HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

December 6, 2016

Hilton Orlando Lake Buena Vista – Palm 3

Lake Buena Vista, Florida, USA

ACTION ITEMS

1. **HDEOCP monitor activity with Seals SP regarding long term bias shifts.**

MINUTES

1.0 Call to order

1.1 The Heavy Duty Engine Oil Classification Panel (HDEOCP) was called to order by Chairman Shawn Whitacre at 1:30 p.m. on Tuesday December 6, 2016, in the Palm 3 Room of the Hilton Orlando Lake Buena Vista Hotel, Lake Buena Vista, Florida.

1.2 There were 14 members present and 71 guests present. The attendance list is included as Attachment **2.**

2.0 Agenda

2.1 The agenda circulated prior to the meeting (included as **Attachment 1**) was modified slightly. New items are a short report on the DD13 test and Laura Birnbaumer will provide an update on a ballot item.

2.2 The Anti-trust statement was presented. **Attachment 1a**

3.0 Minutes

3.1 Fix the start time of the last meeting. The December 2015 and June 2016 meeting minutes were approved.

4.0 Membership

4.1 There were three membership changes. Cory Koglin replaces Mike McLaughlin for Afton. Mary Dery replaces Galen Greene for BASF. Don Smolenski replaces David Gray from Evonik.

5.0 Existing tests/categories

5.1 Review of status of carry-over engine tests that support API CK-4, FA-4 and legacy categories (Sean Moyer, TMC). **Attachment 3**

5.1.1 Sean and Mark Cooper combined efforts for Sean to give one unified report. The EOAT is currently uncalibrated. CAT tests will have availability for the foreseeable future. COAT still working on Micromotion instrument software and calibration issues. Mack legacy tests still have Oil Consumption as a concern. T-12 ring batch available

in January 2017. Cummins tests have no issues. Statement was made that Cummins are looking at an ISX replacement test. No new update for the RFWT. IIIF/IIIG Hardware projected to be depleted 1Q17. A correlation between the 2 tests is expected to be complete by 1Q17. The EOAT using last known hardware and having oil temp control issues. May need provisional licensing until COAT to EOAT correlation is complete.

6.0 Old Business

6.1 Replacement of TMC 1006 reference oil (Brent Calcut, Afton). **Attachment 4**

6.1.1 Reference oil1006 is running out. Much activity has occurred to get a replacement. 1006 Group 1 basestock is not available so it can't be made anymore. There is about a 1.5 year supply. There are 8 test areas that use this fluid; the most critical areas are seals testing. A task force was formed. Input was solicited from elastomer experts. Existing oils were tried and rejected. A clone oil was tried which is the best option. Seals tests scoping for Light Duty and Heavy Duty seals were evaluated. Engine tests will have enough 1006 and new tests do not need 1006. The Sequence VIII might need 1006. Elastomers will use clone and further testing will take place. Group has found a reliably sourced Group 1 basestock. Naming and numbering may or may not change for OEM specs.

6.1.2 Mike Alessi led a related task force to determine if absolute limits could be set for elastomers instead of relative limits.

6.2 Evaluation of fixed limits for elastomer compatibility (Michael Alessi, ExxonMobil). **Attachment 5**

6.2.1 Statistical differences exist between laboratories. **Attachment 5a.** Until lab differences are fixed, fixed limits can't be implemented. The Seals SP had a workshop to improve things. Improved supply buys some time but differences are a problem. TMC cumulative summation (cusum) plots don't look good. **Attachment 5b.** Seals issues have been going on a long time and formal request has been sent to SP chairman. Need to keep this issue in front of HDEOCP. Reference bands are wide and reference tests are not failing. Need to get EMA perspective on this.

6.3 Update on DD13 Scuffing (Suzanne Neal, DTNA; Patrick Joyce, Lubrizol). **Attachment 6**

6.3.1 Suzanne Neal of Daimler and Patrick Joyce of Lubrizol presented an update. A timeline was given of the history getting to an ASTM test method. In October the method received D8074. They invited members to join the SP if interested.

7.0 New Business

7.1 Phosphorus limits for API CK-4 and API FA-4 (Ron Romano, Ford). **Attachment 7**

7.1.1 Ron provided Ford's position on 6.7L wear test and concerns about CK-4 oils less than 1000 ppm phosphorus. Testing internally showed some wear concerns. Showed photos of parts with wear. Ford will not be recommending CK-4 or FA-4 oils and will keep recommending CJ-4 oils. Ford would like a phosphorous limit in D4485. An alternative is to have a phosphorus label on the container. Ford has released a new spec and has an official approval program in place. Optional ways exist to get a formulation approved without the wear test. 200+ products approved already. Status of test is the procedure could be available middle of 1Q17. Ford will start a public task force when ready to release procedure. (Get right presentation from Ron). Ford has published a position statement.

7.2 Review of Ballot item WK51995 to revise ASTM D4485-15a (Laura Birnbaumer, Chevron Oronite). **Attachment. 8**

7.2.1 Laura has a suggestion to modify how PC-11 should be included into D4485. 3 more items need their own ballots. Proposal 1 is to copy CI-4 D5800 language to newer categories. Proposal 2 is to change “requirement” to “required” for T-11 for the Used Oil MRV. Proposal 3 is to break out all viscosity grades for CK-4 to have multiple columns to make it crystal clear. Laura was asked to create the actual proposal.

8.0 Next meetings

8.1 The next meeting will be at the call of the chairman or during ASTM in Boston June 2017.

9.0 The meeting was adjourned at 2:47 pm.

AGENDA
D02.B0.02.1
Heavy-Duty Engine Oil Classification Panel
Tuesday, December 6, 2016 1:30pm EST
Hilton Orlando Lake Buena Vista – Palm 3
Lake Buena Vista, Florida, USA

1) **Call to Order**

2) **Minutes** – Approval of Minutes from June 28, 2016 Meeting in Bellevue, Washington, USA

3) **Membership**

   a) Review current panel membership

4) **Existing tests/categories**

   a) Review of status of carry-over engine tests that support API CK-4, FA-4 and legacy categories (Sean Moyer, TMC)

5) **Old Business**
   a) Replacement of TMC 1006 reference oil (Brent Calcut, Afton)
   b) Evaluation of fixed limits for elastomer compatibility (Michael Alessi, ExxonMobil)
   c) Update on DD13 Scuffing Test (Suzanne Neal, DTNA; Patrick Joyce, Lubrizol)

6) **New Business**

   a) Phosphorus limits for API CK-4 and API FA-4 (Ron Romano, Ford)
   b) Review of Ballot item WK51995 to revise ASTM D4485-15a (Laura Birnbaumer, Chevron Oronite)

7) **HDEOCP Adjournment (transition to DEOAP)**

D02.B0.02.1 HDEOCP

Shawn Whitacre
Chairman
Heavy-Duty Engine Oil Classification Panel

December 6, 2016
Lake Buena Vista, FL USA

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- **For a complete list of standards see** http://www.astm.org/COMMIT/SUBCOMMIT/D02B0.htm

ASTM-HDEOCP Membership

	Oil and Additive Companies		OEMs
1	Shawn Whitacre - Chevron	1	Greg Shank – Volvo Power Train
2	Mike Alessi- ExxonMobil	2	Ryan Denton - Cummins Inc.
3	Dan Arcy - Shell	3	Mesfin Belay - Detroit Diesel
4	Corey Taylor - BP Castrol	4	Hind Abi-Akar - Caterpillar Inc.
5	Josh Frederick - Valvoline	5	Heather DeBaun – Navistar
6	Mary Dery- BASF**	6	Ken Chao - John Deere
7	David Gray - Evonik	7	Eric Johnson- GM Powertrain
8	Cory Koglin – Afton*	8	Jason Andersen- Paccar
9	Robert Stockwell - Oronite	9	Ron Romano - Ford
10	Gail Evans - Lubrizol		
11	Robert Salgueiro - Infineum U.S.A.		
12	David Taber - Phillips 66 Lubricants		
13	Rodney Walker, Safety-Kleen		

* Replaces Mike McLaughlin
** Replaces Galen Greene

HDEOCP Attendance: December 6, 2016

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HDEOCP Attendance: December 6, 2016

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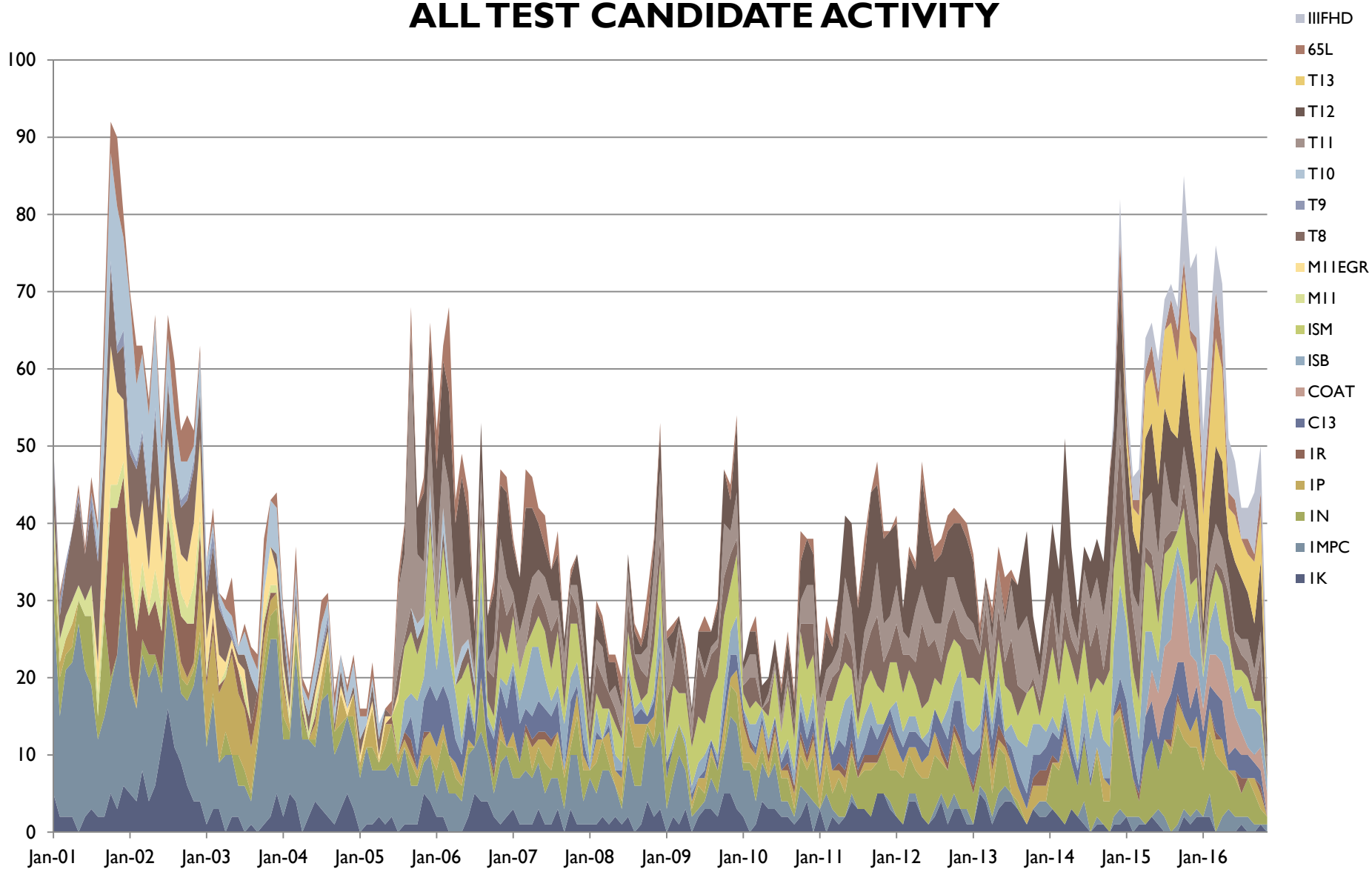
D02.B0.02 Maintenance Report

December 2016

ALL TEST CANDIDATE ACTIVITY



Calibrated Labs and Stands*

Test	Labs	Stands
1K	1	1
1N	4	5
1M-PC	1	1
1P	3	3
1R	1	1
C13	3	3
ISB	3	5
ISM	4	4
EOAT	0	0
RFWT	2	2
T-8/E	2	3
T-11	4	5
T-12/T-12A	4	7
T-13	5	10
COAT	3	3
DD13	3	5

*As of 09/30/2016

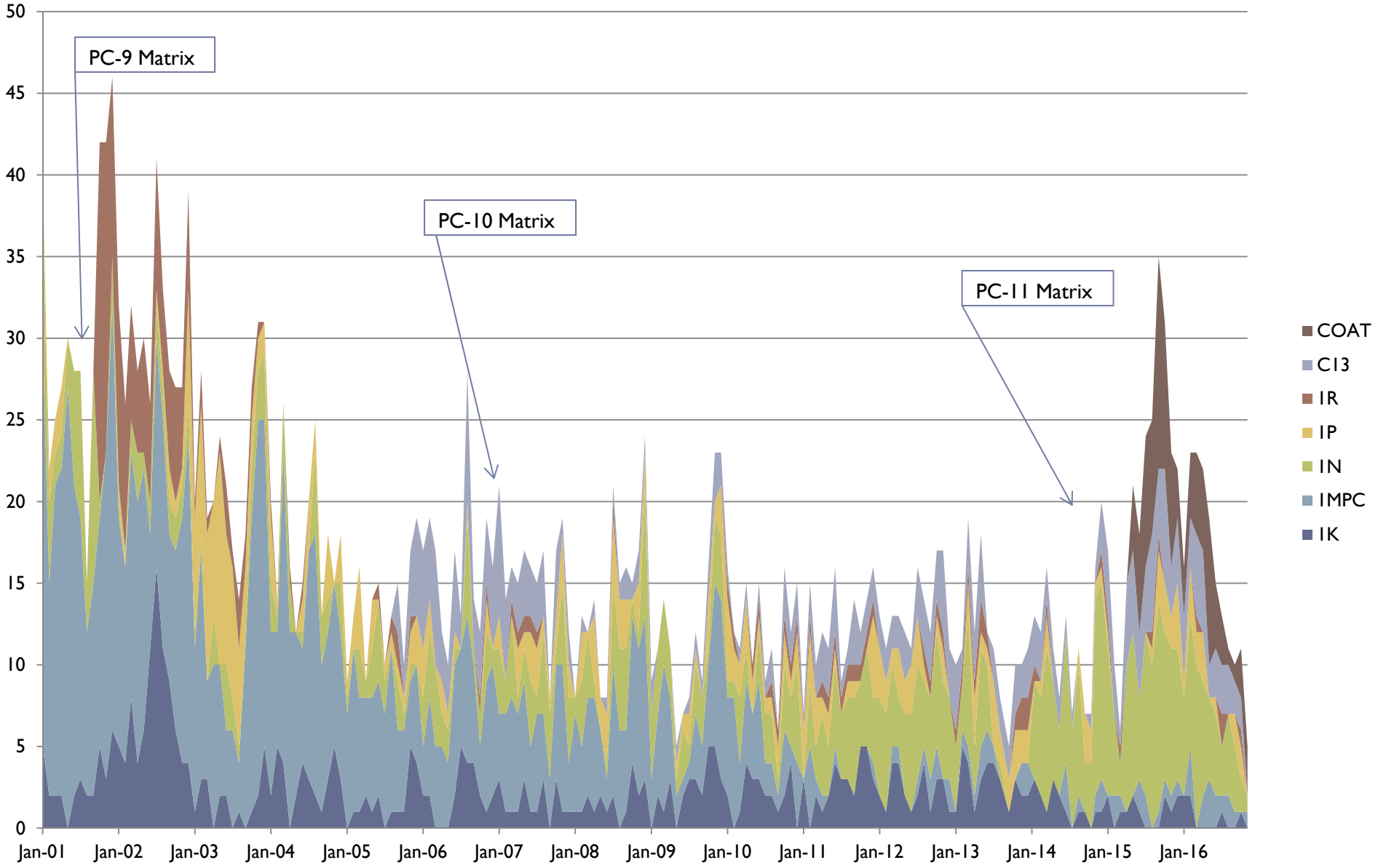
Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2020	Notes
Cat 1K/1N	Auxiliary components	Likely	1980's vintage engine. Ongoing resolution of issues with auxiliary stand and miscellaneous components.
Cat 1P/1R	Crankshaft	Likely	1990's vintage engine. Crankshaft supplier has been identified by Caterpillar.
Cat C13	New liners – references anticipated Oct 2016 – Not yet run.	Likely	Engine block, injectors, turbos only available through reman. Liners with new material and processing but same specs will be introduced mid-2017. New batch of current liners produced.

Additional Caterpillar Test Issues

- **Caterpillar Oil Aeration Test**
  - Surveillance panel working with micro-motion manufacturer on instrument software and calibration standardization across labs.

CATERPILLAR CANDIDATE ACTIVITY



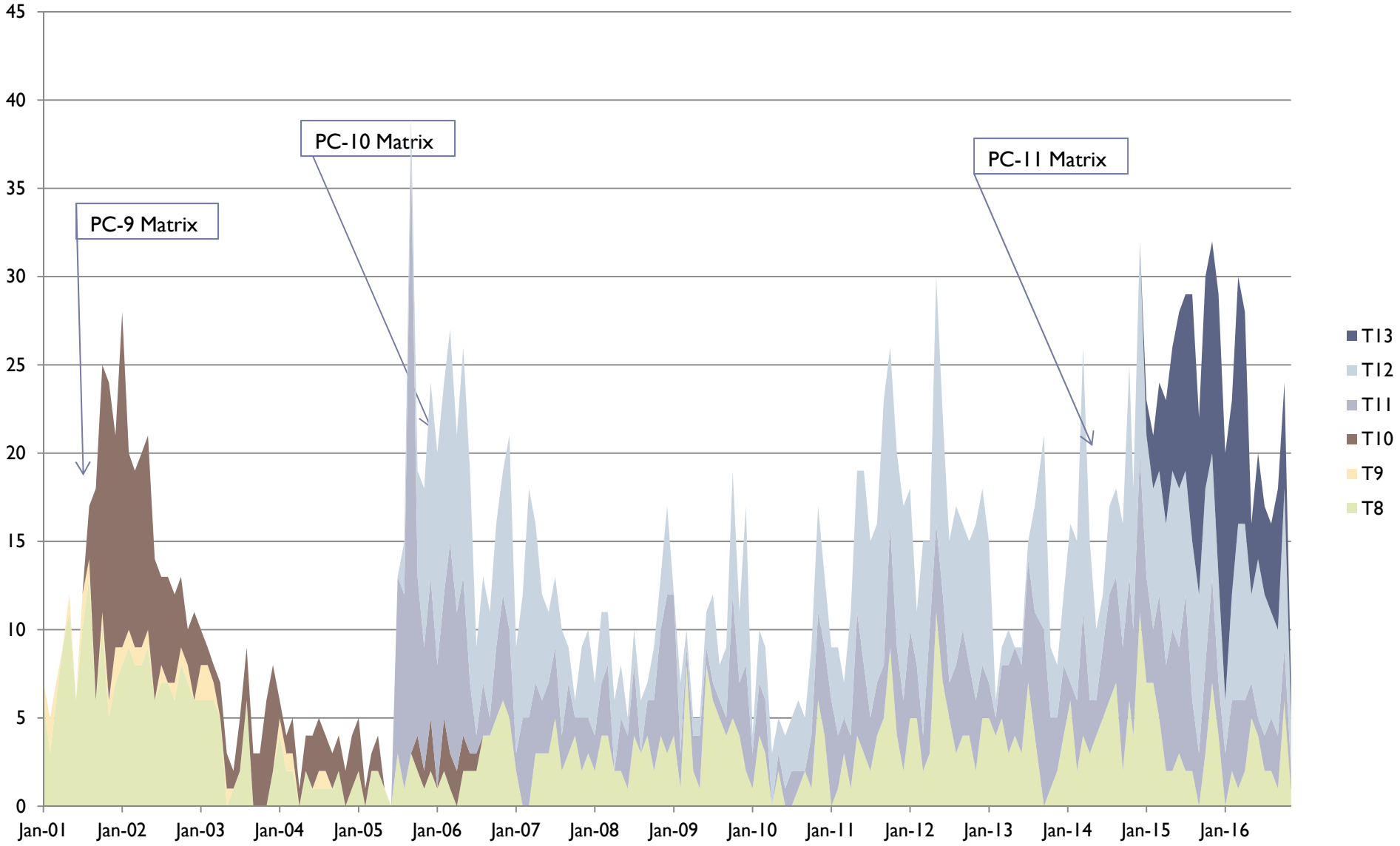
Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2020	Notes
Mack T-11	Oil Consumption	Likely	Engine production ended 2006. Finite number of engine blocks. Engine build life issues with oil consumption.
Mack T-12	Oil Consumption, head gasket	Likely	Engine production ended 2006. Next ring batch available January 2017. Severity to be determined with coordinated references, plus correction factor updates.

Additional Mack Test Issues

- **T-12**
  - Procurement of new top ring batch and coordinated references expected January 2017.

MACK CANDIDATE ACTIVITY



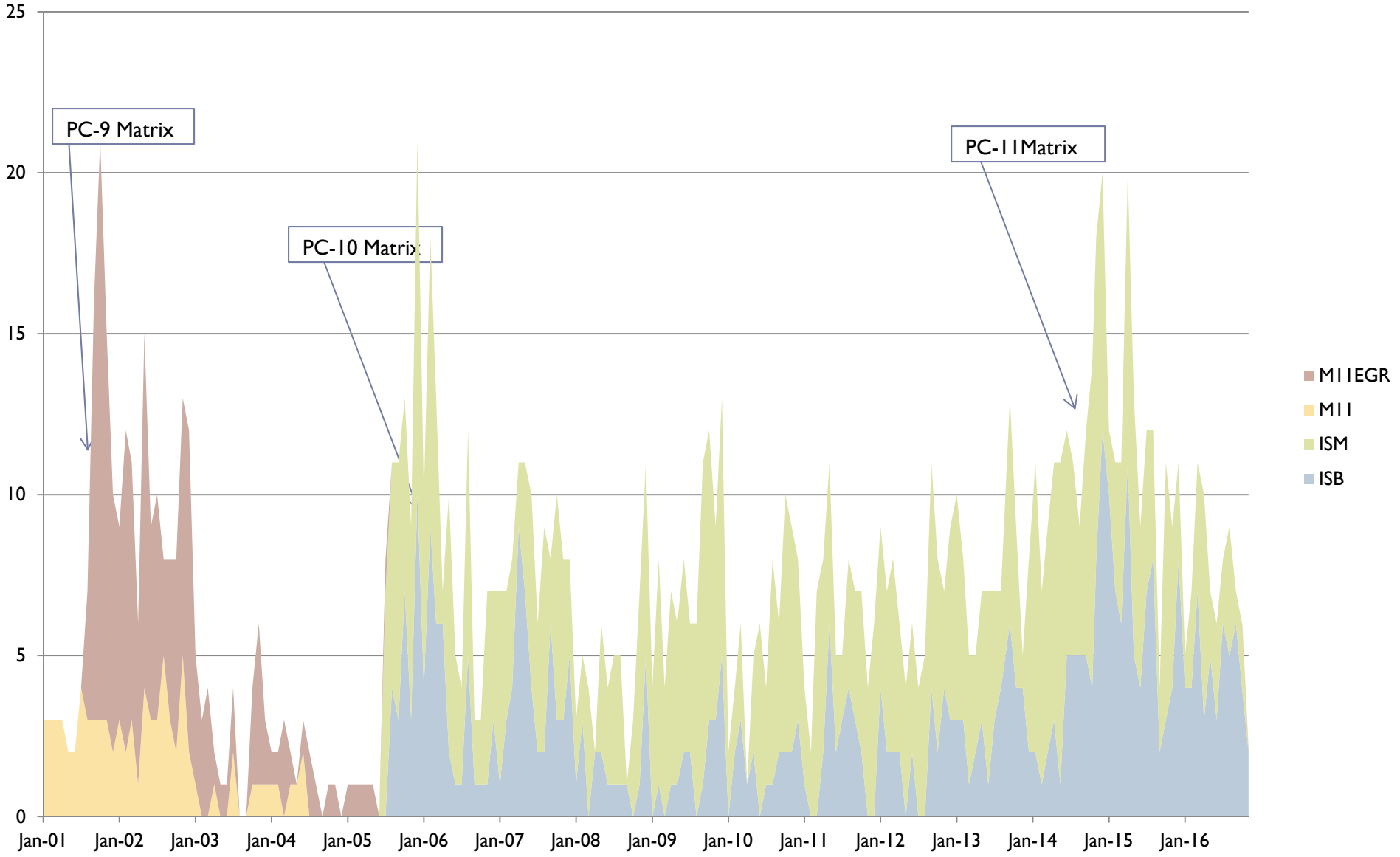
Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2020	Notes
Cummins ISM	**No current issues**	**Likely**	**Cummins is looking at backwards-compatible development using ISX.**
Cummins ISB	**No current issues**	**Likely**	**No current issues.**

Cummins Test Surveillance Panel

- ISM
  - Cummins looking at possibility of developing backwards-compatible ISX test.
- ISB
  - No current test issues.

CUMMINS CANDIDATE ACTIVITY



Availability of API CH-4 through CJ-4 Tests for PC-11

Test	Hardware Issues	Availability Through 2020	Notes
RFWT	Engine configuration	Likely	Long term supply of test parts at CPD. 6.5 L engine no longer in production at AM General, but available through supply network. Injection pump still available.
Seq IIIF/IIIG	Hardware depletion Dec 2016	No	Hardware depletion projected 1Q 2017. Projected 1Q2017 IIIH to IIIF and IIIH to IIIG correlations.
EOAT	Using last known hardware	No	Oil temperature control issues with last known EOAT engine. Test uses controlled coolant temperature but not controlled oil temperature. Lab determining cause. Unavailable?

Engine Oil Aeration Test Surveillance Panel

- No reference tests in last 6 months
- Additional engines are now impossible to source.
  - Last remaining engine is currently in use.
  - Test could be declared unavailable at any point.
- EOAT Panel transferred to CAT panel and correlation work is ongoing.

Roller Follower Wear Test Surveillance Panel

- One reference tests in last 6 months.
- Test is in control and at historical levels.
- No issues to report. Hardware supply available at CPD.

B2 Action Items

- **No Action Items**
- **Comments**

RO-1006 Replacement

Brent Calcut

November 2016

Passion for Solutions™

Background

- TMC Reference Oil 1006 was originally introduced in 1997 as an ILSAC GF-2 category reference oil
- Two subsequent batches were made to support industry reference testing, RO 1006-1 and RO 1006-2
- RO 1006 cannot be reblended because the Group I basestock used in the formulation is no longer in production

Current Status

1006-2 Status

- TMC Inventory of 1006-2 is at 2200 gallons
  - It can not be re-blended
- 1.5-year usage
  - SF105 345 gallons
    - Specified in ASTM D471 & GM Standards
  - EOEC/LDEOC 461 gallons
  - IVA/VG/VIII 140 gallons
  - Total 946 gallons
- Estimated Life ~24 months

Test Monitoring Center

Passion for Solutions™

Current Usage

- **RO 1006 is used as a reference oil in many tests**
  - Heavy Duty Engine Oil Elastomer Compatibility
  - Light Duty Engine Oil Elastomer Compatibility
  - ASTM D471 – Service Liquid 105
  - SAE J2643 – Service Liquid 105
  - ASTM D6891 – Seq IVA
  - ASTM D6593 – Seq VG
  - ASTM D6709 – Seq VIII
  - ASTM D6557 – Ball Rust Test

Overview of Events

- **Task Force was formed after June ASTM meeting to identify possible replacements for RO 1006-2**
  - Members include Afton, Chevron, ExxonMobil, Infineum, OHT, SwRI, TMC and Volvo
- **Input was also solicited from elastomer experts**
- **Existing alternatives were investigated and rejected**
- **Several 'Clone' formulations were developed and screened through LDEOEC and HDEOEC**
  - Additive package is very similar, though not exactly the same
  - A leading replacement candidate was selected

Afton CHEMICAL

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Summary

- **Conclusion: everyone is happy with RO 1006**
  - Minimize change
- **Step 1: initial LDEOEC and HDEOEC scoping of RO 1006 Clones**
  - Leading option will use common Group II base stock
  - Back-up option will use a similar Group I base stock
- **Step 2: select best option from Step 1, blend a drum or two for more extensive evaluation**
  - Update ASTM classification and surveillance panels to develop further test plans and acceptance
  - Update SAE and OEM / Elastomer stakeholders
  - Scope performance in Seq VIII

Afton CHEMICAL

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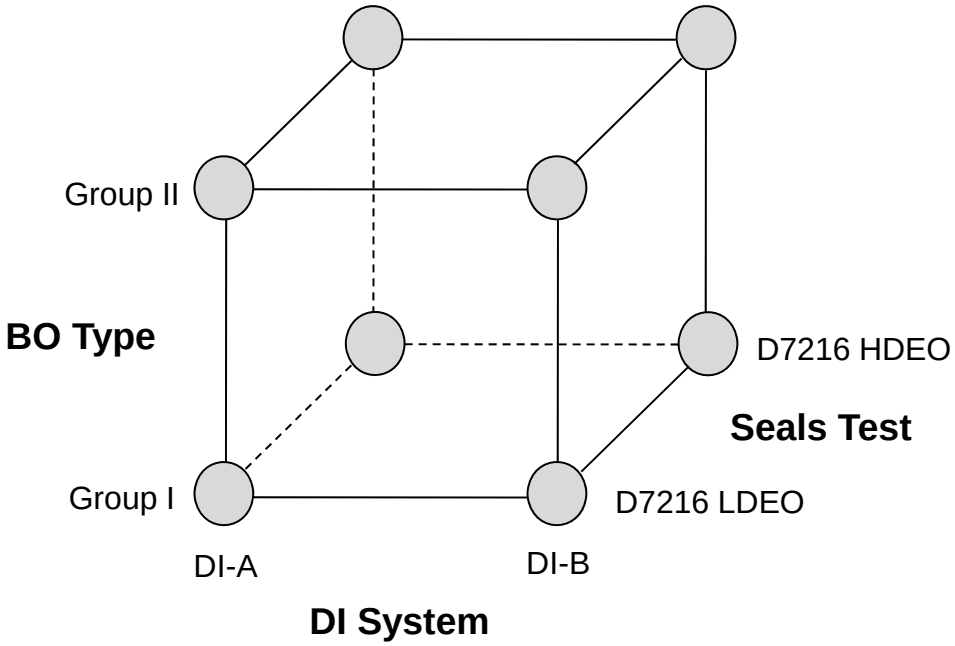
TMC RO-1006 Replacement – Seals Test Scoping



Seals Tests

D7216 LDEO = 5 Elastomer Tests

- FKM1 / HNBR1 / AEM1 / ACM1 / VMQ1

D7216 HDEO = 5 *Elastomer* Tests

- FKM / NBR / VAMAC G / ACM / VMQ

All tests were run at SwRI and completed on October 14 – 27, 2016

Elastomer Compatibility Test – D7216 Annex A2 (LDEO)

150°C, 336 Hr

		DI-A / Group-II	DI-A / Group-I	DI-B / Group-II	DI-B / Group-I	
Polyacrylate (ACM1-16)	Spec Limits					Reference
Volume Change	-5, 9	**2.20** (4.77)	**5.56** (4.85)	**1.74** (4.77)	**5.27** (4.85)	See (data)
Hardness	-10, 10	**2** (-2)	**-2** (-3)	**3** (-2)	**-2** (-3)	See (data)
Tensile Strength	-40, 40	**-5.7** (-8.8)	**-1.9** (-1.6)	**-3** (-8.8)	**-5.2** (-1.6)	See (data)
Hydrogenated Nitrile (HNBR1-17)						
Volume Change	-5, 10	**-0.06**	**1.65**	**-0.64**	**1.08**	1.95
Hardness	-10, 5	**0**	**-2**	**1**	**0**	-1
Tensile Strength	-20, 15	**-9.1**	**-4.9**	**-11.0**	**-8.9**	-1.6
Silicone (VMQ1-19)						
Volume Change	-5, 40	**30.08** (31.89)	**32.52** (33.74)	**29.42** (31.89)	**31.92** (33.74)	See (data)
Hardness	-30, 10	**-21** (-22)	**-24** (-24)	**-20** (-22)	**-23** (-24)	See (data)
Tensile Strength	-50, 5	**-21** (-27.6)	**-35.3** (-32.8)	**-21.3** (-27.6)	**-24.6** (-32.8)	See (data)
Fluorocarbon (FKM1-17)						
Volume Change	-2, 3	**0.44** (0.6)	**0.32** (0.52)	**0.41** (0.52)	**0.53** (0.52)	See (data)
Hardness	-6, 6	**4** (4)	**5** (6)	**0** (6)	**0** (6)	See (data)
Tensile Strength	-65, 10	**-44.6** (-52.1)	**-49.3** (-53.4)	**-25.6** (-53.4)	**-31.9** (-53.4)	See (data)
Ethythene Acrylic (AEM1-17)						Reference
Volume Change	-5, 30	**18.65**	**24.26**	**18.28**	**23.93**	25.07
Hardness	-20, 10	**-10**	**-14**	**-11**	**-15**	-15
Tensile Strength	-30, 30	**-12.4**	**-14.8**	**-6.4**	**-11.8**	-17.7

Elastomer Compatibility Test – D7216 Annex A2 (HDEO)

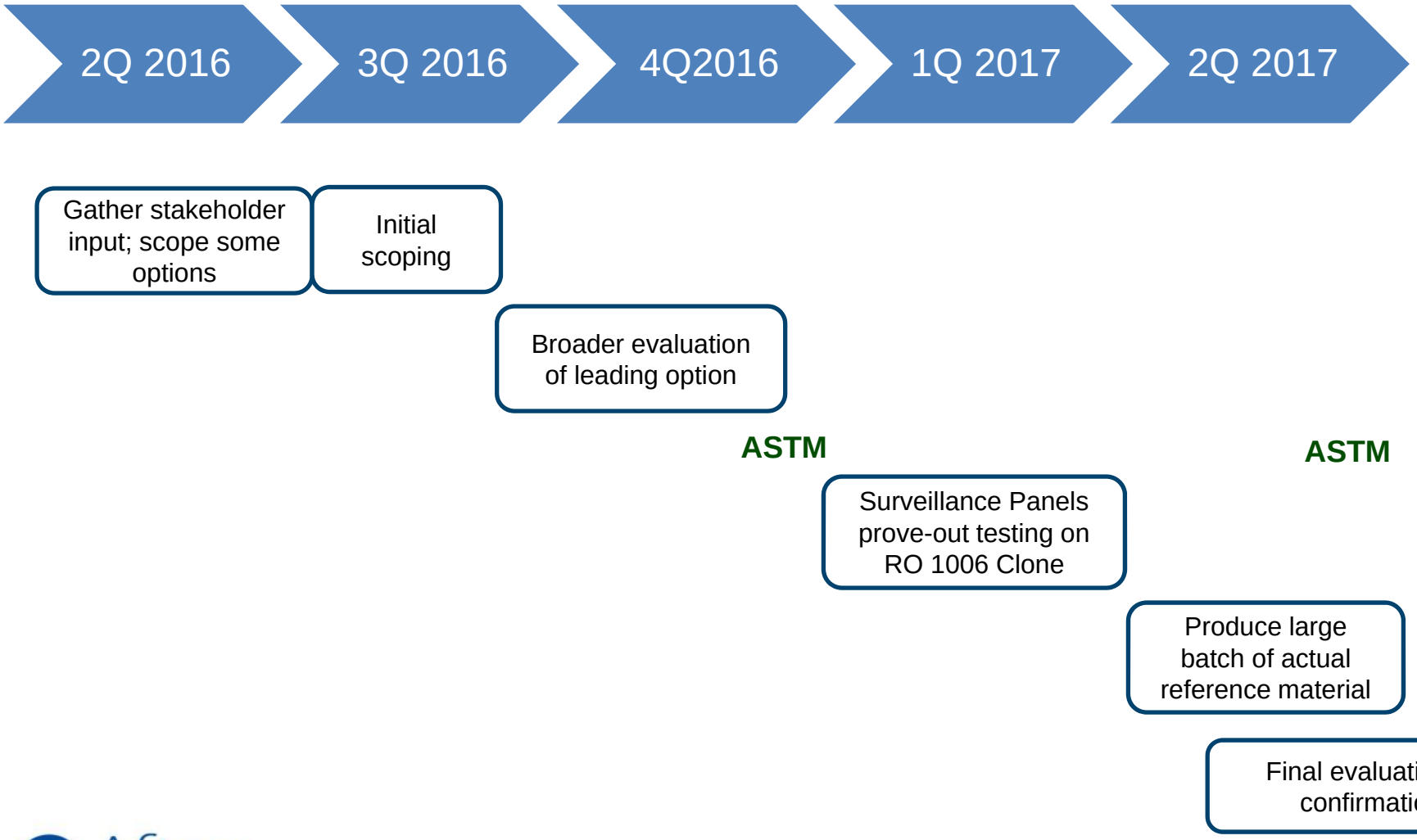
150°C, 336 Hr

		DI-A / Group-II	DI-A / Group-I	DI-B / Group-II	DI-B / Group-I		
							Acceptable Limits
Polyacrylate (ACM)	Spec Limits	ACM-17	ACM-19	ACM-17	ACM-19	Reference	Updated on 3/1/2008
Volume Change	-3, 5	**-0.58** (1.47)	**0.96** (1.44)	**-0.72** (1.47)	**0.94** (1.44)	See (data)	-3.62, 5.62
Hardness	-5, 8	**2** (-1)	**0** (-2)	**3** (-1)	**0** (-2)	See (data)	-6, 9
Tensile Strength	-15, 18	**10.3** (3.2)	**-4.5** (1.4)	**12.6** (3.2)	**4.3** (1.4)	See (data)	-23.2, 26.2
Elongation	-35, 10	**-9.9** (-8.1)	**-10.2** (6.4)	**-12.8** (-8.1)	**7.3** (6.4)	See (data)	-44.1, 19.1
Nitrile (NBR-19)							
Volume Change	-3, 5	**0.00**	**1.29**	**-1.02**	**0.56**	1.79	3.62, 5.62
Hardness	-5, 7	**10**	**10**	**13**	**11**	5	-6, 8
Tensile Strength	-TMC1006, 10	**-61.8**	**-59.2**	**-63.3**	**-61.9**	-29.2	-39.8, 17.3
Elongation	-TMC1006, 10	**-71**	**-69.1**	**-71.5**	**-70.6**	-53.5	-61.6, 15.7
Silicone (VMQ1-20)							
Volume Change	-3, TMC1006	**31.34**	**32.02**	**31.03**	**31.72**	32.67	-4.50, 35.02
Hardness	-TMC1006, 5	**-23**	**-23**	**-22**	**-22**	-24	-27, 6
Tensile Strength	-45, 10	**-29.9**	**-27.1**	**-26.8**	**-28.2**	-30.0	-58.7, 15.7
Elongation	-30, 20	**-24.9**	**-19.9**	**-22.6**	**-21.1**	-24.0	-38.1, 28.1
Fluorocarbon (FKM-19)							
Volume Change	-2, 5	**0.53**	**0.5**	**0.58**	**0.76**	0.61	-2.13, 5.13
Hardness	-5, 7	**7**	**8**	**0**	**1**	9	-6, 8
Tensile Strength	-TMC1006, 10	**-68.3**	**-69.1**	**-39.4**	**-49.2**	-72.0	-78.1, 13.9
Elongation	-TMC1006, 10	**-64.0**	**-65.5**	**-42.6**	**-47.2**	-69.8	-81.5, 16.3
VAMAC-13							
Volume Change	3, TMC1006	**13.96**	**11.19**	**13.59**	**8.56**	19.75	-4.67, 22.37
Hardness	-TMC1006, 5	**-6**	**-11**	**-7**	**-12**	-12	-13, 6
Tensile Strength	-TMC1006, 10	**-17.1**	**-14.4**	**-3.7**	**-10.6**	-14.2	-25.0, 17.1
Elongation	-TMC1006, 10	**-39.1**	**-25.4**	**-18.8**	**-14.0**	-25.0	-38.0, 19.0

Replacement Plans

Currently Using RO 1006-2	Future Plan
HDEOEC (D4485)	RO 1006 Clone
LDEOEC (API 1509 & D4485)	RO 1006 Clone
ASTM D471 (SL 105)	RO 1006 Clone
SAE J2643 (SL 105)	RO 1006 Clone
ASTM D6891 – Seq IVA	TMC to set aside sufficient RO 1006-2 Seq IVB to use other ref. oils.
ASTM D6593 – Seq VG	RO 1006-2 Seq VH to use other ref. oils
ASTM D6709 – Seq VIII	?
ASTM D6557 – Ball Rust Test	TMC to set aside sufficient RO 1006-2

Timeline



Passion for Solutions™

Final Thoughts

- The selected Group I replacement basestock is expected to be available for the foreseeable future
- RO 1006 Clone will be assigned a new TMC code
- Those responsible for ASTM D471 and SAE J2643 will ultimately decide whether to use this Clone and assign a new Service Liquid #, if desired
- EOEC SP continues efforts to improve r&R
- Task Force will continue efforts to set fixed limits in HDEOEC

Afton CHEMICAL

Passion for Solutions™

Development of Fixed Limits for HD Elastomers

- As part of the replacement of TMC 1006, it was hoped that fixed limits could be developed for the EOEC test elastomers
  - Should simplify any future changes in reference oil
- Analysis of the reference data has indicated a statistical difference in performance between laboratories
  - The difference shows up in both fresh elastomer and used elastomers
- Until the laboratory differences are addressed it will not be possible to develop fixed limits for the test
- Surveillance Panel Workshop identified some possible areas for improvement:
  - Bath Setup and Fluid
  - Tensile strength measurement of cross-sectional area
  - Elastomer storage
  - Instrumentation for hardness testing
- If test can be brought into control, fixed limits can then be developed

ExxonMobil

EOEC BASELINE ANALYSIS

D. Boese

June 27, 2014

Performance you can rely on.

Infineum

Summary

- Only statistical significance is considered in this document, no consideration of practical significance of lab differences is made.
- For all parameters (Hardness, Tensile Strength and Elongation), there are labs whose result means are statistically significantly different.
- The elastomer ranking of the mean Hardness and Tensile Strength for one lab differed relative to that of the other four labs.

Data and Analysis

- The purpose of this study is to determine if Instron measurements differ by lab without the confounding effect of differing bath designs.
- Experiment design
  - Developed and facilitated by Mike Birke.
  - Samples of two elastomers were supplied to and tested by five different labs (IAR, ISP, Lubrizol, SwRI and Valvoline).
  - Hardness, Tensile Strength and Elongation were measured for each elastomer sample (fresh – not processed in water bath) at each lab.
- For this document, the labs are identified by a randomly assigned code of K through O. If desired, each lab can request their lab code.
- Analyses for each parameter or measurement type include the follow components:
  - A plot by Lab and Elastomer for visual comparison
  - A table including the means and standard deviations for each lab
  - Regression analysis:
    - Combining the results of both elastomers with factors of Lab, Elastomer and Lab × Elastomer.
    - Separate analysis for each elastomer utilizing Tukey HSD procedure for determining which labs have means which differ from each other.
- Analyses are only concerned with statistical significance. No discussion of practical significance of differences among labs is made.

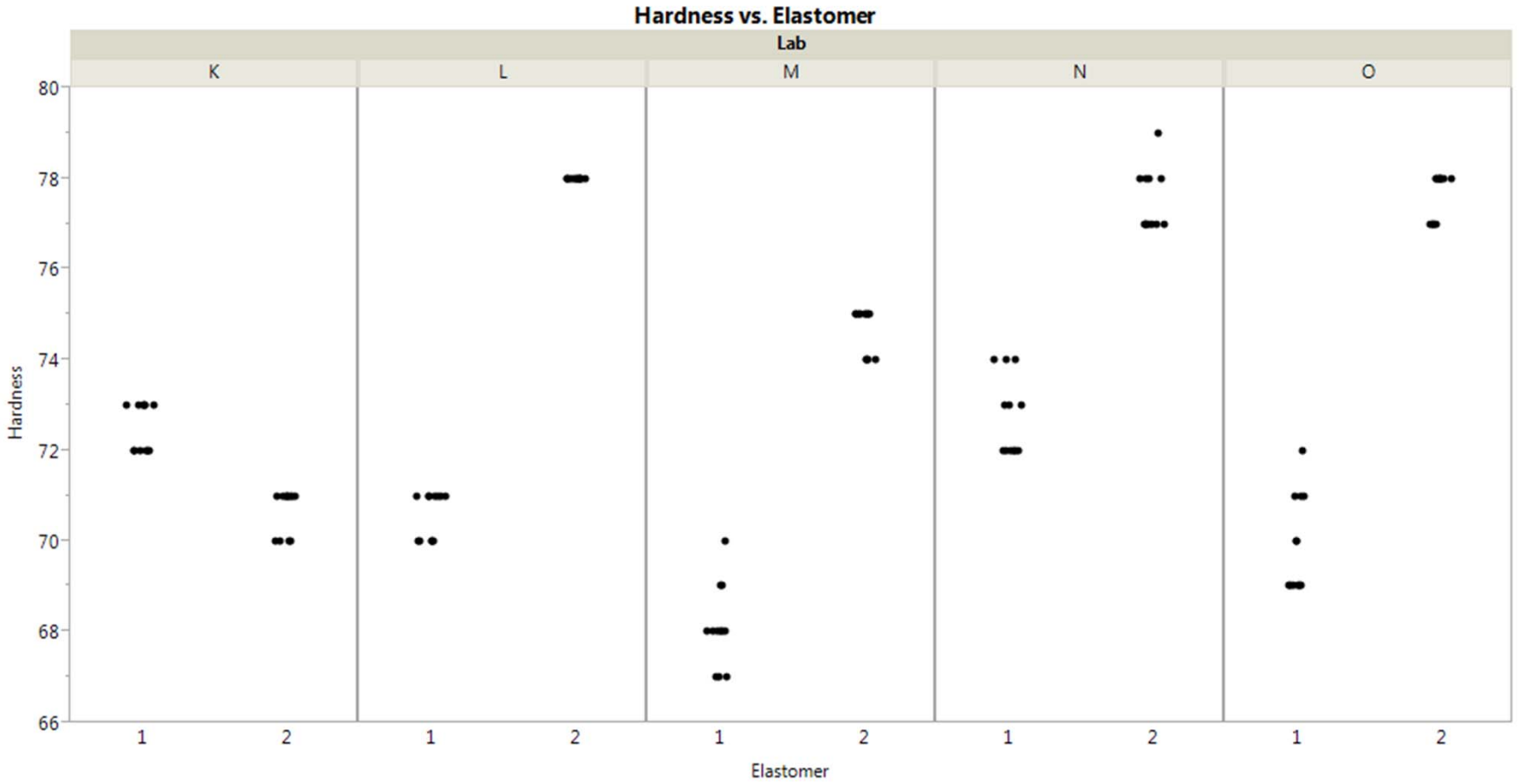
HARDNESS

TENSILE STRENGTH

ELONGATION

HARDNESS

Hardness Plot



- All labs, except Lab K, show a similar difference in Hardness for Elastomers 1 and 2.
- For each elastomer, there is obvious lack of overlap among the labs.

Hardness Summary Statistics

Hardness Summary Table

Lab	Sample Size		Mean			Pooled
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	Std. Dev.
K	12	12	73	71	-2	0.51
L	12	12	71	78	7	0.36
M	12	12	68	75	7	0.73
N	12	12	73	78	5	0.78
O	12	12	70	78	8	0.84

- The range of Hardness means for Elastomers 1 and 2 are 5 and 7, respectively.
- Again, Lab K's difference between the mean Hardness of the two elastomers stands out relative to that of the others.

Hardness Regression Analysis

- Combining the results from both elastomers:
  - The Lab effect is strongly statistically significant.
  - The Elastomer × Lab effect is also strongly statistically significant, largely due to the reversal of lab K means for the two elastomers.
- Analyzing the results from each elastomer separately:
  - Labs are statistically significantly different.
  - For both elastomers, Lab N is in Level Code group 1.
  - Lab K has Level Code 1 for Elastomer 1 and Level Code 2 for Elastomer 3.

Hardness Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

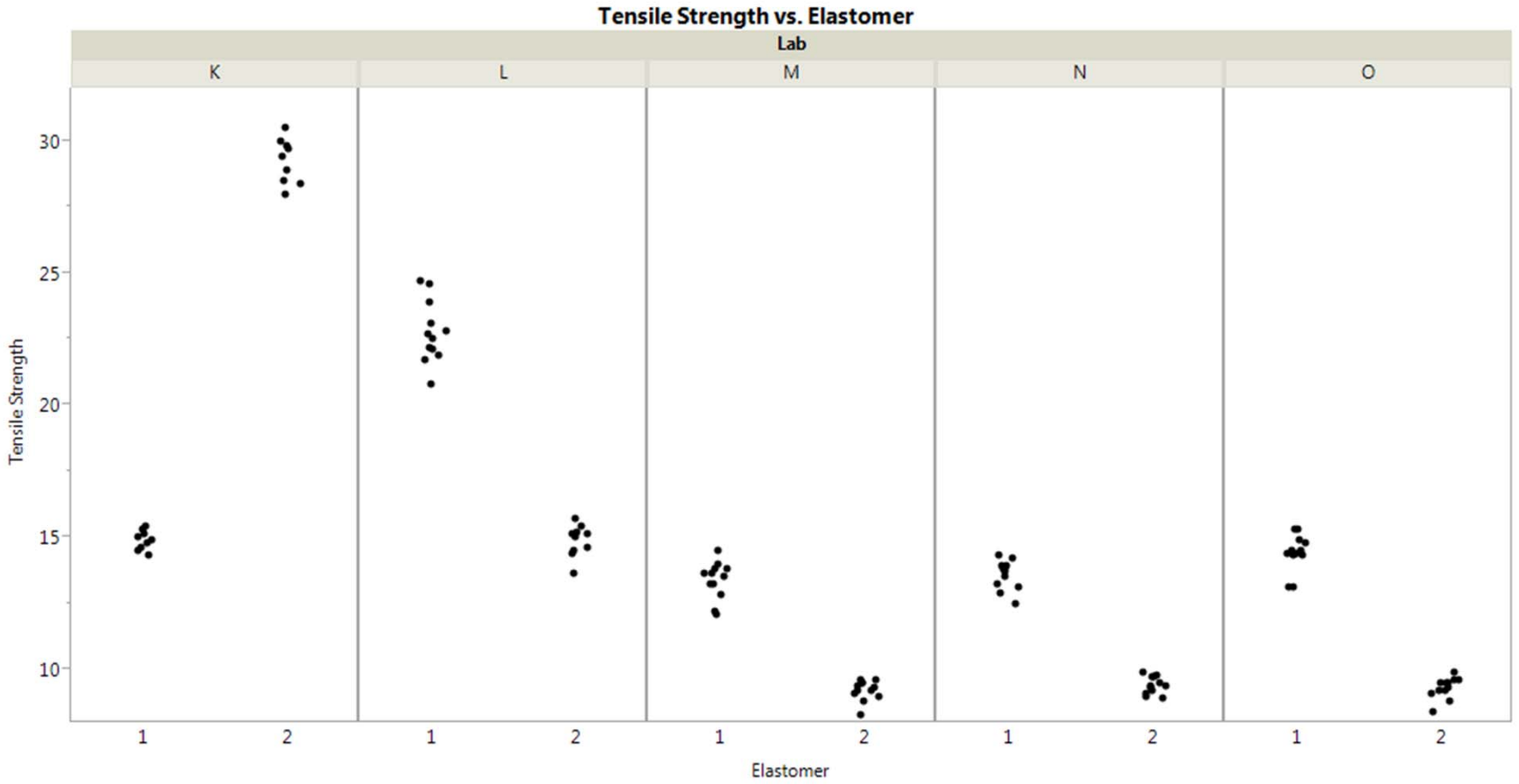
Hardness Least Square Means

Elastomer	Lab	Level Code	LS Mean
1	N	1	73
	K	1	73
	L	2	71
	O	2	70
	M	3	68
2	L	1	78
	O	1	78
	N	1	78
	M	2	75
	K	3	71

Labs not connected by the same Level Code are statistically significantly different.

TENSILE STRENGTH

Tensile Strength Plot



- Relative to the other labs, there is a lack of overlap of the Lab L results for both elastomers and likewise with Elastomer 2 for Lab K.
- For each lab, other than Lab K, Elastomer 1 has the higher mean Tensile Strength.

Tensile Strength Summary Statistics

Tensile Strength Summary Table

Lab	Sample Size		Mean				Pooled Std. Dev.
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	% Change	
K	9	9	14.9	29.2	-14.4	-97	0.65
L	12	10	22.8	14.9	7.9	35	0.96
M	12	12	13.4	9.2	4.1	31	0.57
N	12	12	13.6	9.4	4.2	31	0.45
O	12	12	14.4	9.3	5.1	35	0.57

- For each lab except K, % Change is similar though the Lab L elastomer means are quite different from the other labs.

Tensile Strength Regression Analysis

- Combining the results from both elastomers:
  - The Lab effect is strongly statistically significant.
  - The Elastomer × Lab effect is also strongly statistically significant, largely due to the reversal of Lab K means for the two elastomers.
- Analyzing the results from each elastomer separately:
  - Labs are statistically significantly different.
  - For both elastomers, Labs M and N are in Level Code group 3.
  - For both elastomers, Labs K and L are in Level Code groups 1 and 2.

Tensile Strength Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

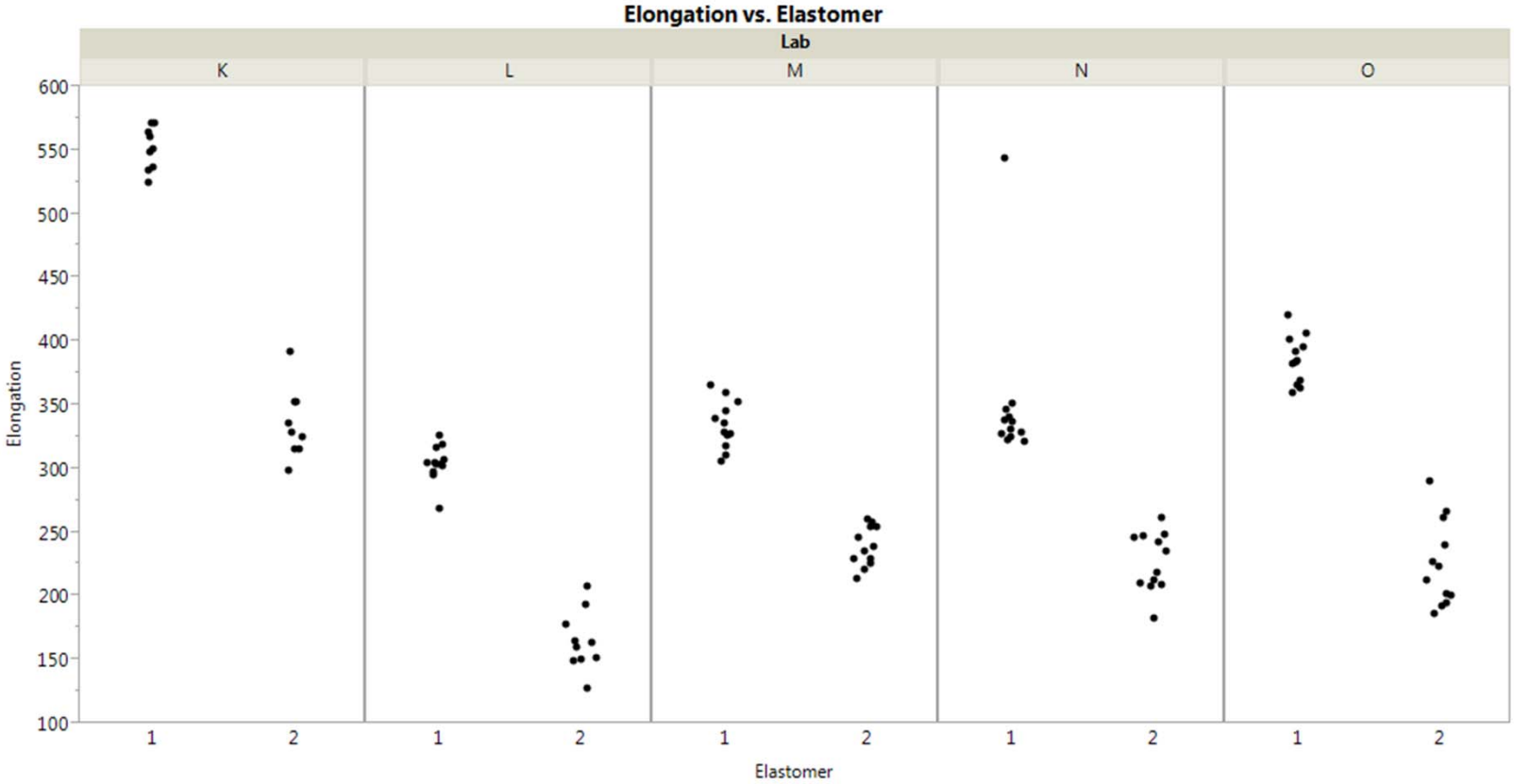
Tensile Strength Least Square Means

Elastomer	Lab	Level Code	LS Mean
1	L	1	22.7
	K	2	14.9
	O	2	14.4
	N	3	13.6
	M	3	13.3
2	K	1	29.2
	L	2	14.8
	N	3	9.4
	O	3	9.3
	M	3	9.2

Labs not connected by the same Level Code are statistically significantly different.

ELONGATION

Elongation Plot



- One of the Lab N Elongation results is an outlier for Elastomer 1.
- For all labs, the mean Elongation for Elastomer 1 is greater than that for Elastomer 2.
- For each elastomer, there is a lack of overlap for the labs.

Elongation Summary Statistics

Elongation Summary Table

Lab	Sample Size		Mean				Pooled
	Elastomer 1	Elastomer 2	Elastomer 1	Elastomer 2	Difference	% Change	Std. Dev.
K	9	9	551	335	217	39.3	22.9
L	12	10	304	165	139	45.9	18.9
M	12	12	334	239	96	28.6	17.2
N	12	12	351	227	124	35.4	46.5
O	12	12	385	225	161	41.7	27.2

- The difference in means for the Elongation of Elastomer 1 and 2 for the labs ranges from 96 to 217 but the range of % Change is 28.6 to 45.9%.

Elongation Regression Analysis

- Combining the data for both elastomers, the Elastomer, Lab and their interaction effects are statistically significant.
- Analyzing the results from each elastomer separately:
  - Labs are statistically significantly different.
  - For both elastomers, Lab K has the highest elongation and Lab L the lowest.

Elongation Effect Test

Factor	DF	p-Value
Elastomer	1	<.0001
Lab	4	<.0001
Elastomer*Lab	4	<.0001

Elongation Least Square Means

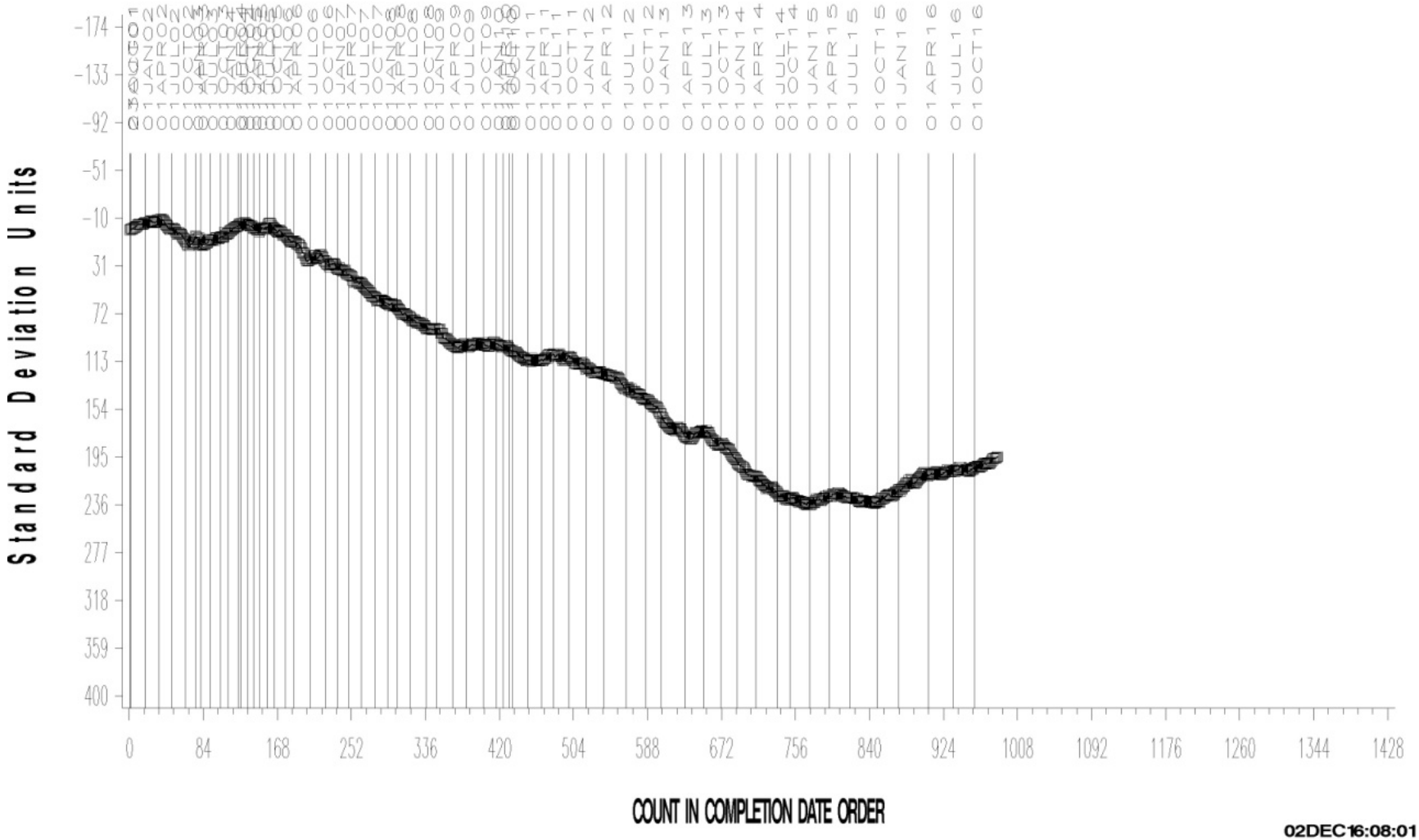
Elastomer	Lab	Level Code	LS Mean
1	K	1	551
	O	2	385
	N	3	347
	M	3	334
	L	4	304
2	K	1	334
	M	2	238
	N	2	225
	O	2	222
	L	3	163

Labs not connected by the same Level Code are statistically significantly different.

EOEC — SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON ELONGATION CHANGE AVERAGE

CUSUM Severity Analysis



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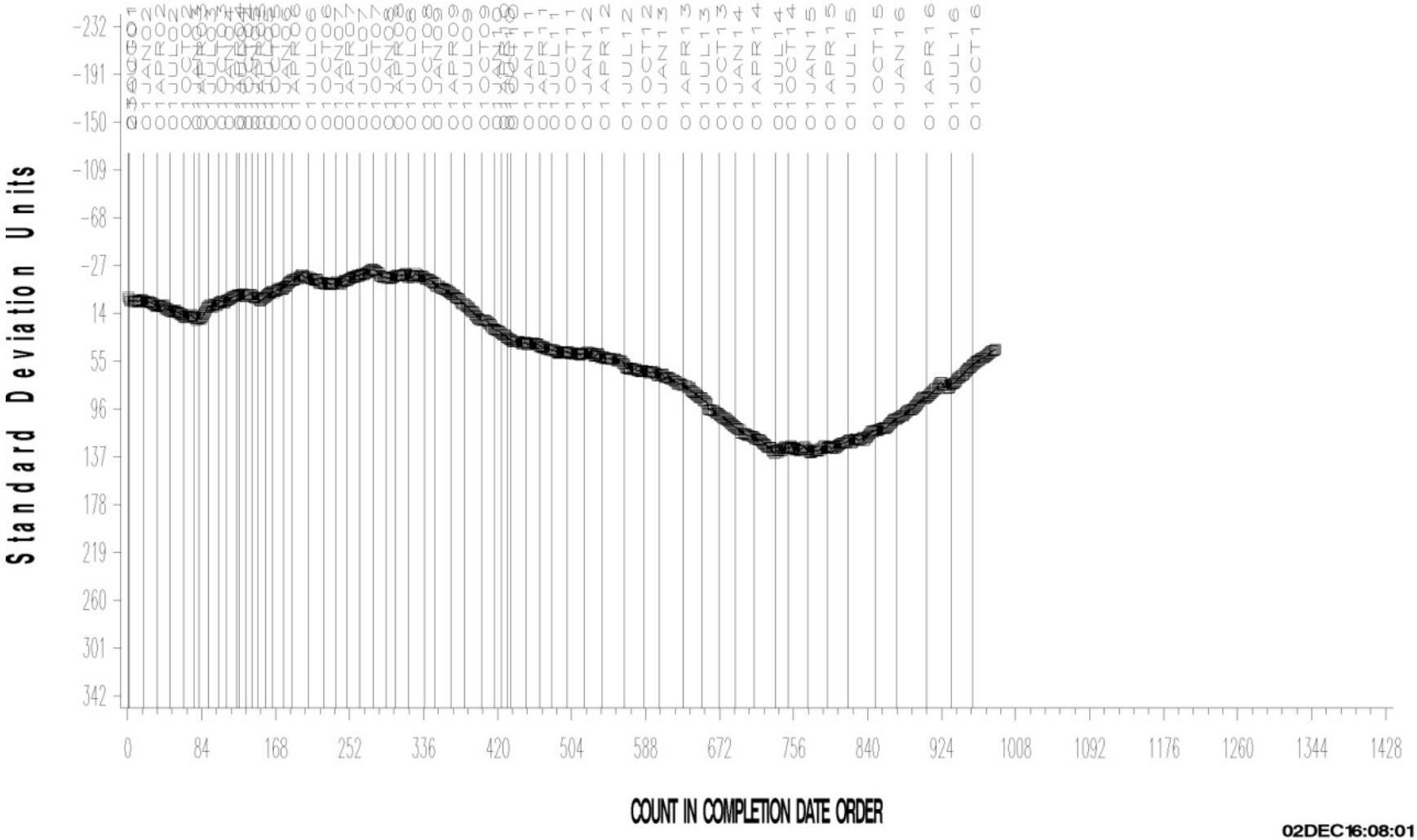
EOEC — SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON POINTS HARDNESS CHANGE AVERAGE

CUSUM Severity Analysis



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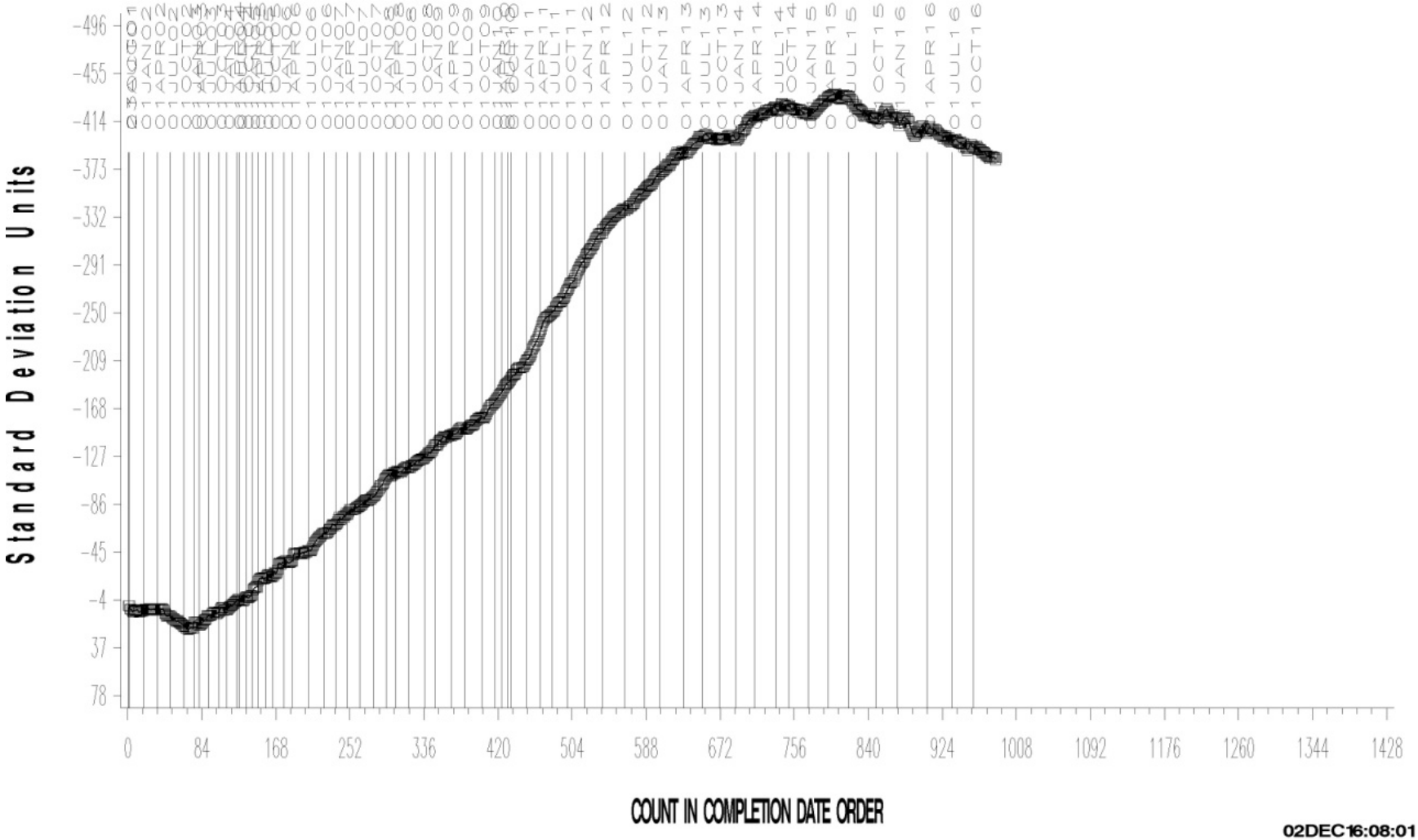
EOEC — SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON TENSILE STRENGTH CHANGE AVERAGE

CUSUM Severity Analysis



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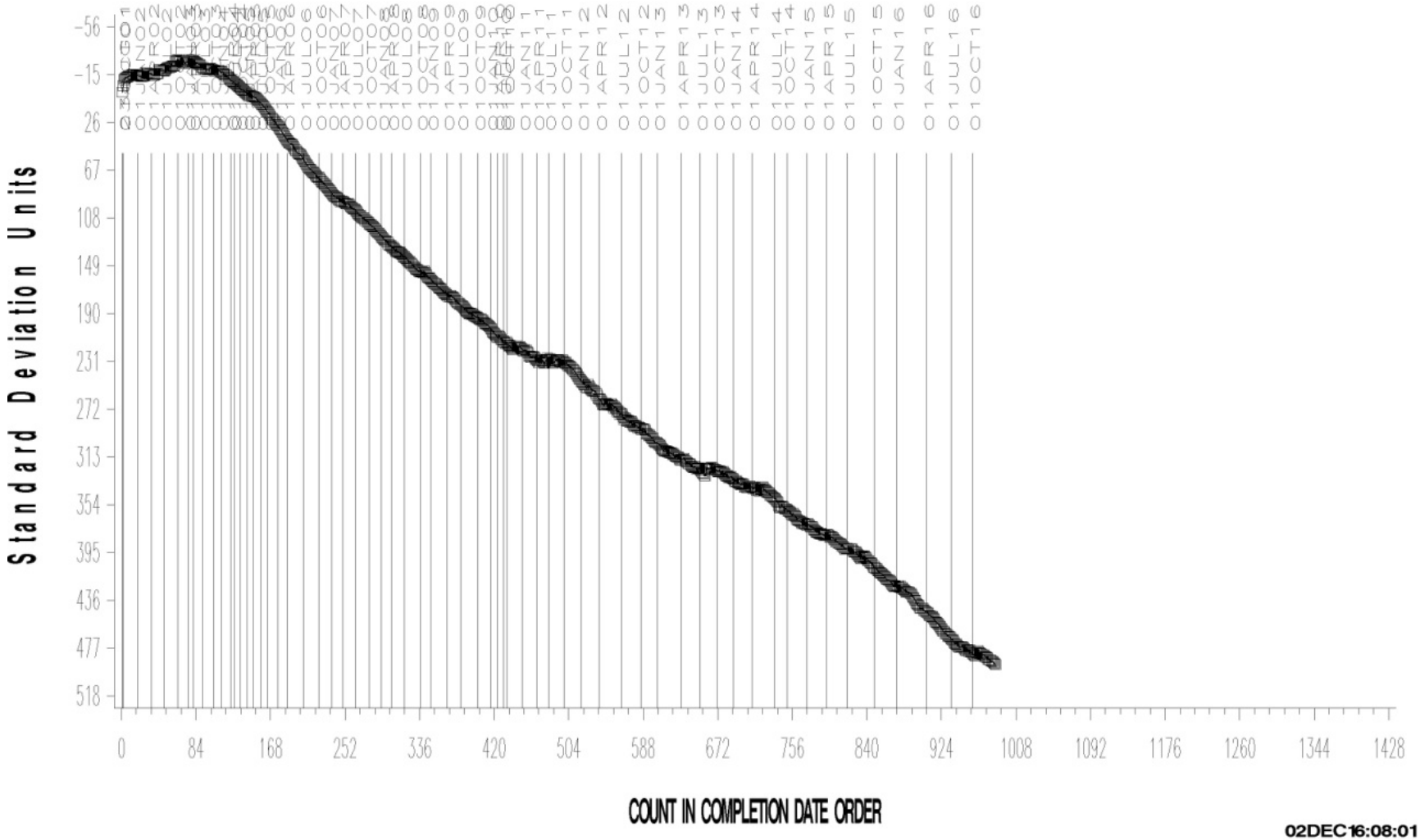
REFERENCE SILICON VOLUME CHANGE AVERAGE

CUSUM Severity Analysis



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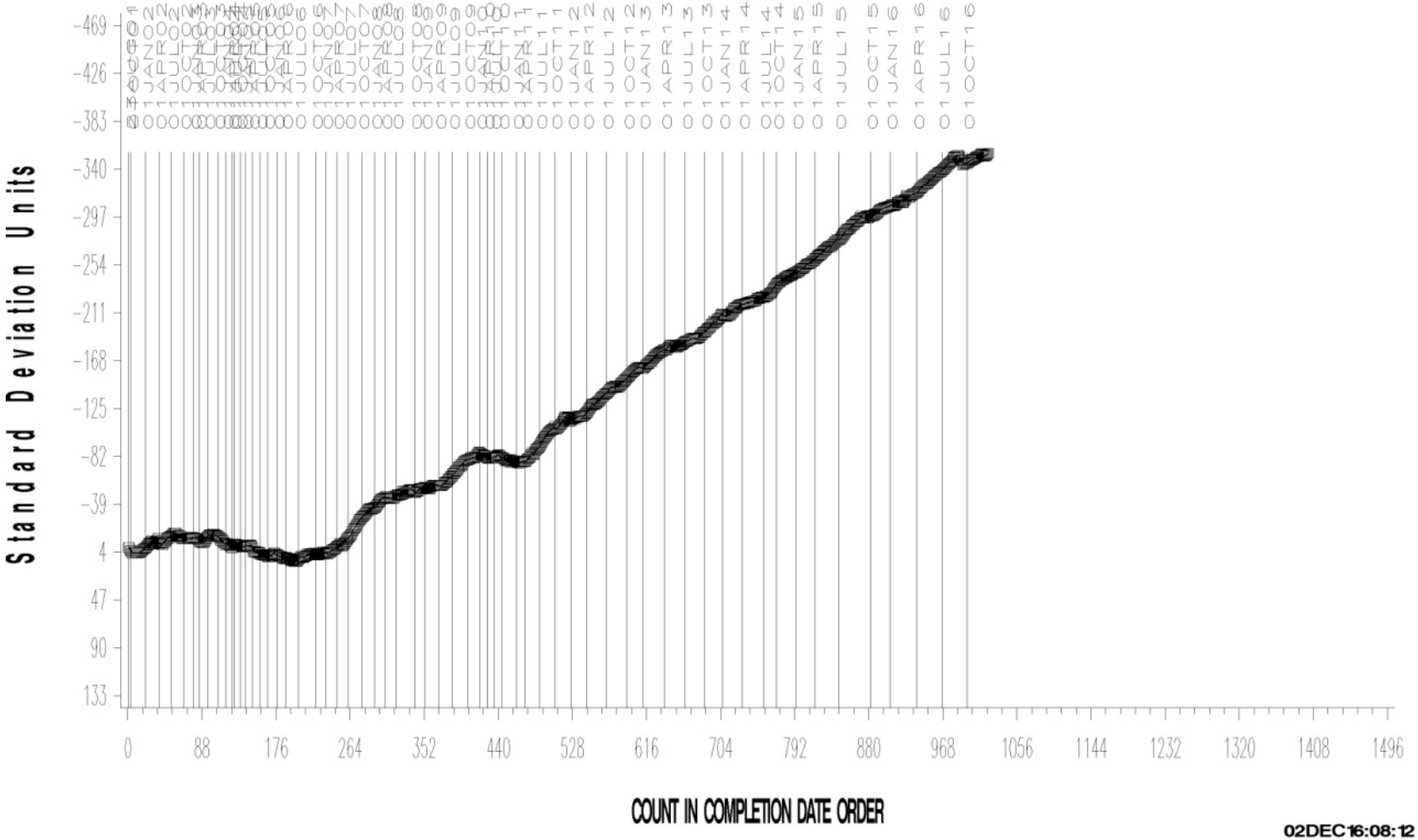
REFERENCE NITRILE ELONGATION CHANGE AVERAGE

CUSUM Severity Analysis



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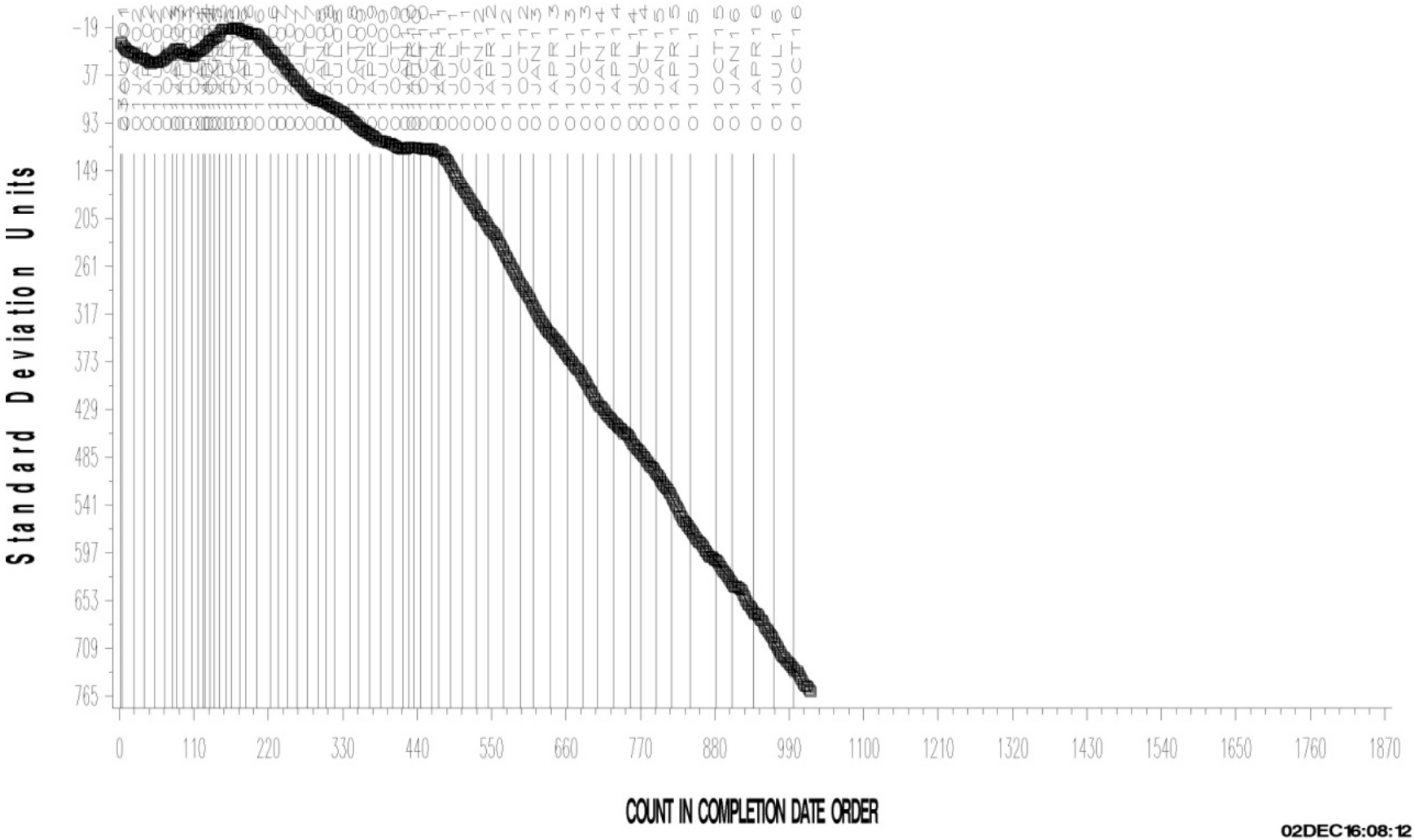
REFERENCE NITRILE POINTS HARDNESS CHANGE AVERAGE

CUSUM Severity Analysis



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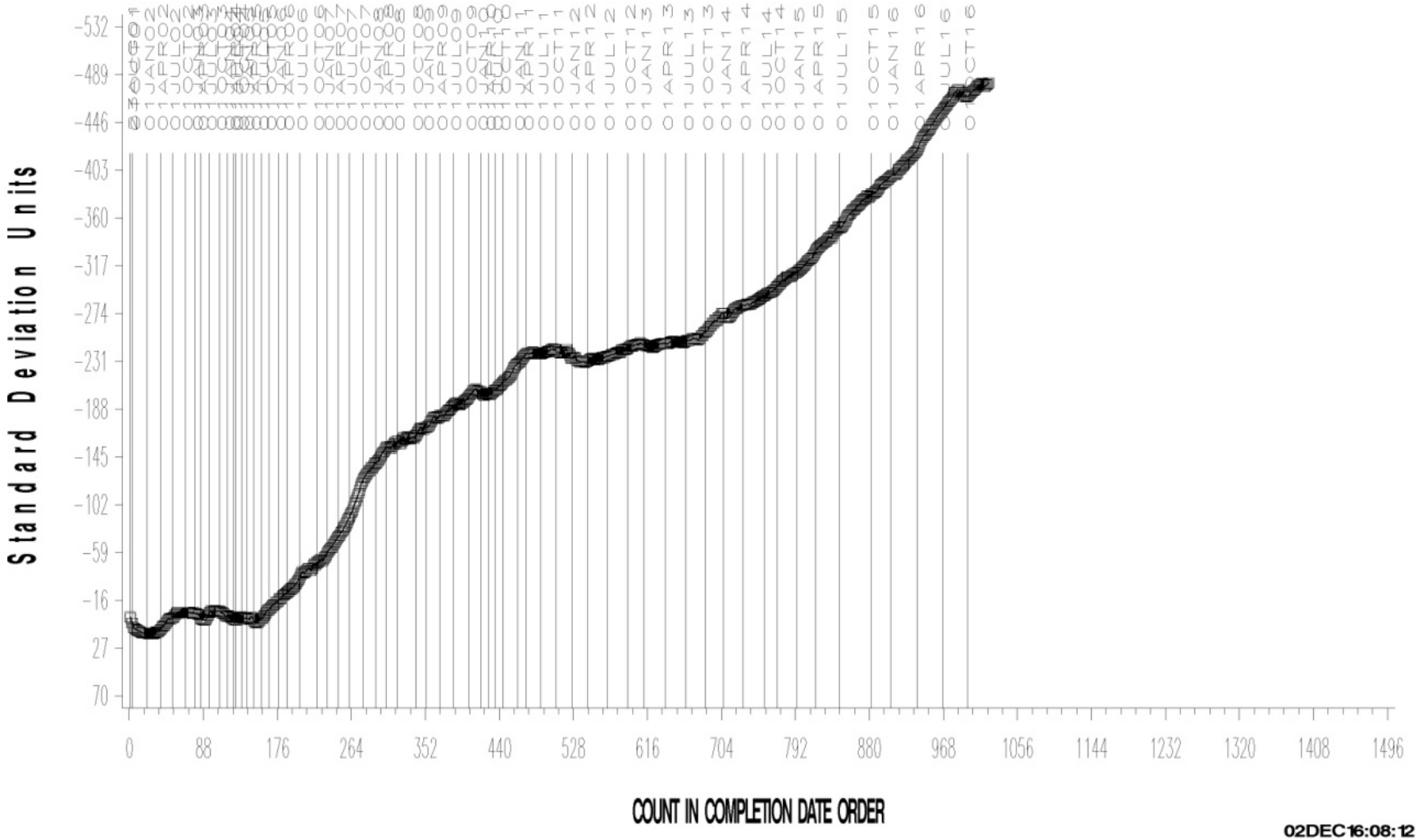
REFERENCE NITRILE TENSILE STRENGTH CHANGE AVERAGE

CUSUM Severity Analysis



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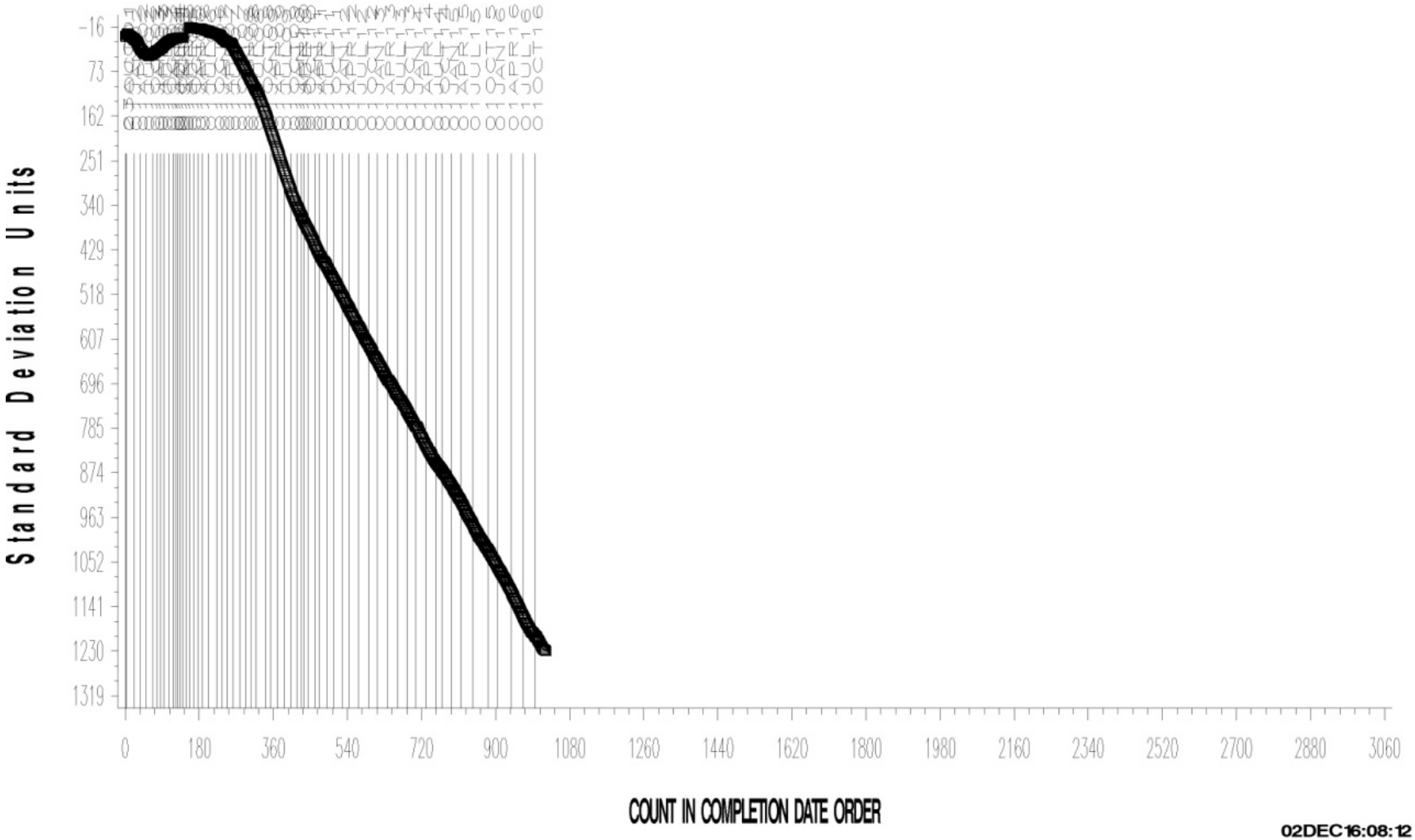
REFERENCE NITRILE VOLUME CHANGE AVERAGE

CUSUM Severity Analysis



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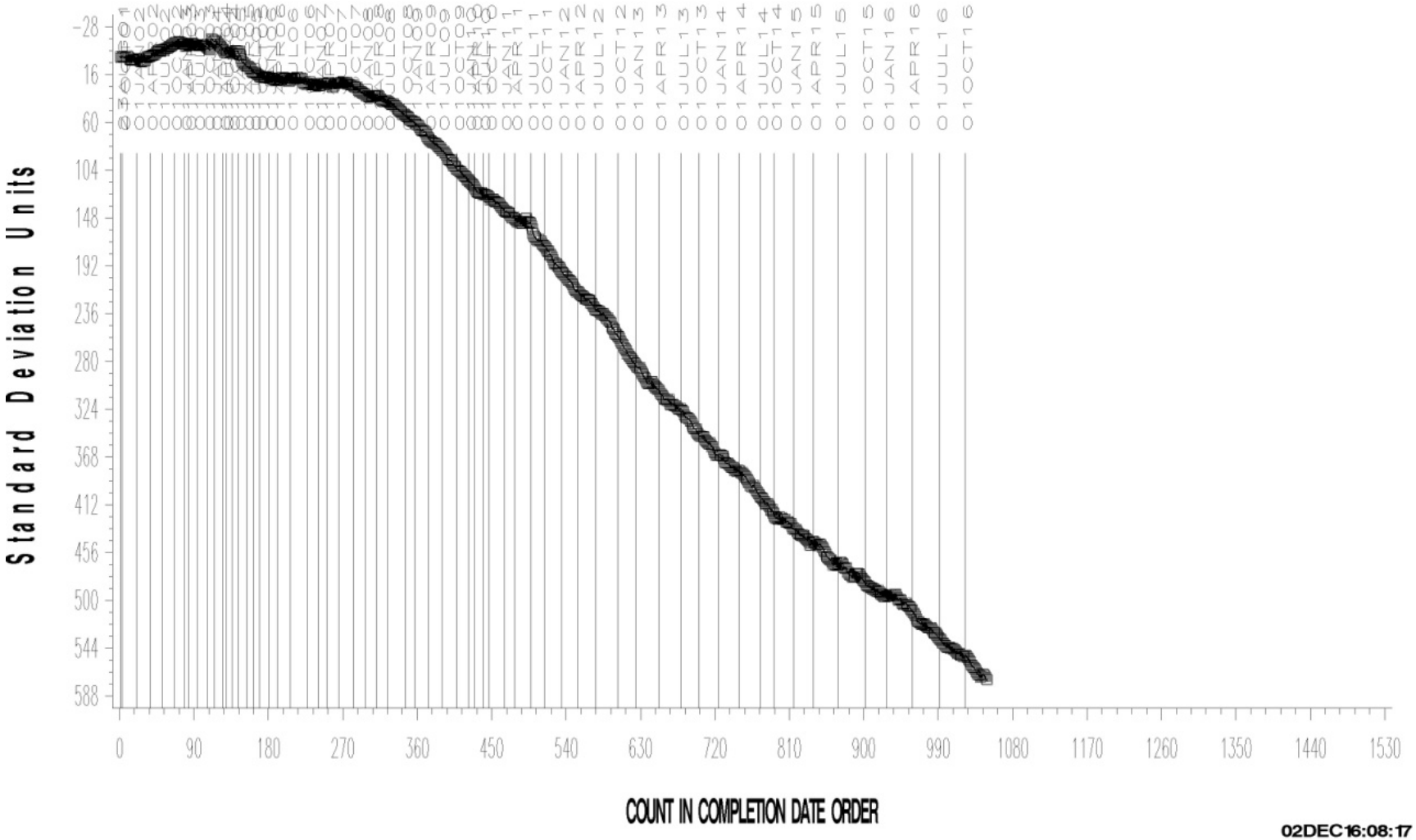
REFERENCE POLYACRYLATE ELONGATION CHANGE AVERAGE

CUSUM Severity Analysis



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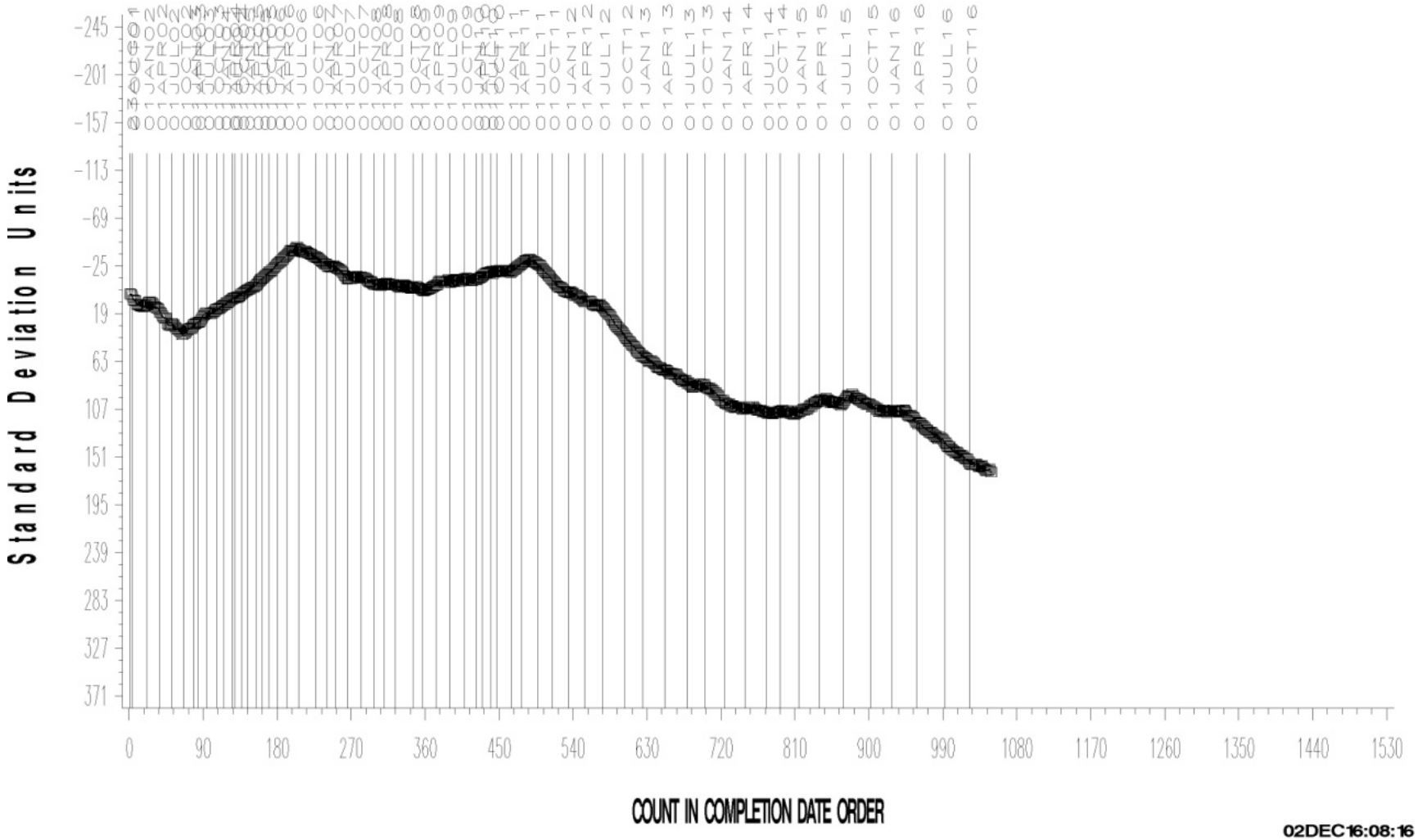
CUSUM Severity Analysis



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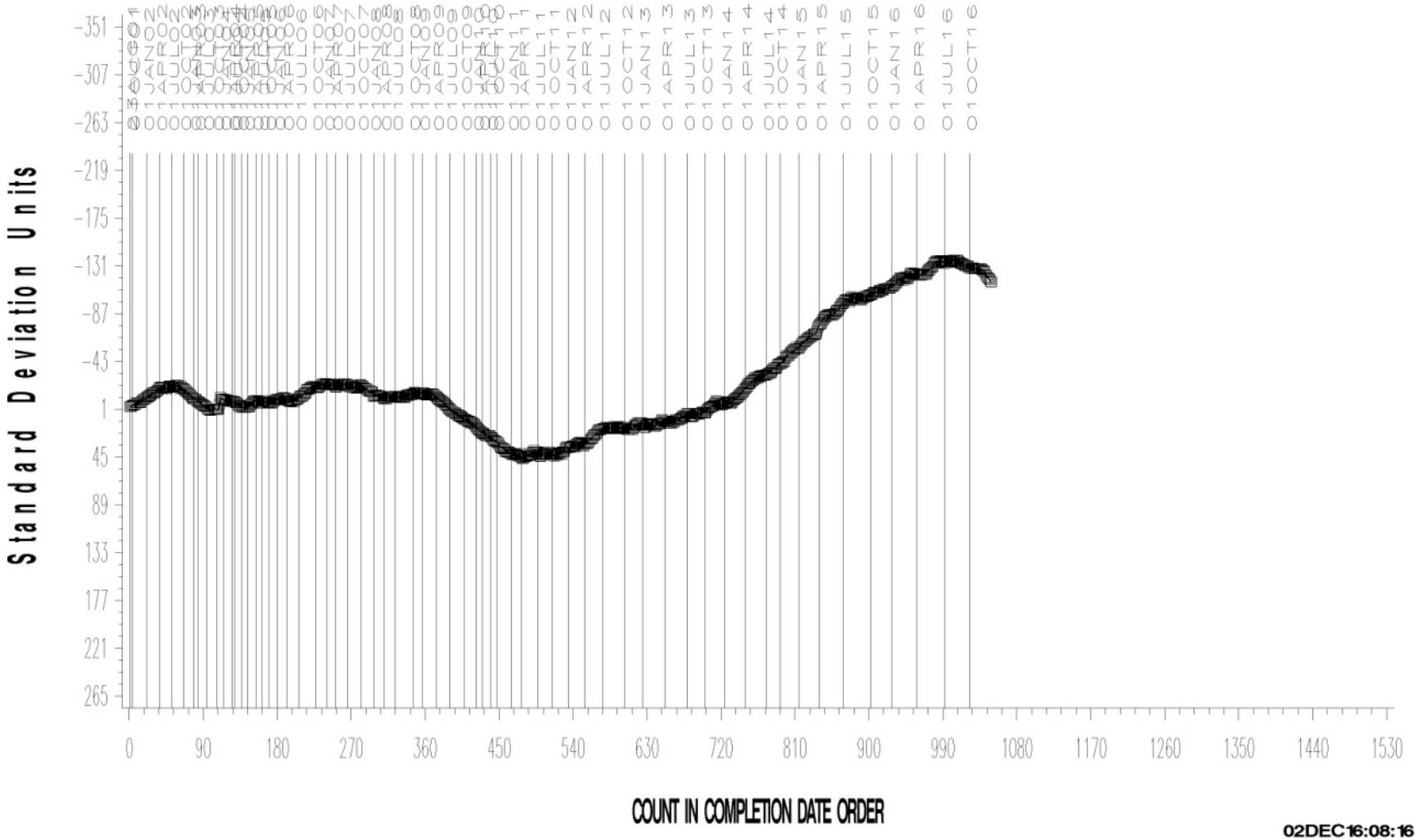
CUSUM Severity Analysis



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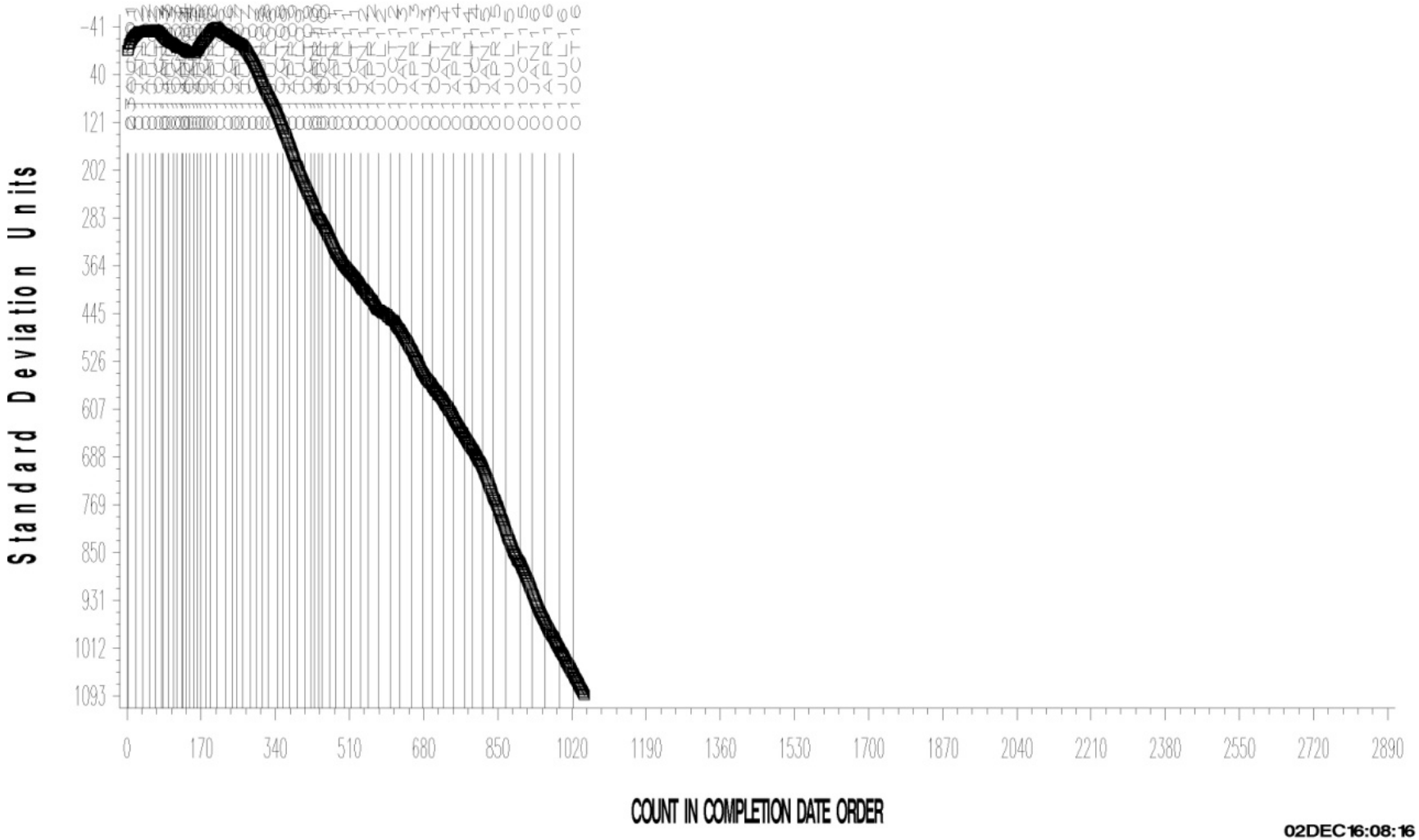

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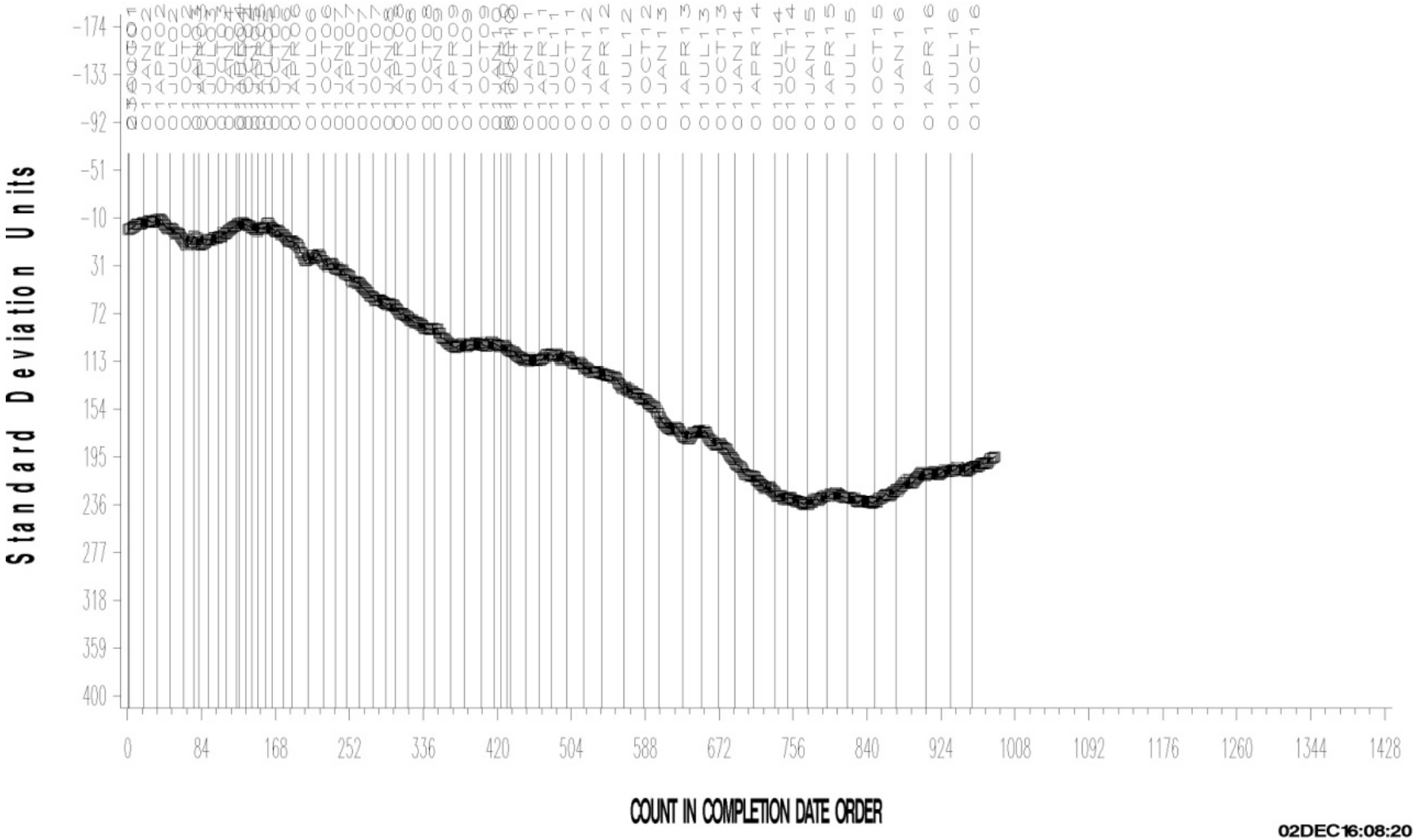
EOEC — SILICONE INDUSTRY OPERATIONALLY VALID DATA

REFERENCE SILICON ELONGATION CHANGE AVERAGE

CUSUM Severity Analysis



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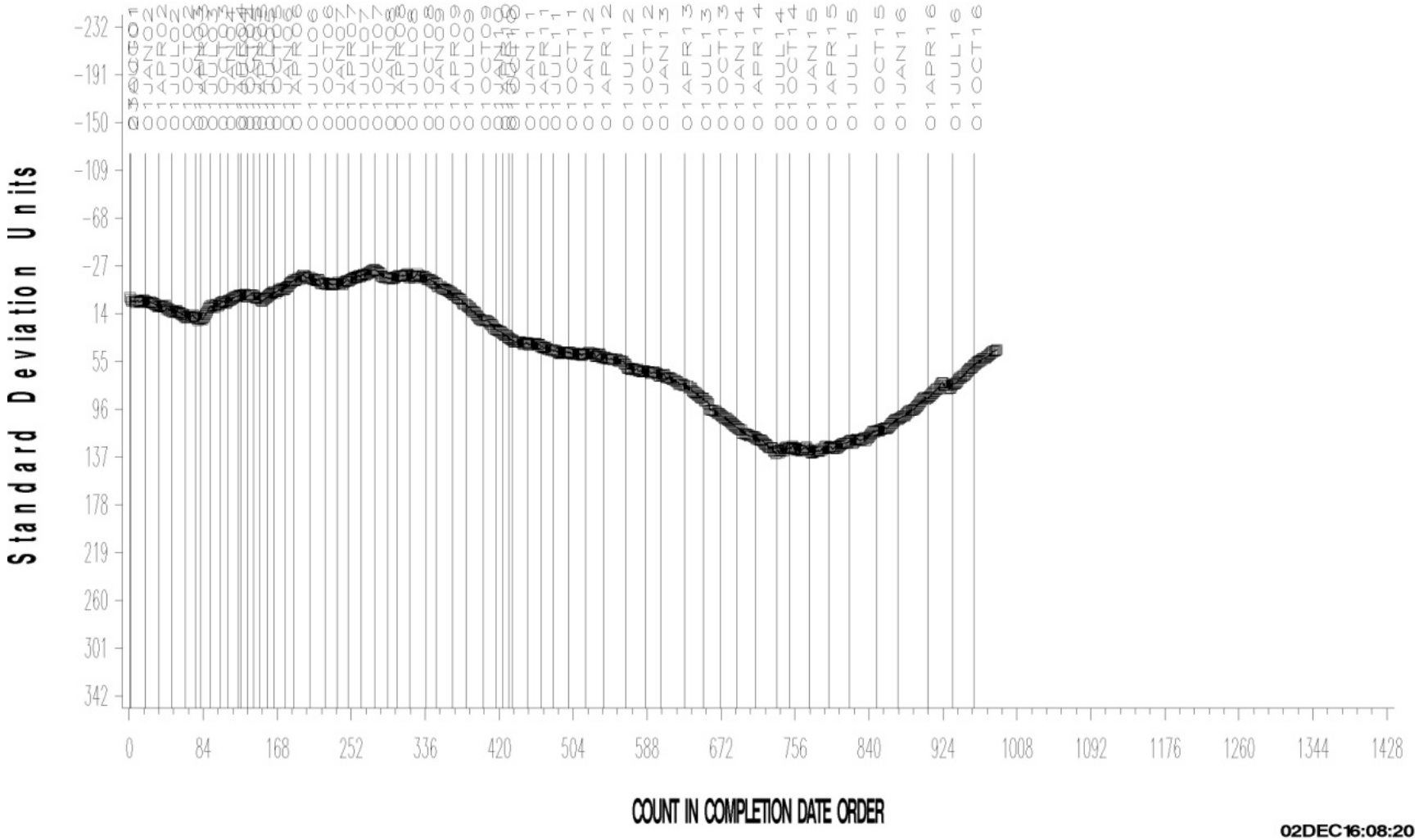
REFERENCE SILICON POINTS HARDNESS CHANGE AVERAGE

CUSUM Severity Analysis



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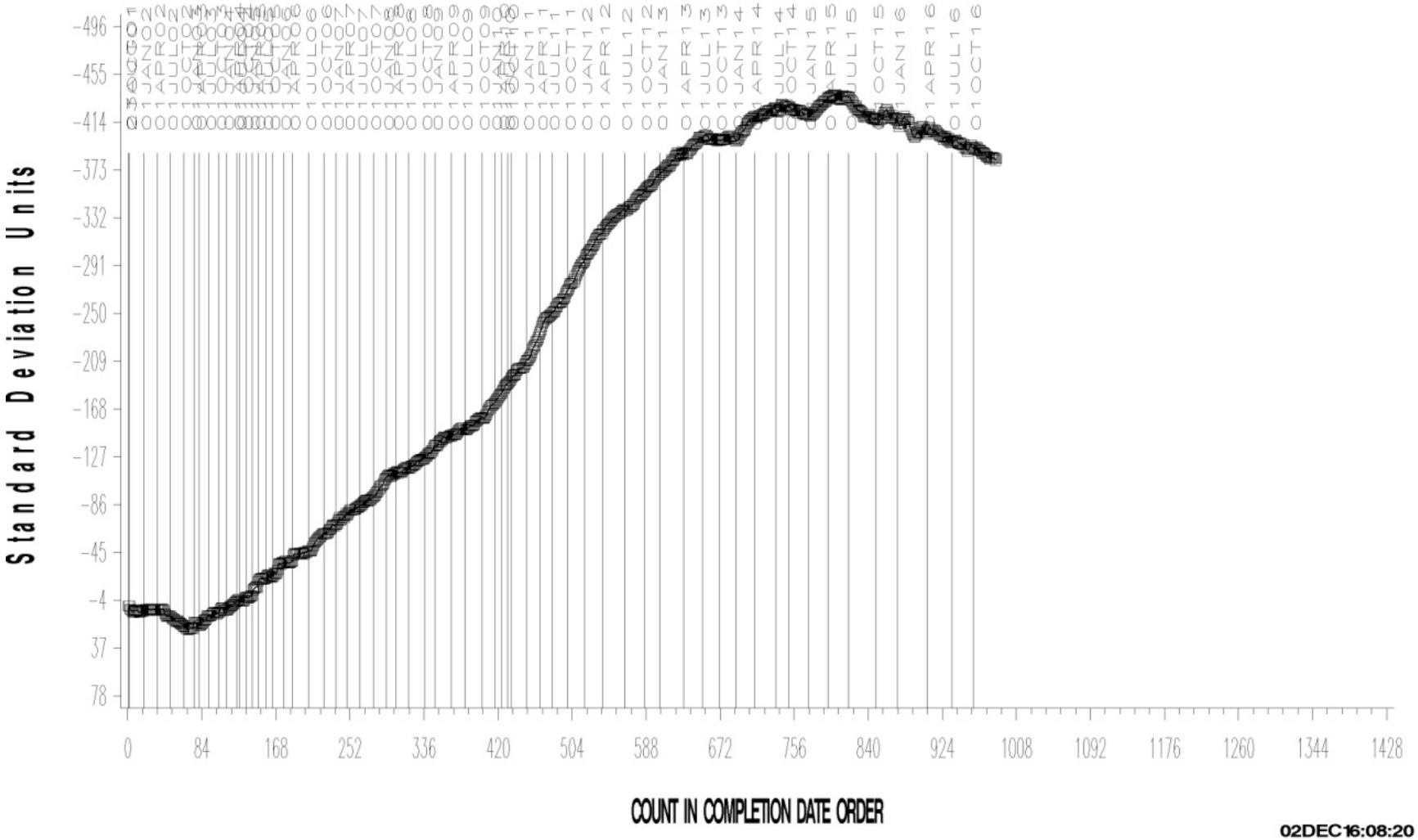
REFERENCE SILICON TENSILE STRENGTH CHANGE AVERAGE

CUSUM Severity Analysis



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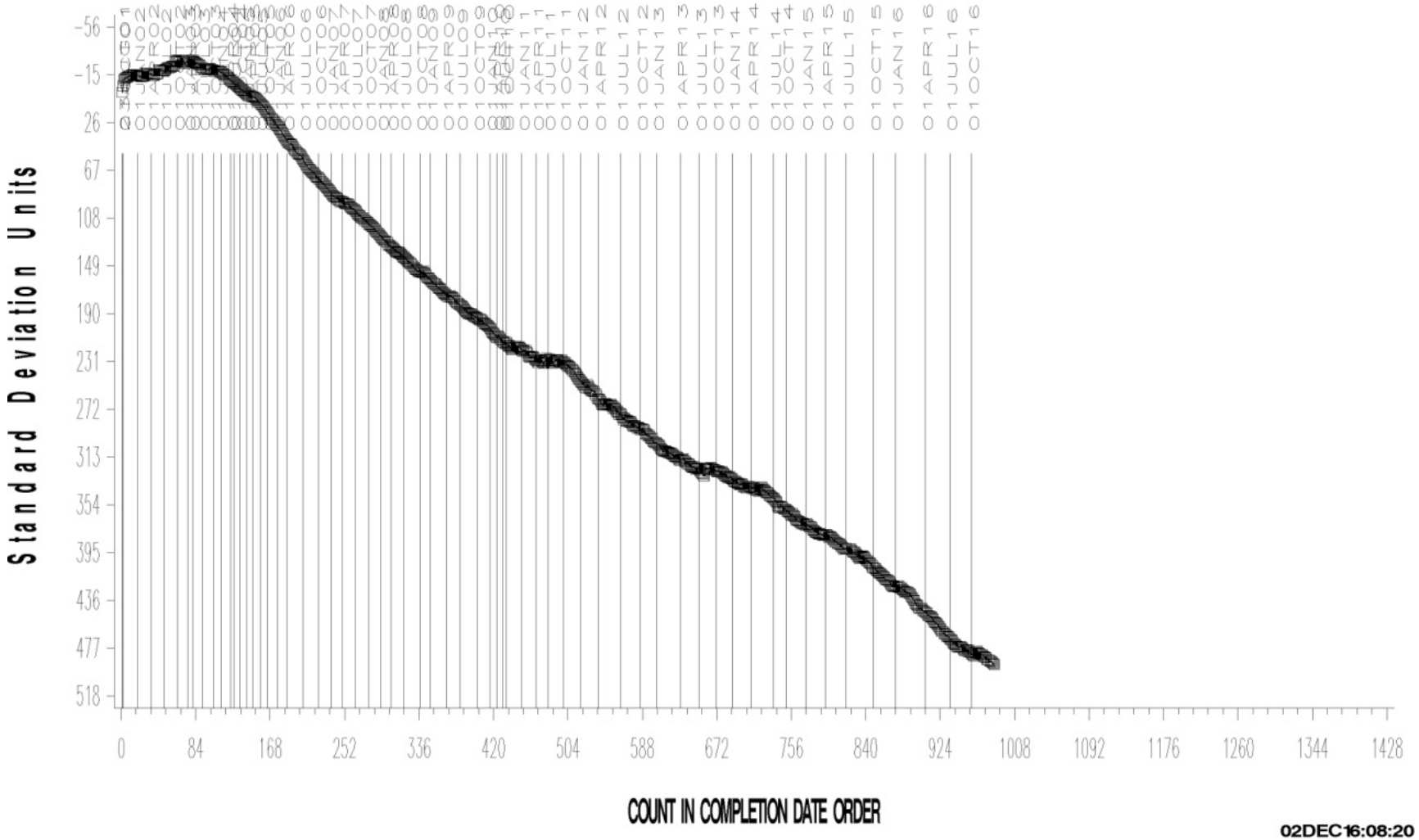
REFERENCE SILICON VOLUME CHANGE AVERAGE

CUSUM Severity Analysis



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DAIMLER

DD13 Scuffing Test Update

Suzanne Neal & Patrick Joyce

23NOV2016

Daimler Trucks

FREIGHTLINER

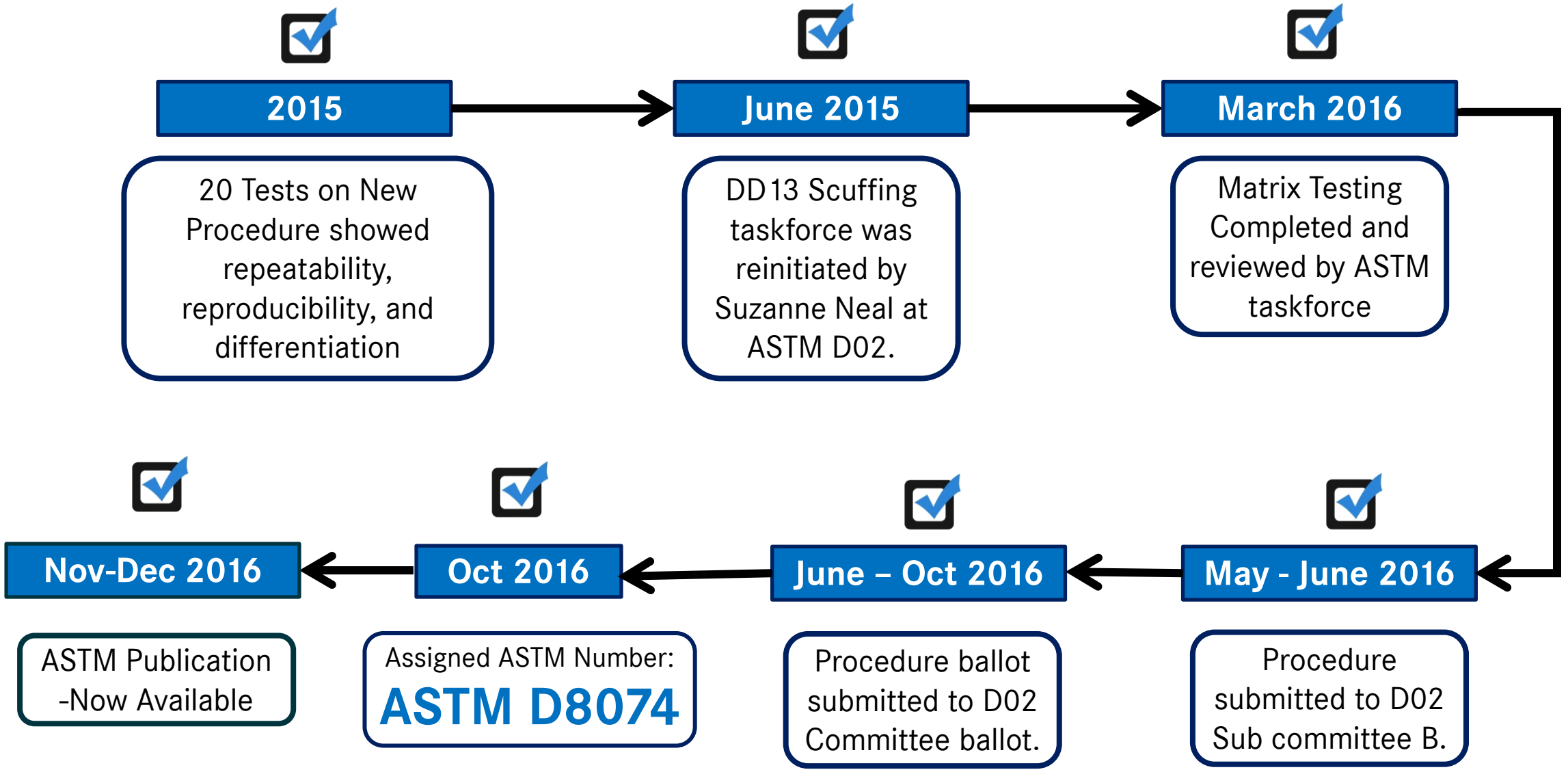
FUSO

WESTERN STAR

Thomas BUILT BUSES

BHARATBENZ

DD13 Scuffing Test Timeline Update



ASTM Website - 11/23/2016

ASTM D8074 - 16

Standard Test Method for Evaluation of Diesel Engine Oils in DD13 Diesel Engine

Active Standard ASTM D8074 | Developed by Subcommittee: D02.B0

Book of Standards Volume: 05.05

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Daimler Surveillance Panel

Daimler Surveillance Panel	
Initiated	ASTM June 2016
Chairman	Patrick Joyce – Lubrizol Corporation
Secretary	Jose Starling – Southwest Research Institute
OEM Representative	Suzanne Neal – Daimler
TMC Representative	Sean Moyer
Next Meeting	December 14th, 2016 11:00 AM to 2:00 PM Eastern Time Zone

Ford Position on CK-4 and FA-4

New Ford Diesel Motor Specification

Heavy Duty Engine Oil Classification Panel

Ron Romano
December 6, 2017

Concerns about CK-4 and FA-4

- Some formulations may not be as robust on wear protection as existing CJ-4 formulations with >1000 ppm phosphorus.
- Ford has seen accelerated 6.7L valve train wear with some CK-4 and FA-4 formulations that we haven't seen with existing CJ-4 formulations.
- We have wear concerns about CK-4 and FA-4 formulations with less than 1000 ppm phosphorus in new and older Ford engines.
- Some examples of observed wear attached. Attached photographs does not include all tests conduct. See January 28, 2015 presentation for more data.

Durability Tests in 6.7L with 5W-30 PC-11B

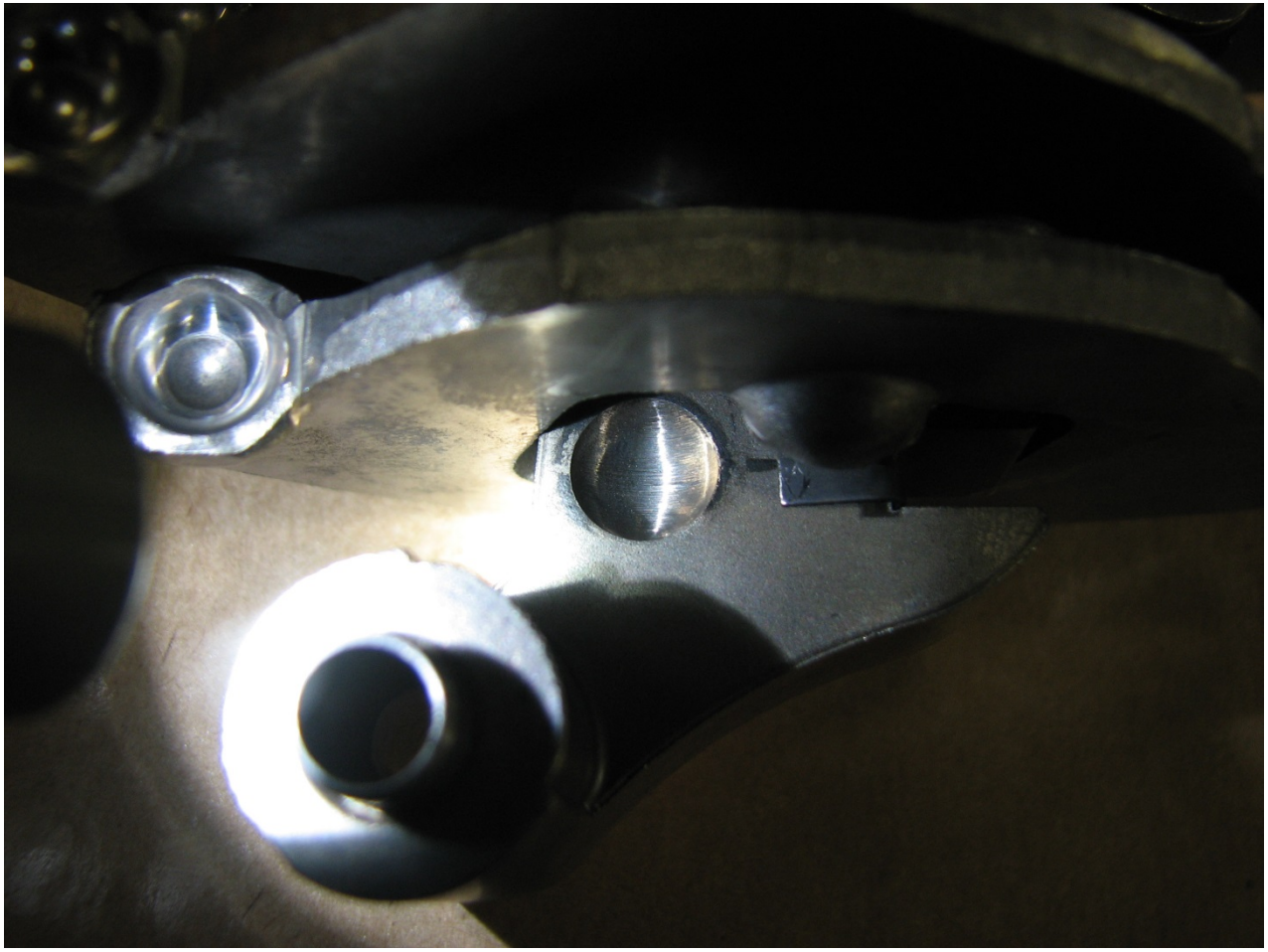
Example of accelerated wear on pushrod ends

Durability Tests in 6.7L with 10W-30 PC-11A

Example of accelerated wear on rocker arm fulcrums

Durability Tests in 6.7L with 10W-30 PC-11A

Example of accelerated wear on rocker arm fulcrums



Ford Diesel Motor Oil Recommendations Going Forward

- Ford will not be recommending CK-4 or FA-4 to service any Ford diesel engines at this time.
- Ford will continue to recommend CJ-4 oils with more than 1000 ppm phosphorus. These should be oils that are license to CJ-4 only without CK-4 in the donut.
- Historically Ford has always recommended API diesel categories but will depart from this for CK-4 since some products will contain <1000 ppm phosphorus.
- Ford recommends that API change CK-4 and CJ-4 to include a minimum phosphorus limit of 1000 ppm.
- Ford recommends that if no phosphorus limit is put in CK-4/CJ-4 then, API require as part of licensing, oils with <1000 ppm phosphorus be labeled “Low Phosphorus”.
- Ford released an OEM specification that will contain addition wear requirements compared to CK-4.
  - WSS-M2C171-F1
- Ford has an official approval program for this spec and will publish an approved products list. Recommend working through your additive company for approval.
- Contact Ron Romano or Chuck Richardson to begin the approval process or for more information.

WSS-M2C171-F1

- Contains all CK-4 requirements and limits
- 6.7L valve train wear test
  - Development in progress
  - Estimated completion 1Q17
  - Upon completion turn over to ASTM to be published as an ASTM test procedure.
- Need approved formulations until test development is complete.
- Optional/additional requirements to approve formulations without the 6.7L engine test
  - 1000-1200 ppm phosphorus
  - CJ-4 formulations licensed prior to January 2016 with an antioxidant boost for T-13.
- Other engine testing conducted on the 6.7L engine may be used if approved by Ford Motor Company prior to testing.

Summery and Next Steps

- WSS-M2C171-F1 published
- Ford position statement published
- 200+ products approved to WSS-M2C171-F1
- Publish an approved products list. Shown in Motor Oil Tab on https://www.fcsdchemicalsandlubricants.com/main/ .
- Complete 6.7L wear test development.

Ford Motor Company CK-4/FA-4 Ford Position Statement

Starting on December 1, 2016 the American Petroleum Institute (API) will begin licensing two new diesel motor categories CK-4 and FA-4. API CK-4 is being released to replace CJ-4. FA-4 is a low viscosity diesel oil released for diesel engines designed for a lower viscosity oil.

API FA-4

Due to its low viscosity FA-4 should not be used in any Ford diesel vehicles at this time.

API CK-4

Ford will not be recommending the use of CK-4 motor oils in any Ford diesel engines, new or old. Testing Ford has done on some CK-4 formulations have shown inadequate wear protection compared to CJ-4 formulations developed and licensed before 2016.

Like many other diesel engine manufacturers, with their own internal OEM specification, Ford will now be recommending oils that meet an OEM specification, Ford Material Engineering Specification WSS-M2C171-F1. The customer should use an oil showing that it meets this specification.

An oil showing CJ-4 in the API donut without showing CK-4 would be acceptable for service even if not showing WSS-M2C171-F1. This oil would most likely be an older CJ-4 formulation, developed and licensed prior to 2016. These oils could be around for about a year after CK-4 licensing begins, December 1, 2016. Field experience and Ford testing has shown that these older CJ-4 formulations provide acceptable 6.7L engine protection.

To insure you protect your Ford diesel engine use an oil meeting Ford specification WSS-M2C171-F1 like Motorcraft Super Duty Motor oil.

Questions

Chevron Oronite

Suggested Edits to ASTM D4485 for PC-11

Laura Birnbaumer

December 6, 2016

ADDING UP™

Suggested Edits to ASTM D4485 for PC-11

- There was a concurrent D02/Sub B ballot that closed August 16, 2016 and Item 54 was a ballot to finalize PC-11 in D4485.
  - I felt there were six items that could be changed to increase the clarity and usability of the standard.
  - The all of the suggestions are editorial and do nothing to change the technical aspect of the D4485 ballots.
- Three of the items were accepted as editorial changes and I editorially withdrew my negative.
  - Capitalize the “A” for the T-11A, include “for used oils” in the description of the MRV method, change the T-13 parameter name to “T-13 FTIR Peak Height Oxidation”
- The other three items to make the standard clearer and easier to use need their own ballots.

Suggested Edits to ASTM D4485 for PC-11

- 6.9 {Test Procedures} Lists D5800 as a test necessary for API CK-4 and API FA-4 but D5800 is not included in 4.1.6 {Performance Classification}.

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  - 4.1.6 provides an explanation of the test methods required for these API Service Categories.
- D5800 is not included in 4.1.5 {Performance Classification} for API CJ-4 while it is included in 6.8.
- But a D5800 description does occur in 4.1.4 for API CI-4.

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- **Proposal:** Copy 4.1.4.11 to both 4.1.5 and 4.1.6 in an appropriate location and number appropriately.

Suggested Edits to ASTM D4485 for PC-11

- In the bench test section, D6896 (MRV TP-1) includes new language "(D7156 Engine test requirement)".

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- I understand the desire to emphasize that the used oil for this D6896 comes from a D7156 but since you can schedule a T-11A without a T-11.

- **Proposal:** change "requirement" to "required" so the first line would now be "D6896 (Sooted Oil MRV TP-1) "(D7156 Engine test required)".

Suggested Edits to ASTM D4485 for PC-11

- Combining the two viscosity grades as one column of limits under CK-4 is confusing where there are different limits for the different viscosity grades especially HTHS Viscosity at 150 °C.

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- Another area where the difference in limits by viscosity grade is controlled by the row title is viscosity after 90 cycle shear.

- Proposal: Make a column of limits by viscosity grade or summer viscosity grade under CK-4 so that there are multiple columns of CK-4 limits.