Daimler Surveillance Panel Meeting Minutes

August 16, 2022
13:00 AM – 14:00 AM EST

Call Participants:
Lubrizol - Robert Slocum (Chairman), Andrew Stevens
Southwest Research Institute – Robert Warden
Intertek – Josh Ward, Joe Franklin
Daimler - Suzanne Neal
Infineum - Elisa Santos
TEI – Derek Grosch
Chevron Oronite – David Lee, Josephine Martinez
TMC – Sean Moyer

Agenda Items

DD13 PC-12 Discussion – Surveillance Panel
DD13 Statistician Follow-up/ NCDT Presentation Prep –

NCDT Presentation Preparation:

- Review of Previous Statistical Analysis:
  - Elisa Santos from Infineum reviewed the historical statistical information available for the DD13 Scuffing test and provided recommendations to Suzanne Neal from Daimler Truck on what slides to include for the NCDT presentation. Goal is for the presentation to summarize the precision matrix history with the right amount of detail for the NCDT audience level.
- Transformations:
  - Elisa Santos reviewed transformation investigation by Kevin O'Malley and recommended to highlight in the NCDT presentation that transformations were investigated but taskforce/panel decided to not implement any transforms at this time (add link to detailed minutes/presentation incase others would like to see more detail).
- Test Development:
  - Team agreed adding a slide with taskforce and surveillance panel participants would be helpful to help educate others on how and who helped with the test development.
  - Recommendation to add slides 13/14 of original SwRI presentation from NCDT February 2022 the presentation because it provides a nice summary/history.

Precision Statement:

- Team clarified with Sean Moyer from TMC that an updated precision statement was generated 4/7/2022 but has not yet been adopted into the ASTM procedure.

Next Steps:

- Suzanne Neal will provide a copy of the NCDT Presentation to be included in the surveillance panel meeting minutes for reference.

Walk-in Topics: None
Meeting was adjourned at 13:36 PM EST.

Next Meeting: TBD

Appended: NCDT Presentation given August 23, 2022

DAIMLER TRUCK

DD13 Scuffing Test NCDT Presentation

August 23rd, 2022 in Detroit, MI

Suzanne Neal

Content of Presentation:

The Daimler Surveillance Panel met on August 9th & 16th, 2022 to prepare the following content for this presentation.

Agenda

Membership History/Overview:

- DD13 ASTM Taskforce & Surveillance Panel

Matrix History:

- Development Process Timeline
- Prove Out Matrix
- Precision Matrix
  - LTMS, Control Charts, Precision Statements
- BOI / VGRA
- Key Contacts/Links

Back-up Slides

NCDT February 2022:

- Educational Presentation on DD13 from SWRI

NCDT April 2022:

- DD13 Scuffing Test – Follow Up Topics
  - Part availability, part screening, etc.

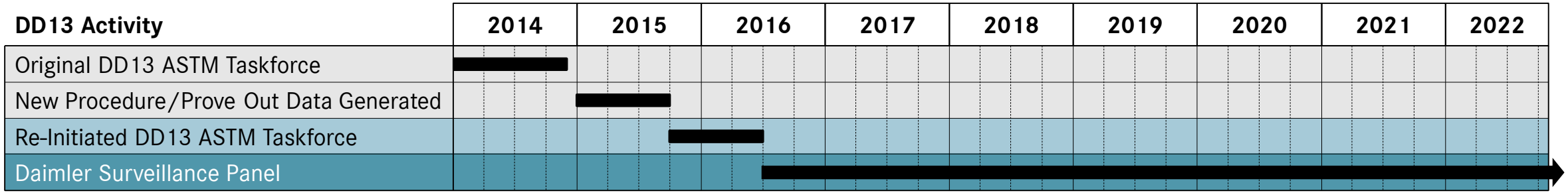
NCDT June 2022:

- DD13 Scuffing Test – Follow Up Topics:
  - Engine Test Development Readiness Template, Annex K, etc.

DAIMLER TRUCK

Membership History/Overview
DD13 ASTM Taskforce & Surveillance Panel

DD13 Membership: Timeline/Participation



DD13 ASTM Taskforce

- OEMs
- Test Labs
- Additive & Oil Companies
- TEI / TMC / Others

Daimler Surveillance Panel

- OEMs
- Test Labs
- Additive & Oil Companies
- TEI / TMC / Others

DD13 Membership Lists: 2015 Taskforce / 2016 Surveillance Panel

DD13 Scuffing Test ASTM Taskforce Membership (2015)

	B02 Contact for D02	Joe Franklin	joe.franklin@intertek.com
	Detroit Diesel List		
	Name	Company	Email
1	Bob Salgueiro	Infineum	bob.salgueiro@infineum.com
2	Pat Fetterman	Infineum	Glen.Fetterman@Infineum.com
3	David Brass	Infineum	David.Brass@Infineum.com
4	Sujay Bagi	PACCAR	sujay.bagi@PACCAR.com
5	Sean A. Moyer	Test Monitoring Center	sam@astmtmc.cmu.edu
6	Mrugesh Patel	Exxon Mobil	mrugesh.n.patel@exxonmobil.com
7	Bob Campbell	Afton Chemical	Bob.Campbell@AftonChemical.com
8	Martin Thompson	Southwest Research	martin.thompson@swri.org
9	Jacob Goodale	Intertek	jacob.goodale@intertek.com
10	Jim Moritz	Intertek	jim.moritz@intertek.com
11	Patrick Joyce	Lubrizol	Patrick.Joyce@Lubrizol.com
12	Dave Duncan	Lubrizol	david.duncan@lubrizol.com
13	John Loop	Lubrizol	John.Loop@lubrizol.com
14	James Matasic	Lubrizol	James.Matasic@lubrizol.com
15	Suzanne Neal	Detroit Diesel	suzanne.neal@daimler.com
16	Gregory Braziunas	Detroit Diesel	gregory.braziunas@daimler.com
17	Mesfin Belay	Detroit DIesel	mesfin.belay@daimler.com
18	Jeremy Dean	Detroit DIesel	jeremy.dean@daimler.com
19	Michael Alessi	Exxon Mobil	michael.l.alessi@exxonmobil.com
20	Jeff Clark	TMC	jac@astmtmc.cmu.edu
21	Jim McCord	SwRI	james.mccord@swri.org
22	Mark Sutherland	TEI	
23	Riccardo Conti	ExxonMobil	riccardo.conti@exxonmobil.com
24	Jim Gutzwiller	Infineum	james.gutzwiller@infineum.com
25	Joan Evans	Infineum	joan.evans@infineum.com
26	Bill Larch	LZ	william.larch@lubrizol.com
27	Gail Evans	LZ	gail.evans@lubrizol.com
28	Kevin O'Malley	LZ	kevin.omalley@lubrizol.com
29	Greg Shank	Mack/Volvo	greg.shank@volvo.com
30	Jim Rutherford	Oronite	jaru@chevron.com
31	Mark Cooper	Oronite	mawc@chevron.com
32	Darryl Purificati	Petro Canada	dpurificati@suncor.com
33	John Pettingill	Petro Canada	jpettingill@suncor.com
34	Elisa Santos	Infineum	

Daimler Surveillance Panel Membership (2016)

#	Name	Company	Email
1	Bob Campbell	Afton	Bob Campbell <Bob.Campbell@AftonChemical.com>
2	Cory Koglin	Afton	Cory Koglin <Cory.Koglin@AftonChemical.com>
3	Shawn Whitacre	Chevron Lubricants	Whitacre, Shawn D <ShawnWhitacre@chevron.com>
4	Jim Rutherford	Chevron Oronite	Jim Rutherford <jaru@chevron.com>
5	Mark Cooper	Chevron Oronite	Mark Cooper <mawc@chevron.com>
6	Dan Kozub	Daimler	Dan Kozub <daniel.kozub@daimler.com>
7	Greg Braziunas	Daimler	Greg Braziunas <gregory.braziunas@daimler.com>
8	Jeremy Dean	Daimler	Jeremy Dean <jeremy.dean@daimler.com>
9	Mesfin Belay	Daimler	Mesfin Belay <mesfin.belay@daimler.com>
10	Susan Yang	Daimler	Susan Yang <susan.yang@daimler.com>
11	Suzanne Neal	Daimler	Suzanne Neal <suzanne.neal@daimler.com>
12	David Gray	Evonik	David B. Gray <david.gray@evonik.com>
13	Bhaskar Prabhakar	Exxon Mobil	Bhaskar Prabhakar <bhaskar.prabhakar@exxonmobil.com>
14	Michael Alessi	Exxon Mobil	Michael Alessi <michael.l.alessi@exxonmobil.com>
15	Mrugesh Patel	Exxon Mobil	Mrugesh Patel <mrugesh.n.patel@exxonmobil.com>
16	Riccardo Conti	Exxon Mobil	Riccardo Conti <riccardo.conti@exxonmobil.com>
17	Steve Kennedy	Exxon Mobil	Steve Kennedy <steven.kennedy@exxonmobil.com>
18	Terry Bates	Facilitator	Terry Bates (batesterryw@aol.com)
19	Bob Salgueiro	Infineum	Bob Salgueiro <bob.salgueiro@infineum.com>
20	David Brass	Infineum	David Brass <David.Brass@Infineum.com>
21	Elisa Santos	Infineum	Elisa Santos <Elisa.Santos@Infineum.com>
22	Jim Gutzwiller	Infineum	Jim Gutzwiller <james.gutzwiller@infineum.com>
23	Joan Evans	Infineum	Joan Evans <joan.evans@infineum.com>
24	Jacob Goodale	Intertek	Jacob Goodale <jacob.goodale@intertek.com>
25	Jim Moritz	Intertek	Jim Moritz <jim.moritz@intertek.com>
26	Joe Franklin	Intertek	Joe Franklin <joe.franklin@intertek.com>
27	Bill Larch	Lubrizol	Bill Larch <william.larch@lubrizol.com>
28	Dave Duncan	Lubrizol	Dave Duncan <david.duncan@lubrizol.com>
29	Gail Evans	Lubrizol	Gail Evans <gail.evans@lubrizol.com>
30	Jim Matasic	Lubrizol	James.Matasic@lubrizol.com
31	Kevin O'Malley	Lubrizol	Kevin O'Malley <kevin.omalley@lubrizol.com>
32	John Loop	Lubrizol	Loop, John <John.Loop@lubrizol.com>
33	Patrick Joyce	Lubrizol	Patrick Joyce <Patrick.Joyce@Lubrizol.com>
34	Chris Castanien	Neste	Chris Castanien <Chris.castanien@neste.com>
35	Sujay Bagi	PACCAR	Sujay Bagi <sujay.bagi@PACCAR.com>
36	Seung-Min Yeo	Shell	Seung-Min Yeo <Seung-Min.Yeo@shell.com>
37	Stede Granger	Shell	Stede Granger <Stede.Granger@shell.com>
38	Darryl Purificati	Suncor	Darryl Purificati <dpurificati@suncor.com>
39	John Pettingill	Suncor	John Pettingill <jpettingill@suncor.com>
40	Jim McCord	SWRI	Jim McCord <james.mccord@swri.org>
41	Jose Starling	SWRI	Jose Starling <Jose.starling@swri.org>
42	Michael Lochte	SWRI	Michael Lochte <michael.lochte@swri.org>
43	Travis Kostan	SWRI	travis.kostan@swri.org
44	Mark Sutherland	TEI	Mark Sutherland <MSutherland@tei-net.com>
45	Jeff Clark	TMC	Jeff Clark <jac@astmtmc.cmu.edu>
46	Sean Moyer	TMC	Sean Moyer <sam@astmtmc.cmu.edu>
47	Greg Shank	Volvo	Greg Shank <greg.shank@volvo.com>

DAIMLER TRUCK

DD13 Scuffing Test Development Process & Timeline

DD13 Development Process & Timeline: 2015 New Procedure

DD13 development process was based on best practices from other API / PC-11 tests being developed around the same time.

year	2015												2016					
month	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June
Define Matrix test procedure																		
Conduct lab visits/inspections																		
Review operational data of Prove-out tests																		
Complete report forms and data dictionary																		
Conduct rating workshop																		
Conduct Precision Matrix																		
Finalize Hours to Scuff Definition (Test Criteria)																		
Analyze matrix testing																		
Calculate test standard deviation along with oil targets & standard deviations																		
Finalize reference oil selection																		
Set up LTMS																		
Determine stand calibration based on precision matrix testing																		
Review and finalize the Qi Limits/control limits																		
Determine calibration and referencing protocols																		
Finalize the test procedure including any additional items including any learnings from the review of the matrix (critical parameters, shutdown protocols, etc.)																		
ASTM ballot issued																		
Appendix K (not required, but will reviewed)																		

DAIMLER TRUCK

DD13 Prove Out Matrix History – Oil C & D (Discrimination)

DD13 Prove Out Testing: General Information

1. Labs:

- Lubrizol / Intertek / Southwest Research

2. Oils:

Oil C :
- Original Oil C from previous taskforce that showed field scuffing

Oil D :
- Original Oil D from previous taskforce that did not show field scuffing.

3. Fuel:

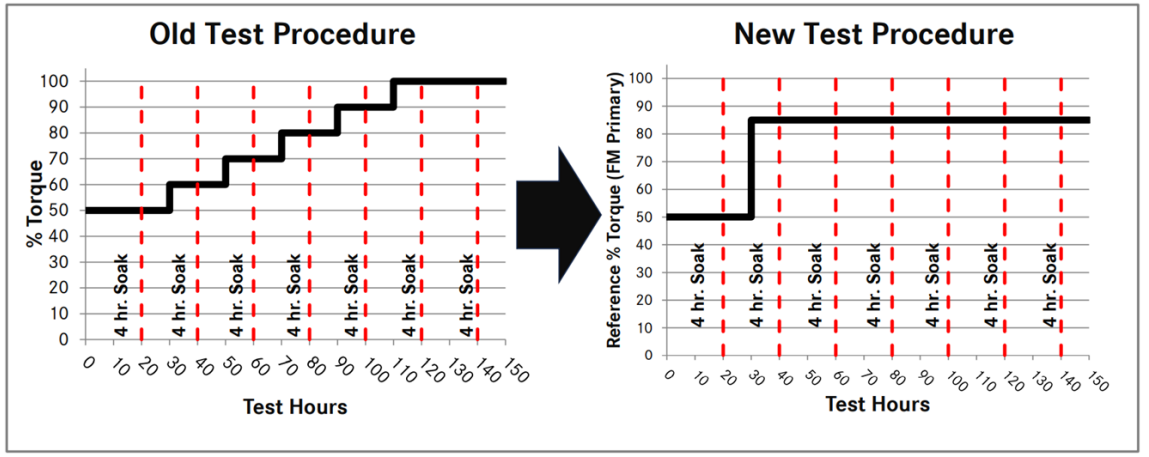
- PC-10 Fuel

4. Part Availability:

- Critical parts available and distributed by TEI.

5. Procedure:

New Testing Procedure:	
Testing Parameters:	○ ~~Open loop control~~ → Boost pressure control ○ ~~Torque control~~ → Fuel mass control
Test Cycle:	○ ~~Alternating Load~~ → Steady State
Tightened Control Parameters	○ Coolant flow, coolant pressure, intake manifold temperature, CAC delta pressure



DD13 Prove Out Testing: Overview of Tests Completed

Prove Out Tests Acceptance:

- Operational data was reviewed in detail to deem test acceptance.
- Reasons why tests were not accepted are described on the next slide.

Important Note: "Time to Scuff":

- Prove out data "time to scuff" determined by crankcase pressure.
- Taskforce learned in prove out matrix that it is possible for a test to scuff without crankcase pressure increase.
- To address this, taskforce implemented new "time to scuff" determination using delta iron for the precision matrix.

Oil C Testing (14 Tests / 8 Accepted)		
LZ	IAR	SWRI
LZ1 - C	IAR1 - C	SWRI1 - C
LZ2 - C	IAR2 - C	SWRI2 - C
LZ3 - C	IAR3 - C	SWRI3 - C
LZ4 - C	IAR4 - C	SWRI4 - C
LZ4a - C		
LZ5 - C		

Oil D Testing (6 Tests / 2 Accepted)		
LZ	IAR	SWRI
LZ1 - D	IAR1 - D	SWRI1 -D
LZ2 - D	IAR2 - D	SWRI2 - D

	Test accepted
	Test not accepted

DD13 Prove Out Testing: Reasons for Test Not Accepted

Tests Eliminated from Prove Out Matrix Analysis	Reason for Elimination
LZ4 - C	• EGR valve closed from 20-40hrs
LZ4A – C	• Ran on non-industry stand, not helpful to precision, several operational issues.
LZ1 - D	• Mechanical failure
IAR2 – D	• Mechanical failure
All SWRI Data (6 Tests)	• Tests did not run for appropriate test length due to programming issue with test time • S1D, S3C had intake manifold control issues • Ramp between stage 1 and stage 2 not representative of current procedure.

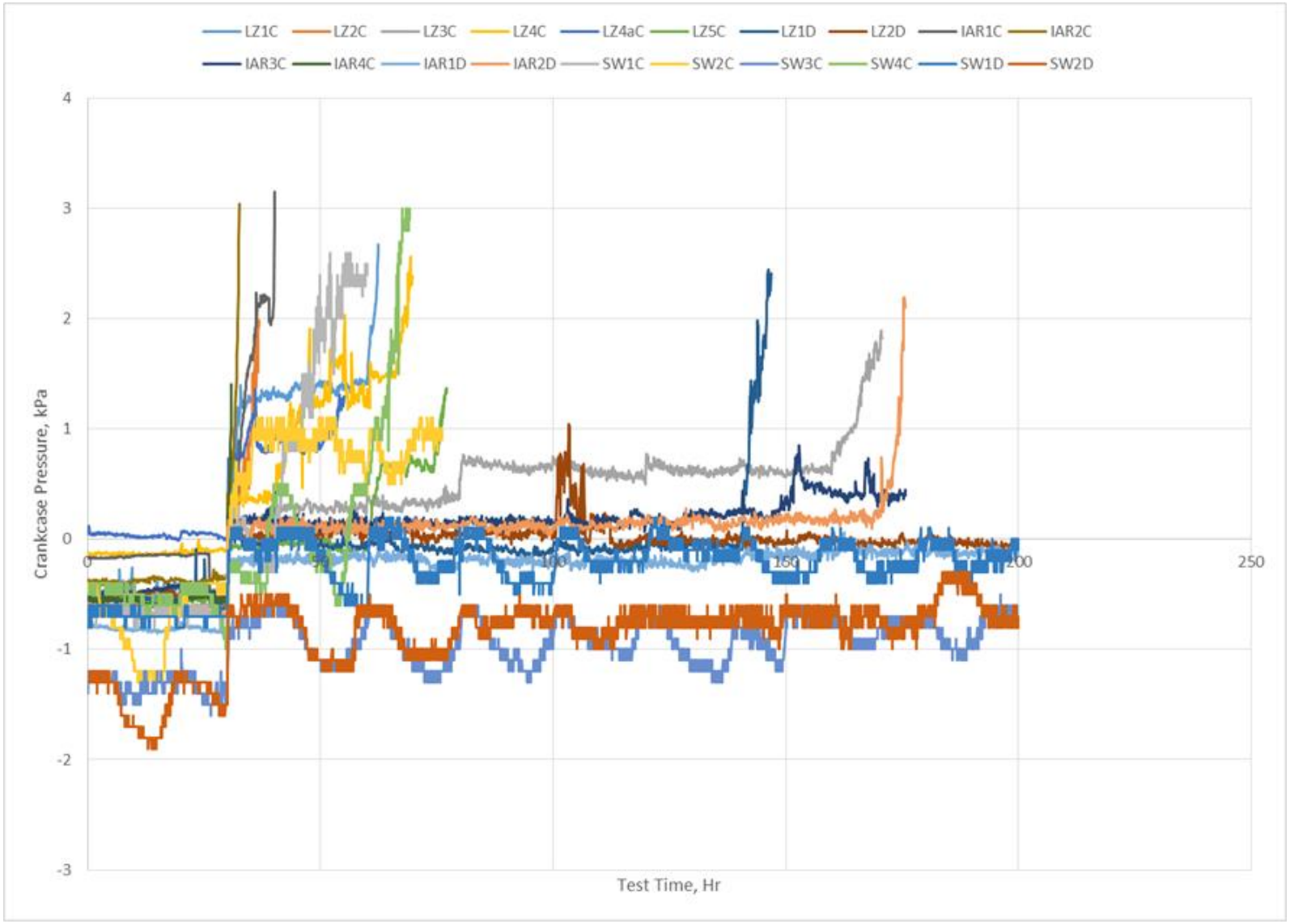
DD13 Prove Out Testing: Graph of All Tests [12 Oil C / 8 Oil D]

Graph:

- The graph on the right shows all tests completed with Oil C and Oil D.

Time to Scuff:

- Results were based on the 2 kPa crankcase pressure time to scuff.
- For Precision Matrix, taskforce improved criteria for time to scuff using delta Fe.
- Some of these results may have occurred at lower hours, but granularity (increased sample frequency) is not available for these tests.



DD13 Prove Out Testing: Graph of Accepted Tests [8 Oil C/2 Oil D]

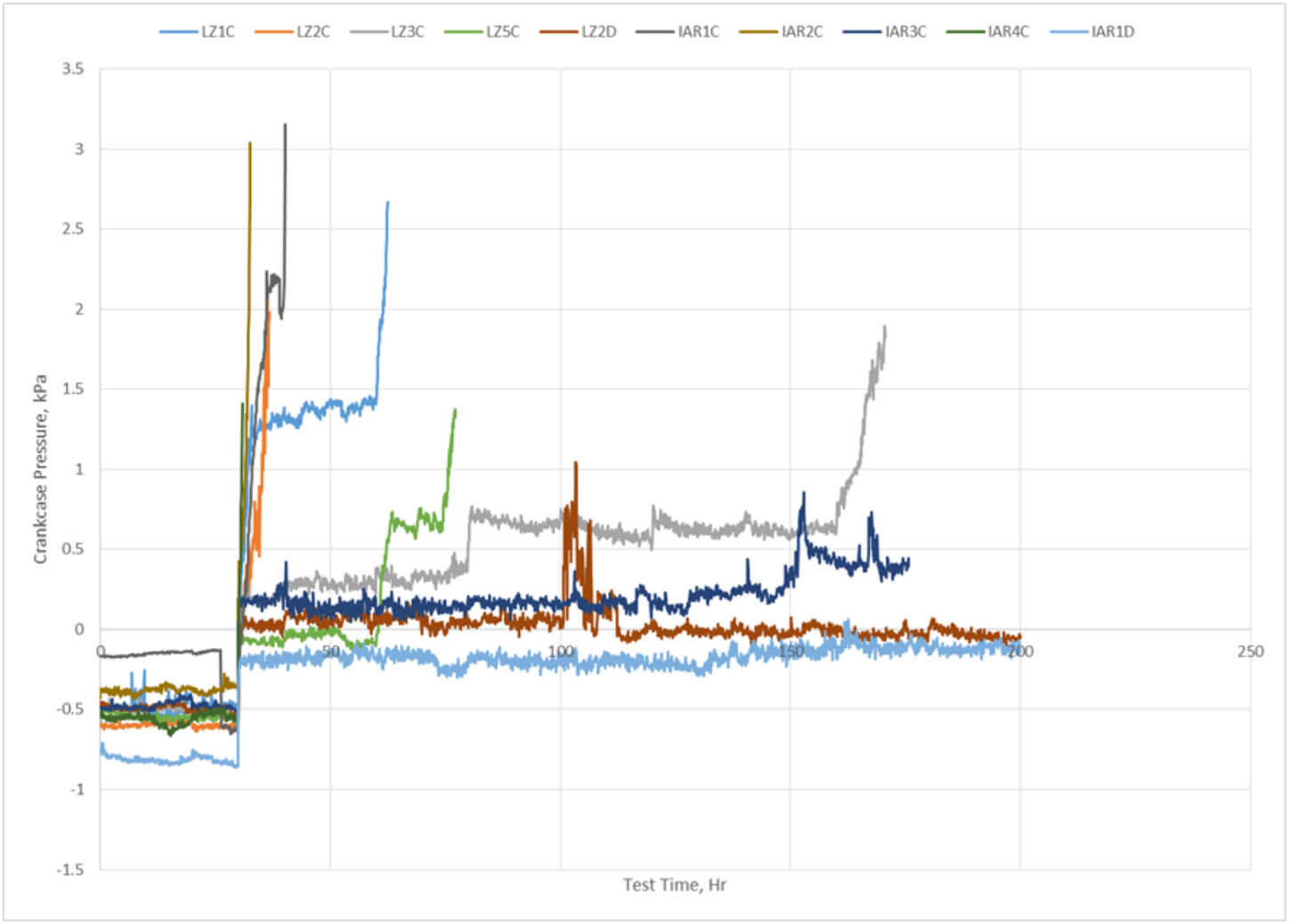
Graph:

- The graph on the right shows tests accepted based on operational data review.

Table:

- Table below shows time to scuff value based on crankcase pressure.

EOT Results (Crankcase Pressure kPa)	
LZ	**IAR**
1C **62**	1C **40.1**
2C **36**	2C **32**
3C **170**	3C **186.5**
5C **77.2**	4C **30.9**
2D **200**	1D **200**



DAIMLER TRUCK

DD13 Precision Matrix History – Oil C & Oil X

DD13 Precision Matrix: Design & Results

Timing:

- Precision matrix was completed in 2016.

Oil Types:

- Oil C: Carry over from prove out matrix.
- Oil X: New oil to be used a reference oil.

Test Labs:

- Lubrizol / SWRI / Intertek.

Results:

- Test data showed both oils scuffed around the same time.
- One Oil X result scuffed late at 122 hours
- Operational data heavily scrutinized, all 12 tests found valid.

Matrix Design

Matrix	LZ	SWRI	INTERTEK
Test 1	Oil X Engine #1	Oil C Engine #1	Oil X Engine #1
Test 2	Oil C Engine #2	Oil X Engine #2	Oil C Engine #2
Test 3	Oil X Engine #2	Oil C Engine #2	Oil C Engine #1
Test 4	Oil C Engine #1	Oil X Engine #1	Oil X Engine #2

Matrix Results: Final Hours to Scuff

Matrix	LZ	SWRI	INTERTEK
Test 1	32	32	35
Test 2	31	32	31
Test 3	40	32	31
Test 4	44	122	31

DD13 Precision Matrix: Investigation into Transformations

Summary:

- Transformations were investigated for the DD13 and discussed by the taskforce & statisticians.
- Taskforce decided to not implement any transformation at this time. (see meeting minutes below)

DD13 Scuffing Test ASTM Taskforce Meeting Notes May 5th, 2016

- https://www.astmtmc.org/ftp/docs/diesel/daimler/minutes/2016/05.05/Combined%20Meeting%20Notes%20%20Attendance%20-%20DD13%20Scuffing%20Test%20ASTM%20Taskforce%20Meetings%20May%205th%202016.pdf

Meeting Minute Excerpt: Transformations:

- 8:48 AM – Reviewing Transformation proposed by Kevin and other option proposed by Infineum, we also reviewed the possibility of no transformation temporarily until we receive more data.
- 8:50 AM – Kevin's Presentation on the transform he proposed and no transformation
- 8:50 AM to 10:40 AM – Discussion between Statisticians (Kevin O'Malley, Jim Rutherford, Elisa Santos) and taskforce.
- 10:45 AM – Taskforce came to the agreement to have no transformation and to put an action item for the surveillance panel to find a new transformation when more data is available

DAIMLER TRUCK

DD13 Precision Matrix – LTMS, Control Charts, Precision Statement


DD13 Precision Matrix: LTMS finalized in the DD13 face-to-face May 5th 2016

LTMS : https://www.astmtmc.org/ftp/docs/ltms/ltms.pdf

Oil	Oil Target Mean	Oil Target Standard Deviation
C	33	26
X	48	26

Reference oil

SA standard deviation = 26

The need to use transformations was discussed at Surveillance Panel meetings. Transformation was not adopted. (see previous slide on Transformations)

* O'Malley Presented to DD13 Task Force on 04/28/2016

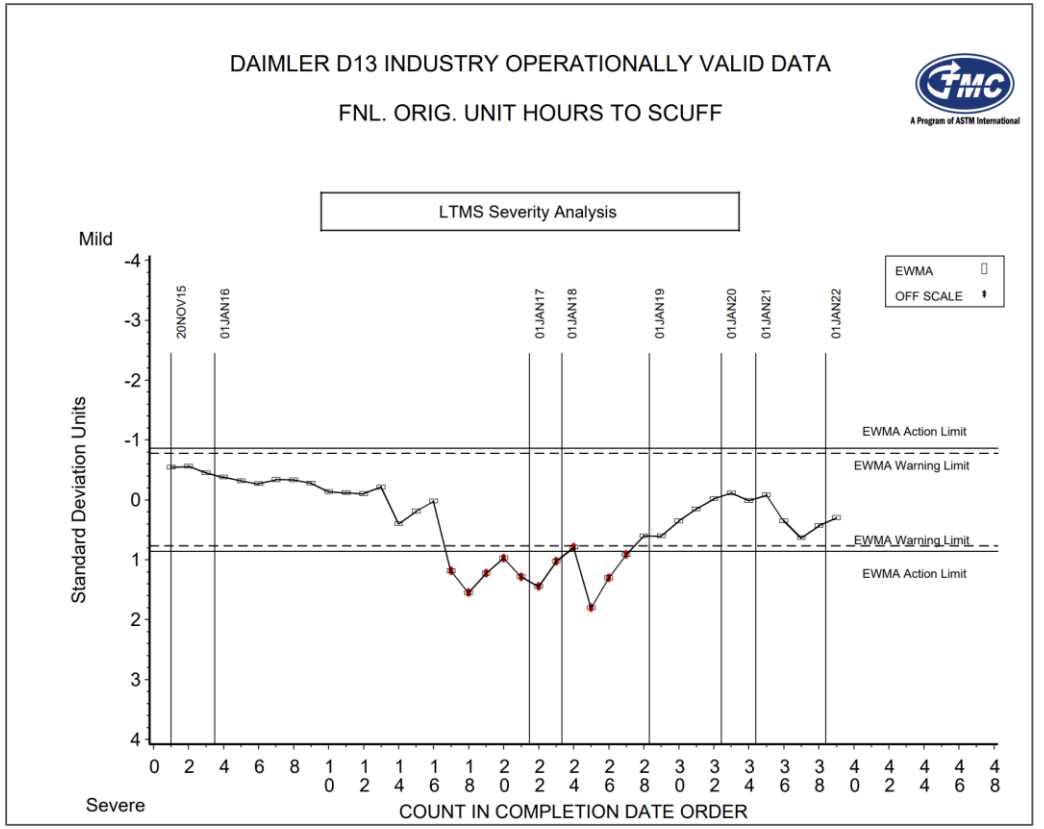
DD13 Scuffing Test: Control Charts

Control Charts: https://www.astmtmc.org/ftp/refdata/diesel/dd13/plots/

- Control charts for DD13 Scuffing test can be found at the link above on ASTM/TMC website.

2020 Control Chart Review:

- In 2020, DD13 control charts were compared to other PC-11 tests control charts, T13 & COAT. The DD13 was found to be compariable to other PC-11 control charts. (Link to presentation is available below.)
- https://www.astmtmc.org/ftp/docs/diesel/daimler/minutes/2020/06.18/Daimler%20SP%20Meeting%20Minutes%20-June%2018,%202020.pdf



DD13 Precision Matrix: Precision Statements for ASTM Method

Precision Statement:

- Table 1 shows the current precision statement in the ASTM procedure.

Additional Investigations:

- SP requested TMC to provide updated precision, shown in the table 2.
- On-going discussions in SP to determine if updated precision will be published in ASTM procedure.

Test Precision for DD13 Scuffing Test

Table 1	Post-Precision Matrix (5/5/16)				
	Intermediate Precision		Reproducibility		No. of Tests
Test Result	S	i.p.	S	R	12
Hours to Scuff	26	72	26	72	

Table 2	4/7/22 Update				
	Intermediate Precision		Reproducibility		No. of Tests
Test Result	S	i.p.	S	R	36
Hours to Scuff	42	118	42	118	

DAIMLER TRUCK

DD13 Scuffing Test – BOI/VGRA

DD13 Scuffing Test: Current OEM BOI/VGRA Guidelines

Below are the current BOI/VGRA that Daimler Truck recommends for DD13 Scuffing Test:

VGRA:

- Readacross may be allowed for oils of higher viscosity measured at 100 °C per ASTM D445 if tested oil has identical additive package and treat rate of candidate oil.

BOI:

- BOI Guidelines provided by API 1509 BOI (Base Oil Interchange: Appendix E) for the Mack T-12 engine test are to be applied.

DD13 Scuffing Test: PC-12 BOI/VGRA

PC-12 Matrix Design Taskforce:

- The PC-12 Matrix Design taskforce is investigating what testing would be needed to determine BOI/VGRA for the DD13 Scuffing Test.

Request for Data:

- To help supplement the PC-12 Matrix Design taskforce investigations, Daimler Truck would like to make a formal request to the industry to provide any existing data available on VGRA or BOI for DD13 Scuffing Test.

Question to API/NCDT:

- What would be the best process to collect this information?

DAIMLER TRUCK

DD13 Scuffing Test – Key Contacts & Links

DD13 Scuffing Test: Surveillance Panel Key Contacts/Links

Daimler Surveillance Panel (SP) Key Contacts	
Activity	SP is Active (Initiated June 2016)
Chair	Robert Slocum – Lubrizol Corporation
Secretary	Jose Starling – Southwest Research Institute
OEM Representative	Suzanne Neal – Daimler Truck
Statistician	Elisa Santos - Infineum
TMC Representative	Sean Moyer
TEI Representative	Derek Grosch
Liaisons	Patrick Joyce / Andrew Stevens – Lubrizol Corporation
Daimler Surveillance Panel (SP) Meeting Minutes/Presentations	
Meeting Minutes	https://www.astmtmc.org/ftp/docs/diesel/daimler/minutes/

Back up Slides

DAIMLER TRUCK

SWRI – DD13 Scuffing Test History/Educational Material

- Presentation from February 2022 NCDT F2F in San Antonio

ASTM D8074 - DD13 Scuffing Test

SOUTHWEST RESEARCH INSTITUTE®

NCDT February 2022
Presentation Prepared by SWRI & Detroit Diesel
Presented by Suzanne Neal & Jose Starling

Agenda

- 1. DD13 Scuffing Test Precision Matrix:
  - 1a. History of Reference Oils
  - 1b. Matrix & Results
  - 1c. ASTM Procedure Test Precision

- 2. DD13 BOI/VGRA
  - Current BOI/VGRA recommended for the test by Detroit Diesel

- Backup Slides:
  - History & Additional Educational Material on DD13 Scuffing Test

1a. History of Reference Oils

- Historical Oils used for Development:
  - Oil C and Oil D were market available CJ-4 10W-30 engine oils used to show differentiation.
    - Oil C (866) = Borderline
    - Oil D = High performing

- Current Reference Oil:
  - Oil X (864) = Reference Oil.
    - Current batch = 864-1

- Additional Information:
  - Oil C/D → CJ-4 Market Products:
    - At the time, Oil C/D were market available products that might not be available once PC-11 was introduced (formulation changes were expected for both products as they transitioned from CJ-4 to CK-4).
  - Oil X → FA-4 Viscosity:
    - The DD13 test was focused preventing scuffing with an emphasis on lower viscosity, Oil X was created at FA-4 viscosity (5W-30) as compared to Oil C/D which are CJ-4 viscosity.

1b. Precision Matrix Results

Add link to the minutes with conclusions from transform review/analysis.

- Precision matrix was completed in 2016.
  - Oils Types in Matrix = Oil X and Oil C.
  - Test Labs = Lubrizol / SWRI / Intertek.

- Test data showed both reference oils scuffed around the same time.
  - One Oil X result scuffed late at 122 hours
  - Operational data heavily scrutinized, all 12 tests found valid

Matrix Design

Matrix	LZ	SWRI	INTERTEK
Test 1	Oil X Engine #1	Oil C Engine #1	Oil X Engine #1
Test 2	Oil C Engine #2	Oil X Engine #2	Oil C Engine #2
Test 3	Oil X Engine #2	Oil C Engine #2	Oil C Engine #1
Test 4	Oil C Engine #1	Oil X Engine #1	Oil X Engine #2

Matrix Results: Final Hours to scuff

Matrix	LZ	SWRI	INTERTEK
Test 1	32	32	35
Test 2	31	32	31
Test 3	40	32	31
Test 4	44	122	31

1c. Test Precision for DD13 Scuffing Test

D8074 – 18

TABLE 8 Test Precision for DD13 Scuffing Test[A]

	Intermediate Precision[B]		Reproducibility[C]	
Test Result	$S_{i.p.}$[D]	i.p.	S_R[D]	R
Hours to Scuff	26	72	26	72

[A] These statistics are based on 12 tests conducted on three stands (one at each of three laboratories) on two ASTM TMC Reference Oils (864 and DD13C) and were calculated on May 5, 2016.
[B] See 13.1.2.
[C] See 13.1.3.
[D] S is the estimated standard deviation.

2. Current BOI/VGRA Guidelines

Below are the current BOI/VGRA that Daimler recommends for DD13 Scuffing Test:

- VGRA:
  - Readacross may be allowed for oils of higher viscosity measured at 100 °C per ASTM D445 if tested oil has identical additive package and treat rate of candidate oil.

- BOI:
  - BOI Guidelines provided by API 1509 BOI (Base Oil Interchange: Appendix E) for the Mack T-12 engine test are to be applied.

ASTM D8074 - DD13 Scuffing Test

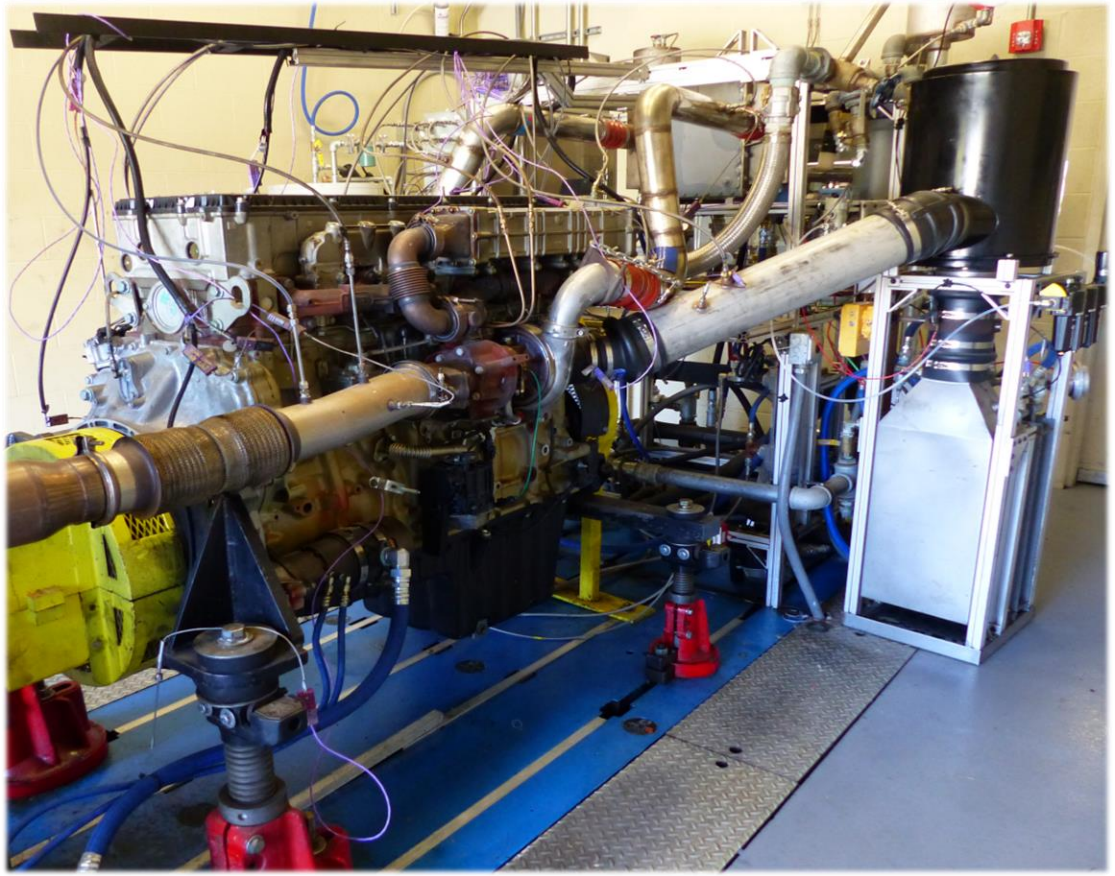
SOUTHWEST RESEARCH INSTITUTE®

NCDT February 2022

History & Additional Educational Material on DD13 Scuffing Test

Test Overview

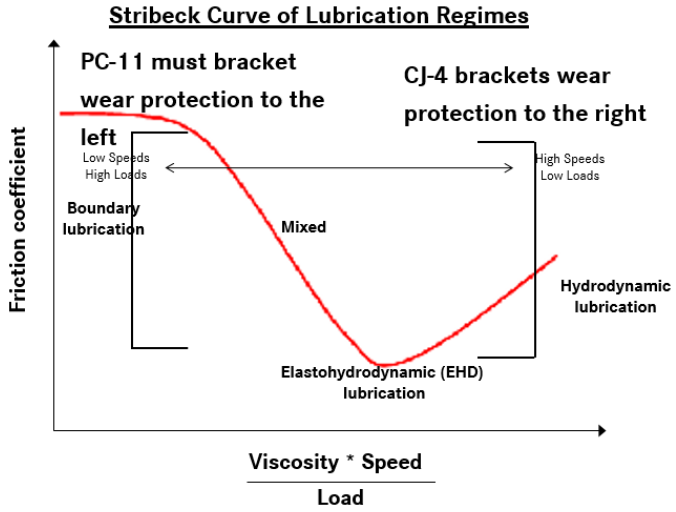
Evaluate a lubricant's performance to protect against adhesive wear between an uncoated piston ring and cylinder liner.



Why was the scuffing test needed?

- All engine wear tests within API CJ-4 addressed abrasive wear
  - Abrasive wear is when a third body is introduced between two lubricated surfaces causing wear
  - Most CJ-4 tests have soot induced wear

- No engine tests within API CJ-4 addressed adhesive wear
  - Scuffing is predominantly adhesive wear, characterized by localized welding, metal transfer and extreme wear rates.
  - More likely as film thickness decreases
  - Greater risk with lower viscosity oils



Start of test development

- Goal – evaluate an oil formulation's resistance to adhesive wear by inducing and measuring piston ring to cylinder liner scuffing
- Daimler had previous experiencing supporting a scuffing test (6V92TA 2-cycle liner scuffing test)
- There was not a scuffing problem in the field that lead to this development, but more of a preventative measure with the planned introduction of lower viscosity grades
- Developing the test on global platform could allow for adoption by API and ACEA
  - Engine Selected - DD13 model (OM471LA in Europe)

DD13 Engine Platform

- DD13 EPA10 MY2013 (FE0) Engine
  - In-Line 6 Cylinder, 12.8L
  - HPCR Fuel System
  - Cooled EGR and VGT
  - Full rebuild each test
- Special Parts:
  - Carbon Scraper Ring Added
  - Uncoated Top Ring
- Rated Power: 410bhp (1800rpm/1622Nm)
- Rated Torque: 2237Nm (1240rpm)

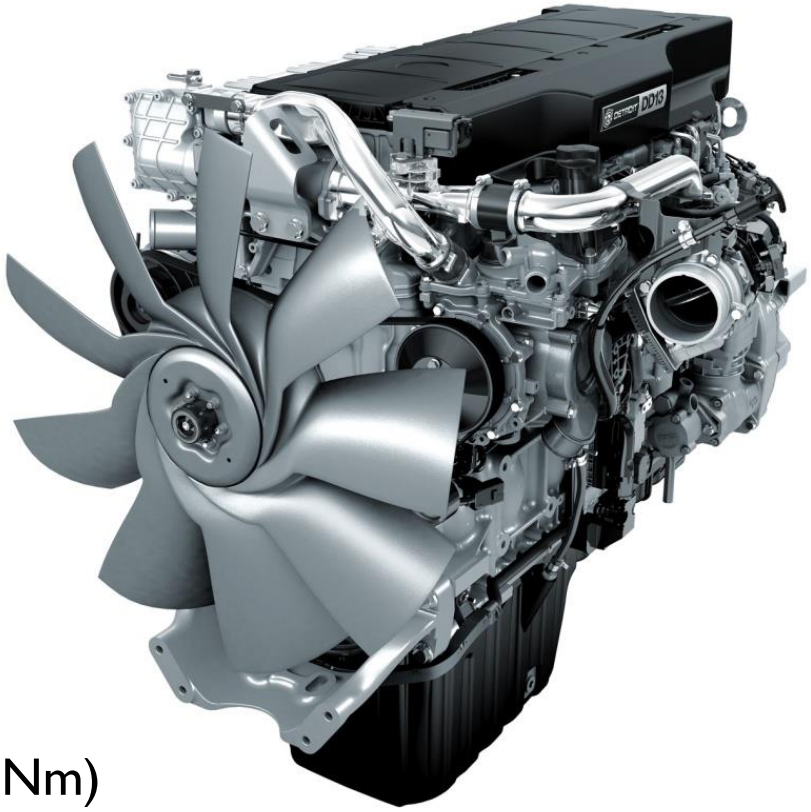


Photo Courtesy of Detroit Diesel

Engine selection and cycle development

- Test cycle Development – Went through several iterations from 2011 to 2015
  - Limited scuffing prompted the test duration to be extended and test cycle was adjusted several times.
  - To decrease time to scuff and shorten test length significantly non-coated top rings were utilized.

DD13 Precision Matrix Part 1

- In 2013 the test development opened up to all labs
  - Allowed additional testing and input from other interested parties.

- In 2014 a precision matrix was designed under the original increasing load procedure: Involved 2 reference oils, 3 labs and 20 total tests.
  - Oil C ~ 31 Hours to scuff
  - Oil D ~200 Hours to scuff
  - Oils selected because of field experience

- Data showed that some enhancements to the procedure were still necessary.
  - Test was decided to not be included in the API PC-11 category.

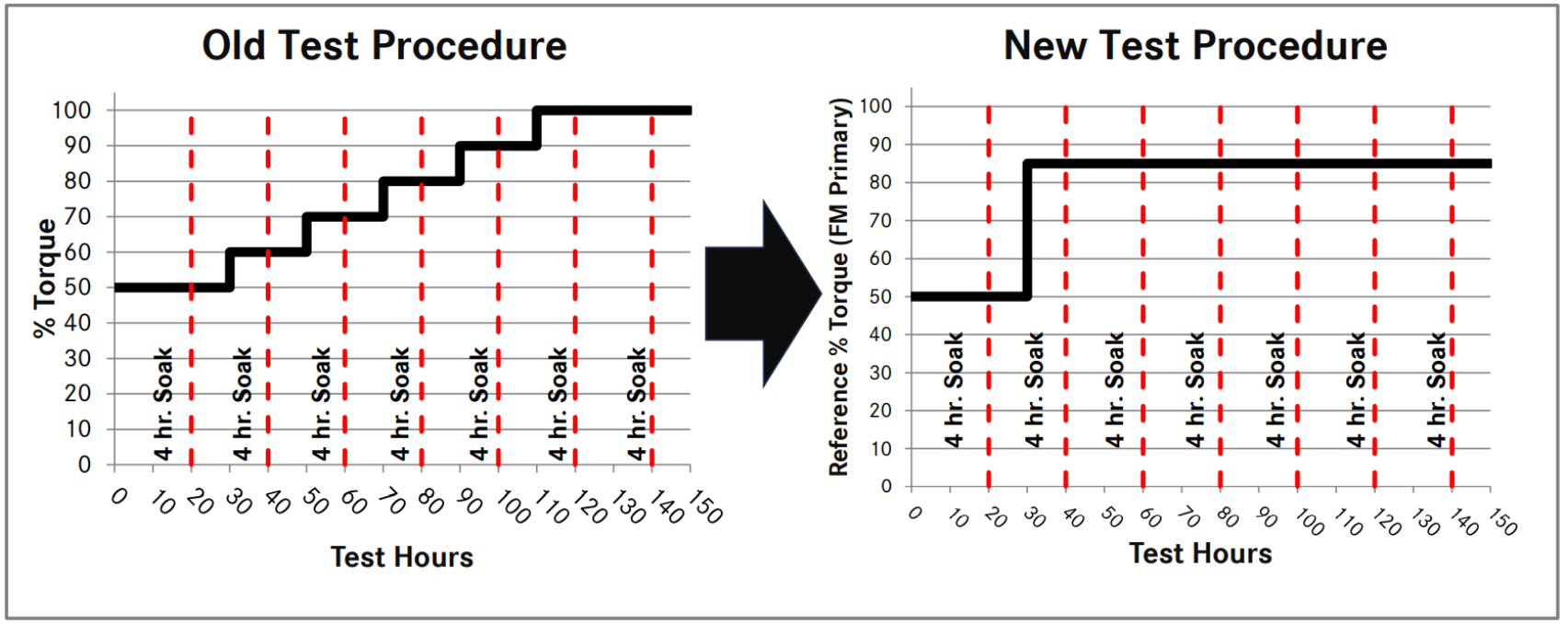
DD13 Test Redevelopment

- The taskforce continued development to make the test a ASTM procedure and internal OEM oil test.

- Bi-weekly meetings with the taskforce and several in person test development workshops took place in 2015 to continue procedure refinement.
  - Procedure reviews
  - Scuffing rating of hardware
  - Build workshops
  - Stand Visits

DD13 Test Redevelopment

New Testing Procedure:	
Testing Parameters:	○ ~~Open loop control~~ → Boost pressure control ○ ~~Torque control~~ → Fuel mass control
Test Cycle:	○ ~~Alternating Load~~ → Steady State
Tightened Control Parameters	○ Coolant flow, coolant pressure, intake manifold temperature, CAC delta pressure

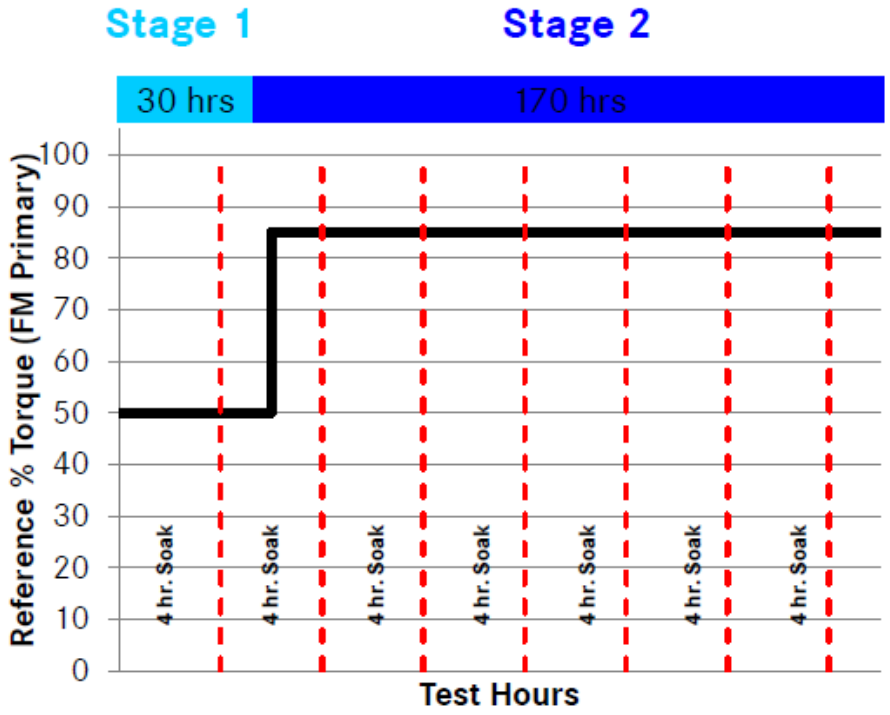


Test Cycle 2014

Test Cycle 2015

DD13 Scuffing Final Procedure

- 30 Hours at stage 1 conditions and 170 hours at stage 2 conditions (stopped when scuffing occurs)
- 10 Minute Transition @ 30 Hrs
  - 5 Minute Ramp from ~800 – 1800 Nm
  - 5 Minute Stabilization
- Shutdowns every 20 Hours
  - 4 Hour Soak
- No Oil Adds



DD13 Scuffing Test operational targets

Parameter	Break-In	Stage 1	Stage 2
Speed (RPM)	1800	1800	1800
Fuel Flow (kg/h)	32	32*	71*
Torque (Nm)	~800	~800	~1800
Coolant Flow (L/min)	340-360	340-360	340-360
Intake Air Temperature (°C)	35	35	35
Coolant Jacket Outlet Temperature (°C)	105	105	105
Oil Gallery Temperature (°C)	118	118	118
Fuel Temperature (°C)	38	38	38
Intake Manifold Temperature (°C)	75	75	87*
Coolant Jacket Inlet Pressure (kPa)	250	250	250
Exhaust Back Pressure (kPaA)	105.5	105.5	125.5*
Intake Manifold Pressure (kPaA)	202.5	202.5	327.5*
Intake Air Restriction (kPaA)	96.4	96.4	94.8*

*Indicates conditions that change set point from stage 1 to stage 2.

DD13 precision matrix Part 2

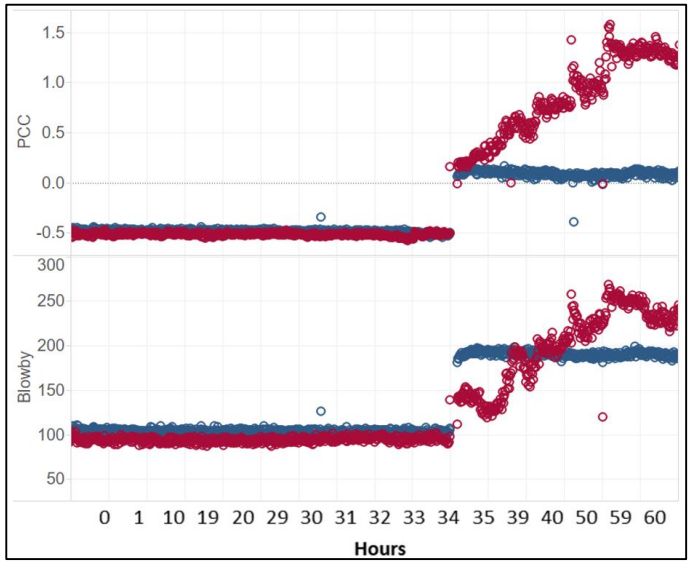
- With significant changes to many items in the procedure, a new test matrix was needed to define a precision statement.
  - Several major changes including the determination of if scuffing had occurred
- A matrix of 12 tests was developed in order to acquire the data necessary to establish test precision.

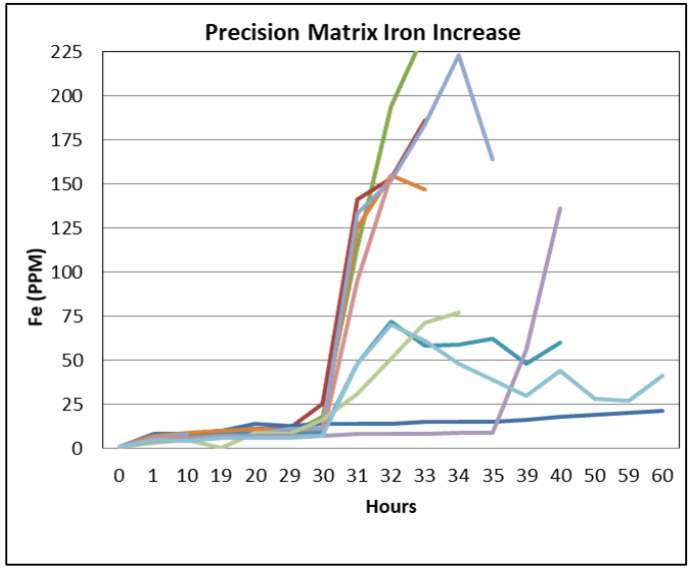
Matrix	LZ	SWRI	INTERTEK
Test 1	Oil X Engine #1	Oil C Engine #1	Oil X Engine #1
Test 2	Oil C Engine #2	Oil X Engine #2	Oil C Engine #2
Test 3	Oil X Engine #2	Oil C Engine #2	Oil C Engine #1
Test 4	Oil C Engine #1	Oil X Engine #1	Oil X Engine #2

How is scuffing determined?

- On test parameters
  - Crankcase Pressure and Blowby
  - ICP Verification (Fe/Cr)
  - Bore scoping if needed

- What is considered Scuffing?
  - Described by CRC Manual 20 and in DD13 procedure.
  - ≥ 27% liner scuffing on at least one cylinder & ≥ 250mg TRWL





Calculating "Hours to Scuff" final value

- Allowed only if scuffing criteria has been met.
- Hours to scuff result based on iron change between oil samples
  - First sample value with ΔFe of ≥ 25 ppm is hours to scuff
- Increase in frequency of oil samples to avoid missing a scuffing event.
  - 99 Total oil samples

Precision Matrix Results

- Precision matrix was completed in 2016.
  - Testing completed with Oil X and Oil C.

- Test data showed both reference oils scuffed around the same time.
  - One Oil X result scuffed late at 122 hours
  - Operational data heavily scrutinized, all 12 tests found valid

Matrix Design

Matrix	LZ	SWRI	INTERTEK
Test 1	Oil X Engine #1	Oil C Engine #1	Oil X Engine #1
Test 2	Oil C Engine #2	Oil X Engine #2	Oil C Engine #2
Test 3	Oil X Engine #2	Oil C Engine #2	Oil C Engine #1
Test 4	Oil C Engine #1	Oil X Engine #1	Oil X Engine #2

Matrix Results: Final Hours to scuff

Matrix	LZ	SWRI	INTERTEK
Test 1	32	32	35
Test 2	31	32	31
Test 3	40	32	31
Test 4	44	122	31

Final procedure review and submission

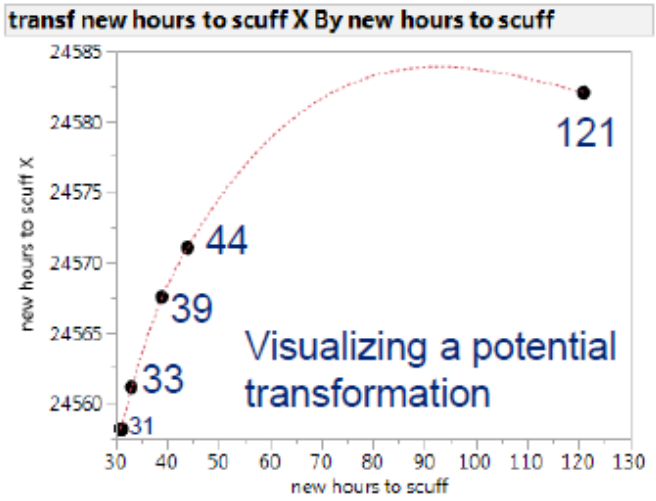
- Final statistical review and updates to procedure.
  - Possible transformation of data reviewed, not used
    - LTMS reference targets updated, Std. Dev used
  - Quality Index limits verified
  - Precision statement added

- Procedure was submitted for ballot in May 2016
  - Assigned ASTM D8074 in Q4 2016
  - Surveillance Panel initiated

TABLE 8 Test Precision for DD13 Scuffing Test[A]

	Intermediate Precision[B]		Reproducibility[C]	
Test Result	$S_{i.p.}$[D]	i.p.	S_R[D]	R
Hours to Scuff	26	72	26	72

[A] These statistics are based on 12 tests conducted on three stands (one at each of three laboratories) on two ASTM TMC Reference Oils (864 and DD13C) and were calculated on May 5, 2016.



Transformation plot from Infineum April 2016 SP Presentation by Elisa Santos

Questions?

DAIMLER TRUCK

DD13 Scuffing: NCDT Follow Up Topics

April 2022 – NCDT F2F Meeting in Chicago

DD13 Scuffing Test - Follow Up Topics

1. **Reference Oil ICP:** Provide More Chemical Detail on Oil X (864) and Oil C (866):

- Completed.
- Data is available on TMC website.
- https://www.astmtmc.org/ftp/docs/ASTM_Reference_Oils.pdf

2. **Oil D:** Determine if Oil D can be made available if needed:

- Completed.
- Oil supplier confirmed Oil D can be made available if needed.

3. **Differentiation:** Investigate runs past 31 hrs:

- Preliminary update.
- Detroit reviewed submissions to Detroit specifications and confirm there are results ranging from 31 hours to >200 hours (and results in between).

DD13 Scuffing Test – Follow Up Topics

4. **Parts Longevity:** Confirm part availability out to 2037:

- Completed.
- Confirmed with cylinder kit engineer that batched parts can be supplied out to 2035 timeframe.

5. **Current Part Availability / Batched Parts:** Confirm parts are batched and provided latest update on part availability:

- Completed.
- See update below (Provided by TEI Monday April 25th, 2022).

Part	Batch	Qty	Years Remaining (Past 12 Months)
Top Ring	C	2262	10.8
2nd Ring	B	2089	9.9
Oil Ring	B	1529	7.3
Piston	B	2100	10.0
Liner	D	2536	12.1

DD13 Scuffing Test – Follow Up Topics

6. **Part Screening:** Provide information on how parts are screened/inspected:

- Completed.
- Below are examples from TEI on how critical parts are batched & measured.

DD-13 Batched Parts Inspection Procedures

All Rings

1) Thoroughly clean all rings with pentane to get any oils or preservatives off.
2) Visually inspect the ring for nicks, scratches, stains or anything out of the ordinary.
3) Do all of the required measurements and reject if out of Daimler specifications and/or specifications agreed upon by the surveillance panel.

Liners

1) Thoroughly clean the liner to get any oils or preservatives off.
2) Visually inspect for any dings around the top and bottom of the liner.
3) Visually inspect the inside of the liner for any rust or "check" marks.
4) Measure the crosshatch angle and required surface finish parameters of the liner.
5) Reject if out of Daimler specifications and/or specifications agreed upon by the surveillance panel.

Pistons

1) Thoroughly clean the piston to get any oils or preservatives off.
2) Visually inspect for any nicks, dings, coating issues or anything out of the ordinary.

DD13 Kit Measurements						Kit #	701			Date	2/16/2022
Rings											
	Top Ring			Serial Number		C-0145	C-0146	C-0147	C-0148	C-0149	C-0150
		Ring Tension @ 132 mm (N)				31.9	33.5	31.5	32.0	35.4	32.0
		Ring Gap @ 132 mm (mm)				0.43	0.39	0.42	0.39	0.43	0.42
		@ 1" before the gap									
			Face	Width (mm)		3.05	3.03	3.02	3.04	3.04	3.03
				Peak Height (µm)		0.38	0.38	0.38	0.38	0.38	0.38
					Location (mm)	0.67	0.51	0.53	0.71	0.46	0.58
					to 0.2 mm Diff (µm)	2.61	2.07	2.37	2.81	1.31	2.09
					to 2.75 mm Diff (µm)	26.78	36.00	29.95	27.44	32.09	31.16
				Ra (µm)		0.15	0.21	0.15	0.16	0.15	0.12
				Rk (µm)		0.25	0.37	0.26	0.25	0.26	0.20
				Rmr1 (%)		9.10	6.90	6.70	10.30	10.90	8.20
				Rmr2 (%)		87.40	83.20	84.50	87.20	87.40	89.90
				Rpk (µm)		0.10	0.09	0.09	0.08	0.11	0.07
				Rvk (µm)		0.18	0.47	0.18	0.28	0.26	0.21
				Vo ((µm*µm)/µm)		0.01	0.04	0.01	0.02	0.02	0.01
				Rz (µm)		1.29	1.85	0.74	1.12	1.01	0.88
			Back of ring width (top to bottom) (mm)			1.92	1.90	1.93	1.92	1.96	1.94
			Ring thickness (front to rear) (mm)			4.69	4.70	4.68	4.67	4.66	4.68
		@ 180° from the gap									
			Face	Width (mm)		3.02	3.06	3.04	3.00	3.04	3.03
				Peak Height (µm)		0.38	0.38	0.38	0.38	0.38	0.38
					Location (mm)	0.42	0.46	0.42	0.67	0.45	0.49
					to 0.2 mm Diff (µm)	2.12	1.31	1.30	4.31	1.56	2.67

DD13 Scuffing Test – Follow Up Topics

7. **Overall Support for the Test in PC-12:** Confirm overall desire to have the DD13 Scuffing Test added to the PC-12 category:
   - EMA Request:
     - EMA continues to support the inclusion of the test in the category.
   - Additional Information:
     - Adhesive Wear Test
     - ASTM Test Method
     - Modern engine that looks at ring/liner performance
     - Test created to ensure protection of ring/liners as the industry moves towards lower viscosity oils (PC-11 and future categories like PC-12) in addition to helping ensure oil formulations at any viscosity (high or low) protect hardware.

8. **Review Precision:** Request update of precision for ASTM method.
   - Completed
   - See next slides.

Detroit Diesel DD13 Scuffing Test
Precision Updates
April 28, 2022

Prepared By: Andrew Stevens, S.P. Chair April 2022

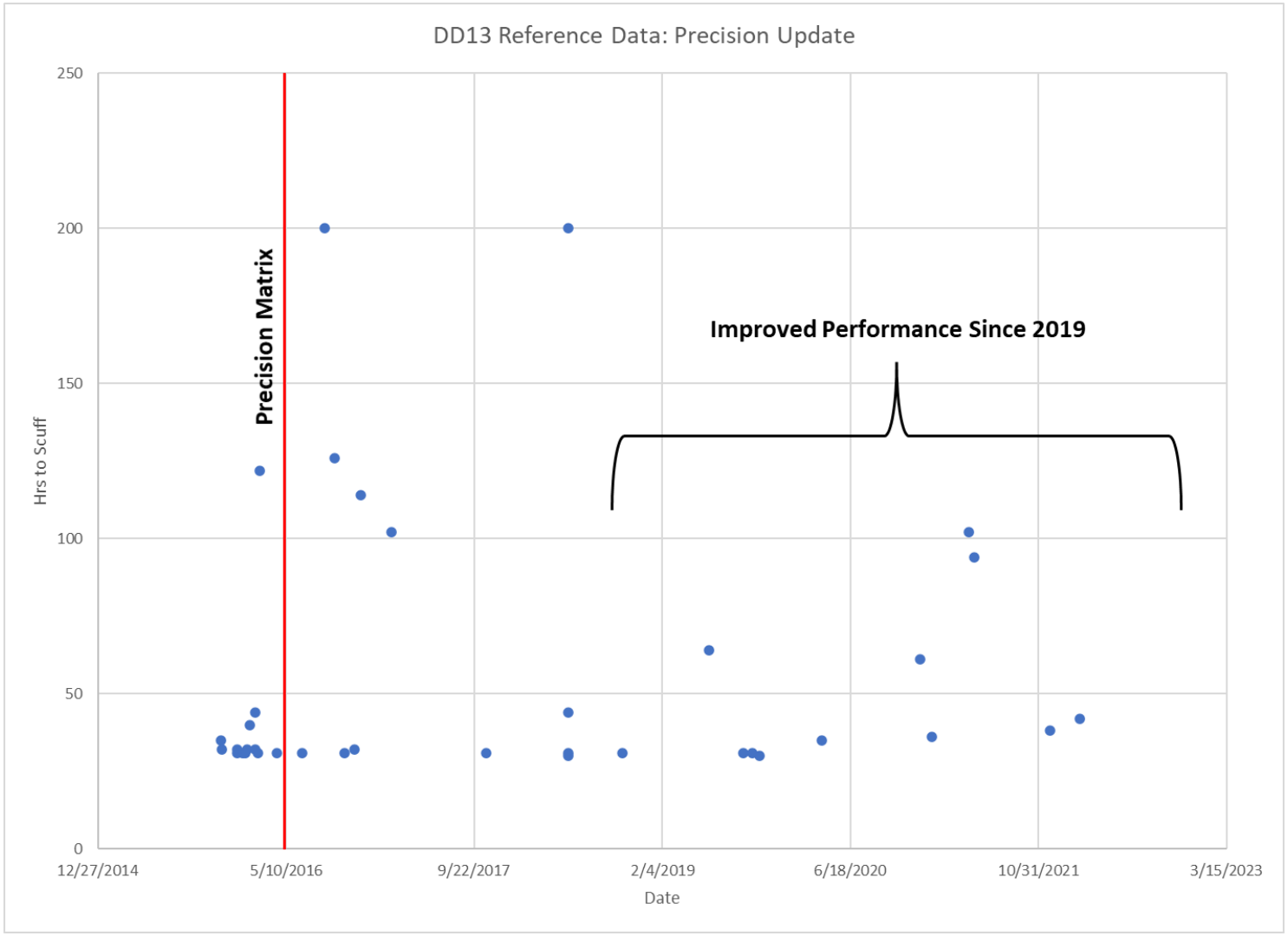
DD13 Precision Update
Updated Calculations

Test Precision for DD13 Scuffing Test

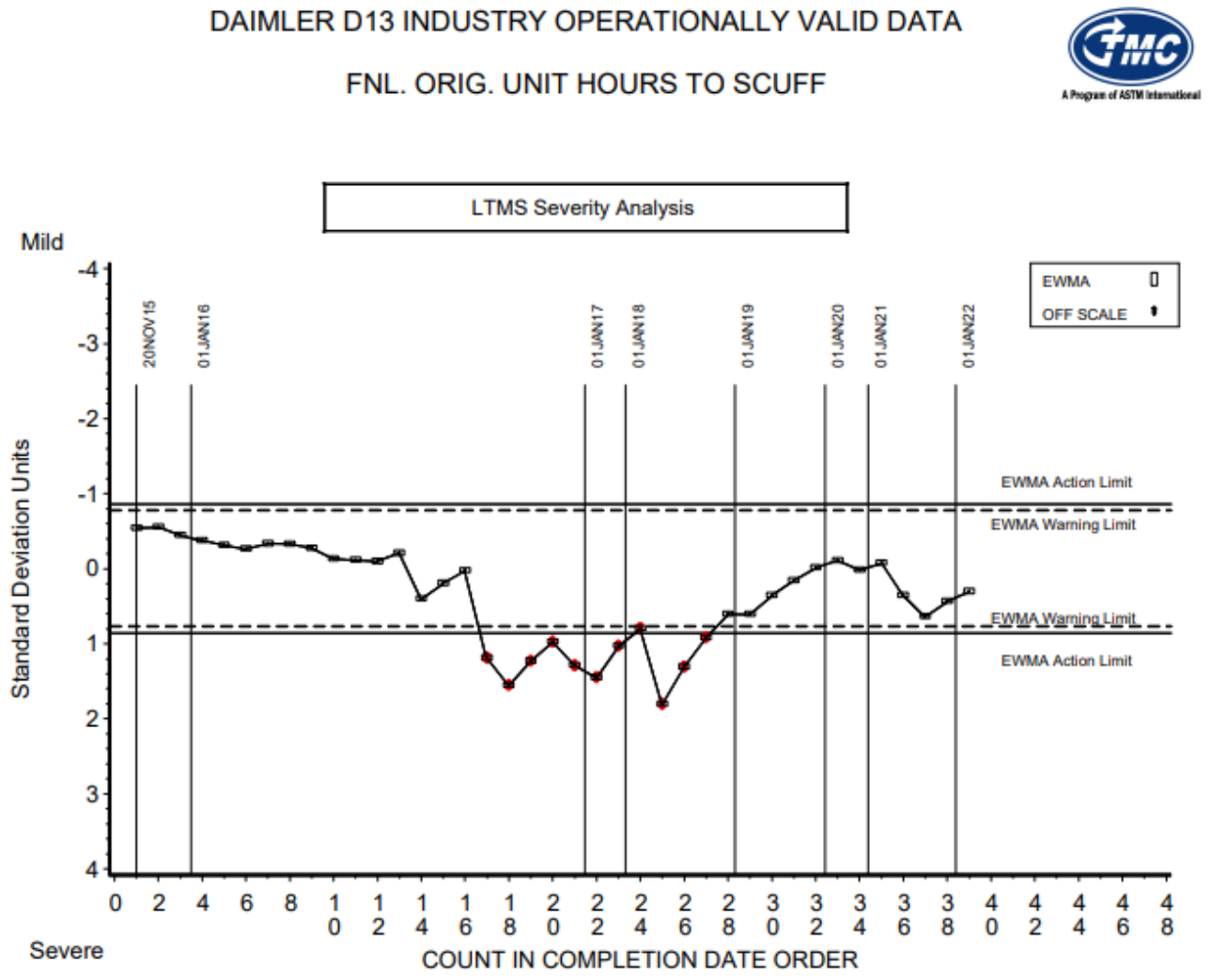
Post-Precision Matrix (5/5/16)					
	Intermediate Precision		Reproducibility		No. of Tests
Test Result	S	i.p.	S	R	12
Hours to Scuff	26	72	26	72	

4/7/22 Update					
	Intermediate Precision		Reproducibility		No. of Tests
Test Result	S	i.p.	S	R	36
Hours to Scuff	42	118	42	118	

DD13 Precision Update - Reference Data Points



DD13 Precision Update - Current Industry Control Chart



DD13 Precision Update - Observations

- **Calculated Precision and Reproducibility have widened vs Precision Matrix**
- **Results since 2019 have improved with less 100+ hr results**
- **Majority of results fall within “typical” range (8 100+ hr results of 36 total)**

DAIMLER TRUCK

DD13 Scuffing Test: Follow Up Topics

NCDT June 2022 at ASTM in Seattle, WA

Suzanne Neal

Agenda:

a) Engine Test Development Readiness Template
b) Updated Precision vs. Part/Batch Updates
c) Relevance – Oil Pump Gear Wear vs. Scuffing Test Result
d) Backup – Annex K

a) DD13 Scuffing Test (Pg. 1 of 2)

Engine Test Development Readiness Template

ACC CoP Tab 6

Completed by: Suzanne Neal

Last Updated: June 23rd, 2022

Test Name: DD13 Scuffing Test ASTM D8074

	Criteria	Remarks (more than yes/no)	Timing	Status
1	Have the Project Management Principles as outlined in ACC PAPTG's Test Development Considerations been reviewed by the Test Development Team? Is there alignment with the Team?	*Yes		Completed
2	Test Discrimination confirmed and statistics published? (Proof of Concept complete)	*Yes		Completed
3	Capable of evaluating all relevant viscosity grades?	*Yes		Completed
4	Test Precision Matrix Plan Defined including target precision?	*Yes		Completed
5	Written Test Procedure Available? Is a Facilitator involved? Is the Test Procedure stable so that all labs are running the same procedure?	*Yes		Completed
6	Test Precision Defined? (Matrix testing completed and analysis performed)	*Yes		Completed
7	Demonstrate performance parameters of test are not redundant to existing engine tests (unless test is developed as a replacement to another test)	*Yes		Completed
8	Reference Oils Selected? Is there commitment to make the reference oil available long term?	*Yes		Completed
9	Do selected reference oils reflect current formulation technology?	*Yes		Completed
10	Hardware availability plan created and does it take into account usage for life of category, as well as other non-API category usage?	*Yes		Completed

a) DD13 Scuffing Test (Pg. 2 of 2)

Engine Test Development Readiness Template

ACC CoP Tab 6

Completed by: Suzanne Neal

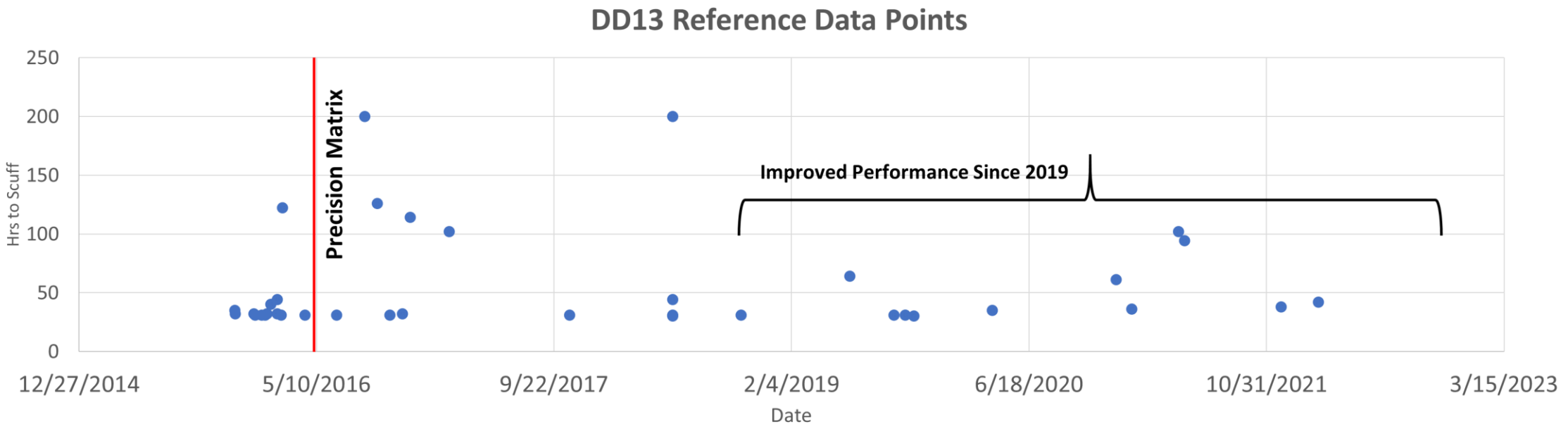
Last Updated: June 23rd, 2022

Test Name: DD13 Scuffing Test ASTM D8074

	Criteria	Remarks (more than yes/no)	Timing	Status
11	Critical features on critical hardware defined, as well as a plan to qualify to those critical features?	*Yes		Completed
12	Parts batches from Precision Matrix available for how long after the PM?	*Yes		Completed
13	Test Fuel Selected and fuel specification defined?	*Yes		Completed
14	Rating & Reporting of Results Defined?	*Yes		Completed
15	Test validity requirements defined and included in procedure?	*Yes		Completed
16	Calibration, Monitoring and Surveillance Actions Defined?	*Yes		Completed
17	LTMS In Place?	*Yes		Completed
18	Is a suitable system in place to handle repeat tests on a candidate oil (MTEP- Multiple Test Evaluation Procedure)?	No		tbd
19	BOI/VGRA Plan in Place?	**No	tbd	Pending

Additional Status Comments: *See presentation from June 2022 for more information. **VGRA established for use in Daimler Spec.

b) Critical part/batch changes added for comparison to latest precision timeline.



Critical Parts – Date Batch Introduced to Kits							
2015	**2016**		**2017**	**2018**	**2019**	**2020**	**2021**
September	**April**	**October**		**February**	**July**		**June**
Top Ring A	Top Ring B	2nd Ring A		*Liner C	2nd Ring B		Top Ring C
		Oil Ring A			Liner D		Oil Ring B
		Piston A					Piston B

- Note: DD13 References Data Points shows the date of a reference test. However, critical part batch changes shows when a new batch was introduced into the part kits (not a direct comparison). A more detailed comparison can be completed if needed.
- *Liner C = Mahle Liners. Previous batches were FM Liners.

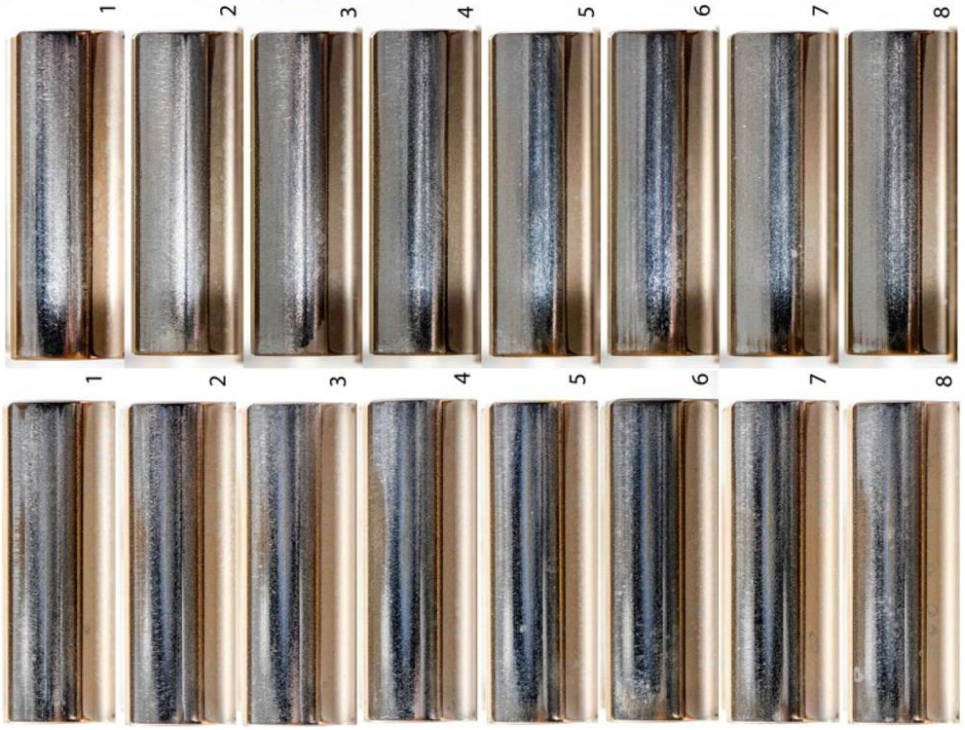
c) DD13 Scuffing Test - Follow Up on Relevance

- **<u>Follow Up Request:</u>** Provide information on how the test is relevant.
  - Example of Relevance: The following slide shows an example of oil pump gear wear vs. scuffing test results comparing the oils highlighted below.

Oil Description	Euro 2.9 “Formulation A”	Euro 3.5 “Formulation A”	Euro 2.9 “Formulation B”	Euro 3.5 “Formulation B”	New Oil to Replace Euro 2.9 “Formulation B”
SAE Viscosity	5W-30	5W-30	5W-30	5W-30	5W-30
~Phos	800 ppm	800 ppm	800 ppm	800 ppm	800 ppm
~HTHS	2.9	3.5	2.9	3.5	2.9
Scuffing Test Result	31 Hours	31 Hours	1 hour	1 Hour	171 Hours
Comments	Positive results on validation engines.		Signs of scuffing occasionally. Gear train wear noted. Oil pump gear wear noted.		Positive results on validation engines. FA-4 Engine Oil

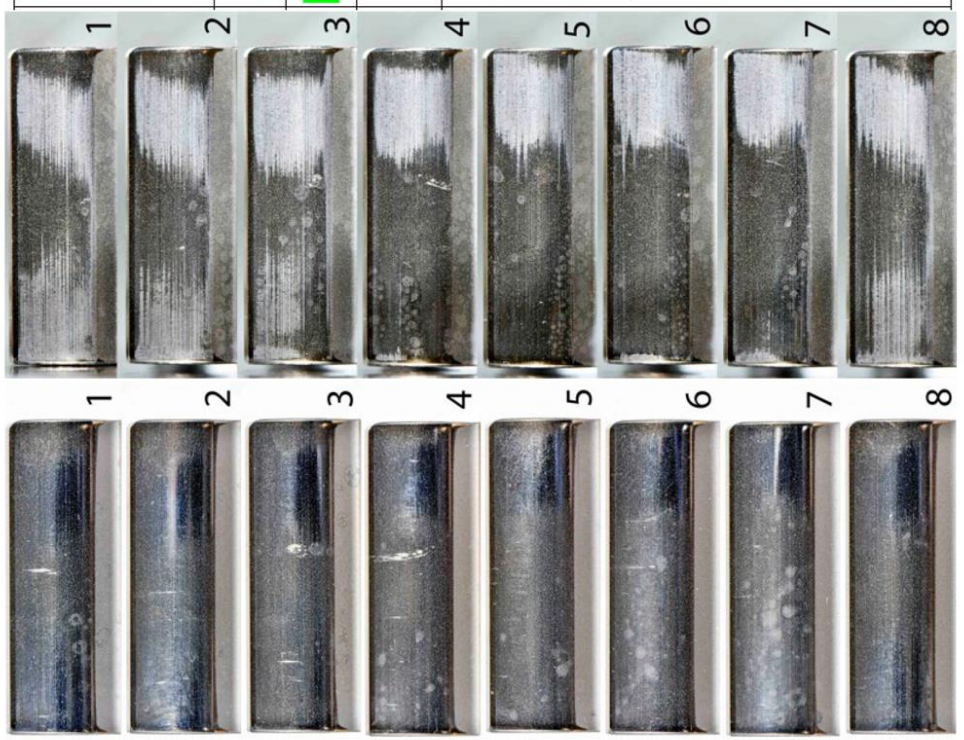
c) Scuffing Test Results vs. Oil Pump Wear Observed in Internal Testing

Oil Pump	**50**	**Fail**	**Yes**	
Body	**60**	**Pass**	**Yes**	Light debris mark. Gear mark at one side. Corresponding gear shaft bore shows some wear.
Pump Gears	**50**	**Fail**	**Yes**	Heavy wear on both gears (production materials)
Valves	**80**	**Pass**	**No**	Light marks.



Euro 2.9 “Formulation B”
DD13 Scuffing Test Result = 1 Hour
Oil Pump Gear Wear = Fail
Internal Test Cycle = 1000 engine hours

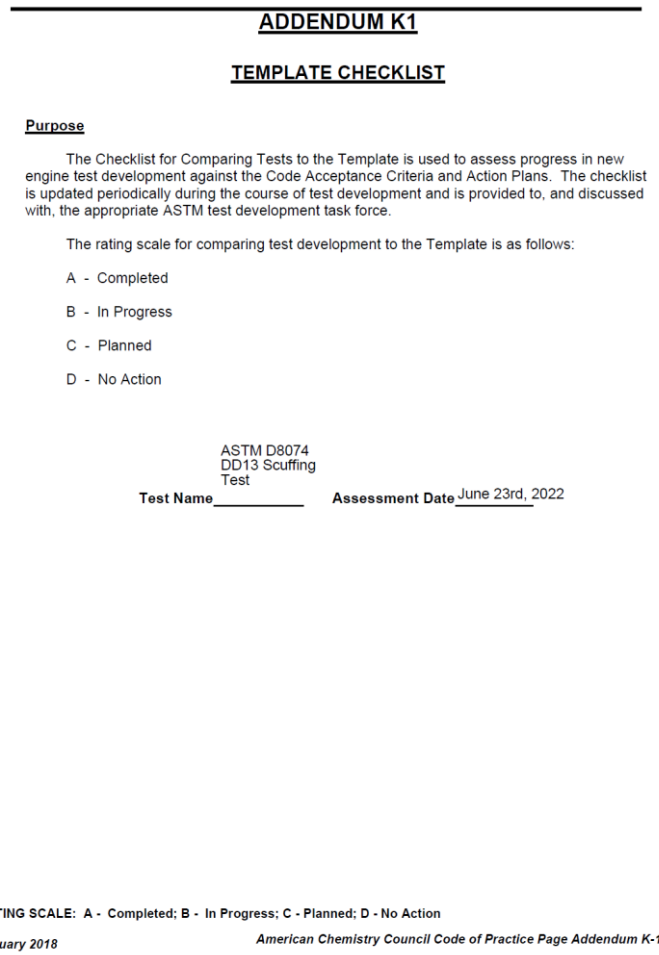
Oil Pump	**90**	**Pass**	**No**	
Body	**85**	**Pass**	**No**	A few debris scratches. Debris marks in bypass valve bore.
Pump Gears	**90**	**Pass**	**No**	Low wear
Valves	**90**	**Pass**	**No**	Debris marks, else okay



New Oil 2.9 to Replace Euro 2.9 “Formulation B”
DD13 Scuffing Test Result = 171 Hour Scuff
Oil Pump Gear Wear = Pass
Same Internal Test Cycle = 1071 engine hours

- Additional Information about Test Cycle = test cycle uses 1000 hour oil drain intervals which is representative of a drain interval in a vehicle.

d) Annex K Summary – DD13 Scuffing Test



ADDENDUM K1

TEMPLATE CHECKLIST

Purpose

The Checklist for Comparing Tests to the Template is used to assess progress in new engine test development against the Code Acceptance Criteria and Action Plans. The checklist is updated periodically during the course of test development and is provided to, and discussed with, the appropriate ASTM test development task force.

The rating scale for comparing test development to the Template is as follows:

A - Completed

B - In Progress

C - Planned

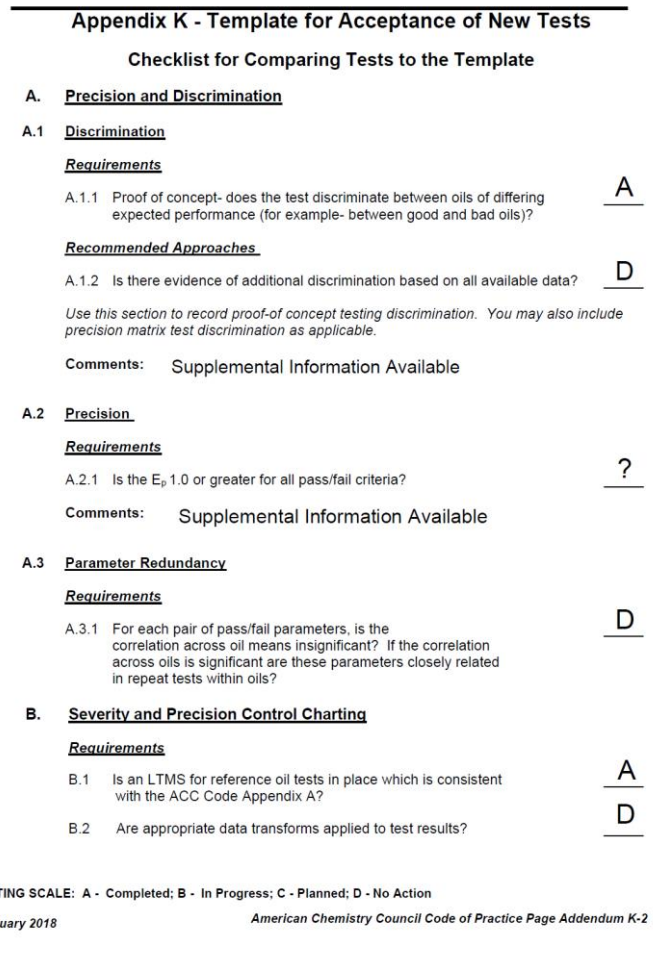
D - No Action

ASTM D8074
DD13 Scuffing
Test

Test Name_____ **Assessment Date** June 23rd, 2022

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-1*



Appendix K - Template for Acceptance of New Tests

Checklist for Comparing Tests to the Template

A. Precision and Discrimination

A.1 Discrimination

Requirements

A.1.1 Proof of concept- does the test discriminate between oils of differing expected performance (for example- between good and bad oils)? — A

Recommended Approaches

A.1.2 Is there evidence of additional discrimination based on all available data? — D

Use this section to record proof-of concept testing discrimination. You may also include precision matrix test discrimination as applicable.

Comments: Supplemental Information Available

A.2 Precision

Requirements

A.2.1 Is the E_p 1.0 or greater for all pass/fail criteria? — ?

Comments: Supplemental Information Available

A.3 Parameter Redundancy

Requirements

A.3.1 For each pair of pass/fail parameters, is the correlation across oil means insignificant? If the correlation across oils is significant are these parameters closely related in repeat tests within oils? — D

B. Severity and Precision Control Charting

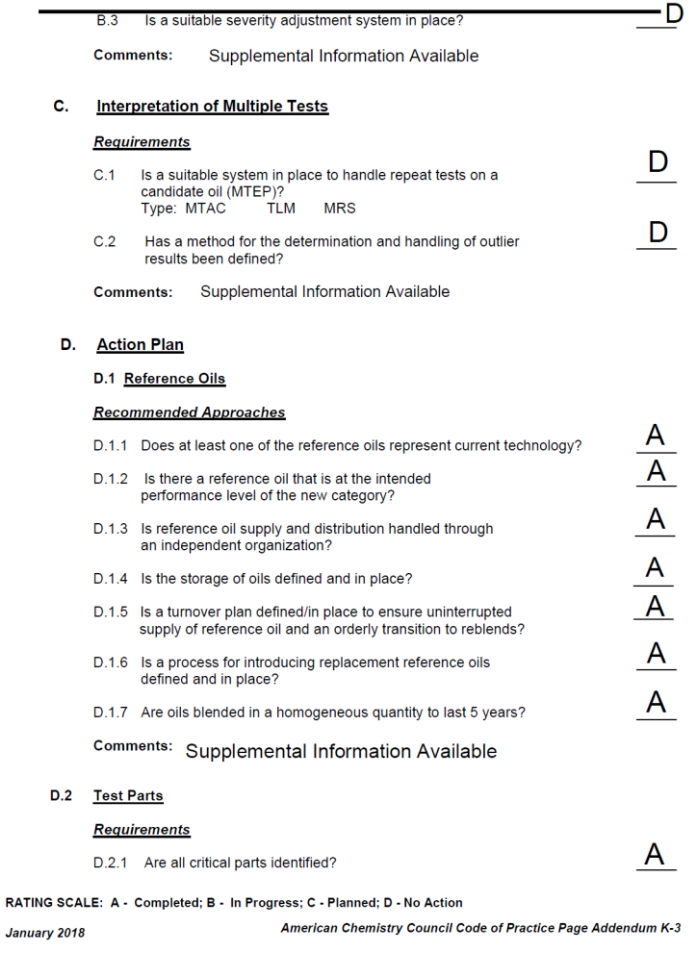
Requirements

B.1 Is an LTMS for reference oil tests in place which is consistent with the ACC Code Appendix A? — A

B.2 Are appropriate data transforms applied to test results? — D

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-2*



B.3 Is a suitable severity adjustment system in place? — D

Comments: Supplemental Information Available

C. Interpretation of Multiple Tests

Requirements

C.1 Is a suitable system in place to handle repeat tests on a candidate oil (MTEP)?
Type: MTAC TLM MRS — D

C.2 Has a method for the determination and handling of outlier results been defined? — D

Comments: Supplemental Information Available

D. Action Plan

D.1 Reference Oils

Recommended Approaches

D.1.1 Does at least one of the reference oils represent current technology? — A

D.1.2 Is there a reference oil that is at the intended performance level of the new category? — A

D.1.3 Is reference oil supply and distribution handled through an independent organization? — A

D.1.4 Is the storage of oils defined and in place? — A

D.1.5 Is a turnover plan defined/in place to ensure uninterrupted supply of reference oil and an orderly transition to reblends? — A

D.1.6 Is a process for introducing replacement reference oils defined and in place? — A

D.1.7 Are oils blended in a homogeneous quantity to last 5 years? — A

Comments: Supplemental Information Available

D.2 Test Parts

Requirements

D.2.1 Are all critical parts identified? — A

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-3*

A = Completed	B = In Progress	C = Planned	D = No Action

d) Annex K Summary Continued – DD13 Scuffing Test

D.2.2 Is a system defined/in place to maintain uniform hardware? A

D.2.3 Is there a system for engineering support and test parts supply? A

Recommended Approaches (if indicating yes on D.2.1, D.2.2-7 are requirements)

D.2.4 Are critical parts distributed through a Central Parts Distributor (CPD)? A

D.2.5 Are critical parts serialized, and their use documented in test report? A

D.2.6 Are all parts used on a first in/first out basis? A

D.2.7 Are all rejected critical parts accounted for and returned to the CPD? A

D.2.8 Does the CPD make status reports to the test surveillance body at least semi-annually? A

D.2.9 Is there a quality control and turnover plan in place for critical test parts, including identification and measurement of key part attributes, a system for parts quality accountability, a turnover plan in place for simultaneous industry-wide use of new parts or supply sources? A

D.2.10 Is the CPD active in industry surveillance panel/group, and in industry sponsored test matrices? A

Comments: Supplemental Information Available

D.3 Test Fuel

Requirements

D.3.1 Is the fuel specified and the supplier(s) identified? A

Recommended Approaches

D.3.2 Is a process in place to monitor fuel stability over time? A

D.3.3 Are approval guidelines in place for fuel certification? A

D.3.4 If the test fuel is treated as a critical part of the test procedure: Is an approval plan and severity monitoring plan for each fuel batch in place? D

D.3.5 Is a quality control plan defined and in place to assure long term quality of the fuel? A

D.3.6 Is a turnover plan defined, in place and demonstrated to ensure uninterrupted supply of fuel? A

Comments: Suplemental Information Available

D.4 Test Procedure

Requirements

D.4.1 Are test preparation and operation clearly documented in a standard format, e.g., ASTM, CEC? A

D.4.2 Are test stand configuration requirements documented and standardized? A

D.4.3 Is operational validity defined for all controlled parameters? A

Recommended Approaches

D.4.4 Is a research report published documenting test precision for reference oils? D

D.4.5 Are there published documents detailing: Field correlation? Test development history? D D

D.4.6 Are routine engine builder workshops planned/conducted?

D.4.7 Do all rate and report parameters judge test interpretation, or judge engine oil performance? A

Comments: Supplemental Information Available

D.5 Rating and Reporting of Results

Requirements

D.5.1 Are the reported ratings for any single parameter in a test from single raters (i.e. not averages from various raters)? A

Recommended Approaches

D.5.2 Are routine rater workshops conducted/planned? A

Comments: Supplemental Information Available

D.6 Calibration, Monitoring and Surveillance

Requirements-

D.6.1 Is a process in place for independent monitoring of severity and precision with an action plan for maintaining calibration of all laboratories? A

D.6.2 Are stand, lab, and industry reference oil control charts of all pass/fail criteria parameters used to judge calibration status? A

D.6.3 Does the specified calibration test interval allow no more than 15 non-reference oil tests between successful calibration tests? A

D.6.4 Is an industry surveillance panel in place? A

Comments:

Supplemental Information Available

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-4*

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-5*

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

January 2018 *American Chemistry Council Code of Practice Page Addendum K-6*

A = Completed	B = In Progress	C = Planned	D = No Action