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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

August 1, 2007

Reply to:

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ASTM D02.B0.03 L-37 Surveillance Panel
Members and Guests:

Attached for your review and comment are the unconfirmed minutes of the:

- **June 27, 2007 L-37 Surveillance Panel Meeting minutes at Dana, Maumee, Ohio. Part 1-minutes plus attachments 1 through Attachment 5.**

Please direct any corrections or comments to my attention.

Sincerely,

Donald T Bartlett

Donald T. Bartlett, Chairman
L-37 Surveillance Panel
Attachments

Report of Meeting
L-37 Surveillance Panel
Dana Corporation, Maumee, Ohio
June 27th, 2007

Sign-in/Review of Agenda & Membership: The meeting was called to order at 9:05 am. The sign-in sheet is ***Attachment #1***. Please not that Lou Pappademos and Mark Basset, both of the Dana Ft. Wayne facility were present as well. Kenny Miller – Dana, Statesville Facility joined us via Teleconference.

Attachment # 2 is the Power Point document that includes the membership list, agenda, and discussion points for today's meeting. An agenda review (page 2) was performed with no additions to the agenda.

The chairman reviewed the membership list with no changes being requested. We have 15 voting members.

Approval of Minutes The minutes of the November 15, 2006 Surveillance Panel Meeting were presented for review and approval.
Motion 1 ⇒ Mr. Koehler, Second ⇒ Mr. Lind) – Move to accept the minutes of the February14 panel meeting and the April 24, May 3, and May 10, 2007 teleconference call meetings as written and no additions or corrections. The motion passed unanimously with a vote of 7-0-0.

Summary of Meeting Discussions

2006 Lubrited Hardware Order Status – B6L566/P4L816

1. ***Attachment # 2***, slides 6, through 10 details a summary status of this gear batch to date. General comments during discussion of attachment # 2:
   - Chairman Bartlett asked about the steel type – did we use different steels in the past? Mr. Kreinbring replied that the drawing matches the light duty type and leaves options for what steel. But 8625 is a wide band and we need to restrict it further with respect to "high hardenability".
   - Mr. Pappademos indicated that Ft. Wayne was getting shallow case depth – so they had to raise the temperature to get the proper cased depth. Hardenability in this heat of steel was low but in the bands, causing changes for heat-treating process; 2.55 DI heat needed, 2.15 heat is what came in, so they had to change the heat and soak time, which changed the distortion from original design. They got the metallurgical properties they wanted, but the distortion caused a problem.
   - Mr. Fett mentioned that production material is changing, so making drawing corrections as such is important.
   - Mr. Kreinbring was asked about all of the updates to the Dana documents that had previously been requested. Mr. Kreinbring stated that the drawing changes have not been made yet, but will happen if and when there is another order. Change request is written, but not in place yet.

- Mr. Miller stated that the same work order will change the carrier drawing as well. He also discussed pattern change and distribution. They were modified after the first pilot build, and were satisfied with the change.

Review of 44-test Matrix data for gear batch B6L566/P4L816 – TMC

1. For the benefit of those new to the group, Mr. Gropp provided a summary of the SAEJ-2360 pass & fail line and its history.
2. ***Attachment # 3***, details Standard Temperature and Low Temperature testing to date. Note the results only contain ratings of the pinion.

3. ***Attachment # 4***, details Oil Performance by LTMSLAB.

4. ***Attachment # 5*** details L-37 Reference Oil Comparison by Distress Type and Oil.

5. ***Attachment # 6***, details L-37 Reference Oil Performance by Pinion Batch. The following general comments were captured in discussions with Attachments 3 through 6:
   - Mr. Lind first discussed the TMC 127 results. He noted that broken teeth happen sometimes with TMC 127 but very rarely with the pass oils, especially not as often as we've seen on this batch. Fails on Pinion Ridging and Spitting = 100% . The best performing oil (TMC 155) had no broken teeth but had 2 fails on ridging, 1 fail on rippling, and 4 fails on spitting. Also note that of the 44 tests, 9 tests exhibited broken teeth. Only one test failed to run full length.
     - ☐ **Action Item:** (SwRI to correct CMIR 58909) as it was reported with no broken teeth, but that is not the case. The VAL column is to be changed to from AC to MG.
     - ☐ **Action Item:** All labs to go back and revalidate/confirm that they have correctly reported tests that exhibited broken teeth.
   - Mr. Gropp explained that TMC 155 is an oil that should pass all the tests ~85% (reasonable %).
   - Mr. Koehler commented with respect to TMC 155 that his concern would be with spitting. (50% failed due to this parameter).
   - Mr. Lind – TMC oils 152 and 153 are 75W-90 factory oils and reported that he has yet to see any correlation provided by the supplier (several requests were made). With respect to this gear batch, both oils do have problems with ridging and pitting/spalling.
   - Ref oil pass ratios are a concern with this gear batch and other comments are as follows:
     - ✓ 153: 0% pass
     - ✓ 155: 50% pass
     - ✓ 152: 12% pass
     - ✓ 5/24 pass which means only ~20% pass rate
     - ✓ ~20% would have been able to go LRI
     - ✓ [All gear batches 152] For current batch compared to all others… Spitting is worse. Ridging is also bad. Low Temp looks better than Standard and better than past gear batches.
     - ✓ [All gear batches 153] For current batch compared to all others, ridging a concern. Low Temp looks better than Standard and better than past gear batches.
     - ✓ 24% of this batch (24 tests) had broken teeth – cannot be used in data to set targets.

- ✓ Mr. Gropp expressed his philosophical view of how a test is developed, and correction factors / exclusion zones to mathematically bring the pass line back to where we needed.

6. Chairman Bartlett shared previous hardware matrix spreadsheets pulled from previous lubrited and non-lubrited Matrix work. ***Attachment # 7, page 1*** is a spreadsheet summary of the Standard temperature only testing for the T758A/L247 Lubrited hardware matrix, 2004.
7. ***Attachment # 7, page 2 and 3*** is a spreadsheet summary of the Standard and Low temperature testing for the V1L417/P4L792 Non-Lubrited hardware matrix approval, 2005.

8. ***Attachment # 7, page 4 and 5*** is a spreadsheet summary of the Standard and Low temperature testing for the V1L351/P4T771 Non-Lubrited hardware matrix approval, 2004.

9. ***Attachment # 7, page 6*** is a spreadsheet summary of the Standard temperature testing for the V1L176/P4L741A Non-Lubrited hardware matrix approval, 2002.

10. ***Attachment # 8,*** provided by Mr. Miller & working with Lubrizol. He was looking at gear set micro-geometry to understand if there is a reason for the results and failures we've seen. He was looking at the variables of Flank in and out, length, and theoretical FEA for Drive side and used the photos and axle build data sheets that Lubrizol provided from their portion of the matrix work sent. There is variance in all things, (contact pattern, build info). Some of his conclusions were:
    - L and F variance in the pictures - given the labels that were used, one of the sheets were labeled F0, (L +1 L -1) but there was subjectivity of the builder when it comes to flank or length position.
    - At least one is labeled F0 and should be -1.
    - All lengths were L2, but no correlation to the length and F to the damage.
    - Test 1, versus Test 5 (broken tooth). Test 1 was spalled, test 5 spalled and broken.
    - Test 1 pretest was more flank neutral than test 5, test 5 is somewhat flanked out. He doesn't think Flank position affects the damage. Most damage appears in the pinion addendum heel, but he doesn't see anything that correlates. Same with the L positioning (his view).
    - Using FEA model – is there a correlation of pressure wave? There does appear to be a correlation of the pressure plot and the location of the failure modes. Pressure plots seem to follow the failure on the teeth. Wear – score – spall in his opinion in order of distress occurrence. Given the hot spots – it compares pretty good to the EOT photos. It matches with the theoretical design on where the failures should occur. The idea in the past was to get a better distribution over the tooth and increase the area that the stress was on – and lower the peak stress (% 14 reductions). And this is what was done in the redesign.

- If there is high stress at those points, then that's generally bad – as it flips back and forth as it runs.
- The same model was used for the 3 non-lubrited batches. So it's telling us that the design is true, and that the patterns and "build" match the design.
- Mr. Pappademos commented, the pinion that was made is substantially different than the past, the original heat of pinion at Ft Wayne, was enough lower, that when heat-treated, (same cycle as before) and time was changed – to get the depth, which changed the distortion from plan. These parts are almost unlapped – to keep the tool marks. So they cant move the position around with lapping – so the pattern was incorrect. So the decision was made to cut the ring to match – because of the face cutting process allows them to tweak the geometry to match the pinion. Mr. Lind mentioned that the ring gear looks good, which is a flip from the past.
- Mr. Miller feels that the geometry tweak was the best change and didn't affect other build parameters. And the fact that the failure locations match the model, reassure that the change was the best.
- Mr. Koehler - knowing all this – something else is pushing us over the edge, these oils generally shouldn't have these failures, and this is indicating that the basic geometry didn't cause this, but did it cause something else to stack up? Mr. Pappademos indicated that the physical change is extremely small in magnitude.
- Mr. Miller stated - This is the lubrited lot – and should exceed the non-lubrited. But since the results are what they are, he's thinking it is now more than just a coating and a surface etching; he would want to look at the surface and metallurgical build up after the fact.
  - ☐ **Action Item:** Mr. Fett is keeping Lubrizol sets CMIR 058195 and CMIR 058292 to perform further metallurgical analysis. He will look at material, heat-treating and Luberizing and report back to the panel. The panel broke for lunch.

How or what must we do to make this specific axle batch usable?

1. The general consensus of the panel was that the axles are: **a)** are yielding sever results on ridging and possible to apply an acceptable correction factor that would work. **b)** Is not acceptable with respect to pitting/spalling (no way of applying correction factors to separate failing and pass oils). **c)** Too many broken teeth concerns.

   - Mr. Lind presented ***Attachment # 9,*** L-37 reference oil performance for ridging by pinion batch. His concern is that there is no separation from TMC 127 fail oil and TMC 153 that is identified as a good 75W-xx oil.
   - Mr. Bartlett commented: 25% of the tests are going to knock off teeth. This is not good for the labs for referencing and candidate testing.
   - Mr. Gropp questioned - could a formulator, who does not know the performance level of his oil, could he run and determine if it is the oil or the hardware responsible for the result? How could he use this batch to develop a new oil formulation? We cannot separate a good oil from a bad oil? If we can't use it as is, can we put some type of correction factor to make it usable?

- Mr. Miller suggested that we modify the break in procedure to prepare the surface finish going into test conditions that simulate what the non-lubrited axles see, that would give one better results. The break-in maybe isn't hitting the entire tooth, and not breaking in the face enough, so, maybe you have to step it up, or break in with a higher load to prep the surface better. Modifying the break in procedure might eliminate the broken teeth. The contact patterns of L1 might also run better - due to the area of peak stress is different than L2.
- Mr. Fett - there is a precedent for modifying the procedure, and if you make your case, he thinks that would be acceptable. As long as we can demonstrate you can discriminate good/bad oils.
- Mr. Bartlett presented ***Attachment # 10***, which is a summary of three tests conducted using a "modified" test procedure to evaluate further options with this gear batch. See slide 15 of attachment # 2 detailing the changes made to the Standard temperature version.
- The chairman provided ***Attachment # 11***, which is a summary of L-37 hardware history that he pulled from the minutes earlier in the year. It dates back to 1995.
- At this point, Steve Bird, Dana engineer from Lugoff S.C, joined via teleconference at 1:20 pm.
- Table of options:

Option	Choices	For	Against	Abstain	
1	Use Batch with Correction Factor		0	5	1
2	Modify Test Operational Conditions		4	0	2
3	Reject & Remake the Hardware		2	0	4
4	Use hardware as is		0	4	2

- Mr. Guzikowski questioned, can the labs send end of test hardware to the Maumee facility from other lubrited gear batches for Dana to perform the same metallurgical analysis?
- Mr. Gropp asked, do we need to be placing the next order now? It was agreed that we would revisit this at our August meeting and provide Dana time to continue there analysis.
- Mr. Fett indicated that there is a new luberizing process available. The labs could send good non-lubrited hardware to be coated to see if this makes a difference? Do labs want to participate? We should run under both luberizing processes to evaluate the difference and determine if the new process is better than the historical one, might make an interesting difference?
- Mr. Bartlett asked the labs to go back and discuss the issues and think about the option. Dana indicated that they would work with us.
- It was agreed that a Tuesday July 3rd Teleconference would be convened to review the metallurgical analysis of the two sets of gears.
- Mr. Koehler questioned if the inner pinion bearing should spin on the pinion shaft? SWRI is seeing indications of spinning on the shaft.
  - ☐ **Action Item:** Mr. Miller indicated that he would look into the interference and stretch size for this and report it to the Chairman.

- ☐ **Action Item:** The labs to send lubrited ring and pinion hardware only to Maumee facility for metallurgical analysis:
  - Lubrizol to send end of test ring and pinions from gear batches T758A/L245; P4L626A/V1L686, and P4L514A/V1L303.
  - Afton to send end of test ring and pinions from gear batch P4L404A/C1l426.
  - Parc to send end of test ring and pinions from gear batch P4L309R/C1L308.

Other Pending and New Action Items:

- **Stand Calibration,** Section 9.2.6, slide 14 of Attachment 2: Several labs are out of hardware and unable to comply with the section 9.2.6 requirement of alternating lubrited and non-lubrited hardware for their reference runs.
  Motion 2 ⇒ Mr. Koehler, Second ⇒ Mr. Smith - Instruct the TMC to modify the L-37 procedure effective 6/27/07 that we suspend section 9.2.6 of the standard till the next batch of hardware is approved (only plain axles is approved). The motion carried with a vote of 5-0-1.
- L-1 contact patterns - actions will be delayed till later.
- Backlash standardizations similar to L-42- actions will be delayed till later.
- Precision issues - actions will be delayed till later.

A motion for adjournment was made by Mr. Koglin and seconded by Mr. Koehler. The meeting was adjourned at 03:15 pm.

Respectfully submitted,

Donald T Bartlett

Donald T. Bartlett
L-37 Surveillance Panel Chairman

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: June 27, 2007

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* Initial to indicate attendance at subject meeting

Attachment 1
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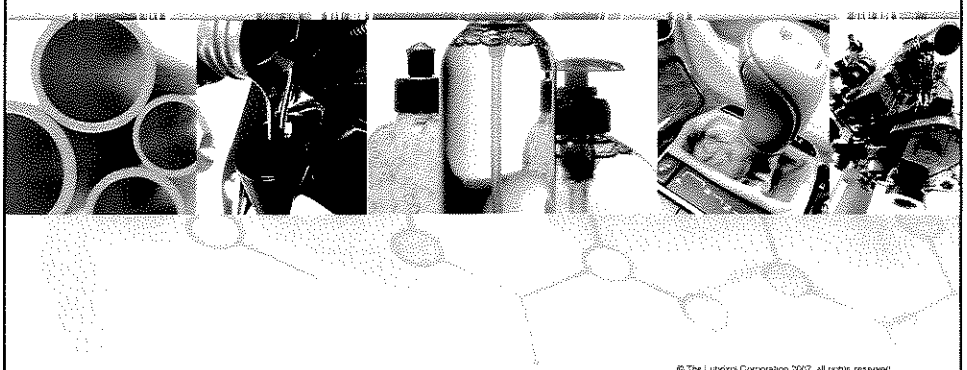
L-37 Surveillance Panel

Dana Corporation
Maumee, Ohio

June 27, 2007

Donald Bartlett



Lubrizol

L-37 SP Agenda

I. Call to Order & Agenda & Membership Review
II. Approve SP Minutes:
  - ✓ February 14, 2007meeting
  - ✓ April 24, 2007 teleconference
  - ✓ May 3, 2007 teleconference
  - ✓ May 10, 2007 teleconference
III. 2006 Lubrited Hardware Review
IV. B6L566 – Data, Statistics, Targets, Options – TMC & Panel
V. Other Panel Actions to Address
VI. Pending Action Items for August Meeting
VII. New Business
VIII. Adjournment

Attachment 2
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L-37 Surveillance Panel Voting Members

Donald Bartlett	The Lubrizol Corporation (Chairman)
Tom Bryson	Volvo Power Train Corporation
Juan Buitrago	Chevron Oronite Company
Allen Comfort	AMSTA-TR-D/210 US Army Tacom-Tardec
John Dharte	American Axle & Manufacturing
Brian Koehler	Southwest Research Institute
Cory Koglin	Afton Chemical Company
Don Kreinbring	Dana Corporation
Don Lind	ASTM Test Monitoring Center
Jim Linden	GMR Research and Development
Thelma Marougy	Eaton Corporation
Bruce McGlone	ArvinMeritor Materials Engineering
Salvatore Rea	Infineum
Dale Smith	PARC Technical Services
Paula Vettel	D.A. Stuart Company

Total 15 Voting Members

Lubrizol

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} APPROVED 7-0-0 No Corrections

III. 2006 Lubrited Hardware Review
IV. 86L566 – Data, Statistics, Targets, Actions – TMC & Panel
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Lubrizol

2006 (P4L816/B6L566) Lubrited Hardware Update

- ✓ Industry Hardware Orders Tendered May, 2006
- ✓ HTF visit to Ft. Wayne November 29, 2006
- ✓ HTF visit to Lugoff December 7, 2006
- ✓ Dana reported production issues & remake of Drive Gears February, 2007

Attachment 2
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Lubrizol

2006 Lubrited Drive Gearing Pattern

Don Kreinbring, 2/10/07

1. Production stopped at lapping because of unacceptable pattern.
2. Trial assembled 10 carriers, patterns mostly L3 with some L4 and L2.
3. Drive pinion material was low end of hardenability band.
4. Increased heat treat temperature, for heavy case depth, caused tooth distortion.
5. Teleconference held to develop plan to prevent problem.

Lubrizol

2006 Lubrited Drive Gearing Pattern (cont)

Don Kreinbring, 2/10/07

6. ECO in process to change gearset, pinion, and gear drawings:
   - Update gear summary number.
   - Restrict pinion steel to 8625.
   - Restrict pinion steel to high end of hardenability band.
   - Restrict gear steel to 8620A.
   - Add note "CAUTION ...(ASTM lab test gages, Special material and processing, etc.)...NO SUBSTITUTIONS ARE PERMITTED.
   - Similar changes and carrier tolerancing will be looked at for the L-42.

Attachment 2
Page 4 & 11
Reference L-37

Lubrizol

2006 Lubrited Axle Build Status

Don Kreinbring, 2/10/07

1. Drive gear forgings were obtained and blanked.
2. Kenny Miller and Lou Pappademos developing first order position change.
3. First recut and firecheck didn't move pattern enough from L3 to L2.
4. Second recut and firecheck look good, PPAP will go to Kenny Miller.
5. Timing for drive gearset completion is unknown, but likely soon.
6. Assembly line has been moved in Lugoff and is up and running.

Lubrizol

2006 B6L566 Hardware received at Laboratories late April, 2007

- ✓ 44-test Standard and Low Temperature hardware approval matrix completed June 8, 2007
- ✓ Each of the 4 labs equally participated – 11 tests
  - 4-tests on TMC 127 (standard)
  - 8-tests on TMC 155 (standard)
  - 8-tests on TMC 152 (standard)
  - 8-tests on TMC 153 (standard)
  - 8-tests on TMC 152 (Canadian)
  - 8-tests on TMC 153 (Canadian)

Attachment 2
Page 5 of 11
Reference L-37

Lubrizol

L-37 SP Agenda

I. Call to Order & Agenda & Membership Review
II. Approve SP Minutes:
- February 14, 2007meeting
- April 24, 2007 teleconference
- May 3, 2007 teleconference
- May 10, 2007 teleconference

III. 2008 Lubrited Hardware Review
IV. B6L566 – Data, Statistics, Targets, Actions – TMC & Panel
V. Other Panel Actions to Address
VI. Pending Action Items for August Meeting
VII. New Business
VIII. Adjournment

Lubrizol

TMC Review of the Data

➢ B6L566/P4L816 Lubrited Hardware:

- Tables
- Graphs

Attachment 2
Page 6 of 11
Reference L-37

Lubrizol

Panel Discussions

- Panel Actions:
  - Can hardware be used for candidates & referencing ?
  - Statistical Targets

Lubrizol

Lubrited/Non-Lubrited Reference Requirement

- D 6121 - Stand Calibration, Section 9.2.6 states:
  - Alternate lubrited and non-lubrited hardware with each reference oil calibration sequence
  - Should we temporarily suspend this requirement ?

Attachment 2
Page 7 of 11
Reference L-37

Lubrizol

Modified Test Procedure Options - Lubrizol

- TMC 152 -
  1. 100 minute Gear conditioning Phase & 20-hour Gear Test Phase @ 80 wheel r/min & 1740 lbf-ft
  2. 100 minute Gear conditioning Phase & 24-hour Test Gear Test Phase @ 73 wheel r/min & 1588 lbf-ft (8.7 % reduction)
- TMC 127 -
  1. 100 minute Gear conditioning Phase + 24-hour Test Gear Test Phase @ 73 wheel r/min & 1588 lbf-ft (8.7 % reduction)

Lubrizol

L-37 SP Agenda

I. Call to Order & Agenda & Membership Review
II. Approve SP Minutes:
  - February 14, 2007meeting
  - April 24, 2007 teleconference
  - May 3, 2007 teleconference
  - May 10, 2007 teleconference
III. 2006 Lubrited Hardware Review
IV. 86L366 – Data, Statistics, Targets, Actions – TMC & Panel
V. Other Panel Actions to Address
VI. Pending Action Items for August Meeting
VII. New Business
VIII. Adjournment

Attachment 2
Page 8 of 11
Reference L-37

Lubrizol

Axles That Were Assembled with L1 Contact Patterns

- D 6121 - Preparation of Axle, Section 8.2.1 states:
  - Record the "as received" drive side contact pattern length and flank values as noted on the axle housing from Dana Corp.
  - Length values of L2 and L3 &
  - Flank values of F-1, F0 and F+1
  - Only values considered acceptable
  - May 3 telecom - 2 tests each lab on L1 & TMC 155 - tabled
  - May 10 telecom – further testing on L1 on hold
  - How should we proceed with the 170 axles with L1 contact patterns on the B6L566 batch only ?

DID NOT DISCUSS AUGUST ?

Lubrizol

Backlash & Other Reporting Options

- D 6121 - Preparation of Axle, Section 8.2.3 states:
  - Record backlash at four equally spaced locations.
  - The average of the four readings shall be from 0.0004 to 0.009 in.
  - Should we align this section similarly to the changes recently adopted by the L-42 panel ?
  - Reporting Mfg's information on housing
  - Add the Axle Serial Number (xUSAxxxxx)

DID NOT DISCUSS AUGUST ?

Attachment 2
Page 9 of 11
Reference L-37

Lubrizol

LTMS Control Charting Concerns and Impact

- EWMA and Shewhart Chart Precision and Severity:
  - Should the Panel take any action to modify or suspend the Pitting/Spalling requirements?
  - Critical vs. non-critical parameters ?
  - Only the B6L566 batch ?
  - All gear batches ?

AUGUST ?

Lubrizol

L-37 SP Agenda

I. Call to Order & Agenda & Membership Review
II. Approve SP Minutes:
  - ✓ February 14, 2007meeting
  - ✓ April 24, 2007 teleconference
  - ✓ May 3, 2007 teleconference
  - ✓ May 10, 2007 teleconference
III. 2006 Lubrited Hardware Review
IV. B6L566 – Data, Statistics, Targets, Actions – TMC & Panel
V. Other Panel Actions to Address
VI. Pending Action Items for August Meeting
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Attachment 2
Page 10 of 11
Reference L-37

Lubrizol

Pending Actions for the Next SP Meeting

1. Rating Aids - Wear and Ridging mold boards
2. Pitting/Spalling vs. Chipping – RCMS Pinions → August
3. Next non-lubrited industry order ?

Attachment 2
Page 11 of 11
Reference 1-37

B6L566/P4L816 MATRIX RESULTS
STANDARD TEMPERATURE TESTS

estkey	Lab	STD	Run	Oil	VAL	Pinbat	DTCOMP	Pwear	Pridg	Pripp	Pspit	Rwear	Rridg	Rripp	Rspit	fpcrat	lpcrat	AVG B/Lash	JUSA	COM1	Lg Br	Sm Br
49555	A	2	73	127	MG	B6L566	20070503	3	7	9	3	4	8	10	9.4	0	2	0.009	4264	Broken Tooth		
58284	B	191	2426	127	AG	B6L566	20070501	6	4	9	1	5	5	10	9.3	0	2	0.008	4326		ST FR	SN USA
49504	D	3A	728	127	AG	B6L566	20070503	7	8	4	10	8	8	9	10	0	2	0.009				
49192	E	2	880	127	MG	B6L566	20070506	5	5	6	2	6	5	9	9.9	0	2	0.007	4125	Broken Tooth		
58317	A	4	83	152	AG	B6L566	20070524	7	8	9	7	7	9	9	9.6	0	2	0.004	4320			
58318	A	4	84	152	AG	B6L566	20070525	7	7	8	7	7	9	9	9.7	0	2	0.007	4316			
58292	B	191	2440	152	LG	B6L566	20070522	3	6	9	3	4	8	10	9.5	1	2	0.01	3814	Broken Tooth / Backlash out	SV FR	ST USA
59298	B	191	2453	152	AG	B6L566	20070605	6	7	8	9.7	7	9	10	9.9	0	2	0.007	3618		SV FR	ST USA
59284	D	3A	746	152	AG	B6L566	20070526	7	8	10	2	8	10	10	9.9	0	2	0.004				
58278	D	3A	731	152	AG	B6L566	20070506	7	8	10	9.9	8	9	10	9.9	0	2	0.007				
58305	E	2	884	152	AG	B6L566	20070515	6	9	9	5	7	10	9	9.9	1	2	0.008	4129			
59307	E	2	885	152	MG	B6L566	20070517	5	8	8	1	6	8	9	2	0	2	0.008	4201	Broken Tooth		
59322	A	4	89	153	AG	B6L566	20070604	6	6	7	9.7	6	8	9	9.9	0	2	0.009	3812			
59323	A	4	90	153	AG	B6L566	20070605	6	6	7	3	6	6	10	9.5	0	2	0.005	4312			
59304	B	191	2434	153	AG	B6L566	20070515	5	6	10	3	6	6	10	9.7	0	2	0.004	3674		SV FR	ST USA
59303	B	191	2445	153	AG	B6L566	20070527	6	5	8	9.8	7	6	9	9.9	-1	2	0.004	3874		SZ FR	ST USA
58283	D	3A	753	153	AG	B6L566	20070607	7	7	9	9.9	8	9	10	9.9	0	2	0.004				
58282	D	3A	737	153	XG	B6L566	20070513	7	8	7	7	8	9	10	10	0	2	0.006		Broken Tooth		
58309	E	2	888	153	MG	B6L566	20070522	3	8	8	2	5	9	9	9.4	0	2	0.008	4317	Broken Tooth		
58310	E	2	889	153	MG	B6L566	20070523	3	9	9	2	3	9	9	2	0	2	0.008	4393	Broken Tooth		
58909	A	2	74	155	AG	B6L566	20070505	7	8	7	6	8	9	9	9.8	0	2	0.004	4328	Broken Teeth		
58910	A	4	82	155	AG	B6L566	20070522	7	8	8	9.7	7	9	9	9.8	0	2	0.008	4256			
58915	B	191	2427	155	AG	B6L566	20070502	7	7	9	9	8	9	10	9.9	0	2	0.004	4568		ST FR	ST USA
58916	B	191	2444	155	AG	B6L566	20070526	6	8	9	9.7	7	9	10	9.9	0	2	0.006	4318		SV FR	ST USA
58889	D	3A	729	155	AG	B6L566	20070504	7	8	10	9.9	8	10	10	10	0	2	0.006				
58890	D	3A	733	155	AG	B6L566	20070514	7	7	9	7	8	9	10	10	0	2	0.009				
58921	E	2	881	155	AG	B6L566	20070508	7	8	8	9.9	7	9	9	9.9	-1	2	0.005	3945			
58922	E	2	894	155	AG	B6L566	20070601	6	9	9	5	7	10	9	8	0	2	0.008	4189			

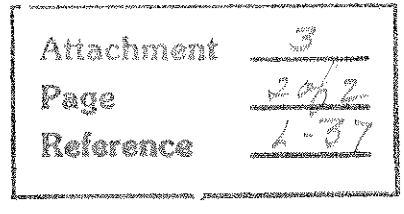
Attachment 3
Page 1 of 2
Reference L-37

1) Test 1 → 49
JUSA 3618 → 4576

2) Broken Teeth
JUSA 3741 → 4393

B6L566/P4L816 MATRIX RESULTS
LOW TEMPERATURE TESTS

estkey	Lab	STD	Run	Oil	VAL	Pinbat	DTCOMP	Pwear	Pridg	Pripp	Pspit	Rwear	Rridg	Rripp	Rspit	fpcrat	lpcrat	AVG B/Lash		COM1		
59320	A	4	85	152	AG	B6L566	20070530	7	8	8	9	8	9	9	9.8	0	2	0.006	4324			
59321	A	4	88	152	AG	B6L566	20070603	7	8	9	9.9	8	9	9	9.9	0	2	0.008	3848			
59299	B	191	2441	152	AG	B6L566	20070523	7	7	9	9.9	8	9	9	9.9	0	2	0.004	4576		ST FR	ST USA
59300	B	191	2447	152	AG	B6L566	20070530	7	8	10	9.9	8	9	10	9.9	-1	2	0.004	4066		SV FR	SN USA
59285	D	3A	735	152	AG	B6L566	20070511	7	7	10	9.9	8	9	10	10	0	3	0.004				
59286	D	3A	749	152	AG	B6L566	20070601	6	8	10	9	8	10	7	9.9	0	2	0.006				
59308	E	2	886	152	MG	B6L566	20070518	6	9	8	2	7	9	9	9.4	0	2	0.008	3741	Broken Tooth		
59309	E	2	887	152	AG	B6L566	20070521	7	9	8	9.8	7	9	9	8	0	2	0.009	4265			
61599	A	4	91	153	AG	B6L566	20070607	7	8	9	9.5	6	9	10	7	0	2	0.007	4308			
61600	A	2	92	153	AG	B6L566	20070608	7	8	7	9.8	7	10	10	9.9	0	2	0.007	3880			
61594	B	191	2437	153	AG	B6L566	20070518	6	7	10	9.9	6	9	10	9.9	0	2	0.007	3998		SV FR	SN USA
61595	B	191	2450	153	AG	B6L566	20070602	6	8	9	9.9	6	9	10	9.9	0	2	0.006	4511		SV FR	ST USA
59287	D	3A	742	153	AG	B6L566	20070520	7	8	9	9.9	8	10	10	10	0	2	0.007				
59288	D	3A	751	153	AG	B6L566	20070605	7	7	9	2	8	10	10	9	0	2	0.005				
59311	E	2	890	153	AG	B6L566	20070524	7	9	9	9.9	7	9	9	9.9	0	2	0.006	4437			
59312	E	2	893	153	AG	B6L566	20070531	7	9	9	9.9	7	10	9	9.9	0	2	0.008	4061			

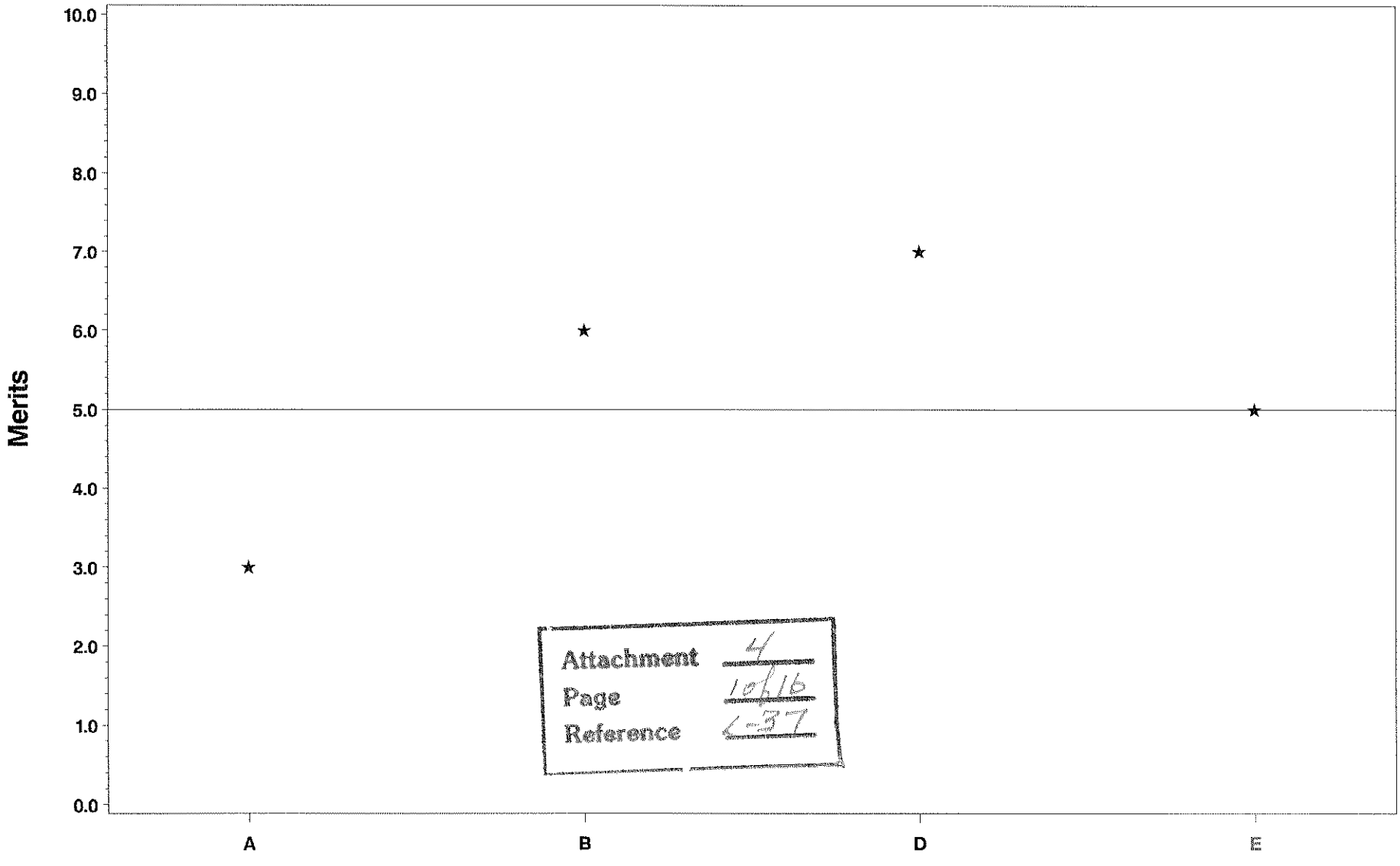


L – 37 Reference Oil Performance by LTMSLAB

Wear – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 127

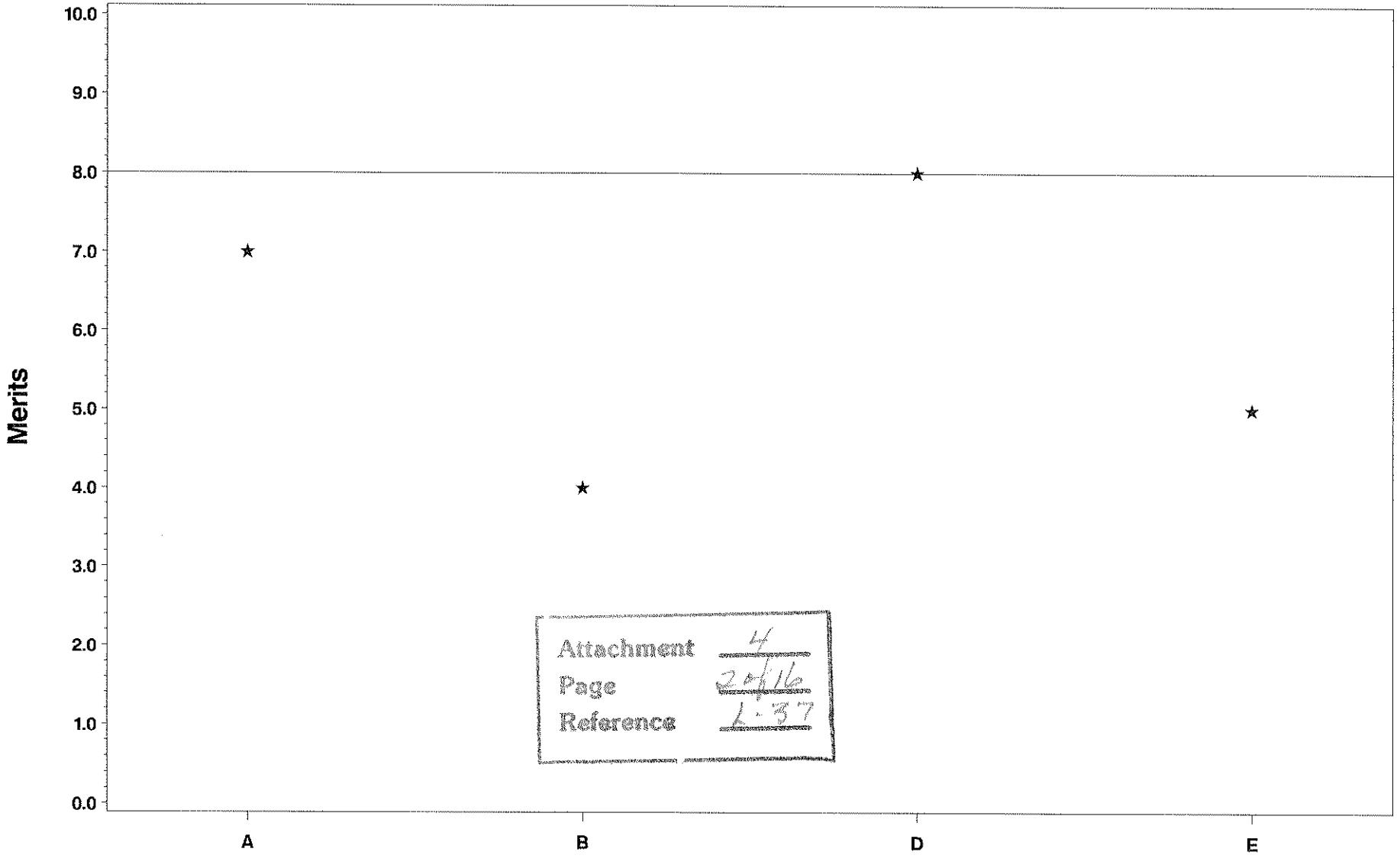


Attachment 4
Page 10 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Ridging -- LUBRITED

Gear Batch B6L566/P4L816
Reference Oil 127



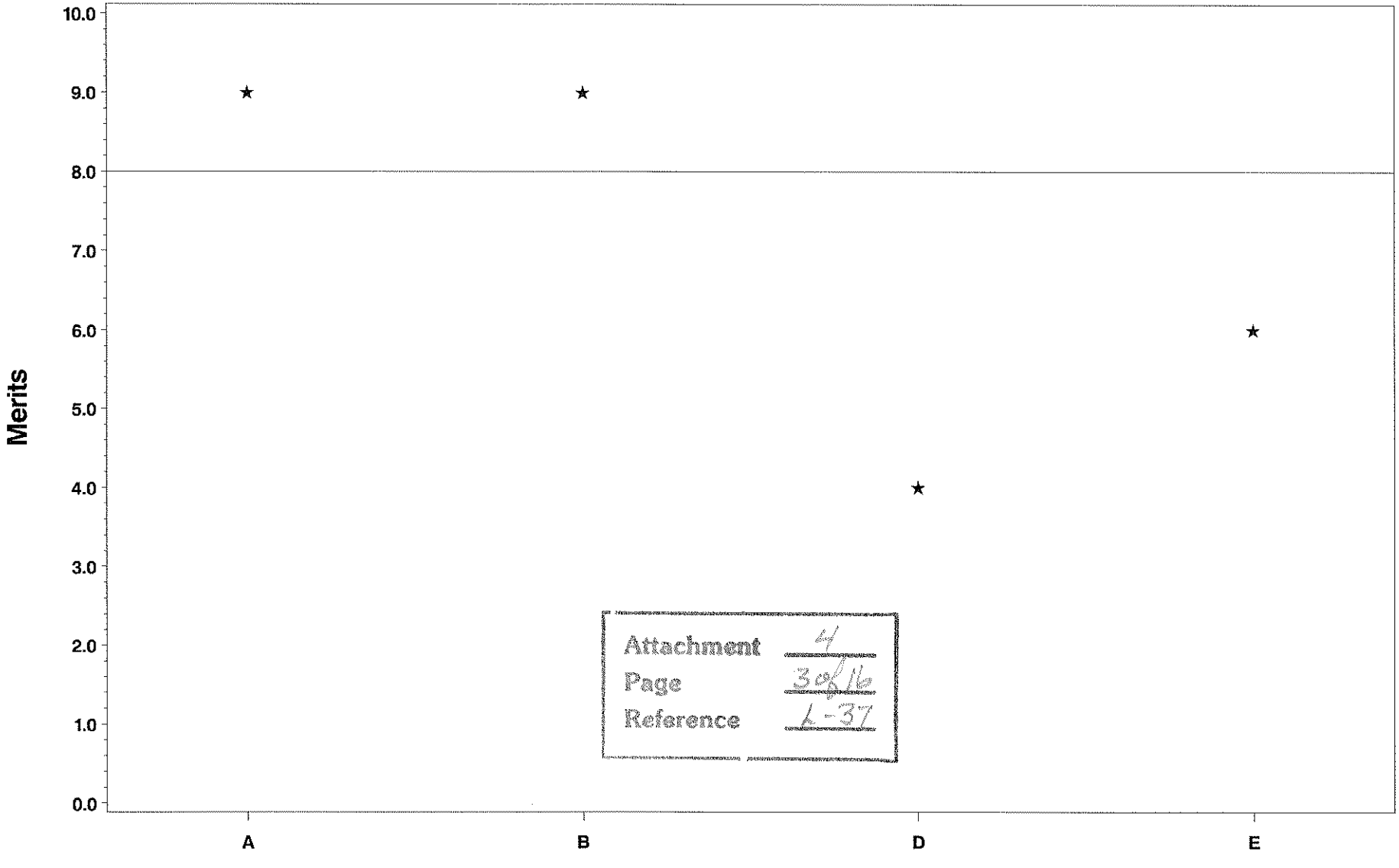
Attachment 4
Page 2 of 6
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Rippling -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 127



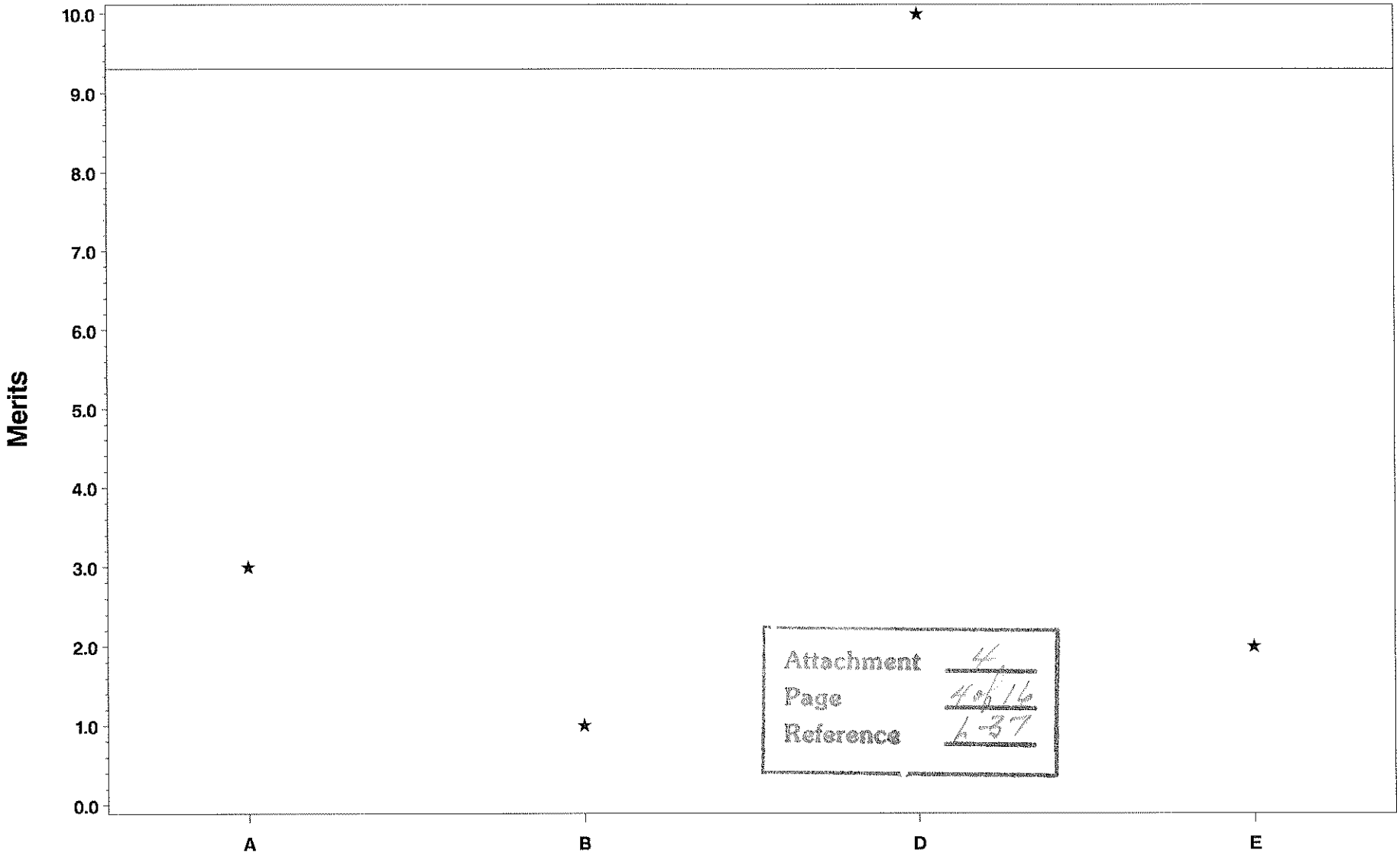
Attachment 4
Page 3 of 12
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Spitting -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 127



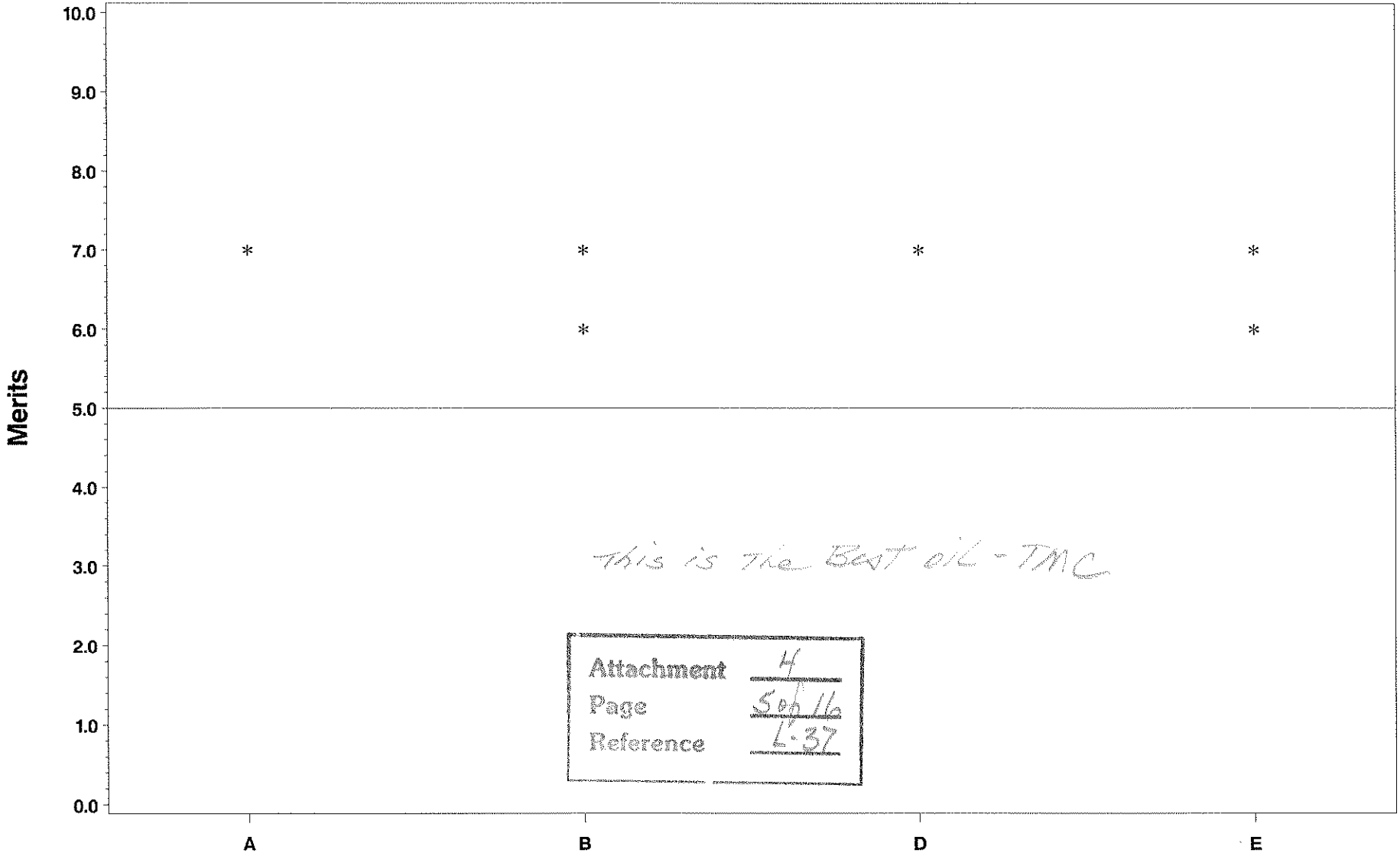
Attachment 4
Page 4 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Wear – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 155

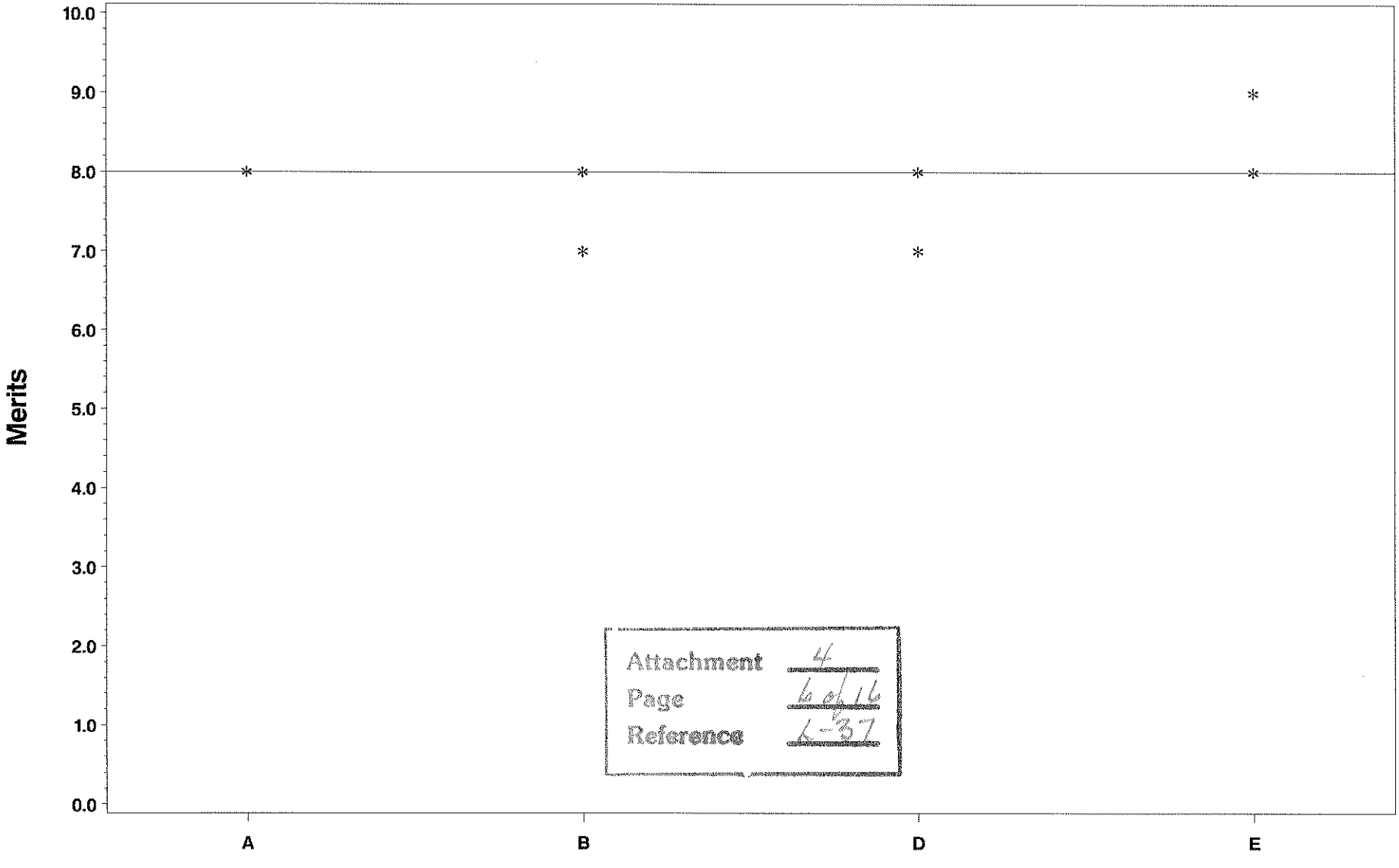


L-37 Reference Oil Performance by LTMSLAB

Ridging -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 155



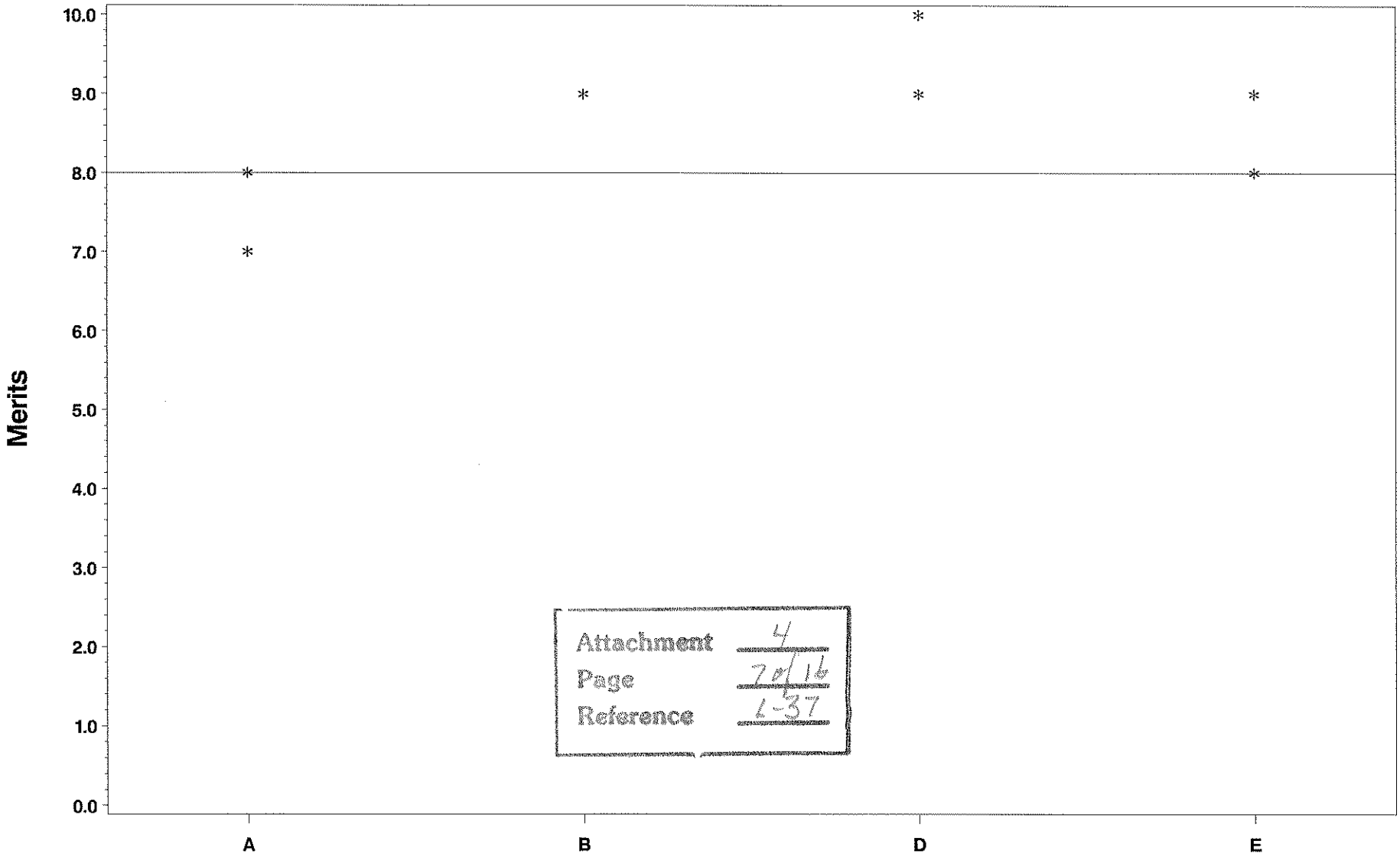
Attachment 4
Page 4 of 16
Reference L-37

L−37 Reference Oil Performance by LTMSLAB

Rippling – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 155



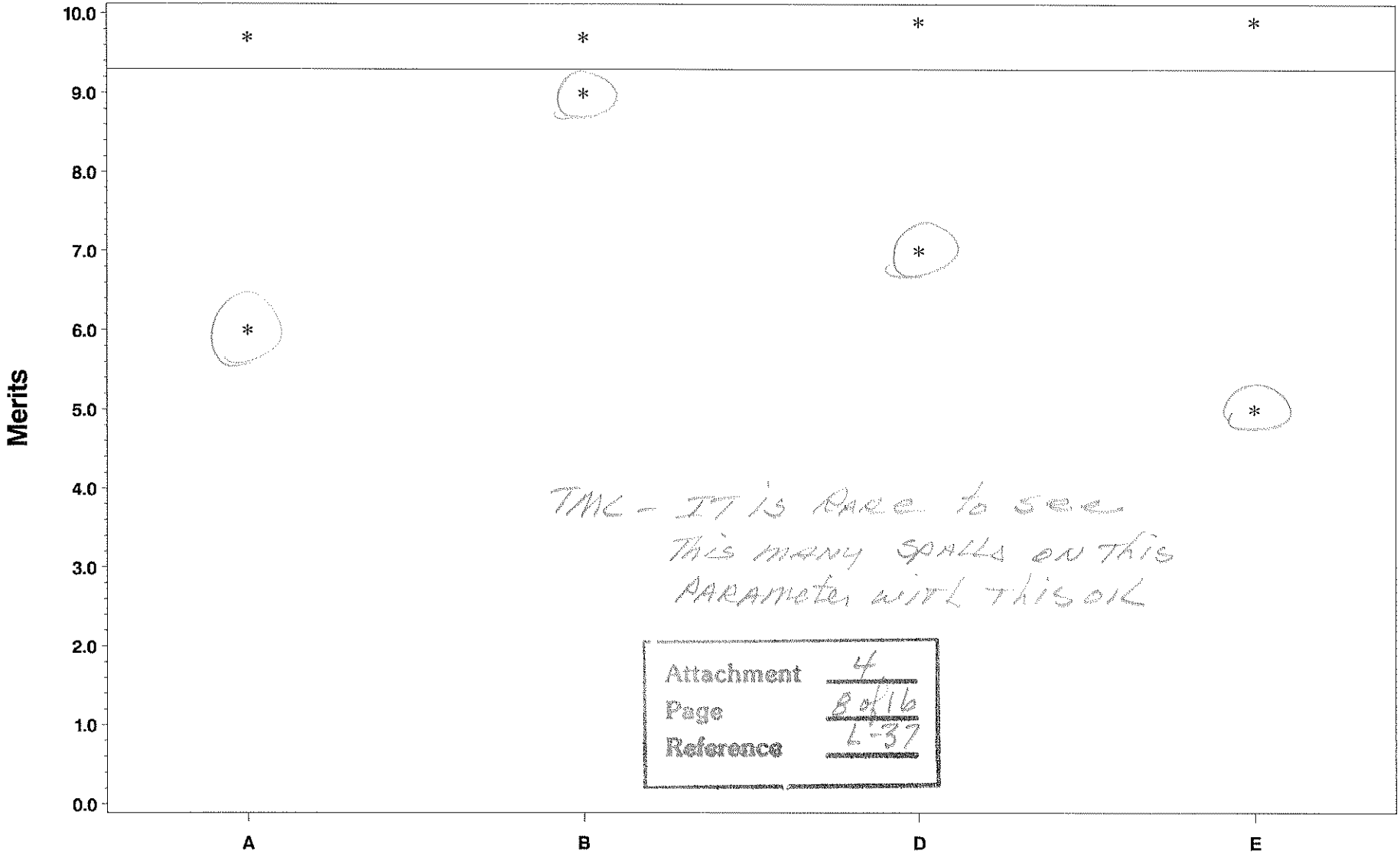
Attachment 4
Page 7 of 14
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Spitting -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 155



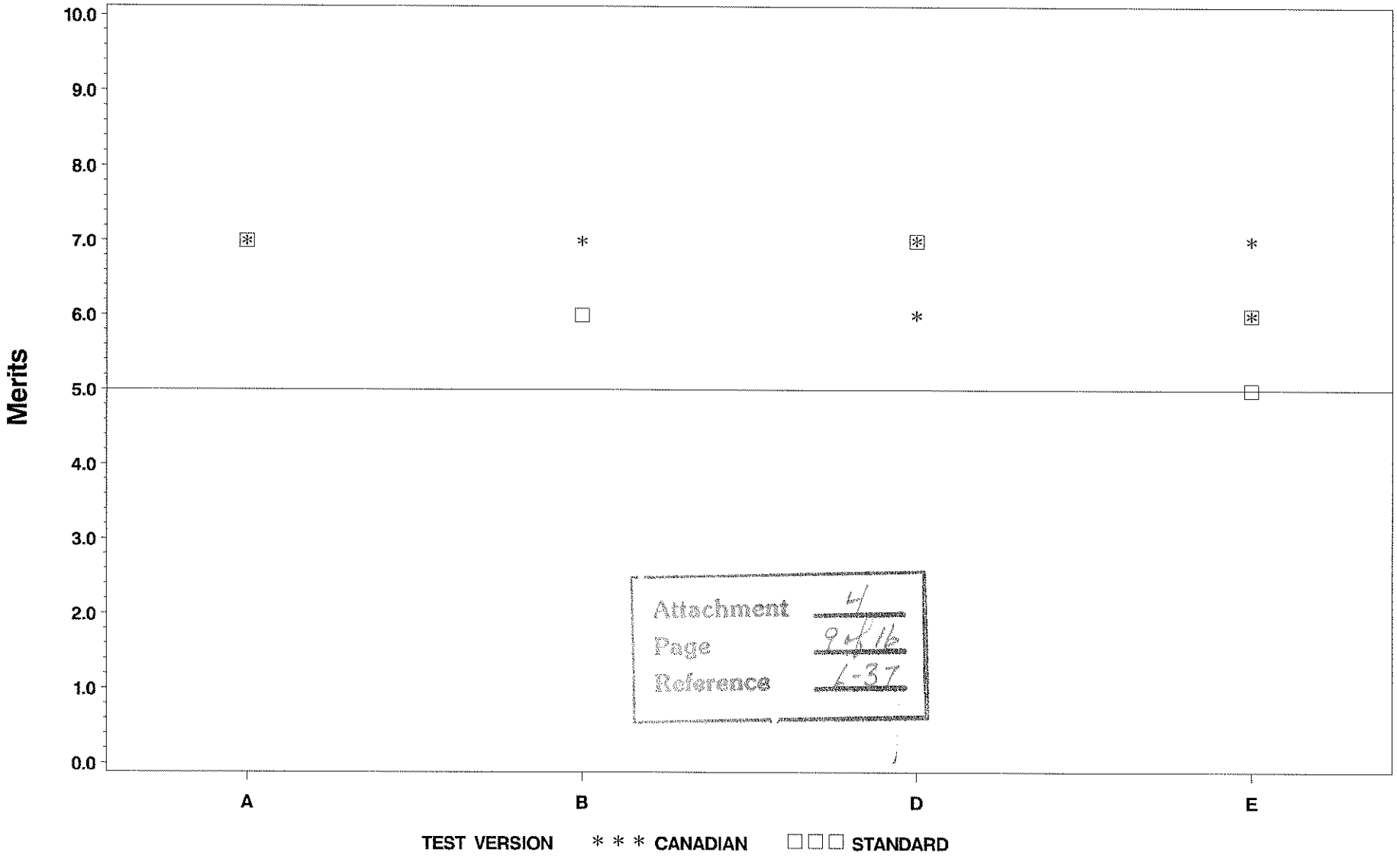
Attachment 4
Page 8 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Wear – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 152

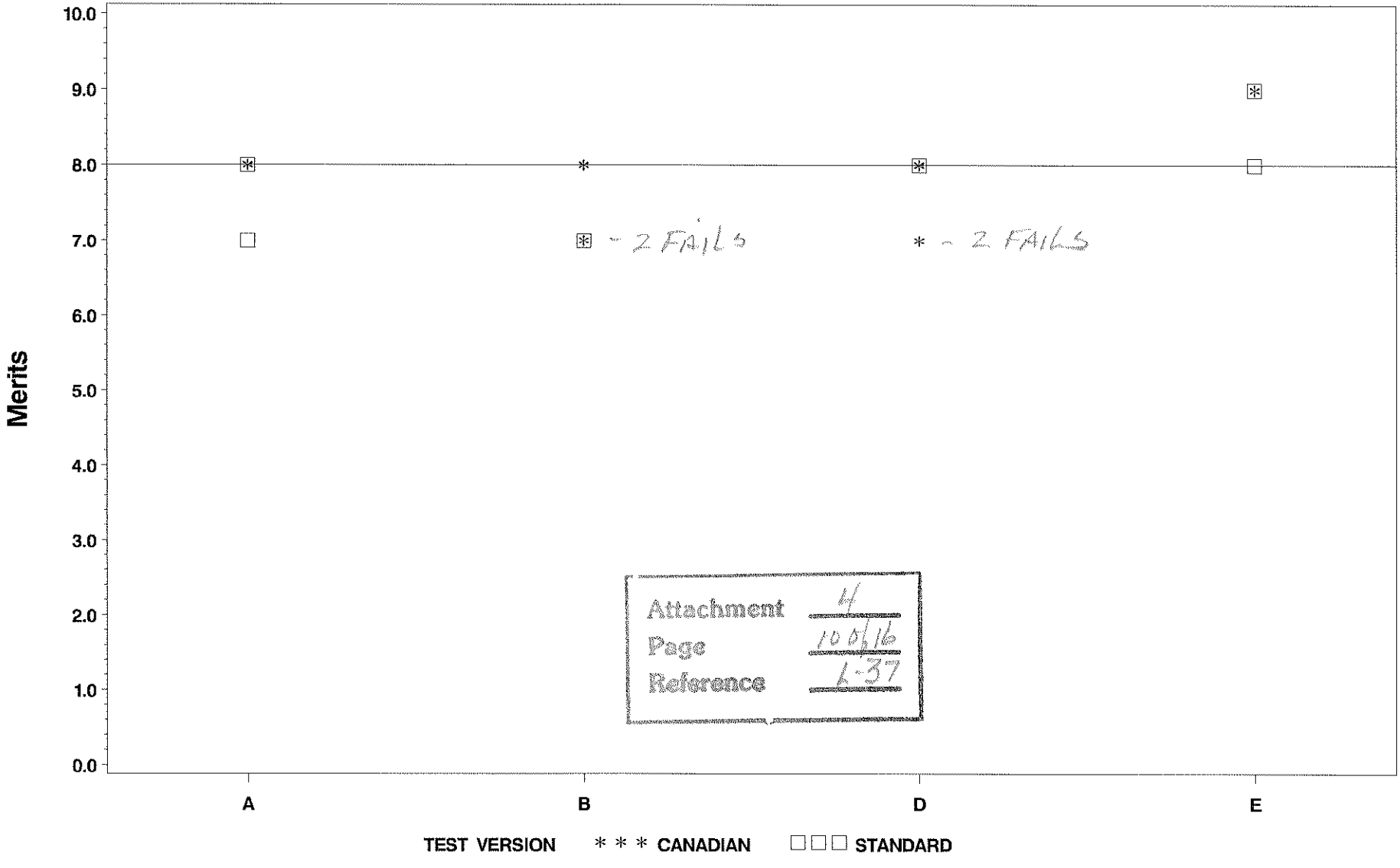


L-37 Reference Oil Performance by LTMSLAB

Ridging – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 152



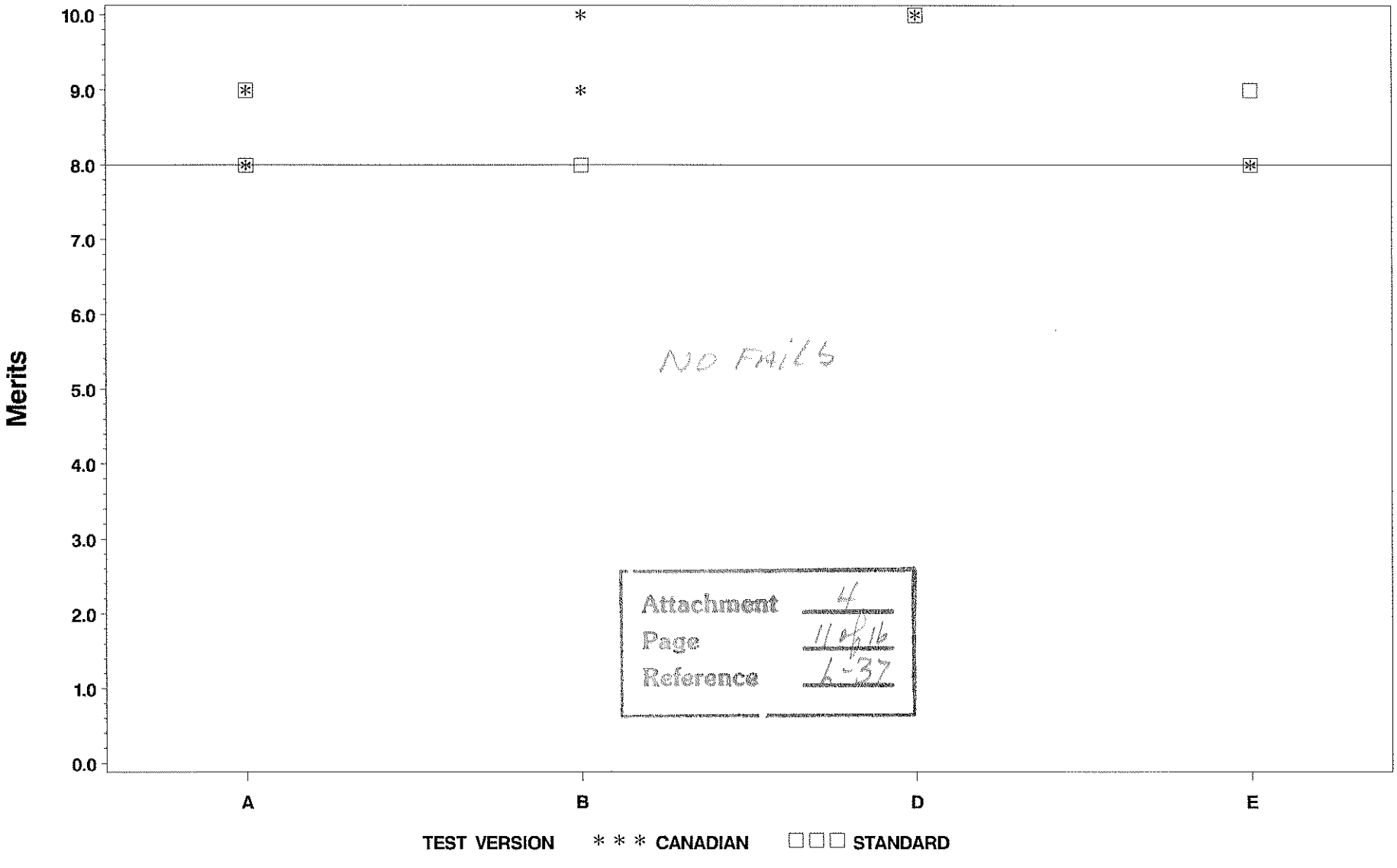
Attachment 4
Page 10 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Rippling – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 152



NO FAILS

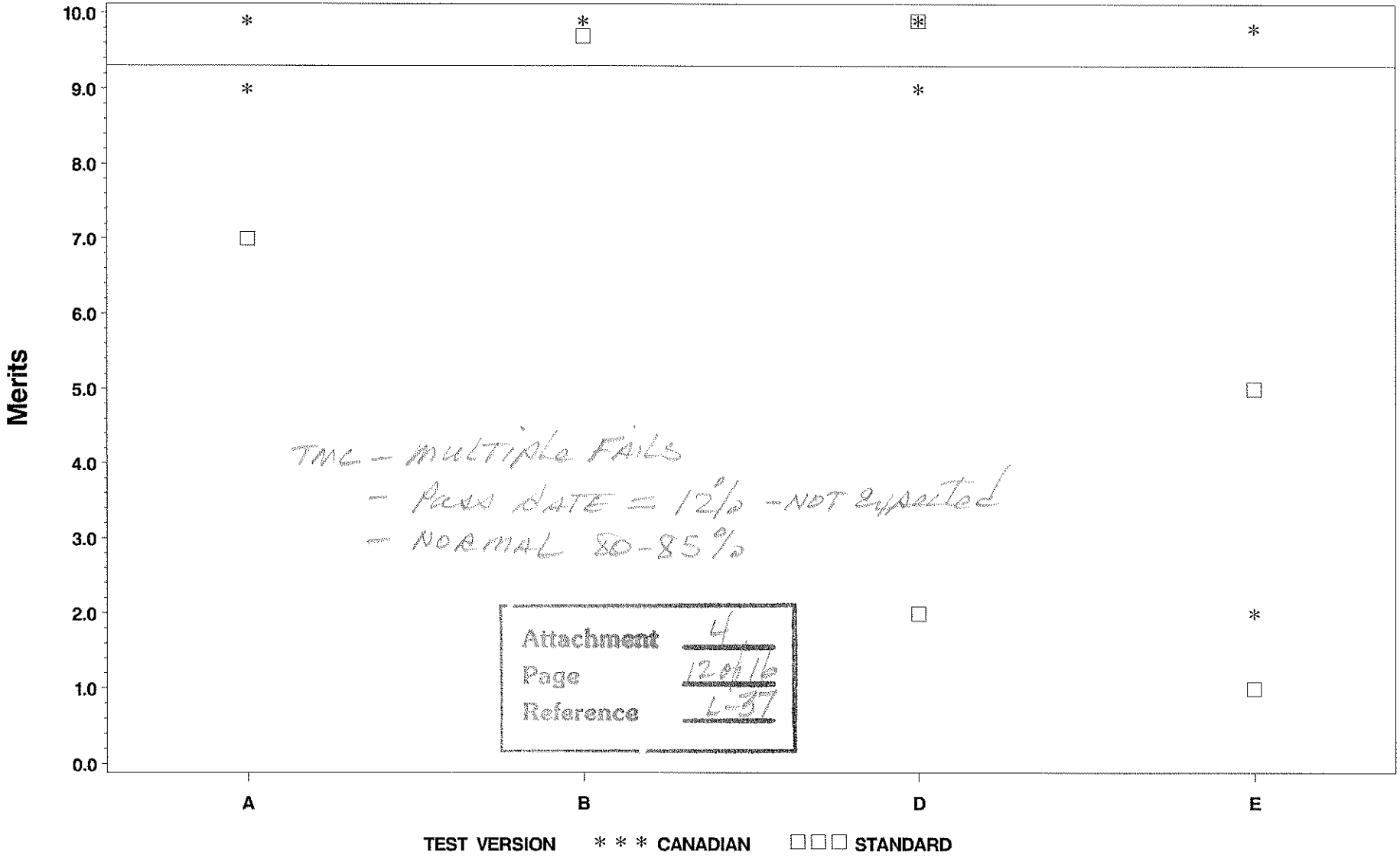
Attachment 4
Page 11 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Spitting – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 152



TMC – multiple fails
– Pass rate = 12% – NOT expected
– NORMAL 20-85%

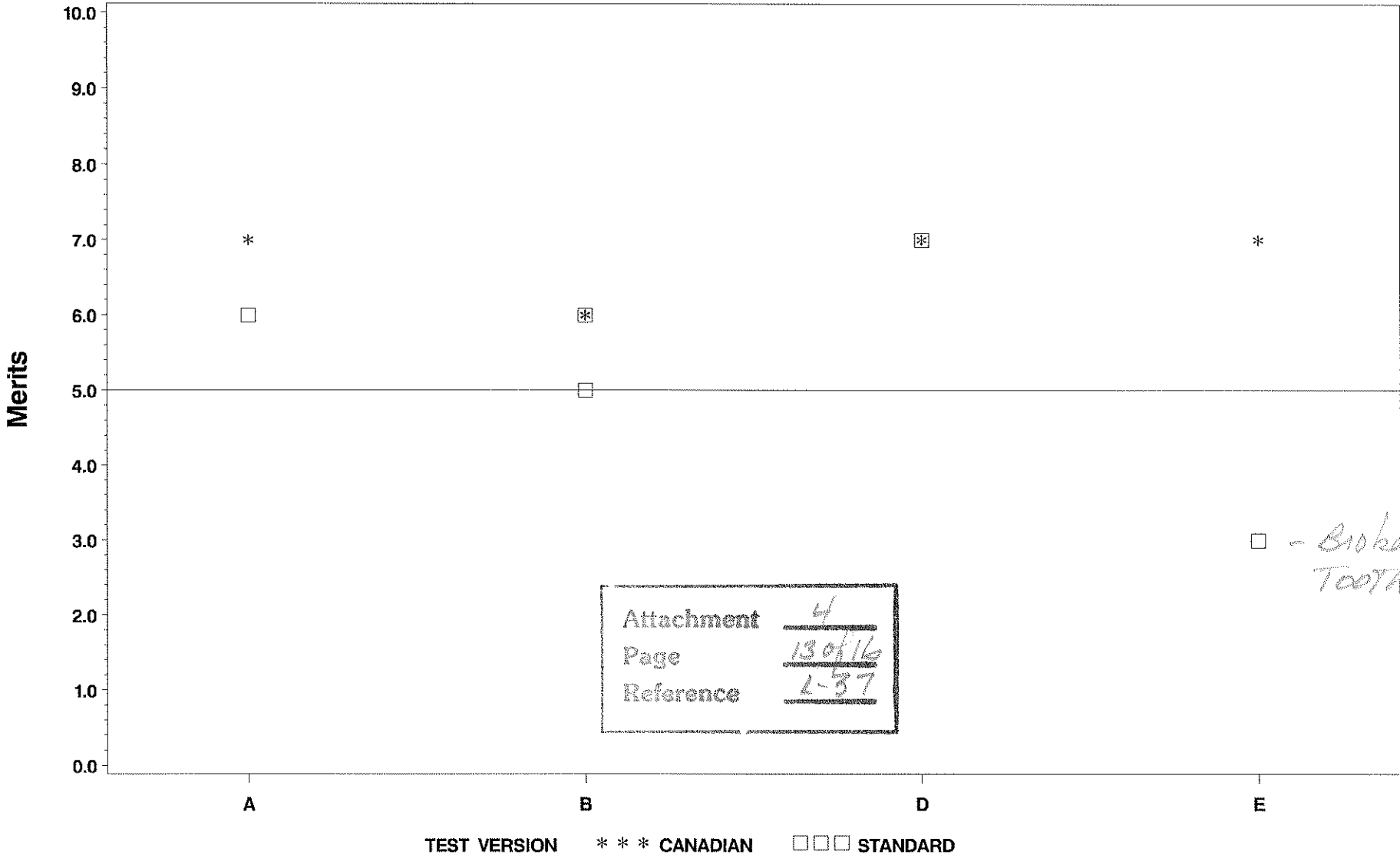
Attachment 4
Page 12 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Wear – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 153

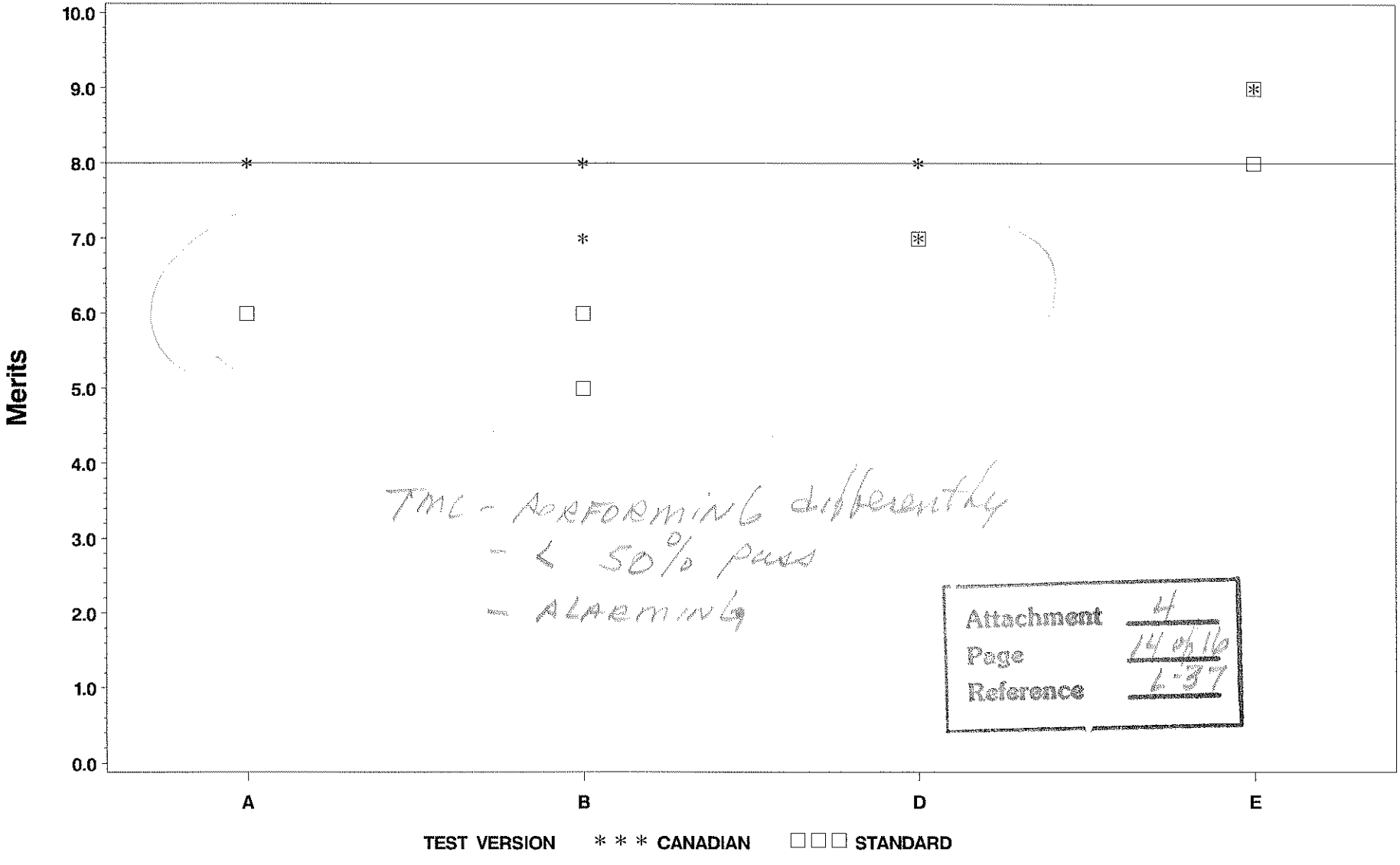


L-37 Reference Oil Performance by LTMSLAB

Ridging -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 153



TMC - Performing differently
- < 50% pass
- Aborting

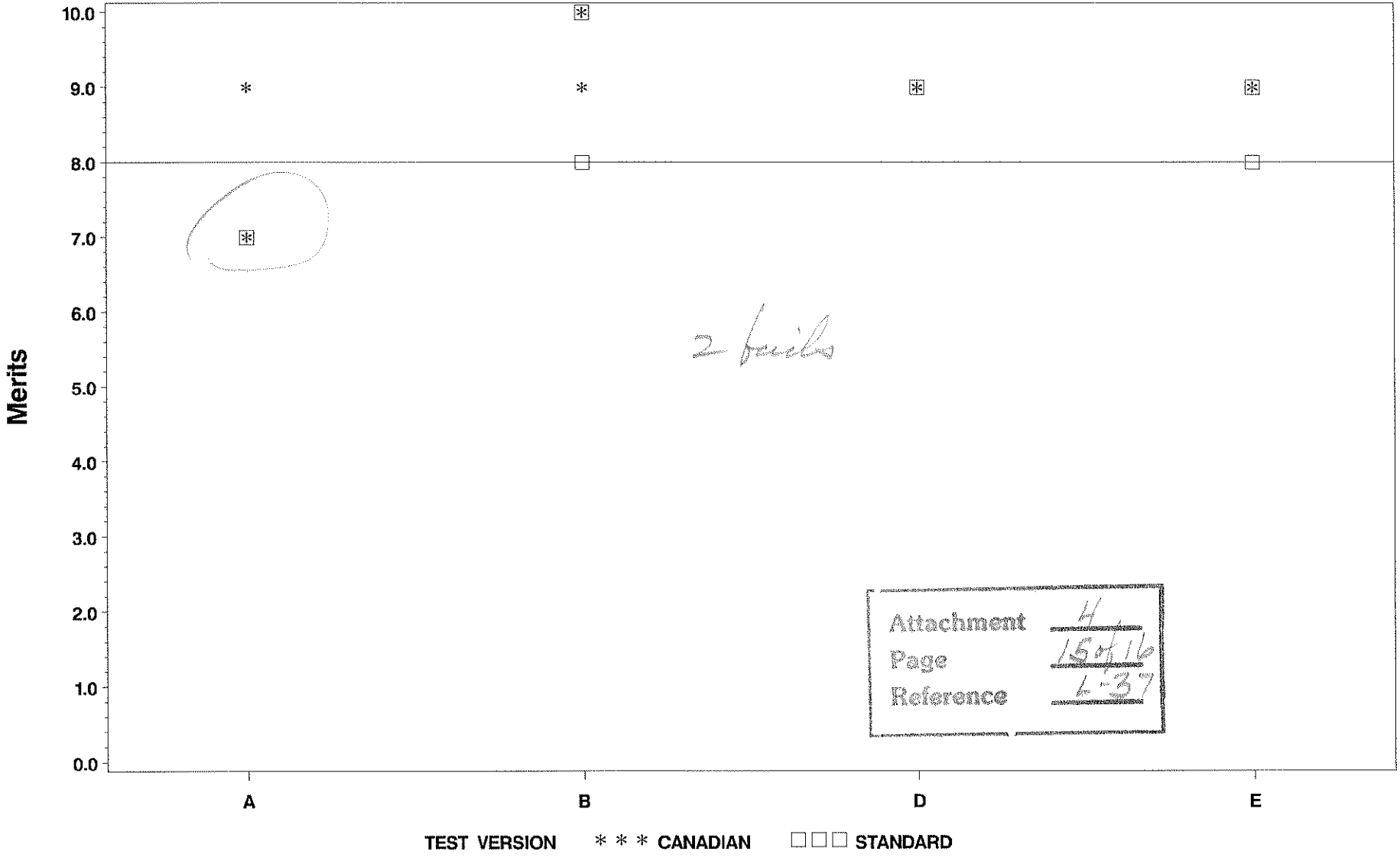
Attachment 4
Page 14 of 16
Reference L-37

L-37 Reference Oil Performance by LTMSLAB

Rippling – LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 153

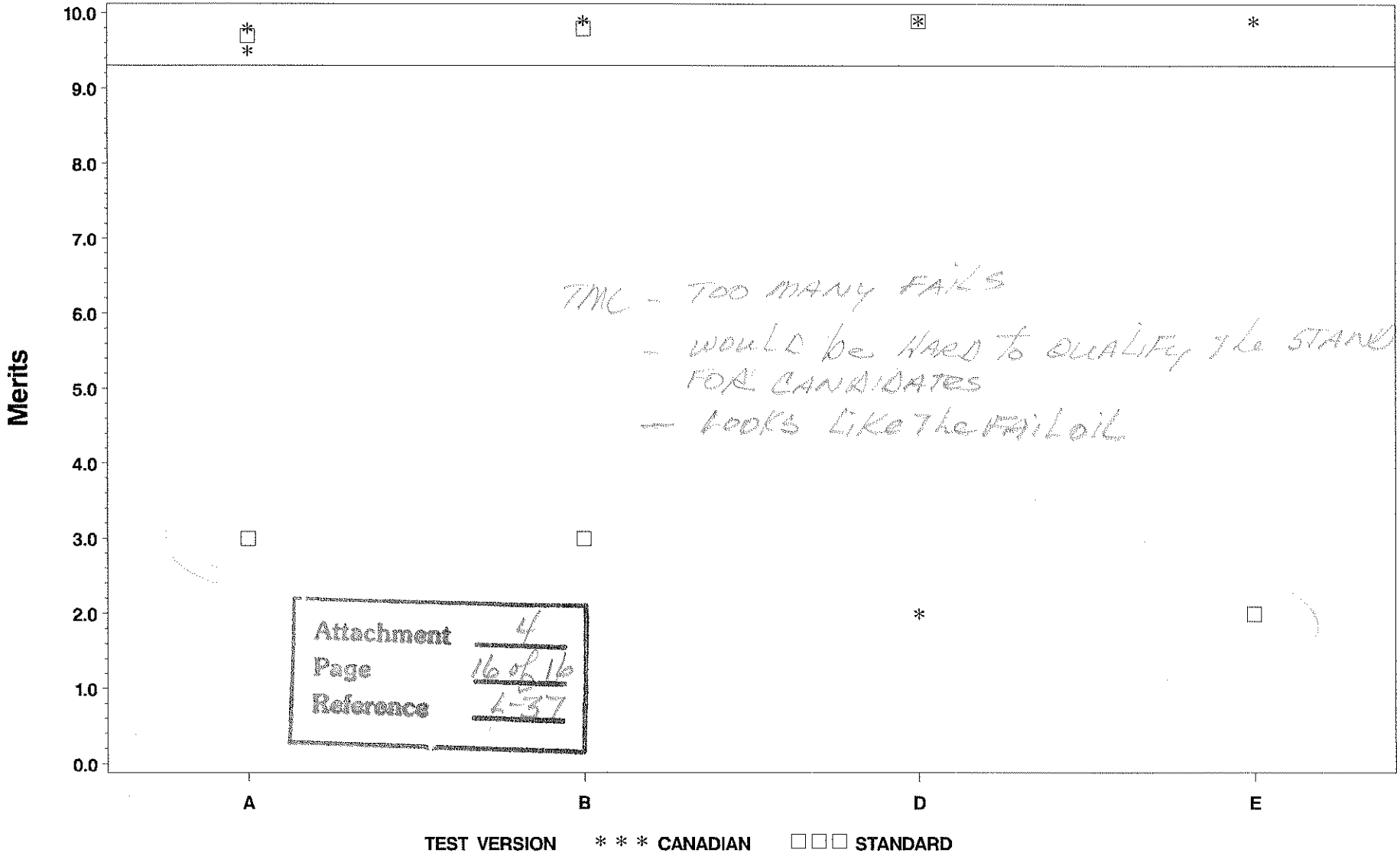


L-37 Reference Oil Performance by LTMSLAB

Spitting -- LUBRITED

Gear Batch B6L566/P4L816

Reference Oil 153

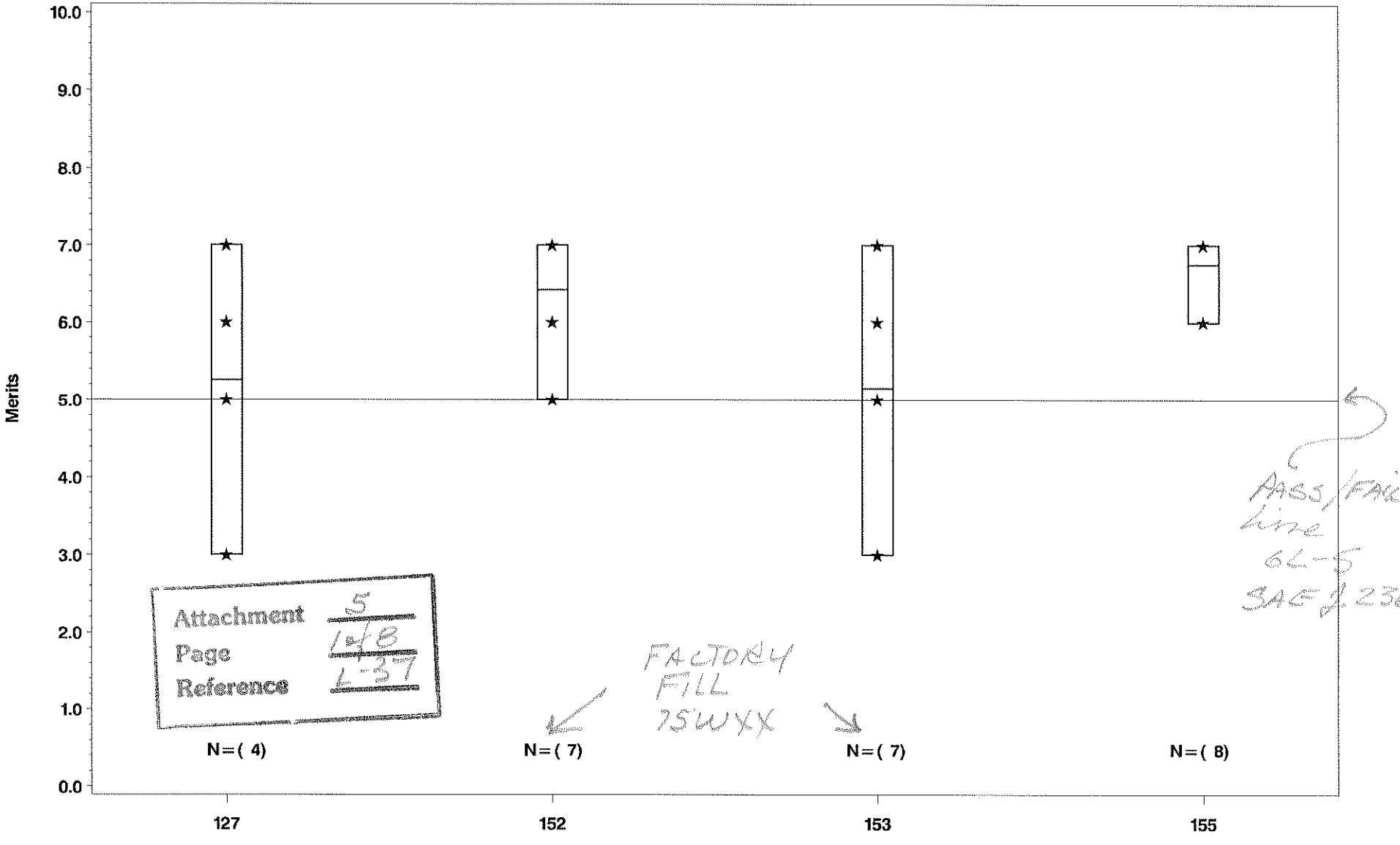


TEST VERSION * * * CANADIAN □□□ STANDARD

L-37 Reference Oil Comparison

Wear – LUBRITED – Standard

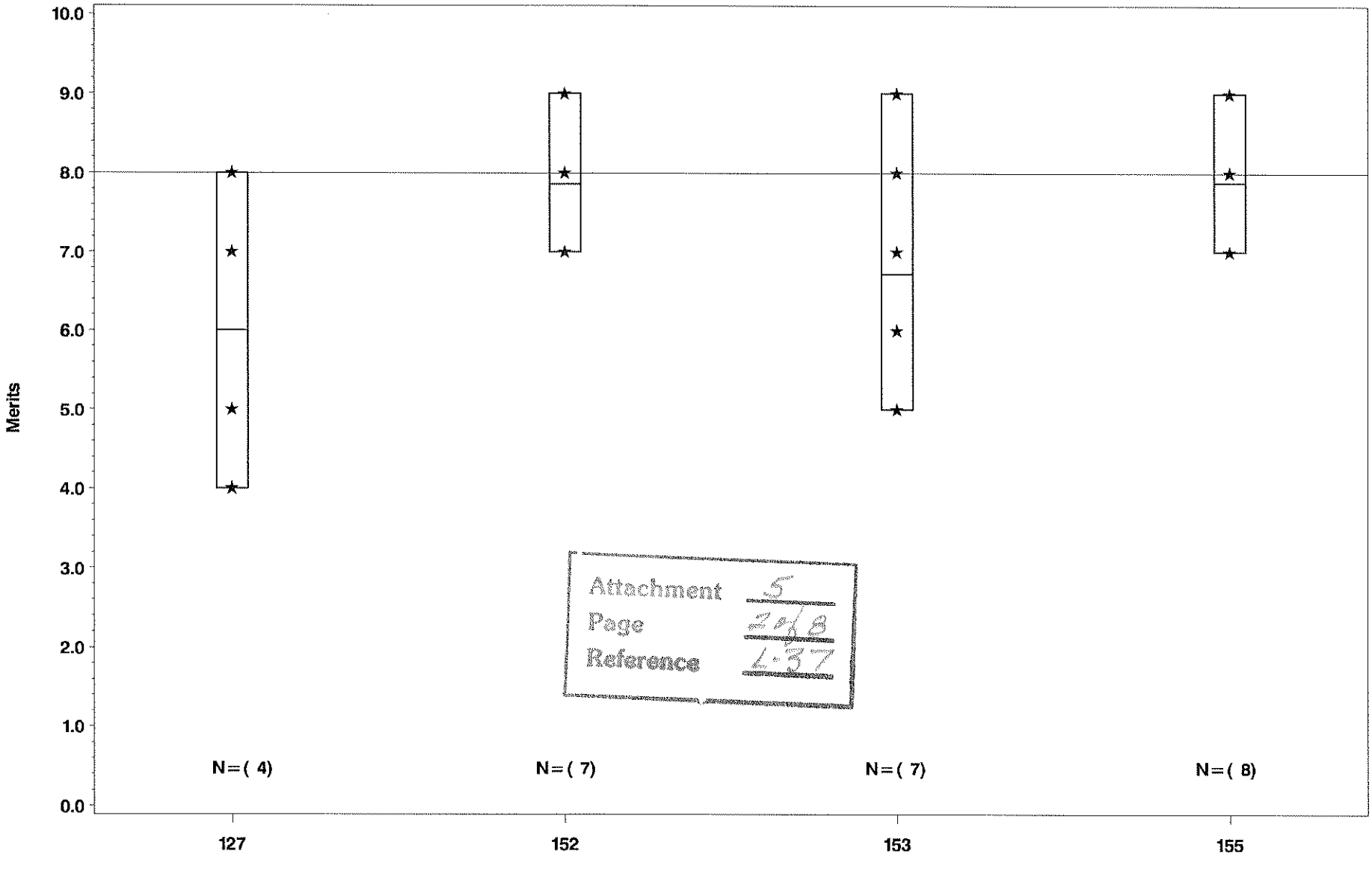
Gear Batch B6L566/P4L816



L-37 Reference Oil Comparison

Ridging – LUBRITED – Standard

Gear Batch B6L566/P4L816

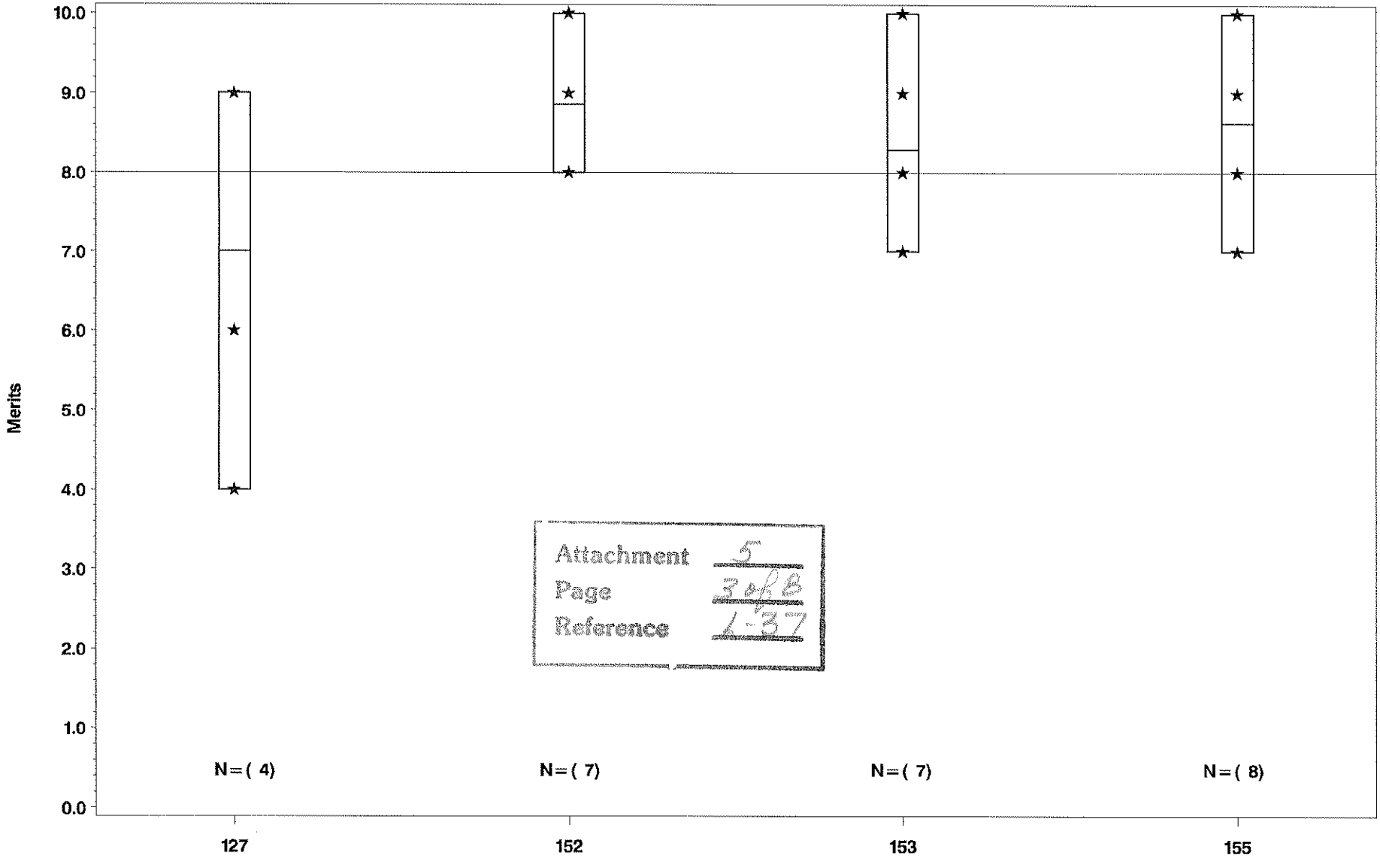


Attachment 5
Page 2 of 8
Reference L-37

L-37 Reference Oil Comparison

Rippling – LUBRITED – Standard

Gear Batch B6L566/P4L816



Attachment 5
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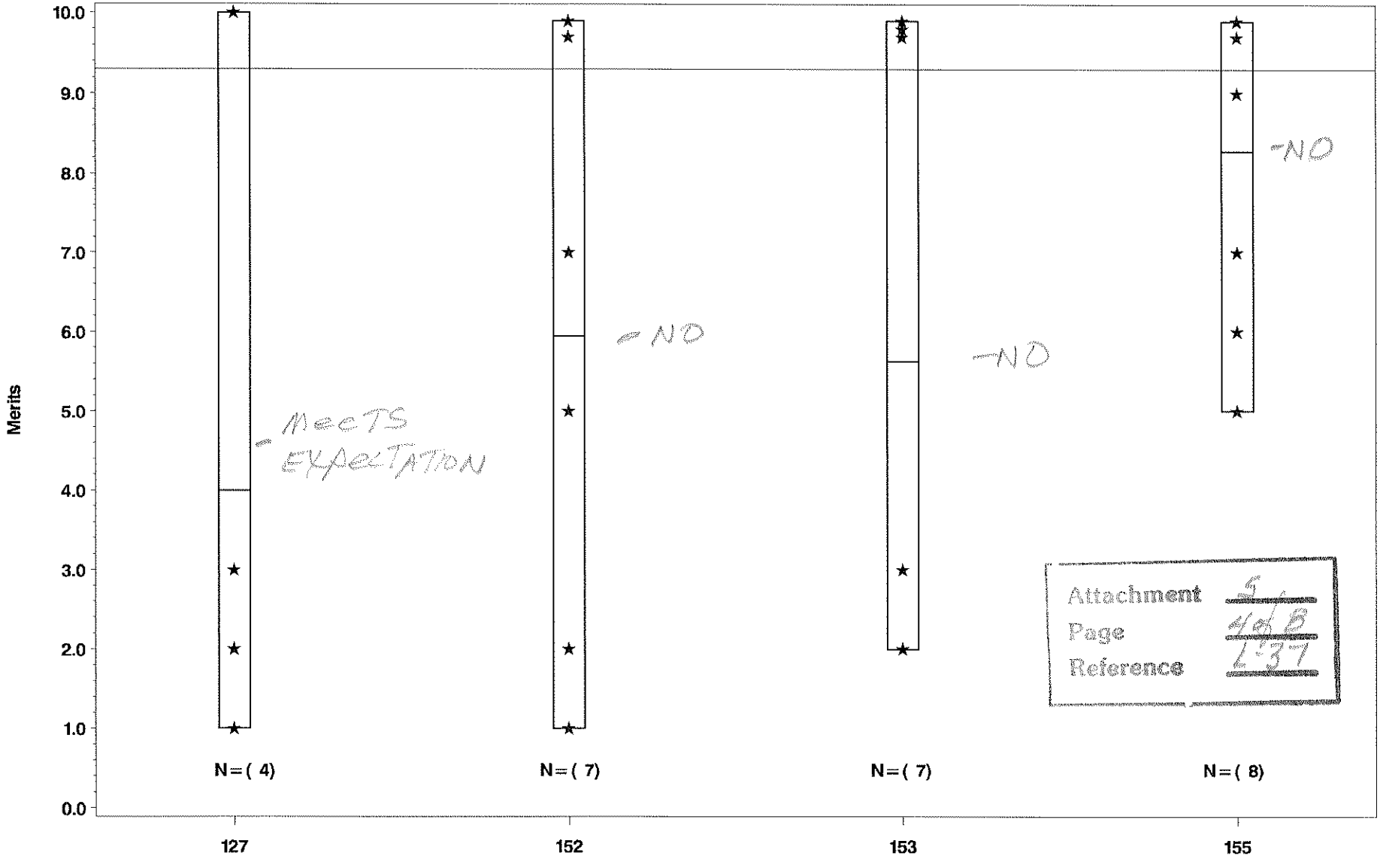
Reference L-37

L-37 Reference Oil Comparison

Spitting – LUBRITED – Standard

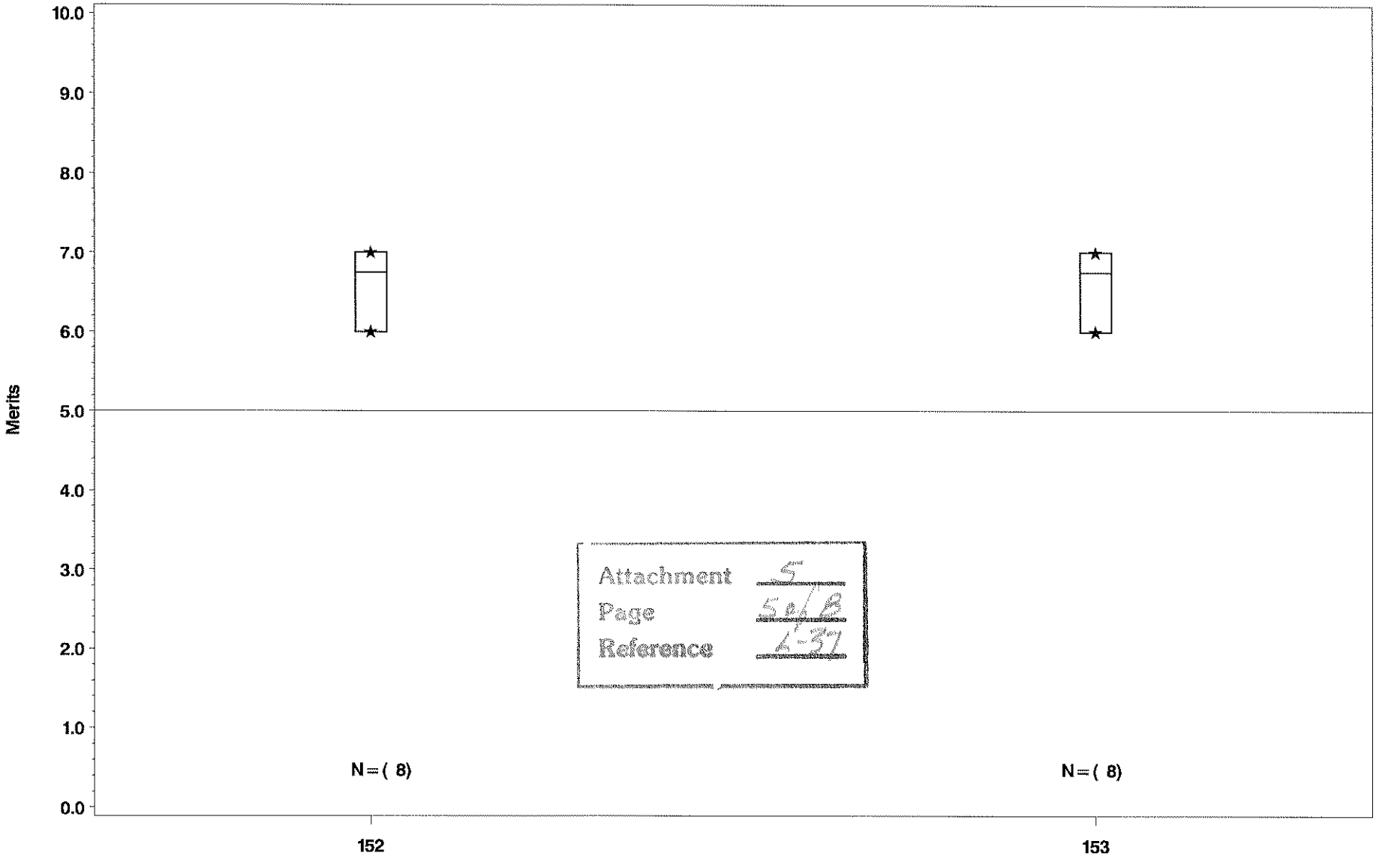
Gear Batch B6L566/P4L816



L-37 Reference Oil Comparison

Wear – LUBRITED – LowTemp

Gear Batch B6L566/P4L816



Attachment 5
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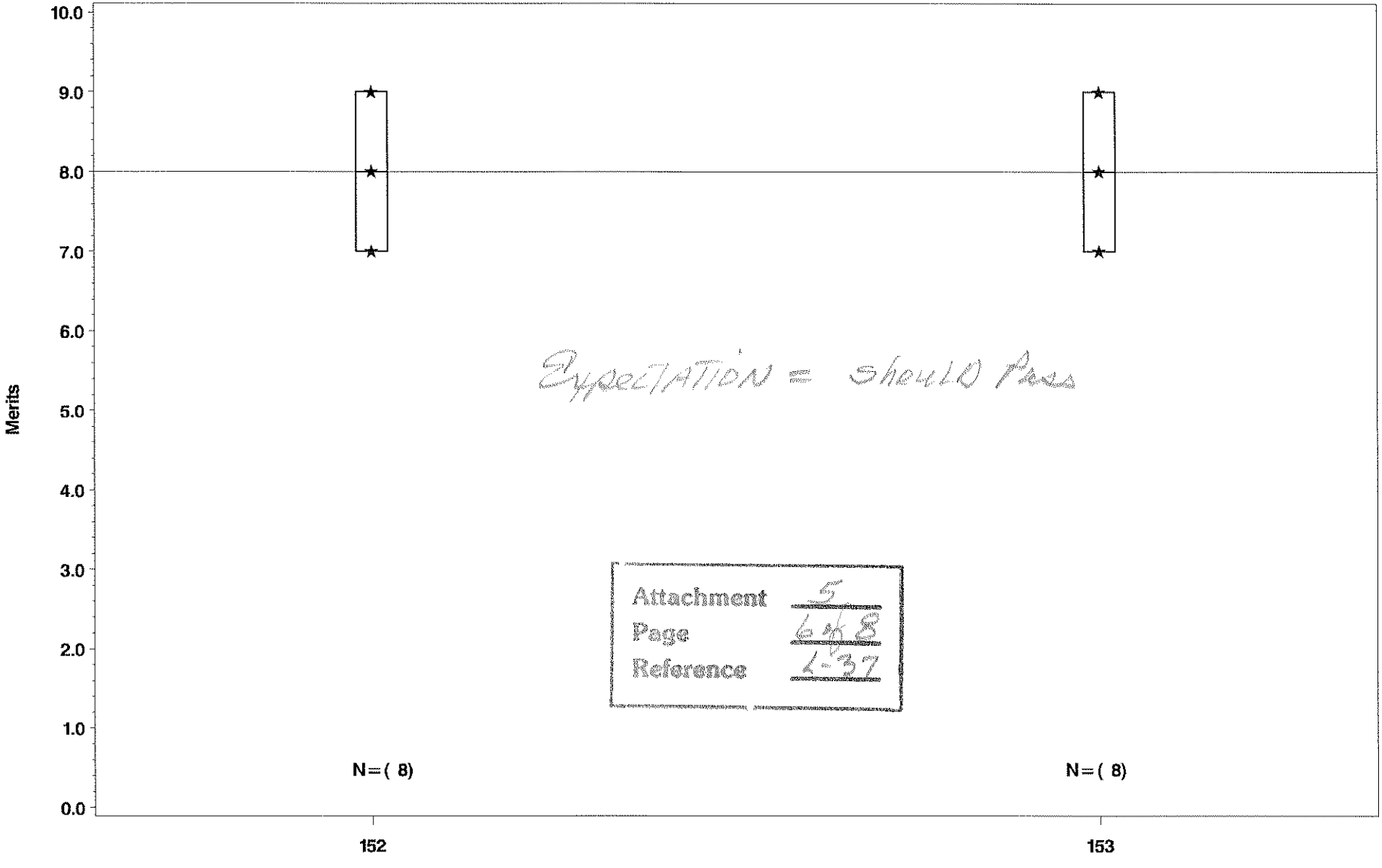
Reference L-37

L-37 Reference Oil Comparison

Ridging – LUBRITED – LowTemp

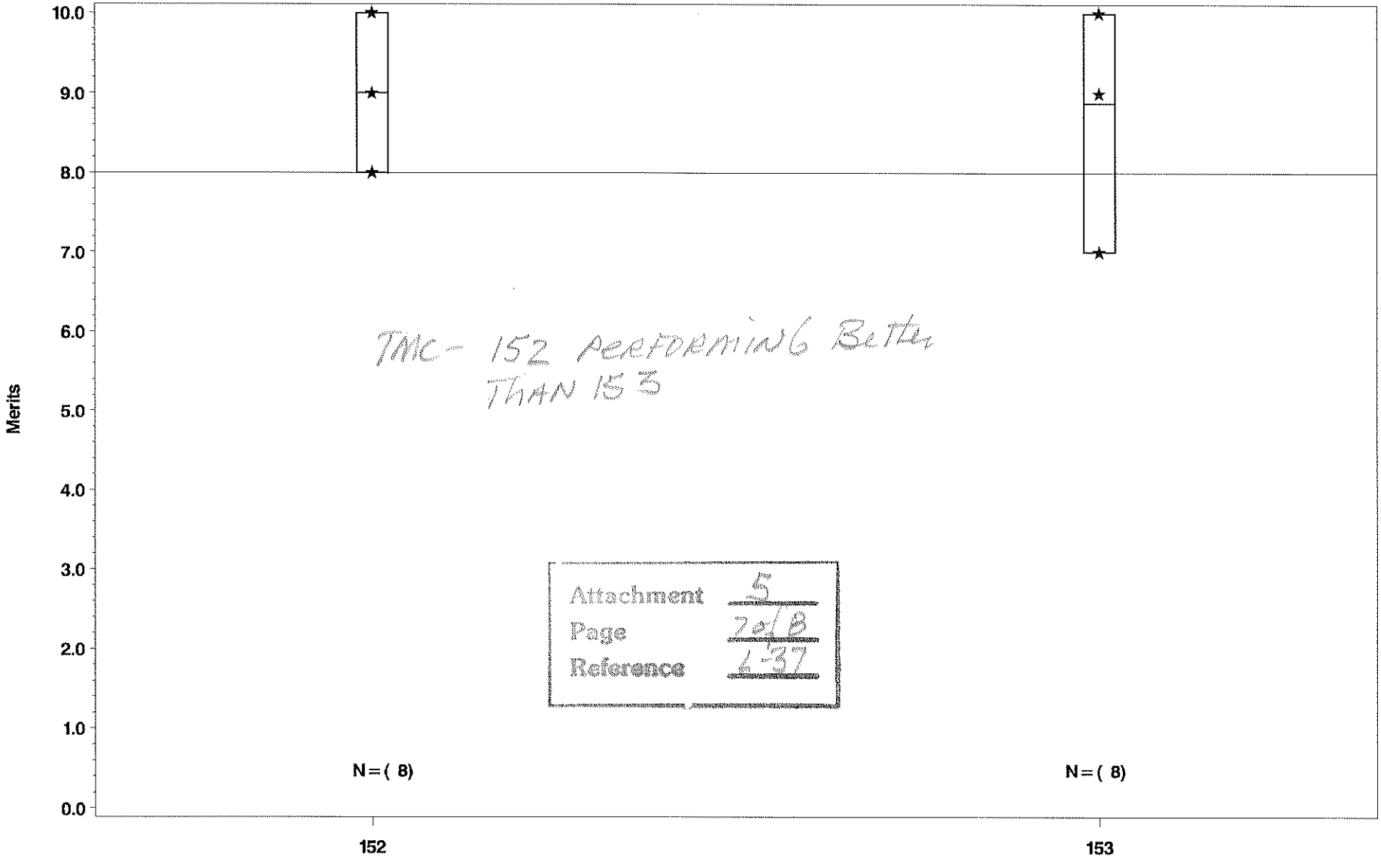
Gear Batch B6L566/P4L816



L – 37 Reference Oil Comparison

Rippling – LUBRITED – LowTemp

Gear Batch B6L566/P4L816



TMC – 152 Performing Better Than 153

Attachment 5
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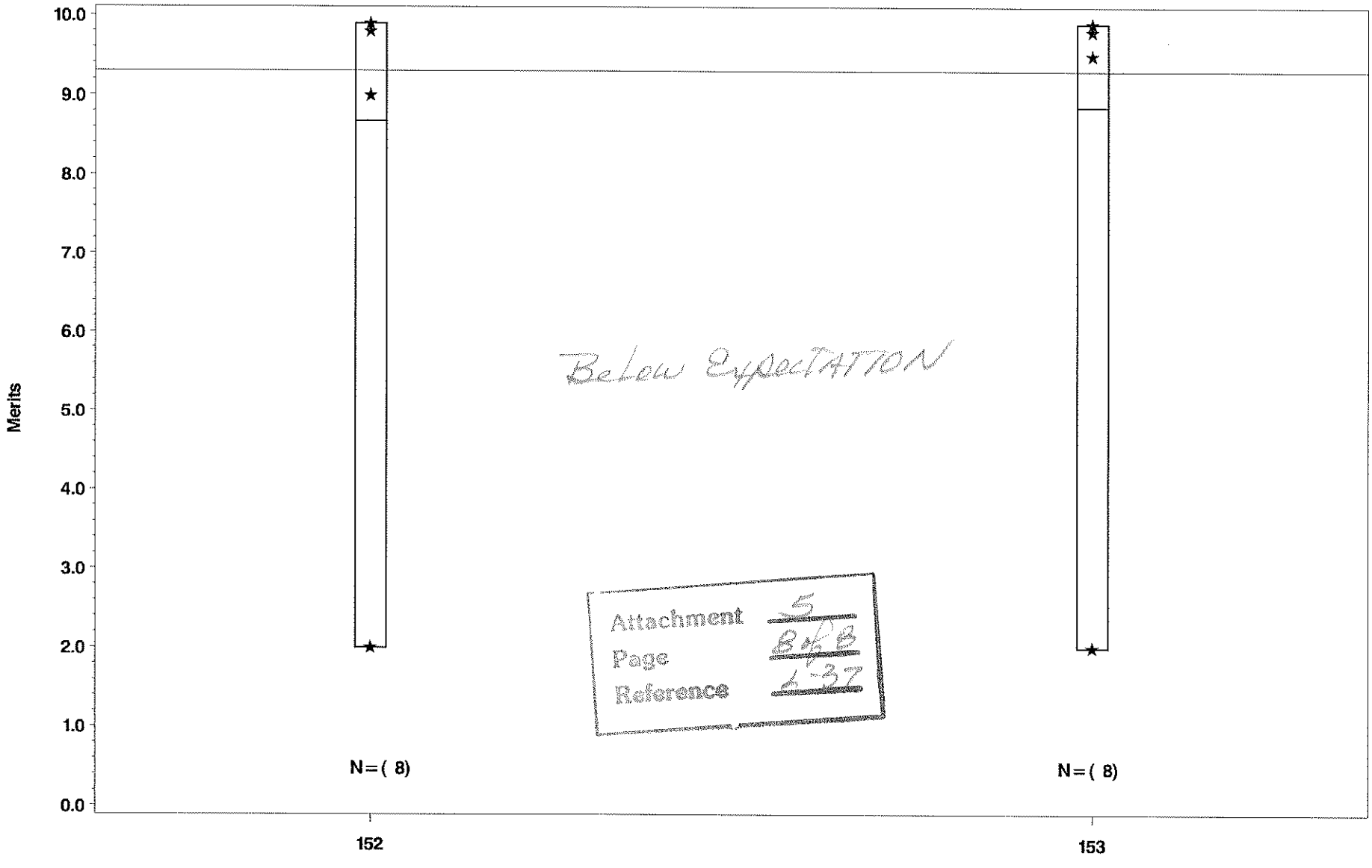
Reference L-37

L-37 Reference Oil Comparison

Spitting – LUBRITED – LowTemp

Gear Batch B6L566/P4L816



Below Expectation

Attachment 5
Page B-4-B
Reference L-37