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COMMITTEE D02 ON PETROLEUM PRODUCTS, LIQUID FUELS, AND LUBRICANTS

Issued: 08.11.2017

Reply to: Dan Worcester
Southwest Research Institute
6220 Culebra Rd.
San Antonio, TX 78238
Phone: 210.522.2405
Email: dworcester@swri.org

These are the unapproved minutes of the 08.09.2017 Sequence VI Conference Call.

The meeting was called to order at 9:05 AM Central Time by Chair Greg Miranda.

Agenda

The Agenda is the included as Attachment 1.

1.0 Roll Call

The Attendance list is Attachment 2. There were no member changes.

2.0 Approval of Meeting minutes from 07.11.2017 Seq. VI SP meeting

2.1 Greg Miranda made the motion and Jason Bowden seconded.

2.2 The minutes were approved unanimously.

3.0 Old Business

3.1 Seq. VIE/F Short Block Hardware Task Force Update Adrian Alfonso

3.1.1 Hardware availability update

Most labs have received 50% of their orders.

3.1.2 Status of Short block hardware introduction Matrix

All tests for 3 labs are reported. The 4th lab is running the final test for the matrix. It will be reported in August. There are 7 OHT-2 engines remaining with OHT. Those are allocated, but a lab needing more engines can contact OHT for possible redistribution. Current testing levels estimate the industry will switch to GM Kit engines in October.

3.2 Seq. VIE Severity Task Force Update Dan Worcester

The Task Force is getting approval for analysis of reference oils. One oil is waiting for supplier response. At the next meeting a Scope and plan moving forward will be provided.

3.3 Seq. VIF Procedure: Preparing for Ballot

This is in process. No completion date has been provided.

3.4 Update on Reference Oil Blend 542-3

See Attachment 3. Andy asked if there was a difference in chemical analysis. They are similar. Labs have remaining 542-2 for VIF tests. 542-2 targets are being used for 542-3. Data will be reviewed on an on-going basis. 5 results for 4 labs have been reported. This oil will also be introduced for VIF references later.

3.5 Seq. VIE Procedure Revisions

See Attachment 4. The oil filter housing in Section 6.6.5.7 is no longer available. The new version is OHT6A-012-5 which has the 28 micron filter screen. Oil circulation pump in Section 6.5.5.2, Viking 4125 has been replaced with model G4124A. The recommendation was to add each as alternates. Amol also noted that the procedure is not clear that BLB 3 should be used for FEI calculations when those stages are run. Some of these changes will also be needed on the VIF procedure.

MOTION #1: Recommend to the Surveillance Panel the procedure be modified with an information letter to include the new oil filter housing and circulation pump numbers.
Greg Miranda, Jason Bowden, second. 12 yes, 0 no, 1 waive. Motion passes.

MOTION #2: Recommend to the Surveillance Panel to revise equations 15.2 and 15.3 to include a note to indicate when BLB3 is required, substitute BLB3 for BLB2 and revise baseline calculations in A16.8 to include a note and additional equations to reflect the use of BLB3 in the calculations when a BLB3 is required to be run.
Rich Grundza, Amol Savant, second. 11 yes, 0 no, 1 waive. Motion passes.

4.0 New Business

4.1 VIF Post PM Vi Limit Review | Calibration of VIF engines | VID-VIF Equivalency
Greg Miranda/ Stats Group

See Attachment 5. The recommendation on Slide 3 is to increase R for FEI 1 from 0.95 to 1.00 and for FEI 2 from 0.63 to 0.95. The upper Vi limit for FEI 1 would increase to 4.64 from 2.6. FEI 2 Vi would be unchanged. These changes would be temporary and need review later. There is a bias indicated, but that will remain unchanged for now. SwRI will run a 5th run on engine 206 after candidate tests complete. Data will be reviewed when this run is completed. Martin recommended reference oil 1011 not be used as the first oil on a new engine.

MOTION #3: Recommend to the Surveillance Panel effective from 07.16.2017, the EOT date of the last reference on one stand at Intertek the R values of 1.00 for FEI 1 and 0.95 for FEI 2 and Vi value of 4.64 for FEI 1 will be applied to VIF reference tests.
Martin Chadwick, Adrian Alphonso, second. 9 yes, 0 no, 4 waive. Motion passes.

4.2 Seq. VIE Appendix K items

4.2.1 Short block build workshop
A second build workshop may be scheduled for ½ day at the same time as the VH workshop to minimize travel.

4.2.2 VIE/VIF Research Report
A Volunteer will be needed. This will be decided at next call.

5.0 Next Meeting

5.1 The next SP meeting is planned in 3-4 weeks.

The meeting adjourned at 11:09 AM.

Sequence VI Surveillance Panel Conference Call Agenda
August 09, 2017 @ 10:00-11:30 EST

Audio Connection

Call-in Number: +1-415-655-0001
Conference Code: 197 726 952

Webex Meeting URL:
https://meetings.webex.com/collabs/#/meetings/detail?uuid=MEE4SII6O0XZW1S1ACIP4FPJ8J-20XT&rnd=167634.43528

1. **Roll Call (start 10:05 EST)**

   1.1. SP Membership changes and additions

2. **Approval of Meeting minutes from July 11, 2017 Seq. VI SP meeting**

3. **Old Business**

3.1	Seq. VIE/F Short Block Hardware Task Force Update 3.1.1 Hardware availability update 3.1.2 Status of Short block hardware introduction Matrix (i.e. status of fourth engine)	Adrian Alfonso
3.2	Seq. VIE Severity Task Force Update	Dan Worcester
3.3	Seq. VIF Procedure: Preparing for Ballot	Greg Miranda
3.4	Update on TMC 542-3 introduction	Rich Grundza
3.5	Seq. VIE Procedure Revisions	All

4. **New Business**

   4.1. VIF Post PM Vi Limit Review | Calibration of VIF engines | VID-VIF Equivalency – Greg Miranda/ Stats Group

   4.2. Seq. VIE Appendix K items
   4.2.1. Short block build workshop
   4.2.2. VIE/VIF Research Report

5. **Next Meeting**

   5.1. TBD

6. **Meeting Adjourned**

ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend
Adrian Alfonso **Voting Member**	Phone: (210) 838-0431 Adrian.Alfonso@intertek.com	Intertek	**ATTEND**
Jason Bowden **Voting Member**	Phone: (440) 354-7007 jhbowden@ohtech.com	OHT	**ATTEND**
Amol Savant **Voting Member**	acsavant@valvoline.com	Valvoline	**ATTEND**
Tim Cushing **Voting Member**	Phone: (248) 881-3518 Timothy.Cushing@gm.com	General Motors	**ATTEND**
Rich Grundza **Voting Member**	Phone: (412) 365-1034 reg@astmtmc.cmu.edu	TMC	**ATTEND**
Jeff Hsu **Voting Member**	Phone: (832) 419-3482 j.hsu@shell.com	Shell	**ATTEND**
Teri Kowalski **Voting Member**	Phone: (734) 995-4032 Teri.Kowalski@tema.toyota.com	Toyota	**ATTEND**
Dan Lanctot **Voting Member**	Phone: (210) 690-1958 dlanctot@tei-net.com	TEI	**ATTEND**
Greg Miranda **Voting Member**	Phone: (440) 347-8516 Greg.Miranda@Lubrizol.com	Lubrizol	**ATTEND**
Katerina Pecinovsky **Voting Member**	Phone: Katerina.Pecinovsky@AftonChemical.com	Afton	**ATTEND**
Brianne Pentz **Voting Member**	Phone: Brianne.Pentz@bp.com	BP	
Andy Ritchie **Voting Member**	Phone: (908) 474-2097 Andrew.Ritchie@infineum.com	Infineum	**ATTEND**
Ron Romano **Voting Member**	Phone: (313) 845-4068 rromano@ford.com	Ford	
Clifford Salvesen **Voting Member**	Phone: (856) 224-2954 Clifford.r.Salvesen@exxonmobil.com	ExxonMobil	
Kaustav Sinha **Voting Member**	Phone: (713) 432-6642 LFNQ@chevron.com	Chevron Oronite	
Haiying Tang **Voting Member**	Phone: (248) 512-0593 HT146@Chrysler.com	Chrysler	
Dan Worcester **Voting Member**	Phone: (210) 522-2405 Dan.Worcester@swri.org	SwRI	**ATTEND**

ASTM SEQUENCE VI

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ASTM SEQUENCE VI

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Matt Bowden	mjbowden@ohtech.com	OHT	
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Tom Smith		Valvoline	
Hap Thompson	Hapjthom@aol.com	VIx Facilitator	ATTEND
Chris Taylor	Chris.Taylor@vpracingfuels.com	VP Racing Fuels	

ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend

MOTION:	**OIL FILTER**	**BLB 3**	**VIF Vi**	
Adrian Alfonso **Voting Member**	YES	YES	YES	
Jason Bowden **Voting Member**	YES	YES	WAIVE	
Amol Savant **Voting Member**	YES	YES	WAIVE	
Tim Cushing **Voting Member**	YES	YES	YES	
Rich Grundza **Voting Member**	YES	YES	YES	
Jeff Hsu **Voting Member**	YES		WAIVE	
Teri Kowalski **Voting Member**	YES	YES	YES	
Dan Lanctot **Voting Member**	WAIVE	WAIVE	WAIVE	
Greg Miranda **Voting Member**	YES	YES	YES	
Katerina Pecinovsky **Voting Member**	YES	YES	YES	
Brianne Pentz **Voting Member**				
Andy Ritchie **Voting Member**	YES	YES	YES	
Ron Romano **Voting Member**				
Clifford Salvesen **Voting Member**				
Kaustav Sinha **Voting Member**	YES STOCKWELL	YES STOCKWELL	YES STOCKWELL	
Haiying Tang **Voting Member**				
Dan Worcester **Voting Member**	YES	YES	YES	
VOTES	12 Y, O N, 1 W	11 Y, O N, 1 W	9 Y, O N, 1 W	

ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend

MOTION:				
Adrian Alfonso **Voting Member**				
Jason Bowden **Voting Member**				
Amol Savant **Voting Member**				
Tim Cushing **Voting Member**				
Rich Grundza **Voting Member**				
Jeff Hsu **Voting Member**				
Teri Kowalski **Voting Member**				
Dan Lanctot **Voting Member**				
Greg Miranda **Voting Member**				
Katerina Pecinovsky **Voting Member**				
Brianne Pentz **Voting Member**				
Andy Ritchie **Voting Member**				
Ron Romano **Voting Member**				
Clifford Salvesen **Voting Member**				
Kaustav Sinha **Voting Member**				
Haiying Tang **Voting Member**				
Dan Worcester **Voting Member**				
VOTES				

ASTM SEQUENCE VI

Name	Email/Phone	Company	Attend

MOTION:				
Adrian Alfonso **Voting Member**				
Jason Bowden **Voting Member**				
Amol Savant **Voting Member**				
Tim Cushing **Voting Member**				
Rich Grundza **Voting Member**				
Jeff Hsu **Voting Member**				
Teri Kowalski **Voting Member**				
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Ron Romano **Voting Member**				
Clifford Salvesen **Voting Member**				
Kaustav Sinha **Voting Member**				
Haiying Tang **Voting Member**				
Dan Worcester **Voting Member**				
VOTES				

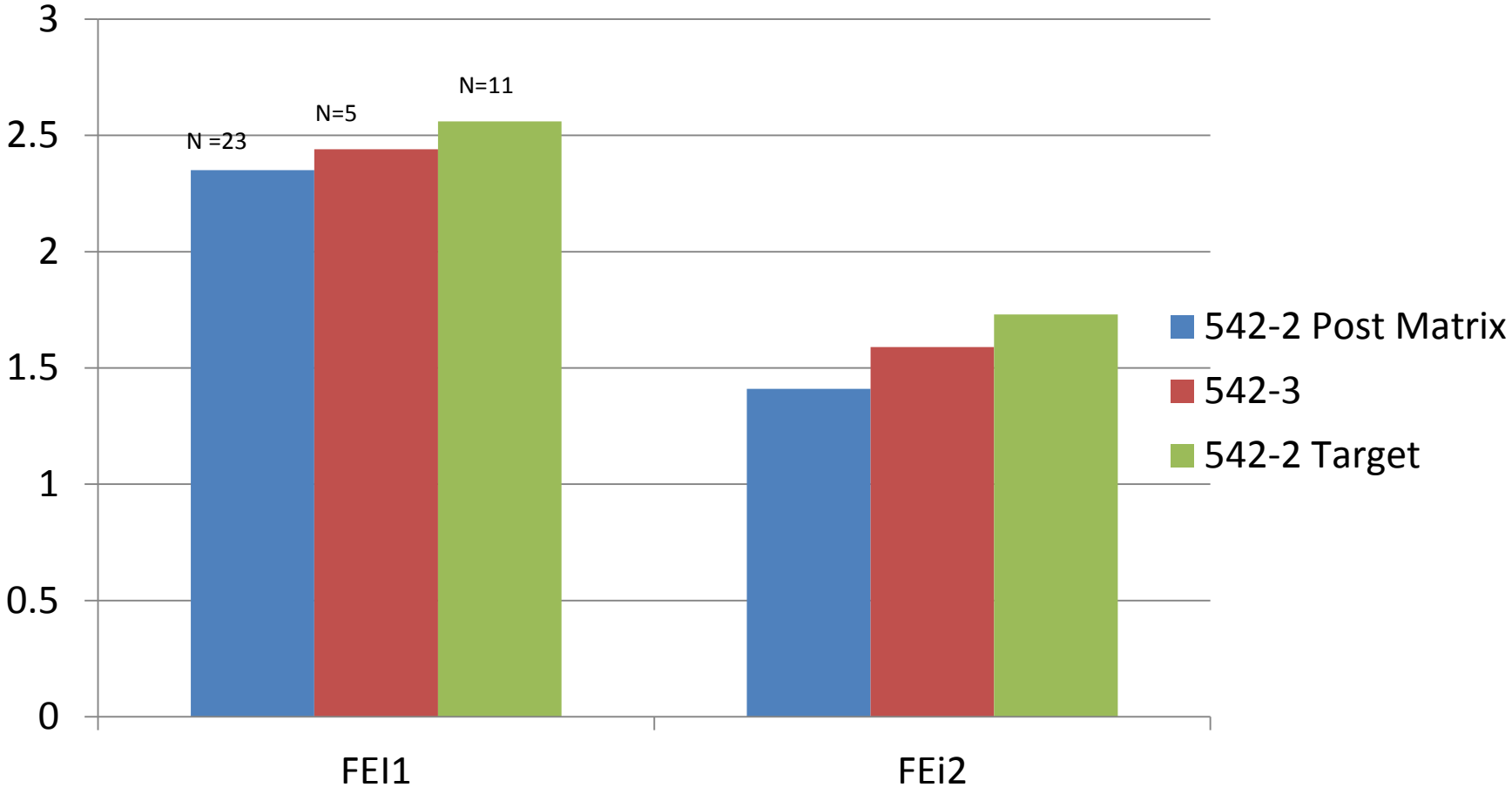
Introduction of 542-3

8/9/17 Sequence VI Conference Call

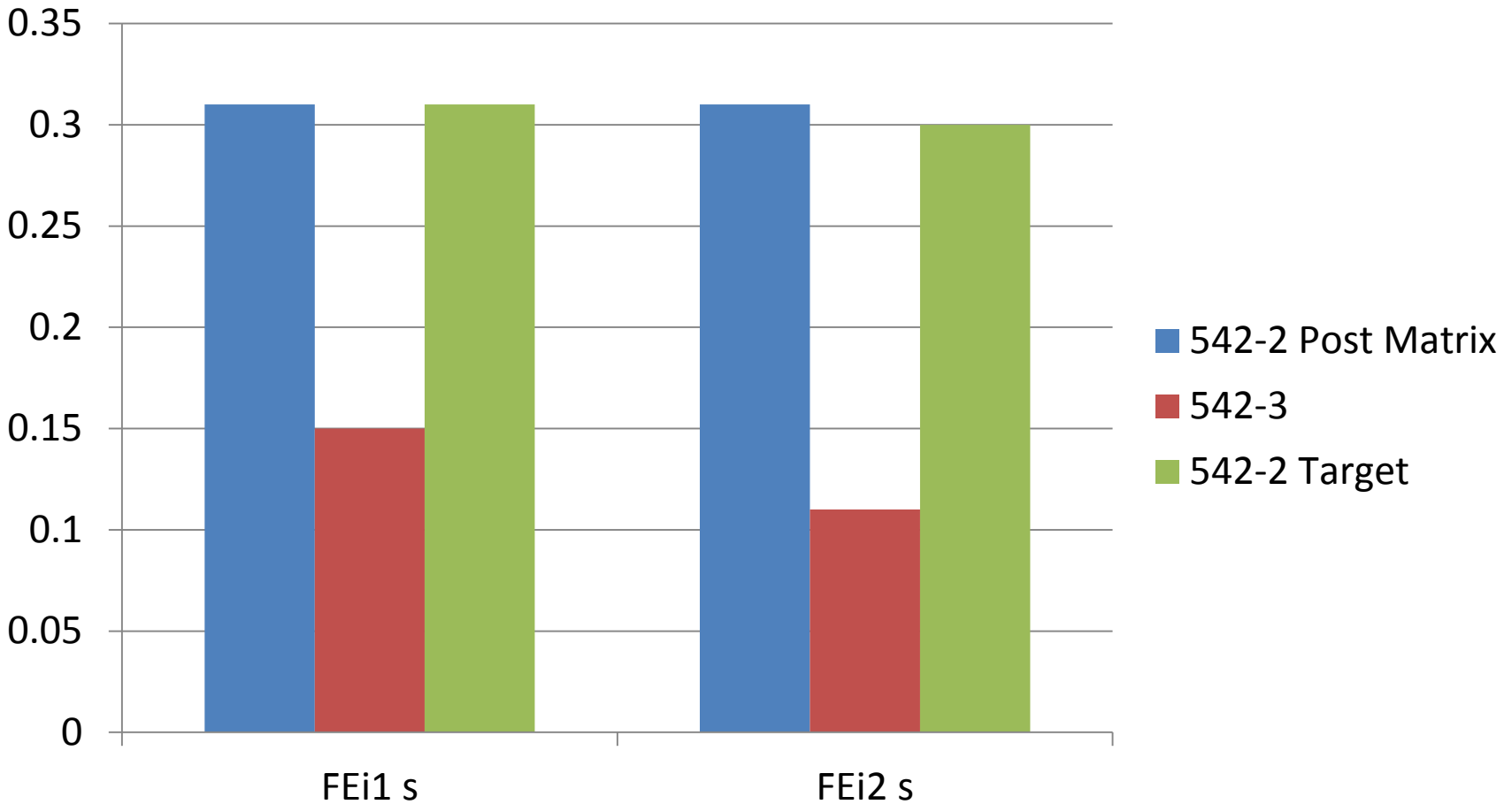
Introduction of 542-3

- 5 tests reported from 4 labs
- All attempts resulted in calibration.

Means of 542-3 Compared to Historic 542-2 performance



Standard deviations of 542-3 Compared to Historic 542-2 performance



Sequence VIE Procedure Revisions

7/6/2017

JAHAI

Oil Filter Housing:

Procedure:

6.6.5.7 Install one oil filter (FIL-1 in Fig. A5.6) in the external oil system. The filter specified is OHT6A-012-2 with a stainless steel screen having a rating of 60 µm, Part No. OHT6A-013-3 (see X1.20). Locate the filter between the engine oil pump and where the oil enters the engine oil gallery.

***The Filter Housing specified as OHT6A-012-2 is no longer a manufactured part. The current filter housing is an OHT6A-012-5 and the procedure needs to be edited to reflect this change.**

Oil Circulation Pump:

Procedure:

6.6.5.2 Use a positive displacement oil circulation pump. A Viking Series 4125, Model G4125, no relief valve, basemounted is specified (see X1.15). The pump shall have a V-belt or direct drive electric drive motor of 1140 r/min to 1150 r/min with a minimum power of 0.56 kW. Voltage and phase are optional.

NOTE 1—If using a V-belt drive, use a 1:1 pulley ratio so that the final speed of the pump is a nominal 1150 r/min.

***The Oil Circulation Pump is specified to be a Viking Series 4125, Model G4125 and is no longer a manufactured part. An appropriate replacement pump is a Viking Series 4124A, Model G4124A. The specifications for the Viking G4125 and Viking G4124A are highlighted in the following two documents**

VIKING® HEAVY DUTY PUMPS

SERIES 125 AND 4125

UNMOUNTED PUMPS

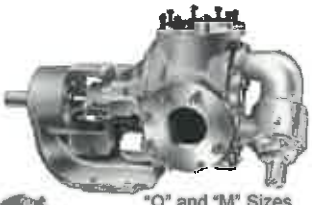

"G", "H", and "HL" Sizes


"AK" and "AL" Sizes


"K," "KK", and "L" Sizes


"LQ" and "LL" Sizes


"LS" Size


"Q" and "M" Sizes


"QS" Size

This series of heavy-duty pumps is available either unmounted or mounted as shown on following pages. Available with packed stuffing box or Buna-N mechanical seal with carbon rotating and Ni-Resist stationary faces. The integral thrust bearing is designed to handle heavy-duty pumping jobs without problems of end play and distortion. For increased versatility of installation and complete selection of ports, many of the pump casings are designed so they can be rotated on the bracket to any 45° or 90° angle from that shown in the illustrations. See revolvable casing feature on Page 141.1. Overpressure relief valve on head is standard for this series. To permit use of this type pump in a greater range of applications, some sizes are available with jacketed head plate. For heavy-duty pumps with jacketed bracket and head, see Catalog Section 142.

Dimensions for Unmounted Pumps—See Page 141.8.

CONSTRUCTION — SERIES 125 AND ① 4125 ("G" THROUGH "M" SIZES)

Pump Construction	Casing	Head	Bracket	Rotor	Idler	Rotor Shaft And Idler Pin	Bushings				Internal Pressure Relief Valve
							Packed		Mechanical Seal		
							Idler	Bracket	Idler	Bracket	
Standard Construction	Iron	Iron	Iron	⑦ Iron	⑫ Iron	Steel	Bronze	Bronze	Carbon Graphite	⑱ Bronze	Iron
⑪ Steel Fitted	Iron	Iron	Iron	Steel	⑫ Iron	Steel	Bronze	Bronze	Carbon Graphite	⑱ Bronze	Iron
⑨ Bronze Fitted	Iron	Iron	Iron	⑨ Bronze	Bronze	Steel	Bronze	Bronze	Carbon Graphite	⑱ Bronze	Iron

SPECIFICATIONS — SERIES 125 AND ① 4125 UNMOUNTED PUMPS

Model Numbers		Port Size	⑥ Nominal Pump Rating		Maximum Hydrostatic Pressure	Steel Fitted Construction Recommended Above This Viscosity	⑧ Maximum Recommended Discharge Pressure When Handling 100 SSU Liquid At Nominal Rated Speeds	⑤ Maximum Recommended Temperature for Cataloged Pump °F. (°C.)		Approximate Shipping Weight With Valve	
Packed	①⑱③ Mech. Seal	Inches	GPM (m³/hr)	RPM	PSIG (BAR)	SSU (cSt)	PSIG	Packed	Mech. Seal	Pounds (KG)	
G125	G4125	1	8 (2)	1800	400 (28)	⑨ 7,500 (1,650)	200	300 (149)	225 (107)	22	(10)
H125	H4125	1½	15 (3)	1800	400 (28)	25,000 (5,500)	200	300 (149)	225 (107)	38	(17)
HL125	HL4125	1½	30 (7)	1800	400 (28)	7,500 (1,650)	200	300 (149)	225 (107)	40	(18)
AK125	AK4125	2	50 (11)	1200	400 (28)	⑪ 25,000 (5,500)	150	300 (149)	225 (107)	78	(35)
AL125	AL4125	2	75 (17)	1200	400 (28)	⑪ 25,000 (5,500)	150	300 (149)	225 (107)	81	(37)
K125	K4125	2	75 (17)	780	400 (28)	25,000 (5,500)	200	300 (149)	225 (107)	105	(48)
KK125	KK4125	2	100 (23)	780	400 (28)	25,000 (5,500)	200	300 (149)	225 (107)	110	(500
L125	L4125	2	135 (31)	640	400 (28)	25,000 (5,500)	200	300 (149)	225 (107)	155	(70)
LQ125	LQ4125	④ 2½	135 (31)	640	400 (28)	25,000 (5,500)	200	300 (149)	225 (107)	175	(79)
LL125	LL4125	④ 3	140 (32)	520	400 (28)	2,500 (550)	200	300 (149)	225 (107)	185	(84)
LS125	LS4125	④ 3	200 (45)	640	400 (28)	75,000 (16,500)	150	300 (149)	225 (107)	190	(86)
Q125	Q4125	④ 4	300 (68)	520	400 (28)	7,500 (1,650)	150	300 (149)	225 (107)	440	(200)
QS125	QS4125	④ 6	500 (114)	520	400 (28)	75,000 (16,500)	150	300 (149)	225 (107)	540	(245)
M125	M4125	④ 4	420 (95)	420	400 (28)	25,000 (5,500)	150	300 (149)	225 (107)	600	(272)

① Buna-N elastomer used in mechanical seal of Series 4125 pumps. Viton®, Neoprene, and PTFE mechanical seals also available.
② "G", "Q", and "QS" sizes have steel idler when steel fitted construction is required.
③ For mechanical seal pumps on applications with viscosities above 15,000 SSU (3,300 cSt), provide details for recommendation.
④ Ports are suitable for use with 125# ANSI cast iron or 150# ANSI steel companion flanges or flanged fittings. All others tapped for standard pipe.
⑤ Standard seal can be used from -20°F. to +225°F. With special construction, temperatures from -60°F. to +650°F. can be handled with this series pumps.
⑥ Nominal rating based on handling thin liquids.
⑦ "AK", "AL", "KK", "LS", and "QS" sizes have ductile iron rotor.
⑧ For maximum recommended discharge pressures when handling other viscosities and/or other speeds, see performance curves, which can be electronically generated with the Viking Pump Selector Program, located on www.vikingpump.com. Performance curves also show preferred constructions. If suction pressure exceeds 50 PSIG (3 BAR), consult factory.
⑨ Check factory before using bronze rotors at viscosities normally requiring steel-fitted construction. "G", "AK", "AL", "LS", and "QS" sizes not available in bronze-fitted construction.
⑱ "AK", "AL", "LS", "Q", "QS," and "M" 4125 models furnished with carbon graphite bracket bushings and mechanical seal is mounted in stuffing box. Mechanical seal is mounted behind rotor in "G", "H", "HL", "K", "KK", "L", "LQ", and "LL" pumps.
⑪ "AK" and "AL" sizes not available in steel-fitted construction.
⑫ "G", "H" and "HL" sizes have powdered metal idler.

Metric conversions are based on US measurements and rounded to the nearest whole number.

Viton® — Registered trademark of DuPont Performance Elastomers.

VIKING UNIVERSAL SEAL PUMPS

SERIES 124A, 4124A, 124AE, 4124AE, 224A, 4224A, 224AE, 4224AE, 324A, and 4324A (Cast Iron)
126A, 4126A, 226A and 4226A (Ductile Iron)
123A, 4123A, 223A and 4223A, 323A, 4323A (Steel Externals)
127A, 4127A, 227A and 4227A, 327A, 4327A (Stainless Steel)

Specifications (U.S. Units) – Non-Jacketed Pumps

Model Number		Standard Port Size	Nominal Pump Rating (100 SSU and below)		Maximum Hydrostatic Pressure	① Maximum Discharge Pressure for 100 SSU liquid at rated speed	② Maximum Recommended Temperature for Standard Pump (°F)		Steel Fitted Recommended Above	Approximate Shipping Weight with Valve
Packed	Stuffing Box Seal	Inches	GPM	RPM	PSIG	PSIG	Packed	Mech Seal	SSU	Pounds
G124A	G4124A	③1	8	1750	400	200	450	225	7,500	25
H124A	H4124A	③1 ½	15	1750	400	200	450	225	25,000	38
H126A	H4126A	③1 ½	15	1750						38
H123A	H4123A	⑤1 ½	15	1750						43
H127A	H4127A	⑤1 ½	10	1150		150	375	375	N/A	48
HL124A	HL4124A	⑤1 ½	30	1750	400	200	450	225	7,500	40
HL126A	HL4126A	③1 ½	30	1750						40
HL123A	HL4123A	⑥1 ½	30	1750						45
HL127A	HL4127A	⑥1 ½	20	1150		150	375	375	N/A	50
AK124A	AK4124A	③2	67	1450	400	200	450	225	25,000	82
AL124A	AL4124A	③2	90	1450	400	200	450	225	25,000	85
K124A	K4124A	③2	80	780	400	200	450	225	25,000	105
K126A	K4126A	④2	80	780						105
K123A	K4123A	⑤2	80	780						120
K127A	K4127A	⑤2	50	520		150	350	350	N/A	125
KK124A	KK4124A	③2	100	780	400	200	450	225	75,000	110
KK126A	KK4126A	③2	100	780						110
KK123A	KK4123A	⑤2	100	780						125
KK127A	KK4127A	⑤2	65	520		150	350	350	N/A	130
L124A/AE	L4124A/AE	③2	135	640	400	200	450	225	25,000	155
L126A	L4126A	③2	135	640						155
LQ124A/AE	LQ4124A/AE	④2 ½	135	640	400	200	450	225	25,000	175
LQ126A	LQ4126A	⑤2 ½	135	640						175
LQ123A	LQ4123A	⑥2 ½	135	640						185
LQ127A	LQ4127A	⑤2 ½	90	420		150	350	350	N/A	205
LL124A/AE	LL4124A/AE	④3	140	520	400	200	450	225	2,500	185
LL126A	LL4126A	⑤3	140	520						185
LL123A	LL4123A	⑤3	140	520						195
LL127A	LL4127A	⑤3	110	420		150	350	350	N/A	240
LS124A	LS4124A	④3	200	640	400	200	450	225	75,000	190
LS126A	LS4126A	⑤3	200	640						190
LS123A	LS4123A	⑤3	200	640						200
LS127A	LS4127A	⑤3	160	520		125	325	325	N/A	220
Q124A	Q4124A	④4	300	520	400	200	450	225	7,500	440
Q126A	Q4126A	⑤4	300	520						440
Q123A	Q4123A	⑤4	300	520						450
Q127A	Q4127A	⑤4	200	350		125	250	250	N/A	460
QS124A	QS4124A	④6	500	520	400	200	450	225	75,000	540
QS126A	QS4126A	⑥6	500	520						540
QS123A	QS4123A	⑤6	500	520						550
QS127A	QS4127A	⑤6	320	350		125	250	250	N/A	560
M124A	M4124A	④4	420	420	400	200	450	225	25,000	600
N324A	N4324A	④6	600	350	400	200	450	225	75,000	810
N323A	N4323A	⑥6	600	350						810
N327A	N4327A	⑥6	600	350		200	250	250	N/A	810
R324A	R4324A	④8	1100	280	400	200	450	225	25,500	1435
R323A	R4323A	⑤8	1100	280						1435
R327A	R4327A	⑤8	1100	280		175	175	175	N/A	1435
RS324A	RS4324A	④10	1600	280	400	125	450	225	75,000	2000
RS323A	RS4323A	⑤10	1600	280						2500
RS327A	RS4327A	⑤10	1600	280		125	175	175	N/A	2500

① For maximum recommended discharge pressures at different viscosities, see performance curves, which can be electronically generated with the Viking Pump Selector Program, located on www.vikingpump.com. If suction pressure exceeds 50 PSIG, consult factory. Higher pressures possible with factory approval based on application details.

② Extra clearances are required above 225°F. Higher temperatures can be handled with special construction, consult factory.

③ Ports are tapped for standard (NPT) pipe. Other thread standards available.

④ Ports are suitable for use with Class 125 ANSI cast iron companion flanges or flanged fittings.

⑤ Ports are suitable for Class 150 ANSI steel or stainless steel companion flanges or flanged fittings.

VIF Post PM Vi Limit Review

Statistics Group

August 1, 2017

Statistics Group

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

Recommendation

- Revise the constant R used in the Repeatability Check calculation (Vi) to reflect the current ratio of variability in the full model and the oil only model for 1st and 2nd run reference oil pairs.
  - FEI1 New R = 1.00 (was 0.95)
  - FEI2 New R = 0.95 (was 0.63)
- Revise the Upper Vi Limit for FEI1 to account for the current average Yi difference in 1st and 2nd run reference oil pairs.
  - FEI1 Upper Vi limit = 4.64 (was 2.8)
- These updates should be considered temporary and a full review of the LTMS and engine hour adjustments should be conducted once all 5th run data is available.
- Interpretation of candidate FEI data may change after the full review is completed

Data

- Precision Matrix:
  - 3 Reference Oils {1011, 542-2, 543}
  - 3 Labs {A, G, B}
  - 5 Engines {A 2 122, A 1 144, G 1 58, G 2 96,, B 1 306}
  - Total number of tests = 18

- Post Precision Matrix:
  - 3 Reference Oils {1011, 542-2, 543}
  - 3 Labs {A, G}
  - 8 Engines {A 1 206, A 1 286, A 4 229, A 4 289, G 1 203, G 1 276, G 3 238, G 4 295}
  - Total number of tests = 16

Engines with calibration issues

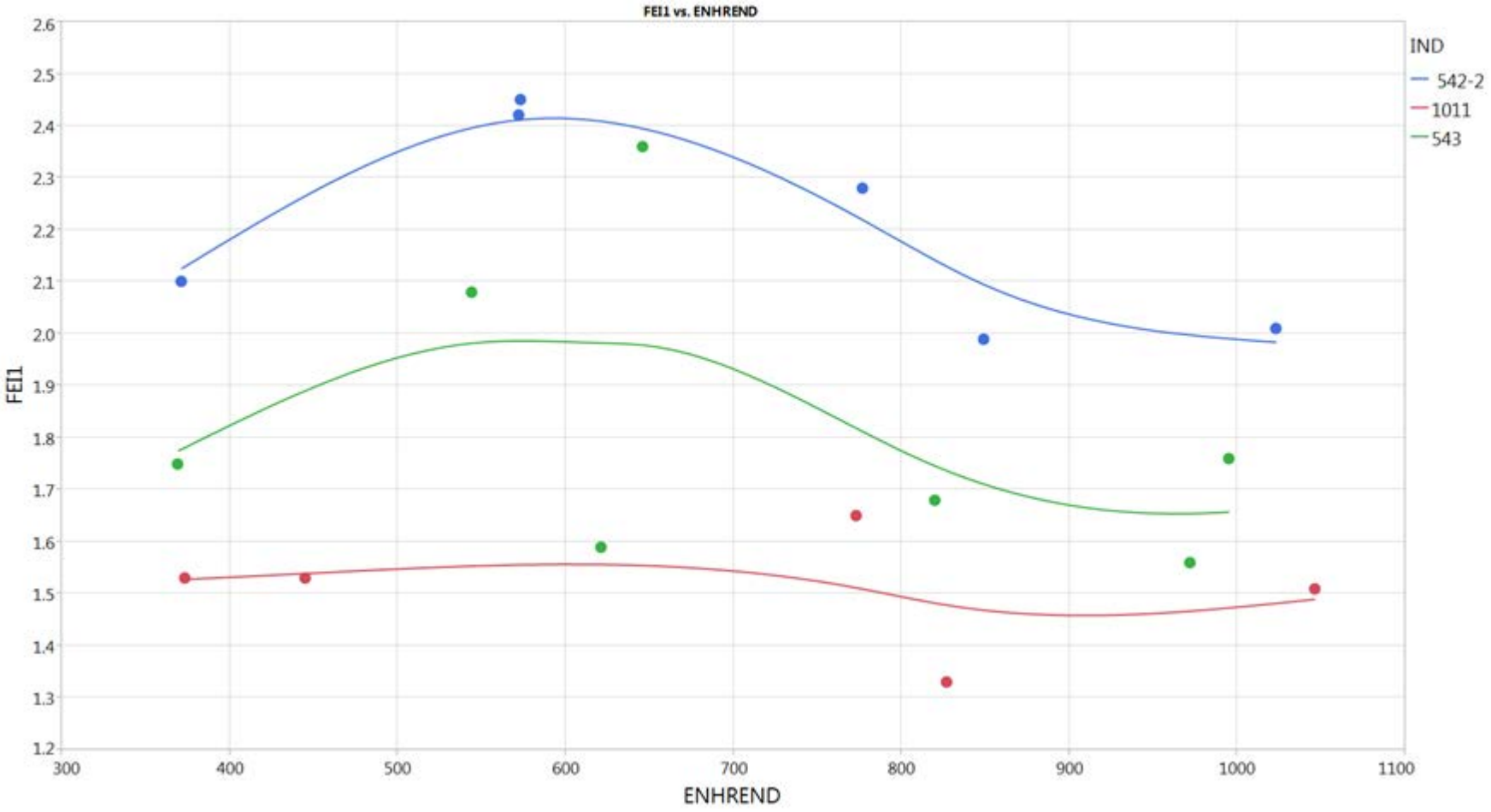
Issues

- Stand calibration limits do not seem to properly account for a bias in FEI1 results from engine run one to run two.
- Stand calibration limits for FEI2 may inflate the repeatability calculation larger than the current data set indicates is necessary.
- RO targets and engine hour adjustments may not be representative of test performance due to the small data set used at test start.
- Is enough information available to determine if 5th run candidates are reasonable or not.

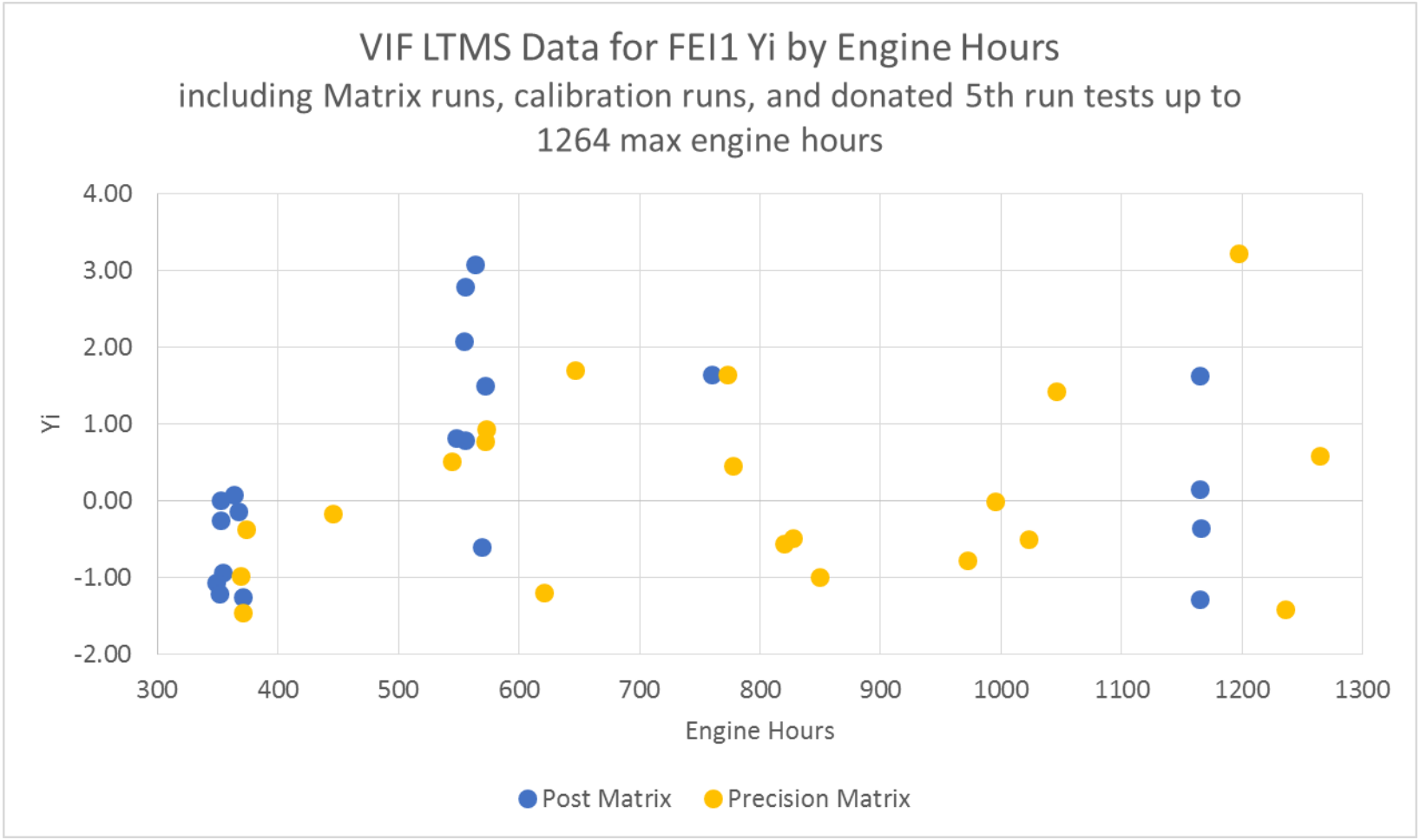
FEI1 Run 1 to 2 Bias

Current data reinforces the existence of the bias observed in the precision matrix. An interim LTMS solution is available until a full LTMS revision can be evaluated.

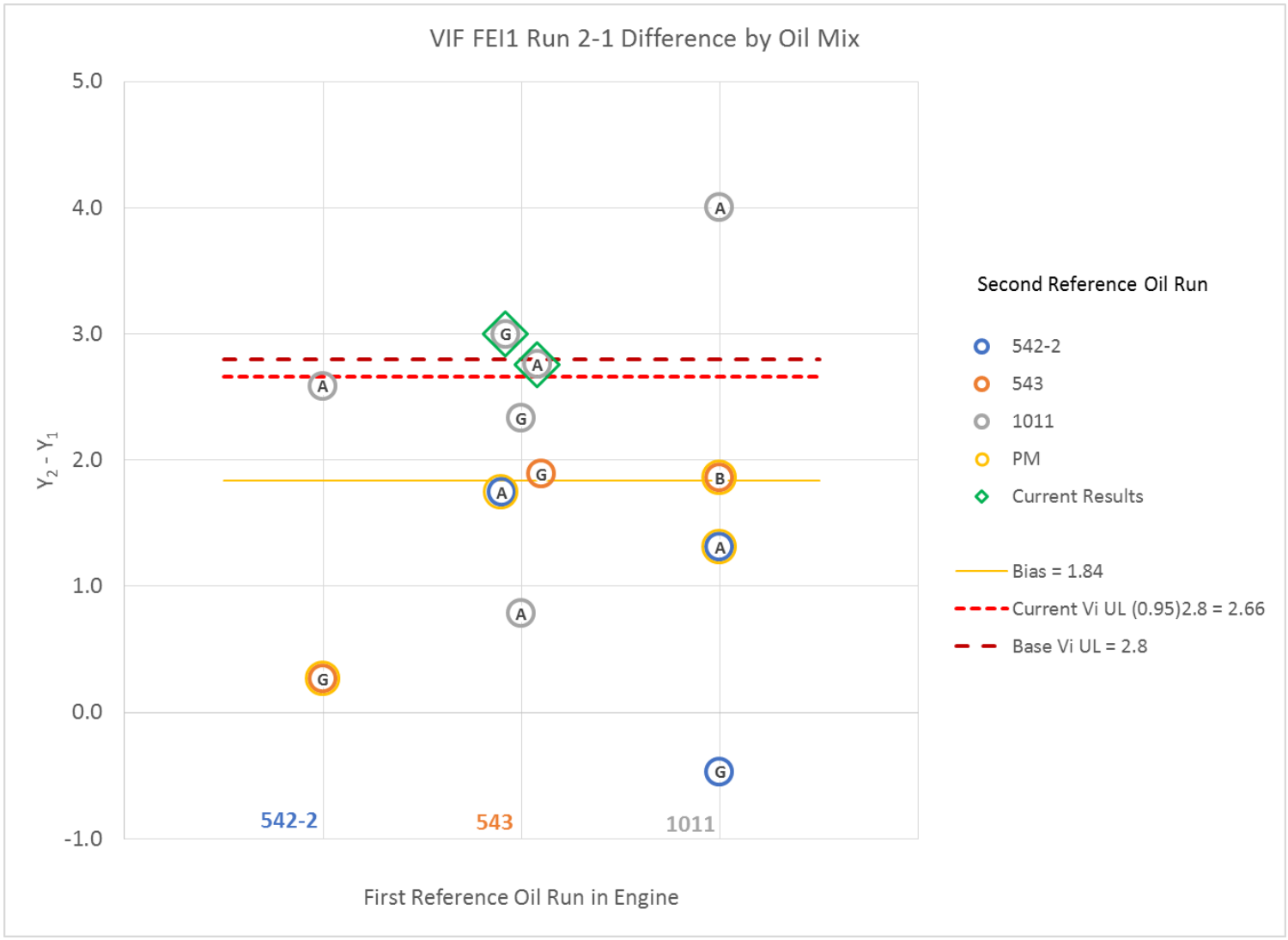
FEI1 performance during the matrix indicated a possible increase in results from run one to run two. There were no 1011 second run results available to help confirm this. The stats group requested additional second run 1011 data in the first five references conducted after the matrix to evaluate this.



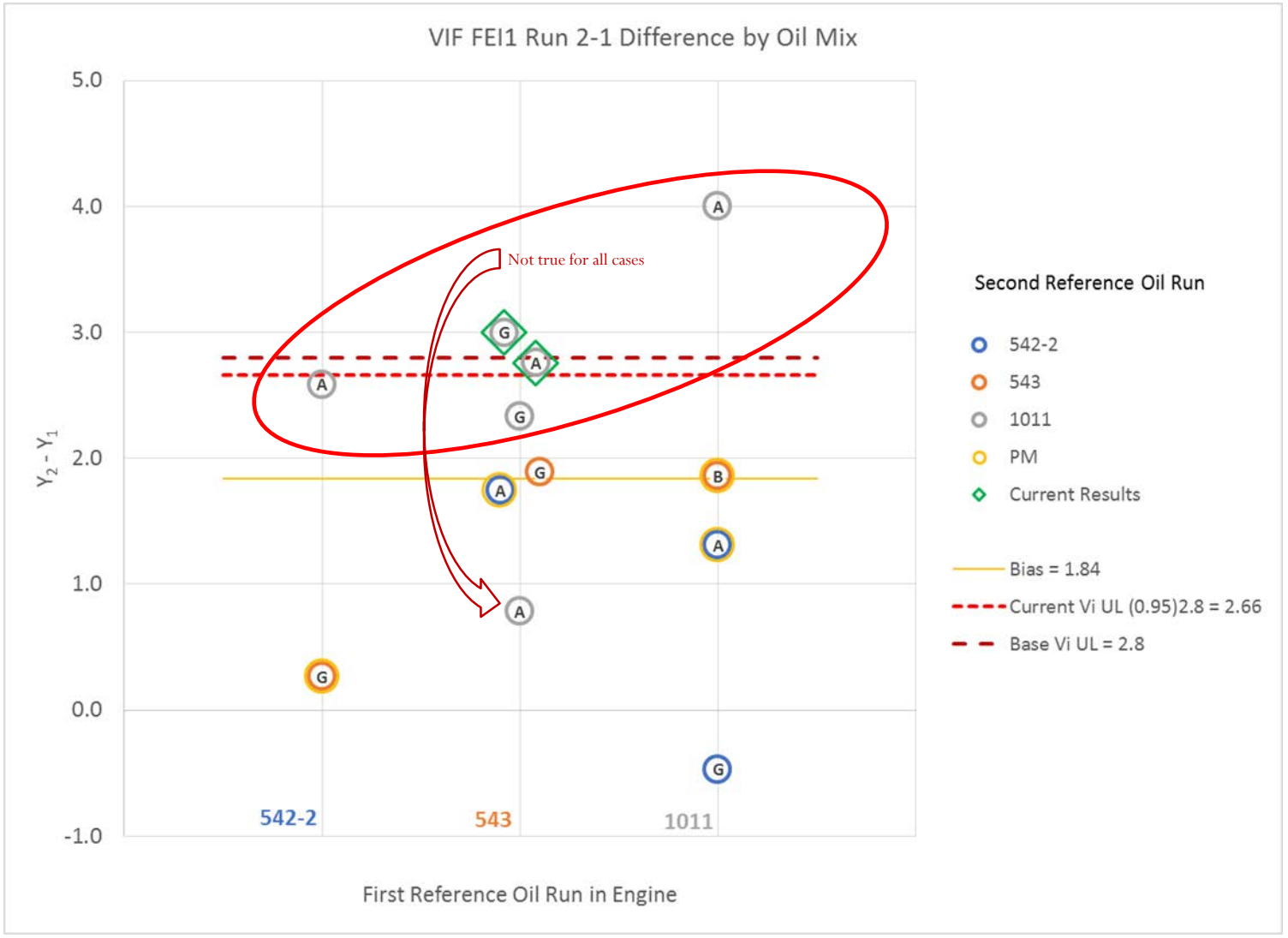
FEI1 Yi performance indicates run one and two may be biased in a manner the current LTMS and engine hour adjustment do not account for. Results available beyond the second run do not indicate a problem.



When focusing on runs 1 and 2 only there are 12 engines that have produced both 1st and 2nd run results (note one had an invalid attempt between the results). There is some evidence that RO assignment may influence the size of the shift from run one to two.



The largest differences between run one and two are consistently RO combinations that run 1011 second. This could be related to the PM data set that did not have a 2nd run 1011 result and not due to oil performance.



Models using only the 24 RO pairs of 1st and 2nd run data indicate the IND only RMSE (0.23) is smaller than the full model RMSE (0.27). This indicates the current R value (0.95) used in the Vi calculation should be 1.0.

General Linear Model: FEI1 versus LTMSLAB, LTMSAPP, ENGNO, IND

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
LTMSLAB	Fixed	3	A, B, G
LTMSAPP(LTMSLAB)	Fixed	6	1(A), 2(A), 4(A), 1(G), 3(G), 4(G)
ENGNO(LTMSLAB, LTMSAPP)	Fixed	8	144(A, 1), 206(A, 1), 286(A, 1), 229(A, 4), 289(A, 4), 58(G, 1), 203(G, 1), 276(G, 1)
IND	Fixed	3	1011, 542-2, 543

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LTMSLAB	2	0.09450	0.04725	0.63	0.553
IND	2	1.18758	0.59379	7.89	0.009
LTMSAPP(LTMSLAB)	4	0.05887	0.01472	0.20	0.935
ENGNO(LTMSLAB, LTMSAPP)	5	0.24404	0.04881	0.65	0.669
Error	10	0.75249	0.07525		
Lack-of-Fit	8	0.46564	0.05820	0.41	0.853
Pure Error	2	0.28685	0.14343		
Total	23	2.29047			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.274315	67.15%	24.44%	0.00%

General Linear Model: FEI1 versus IND

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
IND	Fixed	3	1011, 542-2, 543

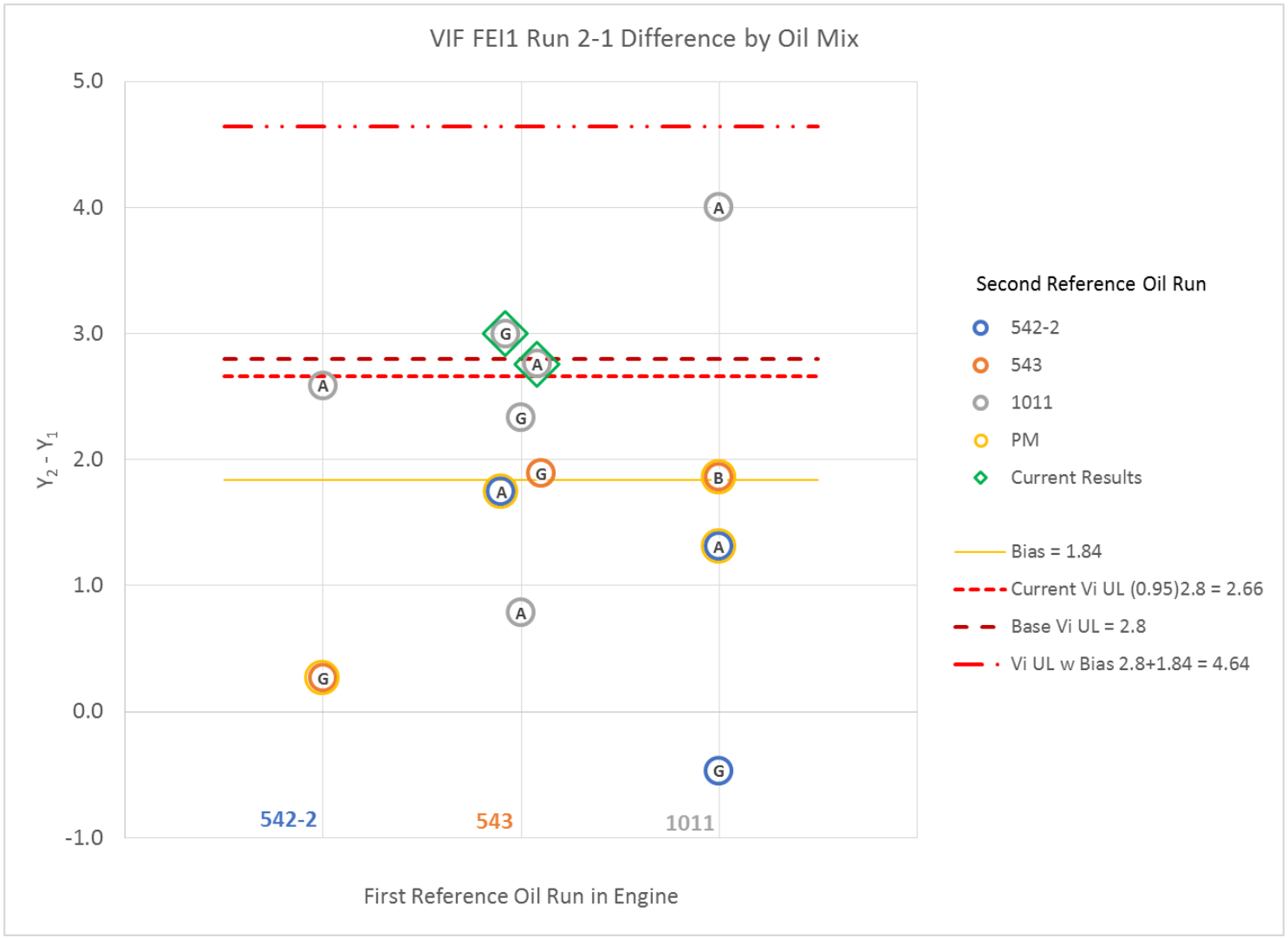
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
IND	2	1.178	0.58896	11.12	0.001
Error	21	1.113	0.05298		
Total	23	2.290			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.230171	51.43%	46.80%	37.12%

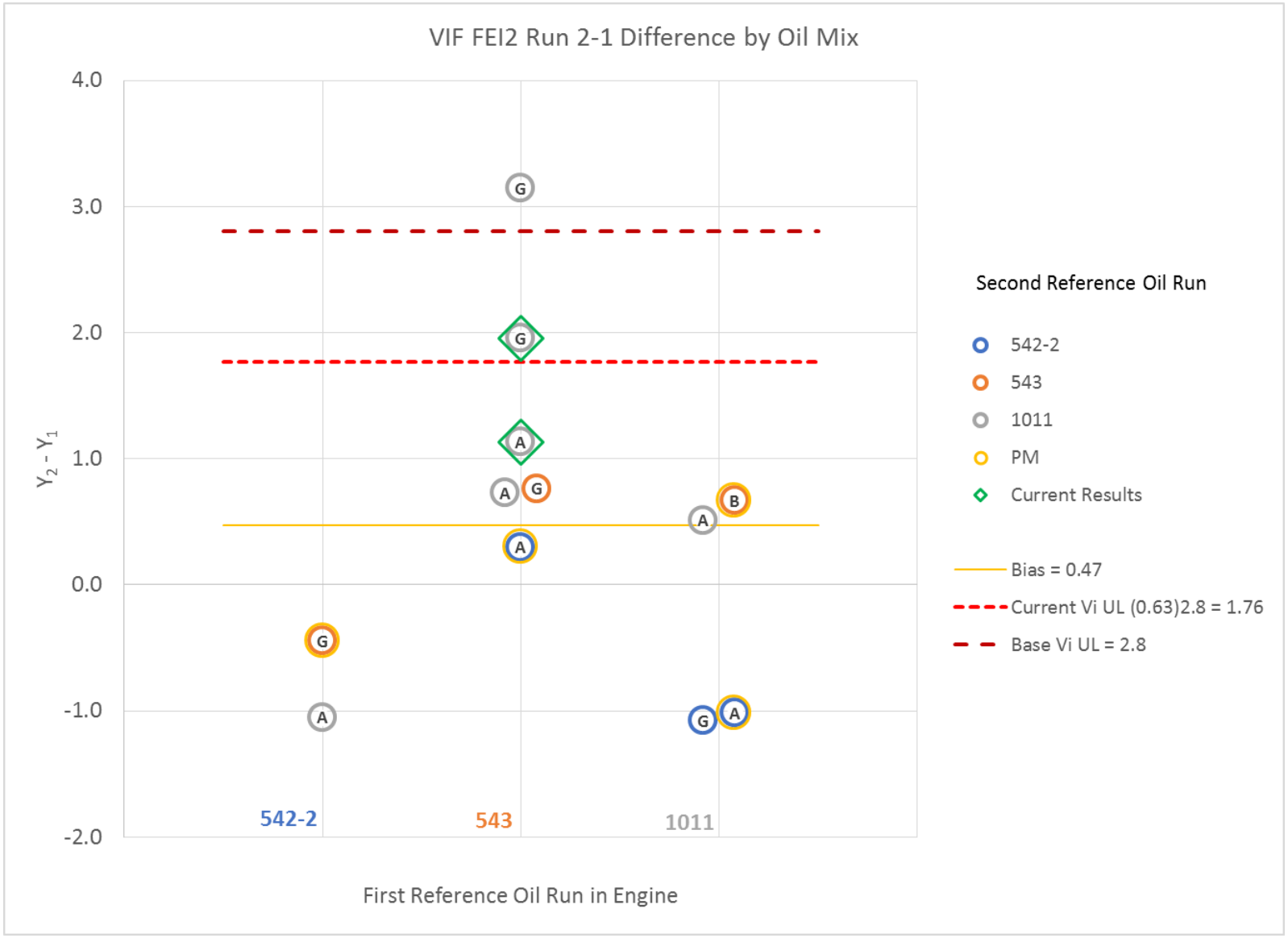
When taking into account a new R value of 1.0 and the average bias that exists between the 1st and 2nd run results due to the increase in run two FEI1 a new upper Vi limit of 4.64 is recommended as a potential interim measure. New RO targets or LTMS approaches could be more appropriate.



FEI2 Repeatability Vi Limits

Current data used for reference acceptance indicates the repeatability inflation factor (R) used in the Vi calculation may be over stating the differences between two tests in the same engine.

FEI2 does not show the large bias between results in an engine that was observed in FEI1. There is still some indication of oil order bias but it is not as clear as FEI1.



Models using only the 24 RO pairs of 1st and 2nd run data indicate the IND only RMSE (0.26) is 0.95 of the full model RMSE (0.25). This indicates the current R value (0.63) used in the Vi calculation should be 0.95.

General Linear Model: FEI2 versus LTMSLAB, LTMSAPP, ENGNO, IND

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
LTMSLAB	Fixed	3	A, B, G
LTMSAPP(LTMSLAB)	Fixed	6	1(A), 2(A), 4(A), 1(G), 3(G), 4(G)
ENGNO(LTMSLAB, LTMSAPP)	Fixed	8	144(A, 1), 206(A, 1), 286(A, 1), 229(A, 4), 289(A, 4), 58(G, 1), 203(G, 1), 276(G, 1)
IND	Fixed	3	1011, 542-2, 543

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
LTMSLAB	2	0.17643	0.08822	1.46	0.277
IND	2	0.56566	0.28283	4.69	0.037
LTMSAPP(LTMSLAB)	4	0.39715	0.09929	1.64	0.238
ENGNO(LTMSLAB, LTMSAPP)	5	0.16636	0.03327	0.55	0.735
Error	10	0.60358	0.06036		
Lack-of-Fit	8	0.54978	0.06872	2.55	0.312
Pure Error	2	0.05380	0.02690		
Total	23	2.75813			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.245679	78.12%	49.67%	0.00%

General Linear Model: FEI2 versus IND

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
IND	Fixed	3	1011, 542-2, 543

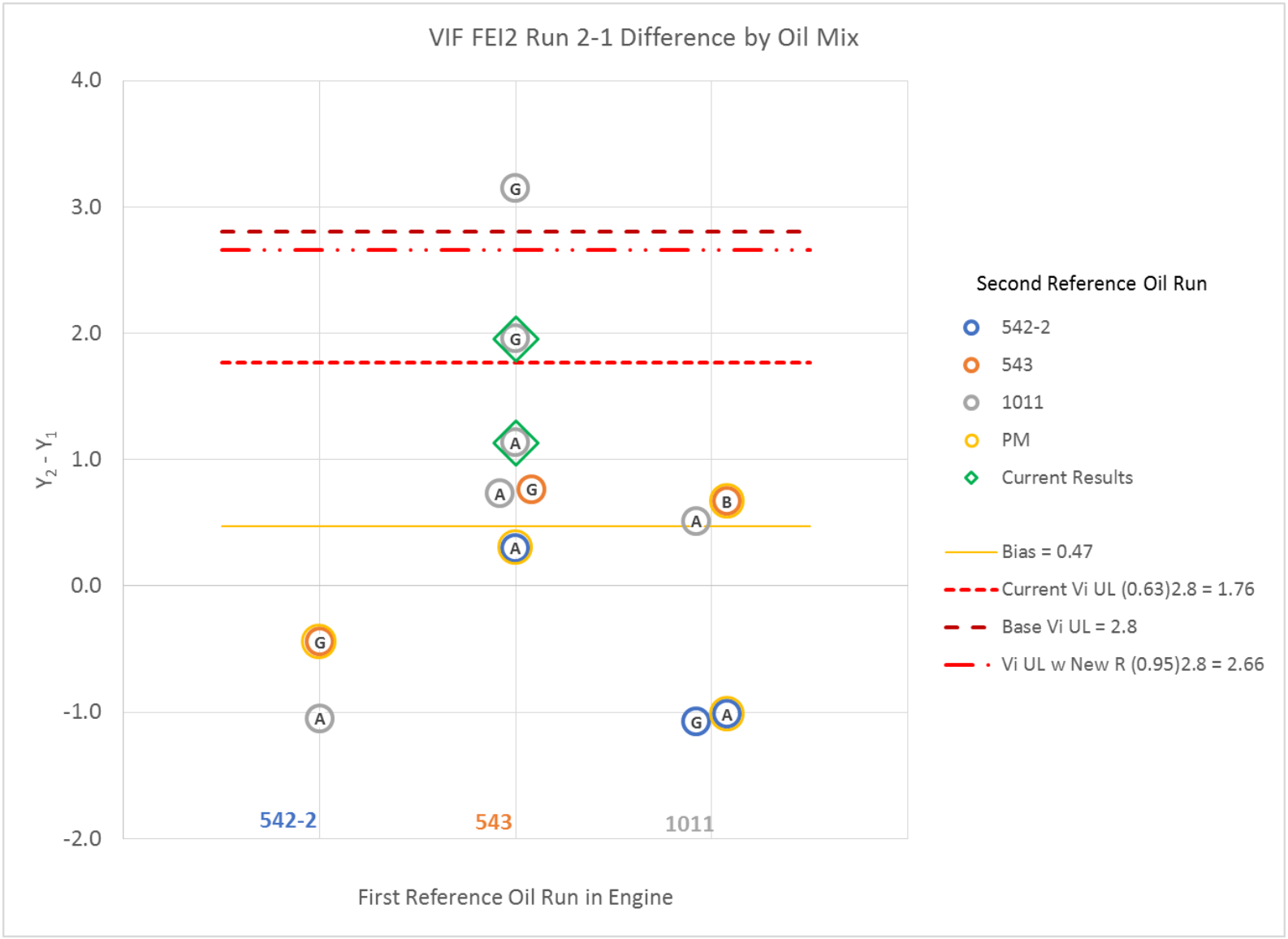
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
IND	2	1.358	0.67903	10.18	0.001
Error	21	1.400	0.06667		
Total	23	2.758			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
0.258206	49.24%	44.40%	34.86%

Recommend adopting the new R value of 0.95 but not including the bias as the evidence at this time does not indicate it is related to 2nd run bias or oil order. In either case one lab G run is outside the limit.



Additional Testing Progress

Planned reference testing (below) was requested at the end of the precision matrix to validate the potential FEI1 run 1 to 2 bias and 5th run opportunities. The original run with 1011 for run 1 and 2 (Engine5) was not acceptable so no 5th run data was generated. In order to obtain another 5th run data point the group requests "A 1 206" replace Engine 5 and conduct a 5th run reference after the upcoming testing completes. The stats group will then pursue a full review of the VIF data and provide new recommendations for the LTMS and engine hour adjustments.

Run Number	A 4 289	G 3 238	A 1 286	G 4 295	A 1 206	Engine5
1	543	1011	542-2	543	543	1011
2	1011	542-2	1011	543	1011	1011
3	Non-Reference Tests					
4						
5	543	1011	542-2	543	1011	1011

Notes:

1. Engine4 and Engine5 run order should be assigned to different labs.
2. Determine next set of testing after analysis of these additional data.

Final Recommendations

- Revise the constant R used in the Repeatability Check calculation (Vi) to reflect the current ratio of variability in the full model and the oil only model for 1st and 2nd run reference oil pairs.
  - FEI1 New R = 1.00 (was 0.95)
  - FEI2 New R = 0.95 (was 0.63)
- Revise the Upper Vi Limit for FEI1 to account for the current average Yi difference in 1st and 2nd run reference oil pairs.
  - FEI1 Upper Vi limit = 4.64 (was 2.8)
- These updates should be considered temporary and a full review of the LTMS and engine hour adjustments should be conducted once all 5th run data is available.
- Interpretation of candidate FEI data may change after the full review is completed