Minutes of the Sequence VIF Task Force teleconference call

September 09, 2015 08:00 CDT

The third meeting of the Sequence VIF Task Force was called to order by Chairman Dan Worcester. The meeting Agenda is included as Attachment 1. The attendance roster is included as Attachment 2.

The minutes from the September 02, 2015 meeting were approved with one minor editorial change. An updated pdf has been sent to the TMC.

Hirano-san presented an update of the Statistician Task Force work. This is included as Attachment 3. The presentation includes the actions made by the Task force during the September 02, 2015 meeting.

Dan Worcester reported that a "VIF" test underway at Southwest Research utilizing ASTM RO 542-2 has produced a preliminary FEI 1 estimation of 1.61% (using VID engine hour correction).

Mike Ragomo of ExxonMobil presented a Power Point slide deck suggesting a single test with the proposed VIF conditions could satisfy the need of both GF-6A and GF-6B. This is included as Attachment 4. Mike suggested the Sequence VIE matrix be placed on "hold" and the VIF matrix be modified to study the use of VIF conditions for both needs. Support for a single test was voiced by some meeting attendees. Others voiced the opinion that the need for moving forward with the VIE matrix and creating a Sequence VID equivalency was paramount. Following lengthy discussion, there was no clear consensus of opinion as to what direction should be pursued. It was mentioned by some participants that the Task Force has evaluated alternatives and at this time has selected the option of proceeding with two tests. The Task Force generally agreed to table discussions until such time as the AOAP group can render an opinion at their meeting on September 10, 2015. If needed, the Sequence VI Surveillance Panel will take up the subject at their next scheduled meeting on September 15, 2015.

On a related topic, David Glaenzer of Afton Chemical brought up the subject of potential short engine life with the VIF procedure as long as oil aging is maintained at 120° C. Much discussion followed relative to lowering the aging temperature and/or reducing the engine load during aging. Automotive OEMs were encouraged to look at bulk oil temperature that is being generated in vehicles.

Some discussion was had relative to what Sequence VIE data is available for oils run in the Toyota Sequence VID Matrix. Attachment 5 shows Sequence VIE results generated at IAR using Toyota Sequence VID Matrix oil 400 (0W-16). Attachment 6 shows Sequence VIE results generated at IAR using Toyota Sequence VID Matrix oil 401 (0W-20).

Adrian Alphonso has agreed to head up a Sequence VIE Engine Rebuild Task Force. He announced that the initial kick-off meeting would be held after the Task Force and SP meetings late next week.

Having no further business, the meeting was adjourned.

Respectfully submitted,

David L. Glaenzer

Afton Chemical Corporation

Attachment #1

GF-6B Sequence VIF Task Force

Toll-free dial-in number (U.S. and Canada):
(866) 588-1857
International dial-in number:
(678) 373-4882
Conference code:
2894131

Scope

The ASTM Sequence VI Surveillance Panel requested a Task Force be formed to determine if the Sequence VIE could be used for 0W 16 oils. The TF will look at development of the VIF test using 100 °C oil temperature and 94 °C coolant temperature for stages 1, 3, 4, and 6.

Objective

Review the Toyota proposal attached and work on selection of reference oils, stands to support testing, and running the Sense Check and test matrices.

The agenda for this meeting is shown below, if you have any additions please send them to me and Cc this distribution.

1.0 Chairman's Comments
2.0 Roll Call
3.0 Approval of Minutes from Meeting 09.02.2015

ftp://ftp.astmtmc.cmu.edu/docs/gas/sequencevi/minutes/VIFTaskForceMinutes20150902.pdf

4.0 Meetings will be every Wednesday morning at 8:00 AM Central Time.
5.0 Toyota matrix update included with email.
6.0 Status of 542 Blend and 400 as reference oils for the matrix.
7.0 FEI 1 from VIF test on oil 542-2 at SwRI.
FEI 1 with VID engine hour correction and no severity adjustments applied

FEI1 vs BLB2 Eng Hr Adj+SA	1.61%

8.0 Next call September 16, 2015 at 8:00 AM Central Time.

Attachment #2

Name	Affiliation	08/27/15	Vote on Option#3	09/02/15	Vote on Alt.Sense	09/09/15	
Adrian Alfonso	Intertek	P	Y			P	
Amol C Savant	Ashland		Y	P	Y	P	
Andrew Ritchie	Infineum	P	W	P	W	P	
Charlie Leverett	Intertek						
Chris Castanien	Nesteoil			P	Y	P	
Cliff Salvensen	ExxonMobil	P					
Cole Hudson	SwRI	P	Y	P	Y		
Dan Worcester Jr.	Chairman, SwRI	P		P		P	
David Glaenzer	Secretary, Afton Chemical	P	W	P	Y	P	
Denny Gaal	ExxonMobil	P				P	
Doyle Boese	Infineum	P		P			
Eric Liu	SwRI	P					
Gordon Farnsworth	Infineum	P		P		P	
Guy Stubs	SwRI			P		P	
Jason Bowden	OH Technologies	P	W	P	Y	P	
Jim Linden	Toyota	P	Y	P	Y		
Jo Martinez	Chevron	P		P		P	
Kaustav Sinha	Chevron	P	Y	P	Y	P	
Kevin OMalley	Lubrizol	P	Y		Y		
Mark Adams	Tribology Testing			P			
Mark Mosher	ExxonMobil	P	Y	P	Y		
Martin Chadwick	Intertek						
Matthew Bowden	OH Technologies	P		P			
Michael Conrad	Lubrizol	P		P		P	
Mike McMillan	Infineum	P		P		P	
Nathaniel Moles	Lubrizol	P		P		P	
Patrick Lang	SwRI						
Ray Burn	ExxonMobil	P					
Rich Grundza	ASTM Test Monitoring	P	W	P	Y	P	
Robert Stockwell	Oronite			P		P	
Ron Romano	Ford Motor Company			P	Y		
Satoshi Hirano	Toyota	P		P		P	
Teri Kowalski	Toyota	P		P		P	
Timothy Cushing	General Motors	P	Y	P	Y	P	
Todd Dvorak	Afton Chemical	P					
Tracy King	Haltermann	P	W				
Valerie Lieu	Chevron	P					
William Buscher	Intertek	P			Y	P	
Bob Campbell	Afton		8-0-5		13-0-1	P	
Mike Ragomo	ExxonMobil					P	

TOYOTA

Proposal of Sequence VIF Test Development to PCEOCP and AOAP

Prepared for
Sequence VIF Taskforce
September 9th, 2015
Toyota Motor Corporation

Current Status of Sequence VIE and VIF

TOYOTA

- Sequence VIE
  - Seq VI SP decided to proceed the VIE precision matrix without 0W-16 in it
    - The motion was in the e-ballot with closing on September 7th
  - Sequence VIE is dedicated for the ILSAC GF-6A
  - Tech 1 0W-16 (TMC1011) to be replaced by Tech 1 5W-30
    - ILSAC has agreed with this replacement
- Sequence VIF
  - Seq VI SP decided to pursue the modification of Sequence VIE to be better fit for xW-16 evaluation
  - This is the Sequence VIF and dedicated for the ILSAC GF-6B
  - Taskforce was formed with Dan Worcester (SwRI) as its chair

Decisions made for Sequence VIF at SP and TF TOYOTA

- Sequence VIF Test Condition
  - Stage 1, 3, 4, and 6 have 100°C/94°C for engine oil/coolant instead of 115°C/109°C
  - All other test conditions and weighting factors stay the same
- Reference Oil Selection
  - 3 reference oils were decided
    - Tech 1 0W-16 (TMC1011)
    - TMC542-2 (0W-20)
    - Oil 400 (0W-16) from the Toyota VID Matrix
      - Latest Market General GF-5 from a major additive supplier
- Matrix Design
  - 30 test matrix with 8 test sense check run was decided
    - Involves 2 independent laboratories as test development
  - Dependent labs add REO data for the LTMS as next step

September 9th, 2015 Prepared for Sequence VIF Taskforce 3

Sequence VIF Test Development TOYOTA

- Test Conditions
  - Oil and Coolant Temperatures at Stage 1, 3, 4, and 6 are 15°C lower than those of Sequence VIE
  - No Change in Aging Conditions

Sequence VIF

Test Stage	1	2	3	4	5	6
Speed, RPM	2000	2000	1500	695	695	695
Torque , Nm	105	105	105	20	20	40
Oil Temp, °C	**100**	65	**100**	**100**	35	**100**
Coolant Temp, °C	**94**	65	**94**	**94**	35	**94**
Stage Weighting (%)	30	3.2	31	17.4	1.1	17.2

Aging condition: 2250 RPM, 110 Nm, 120 °C

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Sequence VIF Test Development

TOYOTA

- REO Availability : will be ready well within 2 weeks
  - TMC1011 (Tech 1 0W-16)
    - Readily available
  - TMC542-2 (0W-20, current VID REO)
    - Approximately 600 gals available
    - More than enough to cover both VIE and VIF for their industry matrices and 1 reference period
  - Oil 400 (0W-16 from Toyota VID matrix)
    - The supplier has been working on gathering materials and blending the sample
    - We expect that 20 drums of the sample will be blended and shipped early in the next week (Sept 14th week) from the supplier

September 9th, 2015 Prepared for Sequence VIF Taskforce 5

Sequence VIF Test Development

TOYOTA

- 30 Test Matrix Design (approved at Taskforce Sept 2nd)

Run	EOT Hour	Engine 11	Engine 21	Engine 12	Engine 22
1	350	Oil 400	TMC1011	TMC542-2	TMC1011
2	550	TMC542-2	TMC542-2	Oil 400	Oil 400
3	750	TMC542-2	TMC1011	Oil 400	TMC1011
4	950	Oil 400	Oil 400	TMC542-2	TMC542-2
5	1150	TMC1011	Oil 400	TMC1011	TMC542-2
6	1350	Oil 400	TMC1011	Oil 400	TMC1011
7	1550	TMC542-2	TMC542-2	TMC1011	Oil 400
8	1750	TMC1011		TMC542-2	

Stage 1 Sense Check Runs will be tested in 2 engines/2 labs

Stage 2 Sense Check Runs will be tested in other 2 engines/2 labs

September 9th, 2015 Prepared for Sequence VIF Taskforce 6

Sequence VIF Test Development

TOYOTA

- REO Discrimination in Sense Check Runs
  - Comparison between TMC542-2 and Oil 400 will provide the best chance to discriminate 2 REOs.

- Oil Ranking :
  - Oil 400 > TMC54-2
- Precision :
  - VID Prove Out Estimate of s
  - FEI1 = 0.22
  - FEI2 = 0.26

	TMC542-2 (0W-20)	Oil 400 (0W-16)
VID FEI Sum	2.29 (1.49 + 0.80)	2.87
VID FEI2	0.8	1.51
Source	LTMS (Aug-2015)	Average of 4 Runs in Toyota VID Matrix Data

Matrices	VIF Sense Check Run	VIF Sense Check Run
No. of Stands	2	2
No. of Labs	2	2
No. of Ref Oils	2	2
Total No. of Tests	8	8
No. of Tests/Oil	4,4	4,4
Significance level (α)	0.1	0.2
Detectable Difference in s of variable and using t	2.17	1.75
Detectable Difference Assuming FEI2 s=0.26	0.56	0.45
Degrees of Freedom		
Oil	1	1
Lab	1	1
Engine Hour	1	1
Mean	1	1
Error	4	4
Total	8	8

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Sequence VIF Test Development

TOYOTA

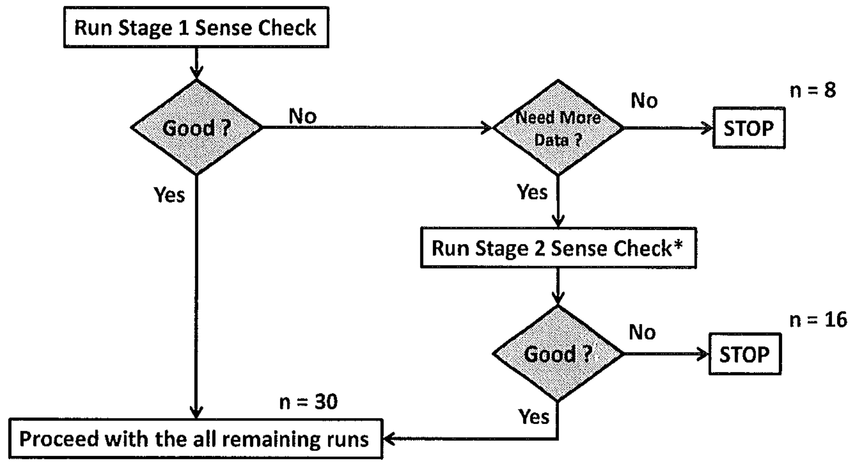
- Test Plan
  - Stepwise Approach was decided
  - 30 Test Matrix
    - Involves 2 independent laboratories and 2 engines at each laboratory
    - To establish test procedure and REO discrimination
    - To establish engine hour correction equations
  - Additional REO Tests
    - Other dependent laboratory participate
    - To establish the LTMS target
    - The same approach as VID development

September 9th, 2015 Prepared for Sequence VIF Taskforce 8

Sequence VIF Test Development

TOYOTA

- 30 Test Matrix Plan : Approved at the Taskforce Sept 2nd



* Stage 2 Sense Check can be re-designed based on the outcome of Stage 1 Sense Check

Sequence VIF Test Development

TOYOTA

- Sponsorship
  - 30 Test Matrix
    - Confirmed that 10 companies are OK to contribute each 3 VIF tests as test sponsors at the cost defined as Seq VIE in the MOA
    - 2 independent laboratories send the individual invoices to test sponsors
    - No MOA funding is used
  - Additional REO Runs
    - Dependent laboratories add REO tests to contribute to the database to establish the LTMS targets
    - Dependent laboratories need to sponsor themselves, unless additional sponsors are available

Sequence VIF Test Development Action Plan TOYOTA

- **Best Case Scenario**

	Action Item	Action by	Target Timing
1	Finalize the SP/TF proposal of the test plan to the AOAP and the PCEOCP for approval	Seq VI SP Seq VIF TF	Before AOAP and PCEOCP on Sept 10th
2	Report the proposal and ask approval at the AOAP and PCEOCP meetings	Seq VI SP/VIF TF	September 10th
3	Blend and deliver REO samples to labs	Toyota / TF	Mid ~ Late Sept
4	Choose 3 sponsors for the sense check matrix (Toyota and other 2 companies)	Toyota / TF	Mid Sept
5	Allocate test engines/stands for the VIF	TF / Labs	Mid Sept
6	Process documentations to start testing (RFQ and Purchase Order)	Sponsors and Labs	Mid Sept
7	Execute the sense check tests	Labs / TF	Late Sept ~ Mid Oct
8	Analyze the Sense Check Matrix and Decide to proceed to the Step 2	TF and SP	Late Oct
9	Process documentations to prepare the Step 2	Sponsors and Labs	Late Sept ~ Late Oct
10	Execute the Step 2	Labs / TF	Nov ~ Dec
11	Analyze and Finalize the VIF Test Procedure	TF and SP	Jan 2016 ?
12	Execute Step 3	SP and Test Labs	Feb ~ Mar ? 2016
13	Analyze and Establish the initial LTMS target	SP	Apr 2016 ?

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Open Items for Seq VI Surveillance Panel TOYOTA

- Number of REO Runs to Calibrate New Engine
  - 3 REO Runs are required for current Sequence VID
  - Some SP members are interested in an investigation to see if 2 REO Runs are necessary enough to calibrate new test engine
- Requirement to Switch between VIE and VIF
  - VIE test engine and VIF test engine are physically separated
  - The same test stand can be used for both VIE and VIF
  - Need to establish new rules to switch VIE engine and VIF engine back and forth on the same test stand

2 VIE 10.1.1.5
VID 10.1.1.5

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Attachment #4
1 of 2

ExxonMobil

Measuring GF-6 Fuel Economy
Do We Need One or Two Tests?

Energy lives here™

Mike Ragomo September 2015

Moving Forward with the Sequence VIE

Pros:

- Linkages to Seq. VID Engine Test
- Original Seq. VID goal > map to FTP (stages & stage weighting)
- Seq. VIE perceived to be a "drop-in" replacement for the VID
- Seq. VID end-of-life approaching creating timing urgency
- Several stands already configured to run Seq. VIE
- GF-5 (GF-6A) oils rank appropriately
- Some preliminary scoping work may have been completed

Cons:

- Seq. VIE aging (engine & oil) greater than "real-world" or FTP
- Have carry-over effects been adequately addressed?
- GF-6 needs statement calls for improved FE potential; newer configuration, improved FE engines being designed to run cooler
- Inability to show FE benefit of 0W-16 over 0W-20
- Proceeding with a test that only works for GF-6A viscosity grades establishes need for a separate test for GF-6B oils

Benefits of a Single Fuel Economy Test

- Common test procedure for both API & OEM specifications
- Streamlines product development & specification delivery timeline
- Simplifies work of Surveillance Panel
  - addressing operational issues having a single test procedure
  - lessens severity drift analysis complexity
- Potentially increases candidate to reference ratio
- Extends life of available hardware

- Possibly a potential adjustment of engine appetite vs. Seq. VIE, but there is no technical reason why Seq. VIF can't discriminate higher viscosities

Evaluate Seq. VIF for both GF-6A & GF-6B

- A single test for both GF-6A & GF-6B categories
- No technical reason why Seq. VIF is unsuitable for higher viscosity grades
- Postpone Seq. VIE matrix start (not expected to delay GF-6A), and evaluate potential use of Seq. VIF to cover both categories
- "No change" to current Seq. VIF proposed matrix
  2 Labs, 2 Engines per Lab
  3 Reference Oils, Total of 30 Test Runs
- Modify choice of oils for proposed prove-out matrix
  - No change to Seq. VIF prove-out test cost
  - Current proposal: Oil 400, TMC 542-2, TMC 1011
  - Revised proposal: Oil 400, TMC 542-2, 5W-30 (Tech 1 or "Oil 402")
- If successful, precision matrix cost would decrease substantially

2 3 4 5 6 7

Test Number (Stand-Runs on Stand-Engine-Runs on Engine)				Engine Hours at EOT
51-201-79-5				1209
Oil Code	Viscosity Grade	Date Complete	Time Complete	Lab
400	0W-16	07/02/2015	16:58	Intertek AR

Test Summary (5 Minute Averages of 2 Second data)						
Matrix II Stage #	3	4	5	7	8	9
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Weight Factor	0.3	0.032	0.31	0.174	0.011	0.172
Nominal Power kW	21.99	21.99	16.49	1.46	1.46	2.91
Stage Length h	0.50	0.50	0.50	0.50	0.50	0.50
kW-h	3.29850	0.35184	2.55595	0.12702	0.00803	0.25026
Base Line Before - 1						
BSFC kg/kW-h	0.28392	0.29807	0.28337	0.69870	0.86587	0.43602
BSFC C.V.%	0.08%	0.05%	0.03%	0.09%	0.18%	0.26%
Fuel Consumed kg	0.936510	0.104873	0.724280	0.088749	0.006953	0.109118
Base Line Before - 2						
BSFC kg/kW-h	0.28278	0.29720	0.28307	0.69215	0.86187	0.43160
BSFC C.V.%	0.01%	0.05%	0.03%	0.17%	0.17%	0.18%
Fuel Consumed kg	0.932750	0.104567	0.723513	0.087917	0.006921	0.108012
Candidate, Phase 1						
BSFC kg/kW-h	0.27715	0.28733	0.28027	0.67998	0.80175	0.43328
BSFC C.V.%	0.02%	0.06%	0.05%	0.08%	0.16%	0.06%
Fuel Consumed kg	0.914179	0.101094	0.716356	0.086371	0.006438	0.108433
Candidate, Phase 2						
BSFC kg/kW-h	0.27790	0.28870	0.28187	0.69343	0.80563	0.44195
BSFC C.V.%	0.02%	0.02%	0.06%	0.19%	0.25%	0.17%
Fuel Consumed kg	0.916653	0.101576	0.720446	0.088079	0.006469	0.110602
Base Line After						
BSFC kg/kW-h	0.28327	0.29817	0.28362	0.68838	0.86757	0.43360
BSFC C.V.%	0.06%	0.08%	0.03%	0.18%	0.17%	0.13%
Fuel Consumed kg	0.934366	0.104908	0.724919	0.087438	0.006967	0.108513
BLB1 to BLB2 Shift by Stage	0.40%	0.29%	0.11%	0.94%	0.46%	1.01%
BLB2 to BLA Shift by Stage	-0.17%	-0.33%	-0.19%	0.54%	-0.66%	-0.46%
FEI1 vs. (0.8 BLB2 + 0.2 BLA)	2.02%	3.38%	1.03%	1.65%	7.10%	-0.30%
FEI2 vs. (0.1 BLB2 + 0.9 BLA)	1.88%	3.14%	0.60%	-0.68%	7.09%	-1.97%

Oil Consumption (ml)	1100
Weighted Fuel Consumed	
Total Fuel Consumed BLB1 kg	1.970483
Total Fuel Consumed BLB2 kg	1.963680
Total Fuel Consumed CA1 kg	1.932871
Total Fuel Consumed CA2 kg	1.943825
Total Fuel Consumed BLA kg	1.967111
Fuel Economy Improvement	
FEI1 vs. (0.8 BLB2 + 0.2 BLA)	**1.60%**
FEI2 vs. (0.1 BLB2 + 0.9 BLA)	**1.17%**
Engine Hours Adjustment	
FEI1 Hour Adjustment	**-0.08%**
FEI2 Hour Adjustment	**-0.08%**
LTMS Severity Adjustment	
FEI1 Severity Adjustment	**0.00%**
FEI2 Severity Adjustment	**0.00%**
Engine Hours Adjusted Results	
Corrected FEI1	**1.52%**
Corrected FEI2	**1.09%**
Unweighted Fuel Consumed	
Total Fuel Consumed BLB1 kg	10.511911
Total Fuel Consumed BLB2 kg	10.473205
Total Fuel Consumed CA1 kg	10.229368
Total Fuel Consumed CA2 kg	10.291135
Total Fuel Consumed BLA kg	10.498111
BLB1 to BLB2 Shift	**0.37%**
BLB2 to BLA Shift	-0.24%
BLB1 to BLA Shift	0.13%

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	3, 5, 7 & 9 Total	4 & 8 Total	Total
Stage Percent of Total Fuel Consumed during Baseline (Weight)									
for (0.8 BLB2 + 0.2 BLA)	47.50%	5.33%	36.85%	4.47%	0.35%	5.50%	94.32%	5.68%	100.00%
for (0.1 BLB2 + 0.9 BLA)	47.50%	5.33%	36.85%	4.45%	0.35%	5.51%	94.31%	5.69%	100.00%
Stage Contribution to Final FEI									
Weighted FEI1 vs. (0.8 BLB2 + 0.2 BLA)	0.96%	0.18%	0.38%	0.07%	0.03%	-0.02%	1.40%	0.21%	1.60%
Weighted FEI2 vs. (0.1 BLB2 + 0.9 BLA)	0.89%	0.17%	0.22%	-0.03%	0.03%	-0.11%	0.97%	0.19%	1.17%
Unweighted Fuel Consumed									
BLB1	3.12170	3.27728	2.33639	0.51005	0.63209	0.63441	6.60255	3.90937	10.51191
BLB2	3.10917	3.26771	2.33391	0.50527	0.62917	0.62798	6.57633	3.89688	10.47321
CA1	3.04726	3.15919	2.31083	0.49639	0.58528	0.63042	6.48490	3.74447	10.22937
CA2	3.05551	3.17426	2.32402	0.50620	0.58811	0.64304	6.52877	3.76237	10.29114
BLA	3.11455	3.27838	2.33845	0.50252	0.63333	0.63089	6.58641	3.91171	10.49811

2 3 4 5 6 7

Test Number (Stand-Runs on Stand-Engine-Runs on Engine)				Engine Hours at EOT
52-193-22-2				549
Oil Code	**Viscosity Grade**	**Date Complete**	**Time Complete**	**Lab**
401	0W-20	07/30/2015	23:57	Intertek AR

Test Summary (5 Minute Averages of 2 Second data)						
Matrix II Stage #	3	4	5	7	8	9
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Weight Factor	0.3	0.032	0.31	0.174	0.011	0.172
Nominal Power kW	21.99	21.99	16.49	1.46	1.46	2.91
Stage Length h	0.50	0.50	0.50	0.50	0.50	0.50
kW-h	3.29850	0.35184	2.55595	0.12702	0.00803	0.25026
Base Line Before - 1						
BSFC kg/kW-h	0.28772	0.29917	0.28912	0.75032	0.89948	0.46795
BSFC C.V.%	0.07%	0.08%	0.04%	0.23%	0.33%	0.14%
Fuel Consumed kg	0.949044	0.105260	0.738976	0.095306	0.007223	0.117109
Base Line Before - 2						
BSFC kg/kW-h	0.28687	0.29938	0.28843	0.74743	0.89870	0.46537
BSFC C.V.%	0.38%	0.13%	0.05%	0.13%	0.16%	0.15%
Fuel Consumed kg	0.946241	0.105334	0.737213	0.094939	0.007217	0.116463
Candidate, Phase 1						
BSFC kg/kW-h	0.27955	0.29037	0.28240	0.72582	0.85122	0.45412
BSFC C.V.%	0.04%	0.05%	0.06%	0.21%	0.19%	0.13%
Fuel Consumed kg	0.922096	0.102164	0.721800	0.092194	0.006835	0.113648
Candidate, Phase 2						
BSFC kg/kW-h	0.27688	0.28908	0.28008	0.72860	0.85665	0.45777
BSFC C.V.%	0.05%	0.03%	0.17%	0.19%	0.17%	0.15%
Fuel Consumed kg	0.913289	0.101710	0.715870	0.092547	0.006879	0.114562
Base Line After						
BSFC kg/kW-h	0.28322	0.29707	0.28430	0.75152	0.90178	0.46843
BSFC C.V.%	0.09%	0.03%	0.05%	0.18%	0.10%	0.16%
Fuel Consumed kg	0.934201	0.104521	0.726657	0.095458	0.007241	0.117229
BLB1 to BLB2 Shift by Stage	0.30%	-0.07%	0.24%	0.39%	0.08%	0.55%
BLB2 to BLA Shift by Stage	1.27%	0.77%	1.43%	-0.55%	-0.33%	-0.66%
FEI1 vs. (0.8 BLB2 + 0.2 BLA)	2.30%	2.86%	1.81%	3.00%	5.36%	2.55%
FEI2 vs. (0.1 BLB2 + 0.9 BLA)	2.36%	2.77%	1.63%	3.00%	4.97%	2.21%

Oil Consumption (ml)	800
Weighted Fuel Consumed	
Total Fuel Consumed BLB1 kg	2.012918
Total Fuel Consumed BLB2 kg	2.007407
Total Fuel Consumed CA1 kg	1.958737
Total Fuel Consumed CA2 kg	1.944857
Total Fuel Consumed BLA kg	1.985307
Fuel Economy Improvement	
FEI1 vs. (0.8 BLB2 + 0.2 BLA)	**2.21%**
FEI2 vs. (0.1 BLB2 + 0.9 BLA)	**2.15%**
Engine Hours Adjustment	
FEI1 Hour Adjustment	**-0.31%**
FEI2 Hour Adjustment	**-0.29%**
LTMS Severity Adjustment	
FEI1 Severity Adjustment	**0.00%**
FEI2 Severity Adjustment	**0.00%**
Engine Hours Adjusted Results	
Corrected FEI1	**1.90%**
Corrected FEI2	**1.86%**
Unweighted Fuel Consumed	
Total Fuel Consumed BLB1 kg	10.721870
Total Fuel Consumed BLB2 kg	10.702712
Total Fuel Consumed CA1 kg	10.406643
Total Fuel Consumed CA2 kg	10.355278
Total Fuel Consumed BLA kg	10.612818
BLB1 to BLB2 Shift	**0.18%**
BLB2 to BLA Shift	0.84%
BLB1 to BLA Shift	1.02%

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	3, 5, 7 & 9 Total	4 & 8 Total	Total
Stage Percent of Total Fuel Consumed during Baseline (Weight)									
for (0.8 BLB2 + 0.2 BLA)	47.12%	5.25%	36.70%	4.75%	0.36%	5.82%	94.39%	5.61%	100.00%
for (0.1 BLB2 + 0.9 BLA)	47.06%	5.26%	36.61%	4.80%	0.36%	5.89%	94.37%	5.63%	100.00%
Stage Contribution to Final FEI									
Weighted FEI1 vs. (0.8 BLB2 + 0.2 BLA)	1.09%	0.15%	0.66%	0.14%	0.02%	0.15%	2.04%	0.17%	2.21%
Weighted FEI2 vs. (0.1 BLB2 + 0.9 BLA)	1.11%	0.15%	0.60%	0.14%	0.02%	0.13%	1.98%	0.16%	2.15%
Unweighted Fuel Consumed									
BLB1	3.16348	3.28937	2.38379	0.54773	0.65662	0.68087	6.77588	3.94599	10.72187
BLB2	3.15414	3.29168	2.37811	0.54562	0.65605	0.67711	6.75498	3.94773	10.70271
CA1	3.07365	3.19262	2.32839	0.52985	0.62139	0.66075	6.59263	3.81401	10.40664
CA2	3.04430	3.17844	2.30926	0.53188	0.62535	0.66606	6.55149	3.80379	10.35528
BLA	3.11400	3.26629	2.34405	0.54861	0.65830	0.68157	6.68823	3.92458	10.61282