRV Apparent Viscosity. The reference oils required for test stand and test laboratory referencing are reference oils accepted by the ASTM Sequence III Surveillance Panel. The means and standard deviations for the current reference oils for each critical performance criterion are presented below.

MRV Viscosity
Unit of Measure: ln(MRV)

Reference Oil	Mean	Standard Deviation
434-2	11.1107	0.5000
436	9.7854	0.4225
438-1	9.8189	0.4882

B. Acceptance Criteria

1. New Test Stands

- Stand must be calibrated according to Sequence IIIH requirements. A Sequence IIIHA test must be conducted as part of each Sequence IIIH test.
- A minimum of two (2) operationally valid calibration tests and/or matrix tests, with no Level 3 e_i alarms, must be conducted in a new stand on any approved reference oils.
- Note that industry matrix runs may be included, as well as reference runs, at the discretion of the surveillance panel.
- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

2. Existing Test Stands

- Stand must be calibrated according to Sequence IIIH requirements. A Sequence IIIHA test must be conducted as part of each Sequence IIIH test.

- Test stands in an existing test lab that have not run an acceptable reference in the past two years, may calibrate with one test provided e_i Level 1 limits are not exceeded. Otherwise a second test is required for calibration.

- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

3. Reference Oil Assignment

Once test stands have been accepted into the system, the TMC will assign reference oils for continuing calibration according to the reference oil mix:

- Scheduled calibration tests should be conducted on reference oils 436, 434-2, and 438-1 or subsequent approved reblends on a 2:1:1 ratio basis (i.e., 50% of reference tests on 436; 25% of reference tests on 434-2; 25% of reference tests on 438-1).

4. Control Charts

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. For the IIIHA, Z_0=Mean Y_i of first two operationally valid tests in the stand. The constants used for the construction of the control charts for the IIIHA, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart		Stand Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand	Level 1	0.3	0.000	Level 1	±1.351
	Level 2		±1.800	Level 2	±1.734
Industry	Level 1	0.2	±0.775	Level 3	±2.066
	Level 2		±0.859	--	--

The following are the steps that must be taken in the case of exceeding control chart limits. The steps are listed in order of priority, although charts should be studied simultaneously to determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance. The laboratory always has the option of removing any stand from the system.

- Exceed Stand chart of Prediction Error (e_i)

  Level 3:

  - Immediately conduct one additional reference test in the stand that triggered the alarm. Do not update the control charts until the follow up reference test is completed and Excessive Influence (refer to Section 1.A.5) has been performed.

  Level 2:

  - The Level 2 limit applies in situations that have been pre-determined by the surveillance panel to have a potential impact on test results. These situations may include the introduction of new critical parts, fuel batches, reference oil reblends, or other test components. When these conditions have been met and a Level 2 alarm is triggered, immediately conduct one additional reference test in the stand that triggered the alarm.

  Level 1:

  - The Level 1 limit also applies to stand in an existing test lab that has not run an acceptable reference in the past two years. The stand can calibrate with one test if the Level 1 limits are not exceeded. Otherwise, immediately conduct another reference test in the stand.

☐ Exceed Stand EWMA of Standardized Test Result (Z_i)

Level 2:

- Immediately conduct one additional reference test in the stand that triggered the alarm. The stand that triggered the alarm is not qualified for non-reference tests until the Level 2 alarm is cleared.
- In instances where surveillance panel has deemed that industry-wide circumstances are impacting the Level 2 alarm, the TMC may be asked to review stand calibration status in accordance with the surveillance panel's findings.

Level 1:

- The Level 1 limit applies to all reference tests that are control charted, even when other alarms have been triggered. Level 1 uses Z_i to determine the stand severity adjustment (SA). Calculate the stand SA as follows and confirm the calculation with the TMC:

MRV Apparent Viscosity (ln(MRV)): $SA = (-Z_i) \times (0.4725)$

☐ Exceed Industry EWMA of Standardized Test Result (Z_i)

Level 2:

- TMC informs the surveillance panel that the limit has been exceeded. The surveillance panel then investigates and pursues resolution of the alarm.

Level 1:

- The TMC investigates whether severity adjustments are adequately addressing the trend, investigates the possible causes, and communicates as appropriate with industry.

Attachment 9

Sequence IIIHB LTMS Requirements

The following are the specific IIIHB calibration test requirements.

A. Reference Oils and Critical Performance Criteria

The critical parameter is Phosphorous Retention. The reference oils required for test stand and test laboratory referencing are reference oils accepted by the ASTM Sequence III Surveillance Panel. The means and standard deviations for the current reference oils for each critical performance criterion are presented below.

PHOSPHOROUS RETENTION
Unit of Measure: Percent

Reference Oil	Mean	Standard Deviation
434-2	79.95	1.49
436	94.15	1.63
438-1	78.92	1.48

B. Acceptance Criteria

1. New Test Stands

- Stand must be calibrated according to Sequence IIIH requirements. A Sequence IIIHB test must be conducted as part of each Sequence IIIH test.
- A minimum of two (2) operationally valid calibration tests and/or matrix tests, with no Level 3 e_i alarms, must be conducted in a new stand on any approved reference oils.
- Note that industry matrix runs may be included, as well as reference runs, at the discretion of the surveillance panel.
- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

2. Existing Test Stands

- Stand must be calibrated according to Sequence IIIH requirements. A Sequence IIIHB test must be conducted as part of each Sequence IIIH test.

- Test stands in an existing test lab that have not run an acceptable reference in the past two years, may calibrate with one test provided e_i Level 1 limits are not exceeded. Otherwise a second test is required for calibration.

- Following the necessary tests, check the status of the control charts and follow the prescribed actions.

3. Reference Oil Assignment

Once test stands have been accepted into the system, the TMC will assign reference oils for continuing calibration according to the reference oil mix:

- Scheduled calibration tests should be conducted on reference oils 436, 434-2, and 438-1 or subsequent approved reblends on a 2:1:1 ratio basis (i.e., 50% of reference tests on 436; 25% of reference tests on 434-2; 25% of reference tests on 438-1).

4. Control Charts

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. For the IIIHB, Z_0=Mean Y_i of first two operationally valid tests in the stand. The constants used for the construction of the control charts for the IIIHB, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart		Stand Prediction Error	
		Severity		Severity	
Chart Level	Limit Type	Lambda	Alarm	Limit Type	Limit
Stand	Level 1	0.3	0.000	Level 1	±1.351
	Level 2		±1.800	Level 2	±1.734
Industry	Level 1	0.2	±0.775	Level 3	±2.066
	Level 2		±0.859	--	--

The following are the steps that must be taken in the case of exceeding control chart limits. The steps are listed in order of priority, although charts should be studied simultaneously to determine the cause(s) of a problem. In the case of multiple alarms, contact the TMC for guidance. The laboratory always has the option of removing any stand from the system.

- Exceed Stand chart of Prediction Error (e_i)

  Level 3:

  - Immediately conduct one additional reference test in the stand that triggered the alarm. Do not update the control charts until the follow up reference test is completed and Excessive Influence (refer to Section 1.A.5) has been performed.

  Level 2:

  - The Level 2 limit applies in situations that have been pre-determined by the surveillance panel to have a potential impact on test results. These situations may include the introduction of new critical parts, fuel batches, reference oil reblends, or other test components. When these conditions have been met and a Level 2 alarm is triggered, immediately conduct one additional reference test in the stand that triggered the alarm.

  Level 1:

  - The Level 1 limit also applies to stand in an existing test lab that has not run an acceptable reference in the past two years. The stand can calibrate with one test if the Level 1 limits are not exceeded. Otherwise, immediately conduct another reference test in the stand.

☐ Exceed Stand EWMA of Standardized Test Result (Z_i)

Level 2:

- Immediately conduct one additional reference test in the stand that triggered the alarm. The stand that triggered the alarm is not qualified for non-reference tests until the Level 2 alarm is cleared.
- In instances where surveillance panel has deemed that industry-wide circumstances are impacting the Level 2 alarm, the TMC may be asked to review stand calibration status in accordance with the surveillance panel's findings.

Level 1:

- The Level 1 limit applies to all reference tests that are control charted, even when other alarms have been triggered. Level 1 uses Z_i to determine the stand severity adjustment (SA). Calculate the stand SA as follows and confirm the calculation with the TMC:

  Phosphorous Retention: $SA = (-Z_i) \times (1.53)$

☐ Exceed Industry EWMA of Standardized Test Result (Z_i)

Level 2:

- TMC informs the surveillance panel that the limit has been exceeded. The surveillance panel then investigates and pursues resolution of the alarm.

Level 1:

- The TMC investigates whether severity adjustments are adequately addressing the trend, investigates the possible causes, and communicates as appropriate with industry.

ASTM SEQUENCE III SURVEILLANCE PANEL

Attachment 10

SCOPE & OBJECTIVES

SCOPE

The Sequence III Surveillance Panel is responsible for the surveillance and continual improvement of the Sequence IIIF and IIIFHD tests documented in ASTM Standard D6984 as update by the Information Letter System, the Sequence IIIG, IIIGA and IIIGB tests documented in ASTM Standard D7320 as updated by the Information Letter System and the Sequence IIIH, IIIHA and IIIHB tests as documented in the most recent Draft Procedure. Data on test precision will be solicited and evaluated at least every six (6) months for Sequence III test procedures. The Surveillance Panel is to provide continual improvement of rating techniques, test operation, test monitoring and test validation through communication with the Test Sponsor, ASTM Test Monitoring Center, the Central Parts Distributor, Fuel Supplier, ASTM B0.01 Passenger Car Engine Oil Classification Panel, ASTM Committee B0.01, ACC Monitoring Agency and ASTM Deposit/Distress Workshop. Actions to improve the process will be recommended when appropriate based on input to the Surveillance Panel from one or more of the previously stated groups. This process will provide the best possible Sequence III Type Test Procedure for evaluating engine oil performance with respect to its ability to prevent oil thickening, varnish formation, oil consumption and engine wear.

OBJECTIVES	TARGET DATE
Monitor critical IIIF/IIIG test hardware inventory	Ongoing
Begin monitoring Sequence IIIH test	April 15, 2016
Endorse use of IIIH to replace tests for IIIF & IIIG	August 1, 2016
Review standard deviations of IIIH reference oils	October1, 2016

David L. Glaenzer, Chairman
Sequence III Surveillance Panel

Updated 03/29/2016