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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

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May 16, 2008

Reply to:

Donald T. Bartlett
The Lubrizol Corporation
29400 Lakeland Blvd.
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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:

- **May 7, 2008 L-37 Surveillance Panel Meeting conducted at the PRI Headquarters, Apollo Room, Warrendale, PA.**

Please direct any corrections or comments to my attention.

Sincerely,

Donald T. Bartlett, Chairman

L-37 Surveillance Panel

Attachments

**Report of Meeting
L-37 Surveillance Panel
Warrendale, PA
PRI Apollo Room**

May 7, 008

Sign-in/Review of Agenda & Membership: The meeting was called to order at 09:10 a.m. The sign-in sheet is included as ***Attachment # 1***. Mr. Rae and Mr. Miller joined via teleconference. Agenda review was performed with no changes.

The membership list was reviewed by Mr. Bartlett. All members were recently contacted. All members on the voting list have requested to remain members and maintain their voting rights. See ***Attachment # 2***.

Mr. Gropp noted that we frequently have only perhaps one-half of the voting members attend many of the surveillance panel meetings. He expressed concern that someone might cite this low attendance by voting members as a reason to question the validity of the votes taken at these meetings. He suggested that each surveillance panel chairman take a very close look at their panel's membership list, and attempt to reduce the number of voting members to only those individuals who routinely attend the surveillance panel meetings. He stated that it is not his intent to discourage anyone from requesting membership on these panels, and that anyone who wants to be on the membership list as a non-voting member should be added.

Action Item ⇒ Mr. Gropp will draft a proposal to the respective panels with his recommendations to address the voting membership issue.

Approval of Minutes: With respect to the approval of the of the February 13th 2008 SP Meeting minutes, Mr. Gropp had several questions regarding the Matrix runs discussed in the February meeting and requests that the approval be performed at the end of the meeting.

Summary of Meeting Discussions

Attachment # 3 represents a PowerPoint presentation the chairman used for the meeting.

2008 Plain, Lubrited & Retrofit Hardware Update - See ***Attachment #3*** and slides 4 through 12 respectively for an overview and detail of panel and Hardware TF activity to date.

Slide 5 was updated to show the ring and pinion gear batch codes provided by Mr. Miller today. Pinion:
- Lubrited and non-lubrited V1L500
 Ring – Retrofit & New Lubrited: P4L870A
 Ring – New non-lubrited: P4T843

Mr. Bartlett pointed out that the Retrofit and New Lubrited hardware will be serialized differently to distinguish them apart in the future.

Mr. Gropp had questions and there was much discussion on the test matrix (s) with respect to how to equally divide testing commitments across each of the labs since all labs were not participating in the hardware purchase. Mr. Lind shared that the past data shows we could cut the Canadian test requirements down from 8 to a total of 7 if no issues were raised up in initial testing. Mr. Gropp expressed his hesitancy to reduce the number of tests further. The 44-test matrix was designed to provide adequate information for setting appropriate targets and identifying the need for possible correction factors for both the Standard and Canadian tests.

Slides 6 (new non-lubrited), 7 (Retrofit), and 8 (new lubrited) detail the hardware approval matrix requirements for the respective hardware type.

Mr. Gropp provided **Attachment # 4** that represents a three-page spreadsheet that the panel reviewed and verbally agreed to adopt. The sheets detail the hardware batch type, TMC oil codes, and respective number of runs each lab has committed to. With respect to New Non-Lubrited hardware, Mr. Gropp volunteered Lubrizol to conduct 2 extra tests (total 17) while Afton and SwRI will run a total of 15. Total tests for the new non-lubrited matrix will be 47.

Action Item ⇒ Mr. Lind to confirm that the labs have enough reference oils in their labs to conduct the 105 matrix tests.

Mr. Miller asked if the tests really added up to 105 tests will be run. Mr. Bartlett mentioned that with each test ~6k\$ and points out that the labs will be spending over a 1/2 million to approve the hardware in testing costs.

The summary (slide 9, attachment 3) of the HTF visit to Maumee Facility was reviewed. **Attachment # 5** is the official minutes of the Maumee facility visit previously shared with the panel and included for formal documentation.

The summary of the HTF visit to the Ft. Wayne Facility (slide 10, attachment 3) was reviewed (slide 10) and included as **Attachment # 6** is the official minutes of the Ft. Wayne facility visit previously shared with the panel and included for formal documentation.

The contact pattern dispersion was discussed in further detail. Mr. Miller reviewed the prints and noted that the axles will be built around L-2 with slight dispersion i.e., L-1.5 to L-2.5. Mr. Miller mentioned that a length of L-1.5 would be called an L-2, Mr. Bartlett responded that a length of L-1 contact pattern would have to be rejected based on current procedural requirements.

Mr. Miller mentioned that L-3 type pattern would cause increased distress due to the finite elemental analysis that they have conducted. He also mentioned that the flank in / flank out affects the distress level more, but could not specify which distress would be affected, all distress should be affected by the increased surface contact stress.

Mr. Miller pointed out that this all may become a moot point with an L-37-1 on the horizon on new hardware.

The panel was updated on the current production build progress (slide 11, attachment 3)

There is a tentative HTF Visit to Lugoff on June 3rd and 4th, 2008 (slide 12, attachment 3). Mr. Miller mentioned these dates looks good as he is out of the office the week of June 8th.

Wear and Ridging Mold Board Study Update – TMC

Mr. Bartlett recapped the history for the request from the panel to the rating task force in 2006 with the goal for the raters to make to improve rater variation to a value less than +/- 1 rating value. It was shortly after that period that the GO RTF recommended to the panel to revisit the use of remaking new mold boards (ridging and wear only) using the LRI distress gear boards that were also used for manual 21 photos. The GO rating task force also made a recommendation to change the rating definitions for wear. See slides 14 & 15 (attachment 3) which details a motion made by Gropp/Koehler on September 19, 2007.

To date, Lubrizol has expended approximately \$ 5500 (to be shared by 4 labs) on the Mold Boards at completion of the exercise.

Mr. Lind reported that the RCMS pinions have rotated through all of the labs. See **Attachment # 7** (the chairman had provided to the panel for review before the meeting). Mr. Lind reviewed the data with the panel. Four labs participated with 7 different raters. Mr. Lind stated that he did not see any improvement in precision. Mr. Koglin felt, at best, the use the Mold Boards provided the same or worse precision; only on a few occasions did the precision look better.

Mr. Koglin and Mr. Smith stated that they both share the same view as Mr. Lind, that the Mold Boards don't appear to improve the precision. Mr. Bartlett reiterated that we are fast approaching the shelf life of the master mold that each of the Mold Boards were made from. There was much discussion leading us to the following motions.

Motion # 1 ⇒ Mr. Smith, Second ⇒ Mr. Koglin – Based on the review of the data and no visual improvements in precision, the panel recommends that we reject the use of the mold boards and new wear rating definitions and stick to existing photos and definitions. The motion passed unanimously, 7 for, 0 opposed, and 1 abstention.

Motion # 2 ⇒ Mr. Gropp, Second ⇒ Mr. Smith - Each lab will immediately collect and destroy the Mold Boards in their possession. The motion passed unanimously, 7 for, 0 opposed, and 1 abstention.

Gear Teeth Chipping Definition - Bartlett

A previous action item was to address rating issues with respect to two of the RCMS pinion # 44 and # 45 (pulled the RCMS at a previous meeting). Some raters were formally calling the anomalies at the top land as chipping and others as pitting or broken teeth.

Refer to slides 17 – 20 (attachment 3). Mr. Fett believes this is chipping and is caused from excessive compressive stress built into the gear from the shot peening process. Mr. Miller commented that the pinions have excessive wear, and that the crown edge is the most brittle spot on the tooth. Stresses have been elevated. If there is not sufficient relief at the edge, the edge will fatigue/chip due to through hardening at the corners.

Mr. Smith feels that a definition should be defined and the pinions placed back in active service. The panel discussed possible rating definitions to address the chipping vs. pitting. The general consensus is that it should be considered chipping, and not rated as pitting. The panel struggled over building a definition. Mr. Gropp stated that the definition will not work if we do not pin down a defined maximum location from the crown (like 1/16 "). Mr. Lind said that we could possibly use something such as "If pitting spreads into the crown of the tooth. . . "

Action Item ⇒ Chairman to pull the lab engineers and Mr. Miller together via a teleconference to wordsmith a description and make a recommendation to be email balloted to address this issue.

Approval of Minutes: There was no time left to address Mr. Grop's questions so the approval of the February 13, 2008 meeting minutes will be done at the next meeting.

Motion # 3 ⇒ Mr. Smith, second ⇒ Mr. Koglin. Move to adjourn the meeting at 11:08.

Respectfully submitted,

A handwritten signature in blue ink that reads "Donald T. Bartlett". The signature is written in a cursive style with a large, stylized initial 'D'.

Donald T. Bartlett
L-37 Surveillance Panel Chairman

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: May 7, 2008

Initials*	Name	Voting Status	Company Name & Address	Phone/Email Info
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	Barker, Chris	Non Voting	Southwest Research Institute PO Drawer 28510 San Antonio, Texas 78228-0510	Phone: 210-522- Fax: 210-684-7523 E-Mail: chris.barker@swri.org
<i>DB</i>	Bartlett, Don	Voting/Chair	The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092	Phone: 440-347-2388 Fax: 440-347-2878 E-Mail: donald.bartlett@lubrizol.com
<i>DCB</i>	Bell, Don	Non Voting	Afton Chemical 500 Spring Street Richmond, VA 23219	Phone: 804-788-6332 Fax: 804-788-6243 E-Mail: don.bell@aftonchemical.com
	Bryson, Tom	Voting	Mack Trucks 13302 Pennsylvania Avenue Hagerstown, Maryland 21740	Phone: 301-790-6744 Fax: 301-790-5605 E-Mail: thomas.bryson@volvo.com
	Buitrago, Juan	Voting	Chevron Oronite Company 100 Chevron Way Richmond, California 94802	Phone: 510-242-1161 Fax: 510-242-3392 E-Mail: jabu@chevrontexaco.com
	Chambers, Harold	Non-Voting	Ford Motor Co. ATNCP Livonia 35500 Plymouth Livonia, MI 48150	Phone: 313-805-8591 Fax: 313- E-Mail: hchamber@ford.com
	Comfort, Allen	Voting	AMSTA-TR-D/210 Tank Automotive & Armament 6501 East 11 Mile road Warren, MI 48397-5000	Phone: 586-574-4225 Fax: 586-574-4244 E-Mail: allen.s.comfort@us.army.mil

Attendance 1
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* Initial to indicate attendance at subject meeting

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: May 7, 2008




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	Farber, Frank	Non Voting	ASTM Test Monitoring Center 6555 Penn Avenue Pittsburgh, Pennsylvania 15206	Phone: 412-365-1030 Fax: 412-365-1047 E-Mail: fmf@astmtmc.cmu.edu
	Foeking, Brian	Non Voting	The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092	Phone: 440-347-2130 Fax: 440-347-9011 E-Mail: brian.foeking@lubrizol.com
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<i>KG</i>	Greene, Galen	Non-Voting	The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092	Phone: 440-347-2394 Fax: 440-347-2878 E-Mail: galen.greene@lubrizol.com
<i>JG</i>	Gropp, Jerry	Non Voting	The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092	Phone: 440-347-1223 Fax: 440-347-1555 E-Mail: jerrold.gropp@lubrizol.com
	Haire, Mike	Non Voting	Chevron Oronite Company 100 Chevron Way, Rm 71-7302 Richmond, California 94802	Phone: 510-242-2740 Fax: 510-242-3758 E-Mail: mhaire@chevron.com
<i>SH</i>	Higuchi, Sam	Non Voting	Afton Chemical 500 Spring Street Richmond, VA 23218	Phone: 804-788-5375 Fax: 804-788-6358 E-Mail: samuel.higuchi@aftonchemical.com

* Initial to indicate attendance at subject meeting

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ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: May 7, 2008

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	Koehler, Brian	Voting	Southwest Research Institute PO Drawer 28510 San Antonio, Texas 78228-0510	Phone: 210-522-3588 Fax: 210-684-7523 E-Mail: bkoehler@swri.org
	Koglin, Cory	Voting	Afton Chemical 500 Spring Street Richmond, VA 23219	Phone: 804-788-5305 Fax: 804-788-6358 E-Mail: CoryKoglin@aftonchemical.com
	Kozlowski, Ralph	Non Voting	PARC Technical Services, Inc. 100 William Pitt Way Pittsburg, PA 15238	Phone: 412-826-5044 Fax: 412-826-5443 E-Mail:
	Lind, Don	Voting	ASTM Test Monitoring Center 6555 Penn Avenue Pittsburgh, Pennsylvania 15206	Phone: 412-365-1034 Fax: 412-365-1047 E-Mail: dml@astmtmc.cmu.edu
	Linden, Jim	Voting	GM Research & Development 30500 Mound Rd. MC 480-106-160 Warren, MI 48090	Phone: 586-986-1888 Fax: 586-986-2094 E-Mail: James.L.Linden@GM.com
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	Marougy, Thelma	Voting	Eaton Corporation 26201 Northwestern Highway Southfield, MI 48034	Phone: 248-226-6985 Fax: 248-226-2739 E-Mail: thelmaemarougy@eaton.com

* Initial to indicate attendance at subject meeting

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Reference _____

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: May 7, 2008

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	Radonich, Peter	Non Voting	The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092	Phone: 440-347-2184 Fax: 440-347-9011 E-Mail: peter.radonich@lubrizol.com
<i>RS/TLC</i>	Salvatore, Rea	Voting	Infinium USA, L.P. 1900 E. Linden Ave Linden, NJ 08066 78228-0510	Phone: 908-474-6602 Fax: 908-474-3597 E-Mail: salvatore.rea@infinium.com

* Initial to indicate attendance at subject meeting

Attachment _____

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Reference _____

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: May 7, 2008

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<i>ASJ</i>	Smith, Dale	Voting	Intertek - PARC Technical Services, Inc. 100 William Pitt Way Pittsburgh, PA 15238	Phone: 412-423-1120 , ext 403 Fax: 412-826-5443 E-Mail: Dale.Smith@intertek.com
	Sullivan, Bill	Non Voting	William T. Sullivan, Inc. 5 Scheiber Drive Brick, NJ 08723	Phone: 908-930-3512 Fax: 267-220-7750 E-Mail: wtsullivan@comcast.net
	Vettel, Paula	Voting	D. A. Stuart Company 4580 Weaver Parkway Warrenville, Illinois 60555	Phone: 630-393-8859 Fax: 630-393-8577 E-Mail: pvettel@dastuart.net
	Zakarian, Jack	Non Voting	Chevron Products 100 Chevron Way Richmond, CA 94802	Phone: 510-242-3595 Fax: 510-242-3758 E-Mail: jaza@chevron.com
	<i>H Gao, Hong</i>		<i>Conoco Phillips 1000 S Pine St. Ponca City, OK 74602</i>	Phone: <i>580-767-2126</i> Fax: <i>580-767-4534</i> E-Mail: <i>hong.gao@conocophillips.com</i>
				Phone: Fax: E-Mail:

* Initial to indicate attendance at subject meeting

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L-37 Surveillance Panel Voting Members


Donald Bartlett	The Lubrizol Corporation (Chairman)
Tom Bryson	Volvo Powertrain 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 Lind	ASTM Test Monitoring Center
Jim Linden	GMR Research and Development
Thelma Marougy	Eaton Corporation
Bruce McGlone	ArvinMeritor Materials Engineering
Kenny Miller	Dana Corporation
Salvatore Rea	Infineum
Dale Smith	Intertek - PARC Technical Services
Paula Vettel	D.A. Stuart Company

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Lubrizol

L-37 Surveillance Panel
 PRI Headquarters,
 Warrendale, Pa.
 May 7, 2008

Donald Bartlett



Lubrizol

L-37 SP Agenda

- I. Call to Order, Agenda, & Membership Review
- II. SP Minutes to Approve:
 - ✓ February 13, 2007 SP Meeting
- III. 2008 Green, Lubrited & Retrofit HDW Update 30 min
- IV. Mold Board Study Update 30 min
- V. Pitting/Spalling vs. Chipping RCMS Pinions 44 and 45 30 min
- VI. New Business
- VII. Adjournment

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Lubrizol

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
Kenny Miller	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

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Attachment 3

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Reference 5/7/08

Lubrizol

2008 Hardware Status to Date

- ✓ Dana statements and agreements with ASTM to date:
 - ✓ Purchased one heat steel for all non-lubrited and lubrited pinions.
 - ✓ Purchased one heat steel for all lubrited rings.
 - ✓ Non-lubrited rings will use rings from the 2005 batch/heat of steel.
 - ✓ Will "same batch lot" order all associated parts for new axle assembly builds.
- ✓ Green - new axle assembly cost is \$ 992.00
- ✓ Lubrited - Retrofit of 2007 B6L566 and 'other' parts
 - ✓ At no cost to labs
 - ✓ Labs to pay shipping one way
 - ✓ Axles to use the "Alternate" lubriting process
- ✓ Lubrited - new axles assembly cost is \$ 1005.00
 - ✓ Axles to use the "Alternate" lubriting process

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Lubrizol

2008 Hardware Order Information

<u>Axle Type</u>	<u>Total Order</u>	<u>Ring Code</u>	<u>Pinion Code</u>	<u>Labs</u>
Plain	1084*	P4T813	New y xx 3	
Lub - Retrofit	974	New xx	New xx 4	
Lub - New	237	New xx	New xx 2	
Total	2295			

* Additional order of Plain Axles

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* P4L870A
* * VIL500

Lubrizol

Agreement 1 – Oct. 25th 2007 SP Telecom Mtg.

- ✓ Non-Lubrited Hardware Matrix – 3 Labs, Afton, Lubrizol, SwRI
- ✓ Conduct the standard 47* - test approval matrix
 - » 3 Standard test on TMC 127*
 - » 8 Standard test on TMC 151
 - » 8 Standard test on TMC 152
 - » 8 Standard test on TMC 153
 - » 8 Canadian test on TMC 152
 - » 8 Canadian test on TMC 153
 - » 4 Standard test on TMC 134*

* Amended 2/13/2008
* Run TMC 134 spread out in matrix after TMC 127
* Lubrizol will run 2 of TMC 134 runs

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Attachment 3
Page 2067
Date 5/7/08

Lubrizol

Agreement 2 – Oct. 25th 2007 SP Telecom Mtg.

- ✓ Lubrited Retrofit Hardware Matrix – 4 Labs
- ✓ Conduct the standard 44- test approval matrix
- ✓ Consensus was the retrofit plus all new axle assemblies would be of the same heat of steel
 - » 4 Standard test on TMC 127
 - » 8 Standard test on TMC 151
 - » 8 Standard test on TMC 152
 - » 8 Standard test on TMC 153
 - » 8 Canadian test on TMC 152
 - » 8 Canadian test on TMC 153
 - * No TMC 134 per SP 2/13/2008

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Lubrizol

Agreement 3 – Oct. 25th 2007 SP Telecom Mtg.

- ✓ New Lubrited Hardware Matrix – 2 Labs
- ✓ Conduct 14- test approval matrix *
- ✓ Afton and Lubrizol will conduct 1 test each as follows:
 - » 1 Standard test on TMC 127
 - » 1 Standard test on TMC 151
 - » 1 Standard test on TMC 152
 - » 1 Standard test on TMC 153
 - » 1 Canadian test on TMC 152
 - » 1 Canadian test on TMC 153
 - * Amended 2/13/2008
 - * 1 Standard test on TMC 134

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Lubrizol

Lab HTF Visit to Maumee Facility

- ✓ Visit was Wednesday, March 5, 2008
 - Reviewed and documented Maumee assembly process
 - Tour of Assembly area
 - Questions & review bench vs. line builds
 - Documented expectations
 - Reviewed action items

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Attachment	<u>3</u>
Page	<u>3 of 7</u>
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Lubrizol

Lab HTF Visit to Ft. Wayne

- ✓ Visit was Thursday, March 6, 2008.
 - Review hardware order PO change - Plains
 - Review the drawings and re-validate any changes required before proceeding
 - Design theory analysis work
 - Review the heat treating process
 - Review the alternate lubrited process
 - Resolved issues with contact pattern position i.e. - L1 vs. L2 and L3 (procedure specified)
 - Reviewed action items

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Lubrizol

Status to Date with Production

- Fire check audits in progress
- Hardware to be available for builds mid/end of June
- Will start with both Lubrited Retrofit and new builds first
- Dana will co-ordinate retrofit pick ups with the labs:
 - SwRI , one truck on May 23rd. 2nd truck will follow at call
 - Lubrizol second
 - Afton third
 - Parc fourth

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Lubrizol

Lab HTF Visit to Lugoff

- Tentatively set for June 3 and 4, 2008.
 - Engineer contact replacing Mr. Bird is Mr. Lawrence
 - Confirm expectations that the support hardware, i.e., carrier housing, diff case, bearings, and other associated parts will be batch lotted
 - Review drawings and re-validate any changes since last batch assembly
 - Will assemble Lubrited hardware first
 - Review action items

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Attachment 3
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 Reference 5/7/08

Lubrizon

L-37 SP Agenda

I.	Call to Order, Agenda, & Membership Review	
II.	SP Minutes to Approve:	
	✓ February 13, 2007 SP Meeting	
III.	2008 Green, Lubrited & Retrofit HDW Update	30 min
IV.	Mold Board Study Update	30 min
V.	Pitting/Spalling vs. Chipping RCMS Pinions 44 and 45	30 min
VI.	New Business	
VII.	Adjournment	

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Lubrizon

Mold Board Study Update

- Motion made September 19, 2007 – Gropp/Koehler
 - » After the raters initial meeting, the TMC is to send selected RCMS pinions around for all raters to 'round robin rate'.
 - » Raters to rate pinions using all tools, i.e., the photos, moldboards, and definitions.
 - » Note: see attachment 10, 8/8/2007 Panel minutes detailing GO RTF proposal to modify the wear definition as follows:
 - Light (7) - Absence of tool marks at the heel or toe, which may or may not include the presence of a barely discernible wear step.
 - Light Medium (6) - presence of a discernible wear step.

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Lubrizon

Mold Board Study Update

- Motion made September 19, 2007 – Gropp/Koehler
 - » The complete moldboard exercise is to be completed by May 1st, 2008.
 - » We would like the raters & TMC to make a recommendation to the Surveillance Panel (June 2008 meeting) that the use of the molds either be adopted (because variability has been reduced) or rejected (because variability has not been reduced).
 - » Note: The understanding would be that the new Wear definition proposal and both Mold Boards are not to be used to rate reference and candidate tests in the labs until addressed officially by the L-37SP.

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Attachment	<u>3</u>
Page	<u>5 of 7</u>
Reference	<u>5/7/08</u>

Lubrizol

L-37 SP Agenda

- I. Call to Order, Agenda, & Membership Review
- II. SP Minutes to Approve:
 - ✓ February 13, 2007 SP Meeting
- III. 2008 Green, Lubrited & Retrofit HDW Update 30 min
- IV. Mold Board Study Update 30 min
- V. Pitting/Spalling vs. Chipping RCMS Pinions 44 and 45 30 min
- VI. New Business
- VII. Adjournment

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Lubrizol

Gear Set 44 (RCMS)

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Lubrizol

Gear Set 45 (RCMS)

18

Attachment 3
 Page 6 of 7
 Reference 5/7/08

Lubrizol

Pitting/Spalling vs. Tooth Chipping

- ❖ RCMS Pinions 44 and 45 –
- ❖ Greg Fett comments –
 - Believes that the anomaly at the top of the L37 gear teeth is chipping
 - Is a result of the wear on the tooth face and the compressive residual stress from the shot peening operation
 - The shot peening operation puts a considerable amount of compressive residual stress in the corner of the tooth tip
 - Shot peening tends to make it want to crack or pop off
 - When there is wear on the tooth face the stress is relieved on one side only which tends to cause these cracks
 - These are not normal pitting which is associated with localized high contact stresses or poor lubricant performance.

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Lubrizol

Pitting/Spalling vs. Tooth Chipping

Panel Direction ?

- Define the contact area around the crown ?
- Write a description for chipping ?
- Excluded and note in comments section ?
- Put pinions back into RCMS ?

20

Lubrizol

Thank You !

- 8 Hardware TF Teleconferences Since February SP Mtg
- 2 Dana Facility Visits, Maumee and Ft. Wayne
- Dana
- TMC
- Labs

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Attachment	<u>3</u>
Page	<u>7 of 7</u>
Reference	<u>5/2/00</u>

Hardware: Retrofit, Lubrified

Oil	Test Conditions	Number of Tests to be Conducted					Total
		Afton	Intertek	Lubrizol	SwRI	Total	
TMC 127	Standard	1	1	1	1	4	
TMC 134	Standard	0	0	0	0	0	
TMC 151	Standard	2	2	2	2	8	
TMC 152	Standard	2	2	2	2	8	
TMC 152	Canadian	2	2	2	2	8	
TMC 153	Standard	2	2	2	2	8	
TMC 153	Canadian	2	2	2	2	8	
		=====	=====	=====	=====	=====	
Total		11	11	11	11	44	

Attachment	4
Page	1 of 3
Reference	5/7/08

Hardware: New, non-lubricated

Oil	Test Conditions	Number of Tests to be Conducted				Total
		Afton	Intertek	Lubrizol	SwRI	
TMC 127	Standard	1	0	1	1	3
TMC 134	Standard	1	0	2	1	4
TMC 151	Standard	3	0	3	2	8
TMC 152	Standard	2	0	3	3	8
TMC 152	Canadian	3	0	2	3	8
TMC 153	Standard	3	0	3	2	8
TMC 153	Canadian	2	0	3	3	8
		=====	=====	=====	=====	=====
Total		15	0	17	15	47

Attachment	<u>4</u>
Page	<u>2 of 3</u>
Reference	<u>5/7/08</u>

Hardware: New, Lubrified

Oil	Test Conditions	Number of Tests to be Conducted					Total
		Afton	Intertek	Lubrizon	SwRI		
TMC 127	Standard	1	0	1	0		2
TMC 134	Standard	1	0	1	0		2
TMC 151	Standard	1	0	1	0		2
TMC 152	Standard	1	0	1	0		2
TMC 152	Canadian	1	0	1	0		2
TMC 153	Standard	1	0	1	0		2
TMC 153	Canadian	1	0	1	0		2
		=====	=====	=====	=====	=====	=====
Total		7	0	7	0		14

Attachment	<u>4</u>
Page	<u>3 of 3</u>
Reference	<u>5/7/08</u>

L-37 HTF Facility Visit to Dana, Maumee, Ohio
Wednesday, 03/05/2008

Attendees:

Dana -	Guzikowski, Miller, Fett, Horvath
SwRI -	Koehler
Lubrizol -	Bartlett, Gropp, Graziano
Afton -	Koglin, Hyguchi

We met at Maumee to discuss the production of the next batch of plain L-37 test axles and the retrofitting of the existing batch of Lubrited axles with new test gears. The agenda item summary is as follows:

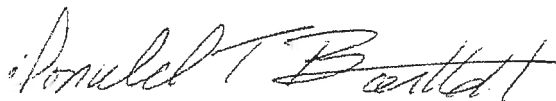
- Review of Maumee assembly process - Mike Horvath briefed the HTF on the assembly flow process that would use one of their 3 available build lines. Dana can only build '6' axles per day for 5 days a week (could be more depending if another line opens up).
- Tour of assembly area - Mike Dewitt and Mike Horvath conducted the tour and answered questions. We toured their analytical labs, testing facility, and prototype assembly facility. Very clean, very nice, well equipped. This building is only 4 years old. Most impressive!
- Questions & review of rebuild procedure with respect to the bench build vs. line build to meet D6121 requirements. We discussed all the axle retrofit details. They had a step-by-step procedure. We requested some changes. See **Attachment # 1**. Maumee will have to talk to the Lugoff facility for in line build information details.
 - Rotating torque (what we call break/turn) during Lugoff assembly is of pinion only. This is what is painted on housing. Full assembly rotating torque is not taken.
 - Maumee will keep a spreadsheet detailing the initial Lugoff axle serial number and re-serialize the axle. They will be documenting many of the Maumee requirements as well. Spreadsheet will be shared with the labs.
 - All existing parts to be reused unless damaged during assembly. This includes bearings, cups, seals and shims.
 - Discussed carrier assembly handling damage to tooth surfaces that render the axle unusable. Attention to detail heard loud and clear.
 - Pinion nut, per Dana, can be used up to 3 times. Agreement is to change out if adjustments are needed and only allowed to be used 2 times.
 - Housings are to be repainted with black paint and remarked with rotating torque, backlash, contact pattern and set number. Serial number either on tube or cover.
 - The procedure allows for after assembly contact patterns of L2 F0, +1, -1 and L3 F0, +1 and -1. We want to target L2 and F0.
 - Do not use RTV to seal the cover to the housing, use the standard gasket used by Lugoff.

Attachment	<u>5</u>
Page	<u>14/6</u>
Reference	<u>5/7/08</u>

- Discuss logistics of return and re-distribution - Dana will pay shipment of the axles to Dana. The Labs will pay for shipment back to the labs. Once two rounds are made, 2 pallets at a time will ship to each lab
 - SwRI hardware to be the first to ship, followed by LZ, Afton and PARC. Shipments continue until the respective lab inventory is exhausted.
 - Initially, each lab will get two pallets (in a rotated order) as the axles are completed followed by remaining axles.
- Document expectations – Bartlett - reiterated the importance of the '3' C's for consistency.
- Action Items –
 - Mr. Miller, Mr. Horvath and a contact from Lugoff are to communicate on the standardization of rebuild process so that bench build and in line build match.
 - Mike DeWitt is the Dana contact for shipping axles to and from the labs.
 - SwRI, Afton, and Parc are to E-mail Don Bartlett with: your contact info, preferred shipper, and final lubrited axle retrofit count.
 - Mr. DeWitt and labs agreed that we will keep the laboratory engineers as the lab contact. All lab engineers would receive all communications with shipping and builds so as to keep consistent and timely flow of all information.

We especially wish to thank the Dana Maumee facility for their hosting of this meeting, lunch, and full support of all issues.

Meeting was adjourned at 2:25 p.m.




Donald T. Bartlett,
L-37 Surveillance Panel Chairman

Attachment	<u>5</u>
Page	<u>246</u>
Reference	<u>5/7/08</u>

Attachment 5
 Page 3 of 6
 Reference 5/7/08

ATT# 1
 3/5/08
 L-37 ATF

 AUTOMOTIVE SYSTEMS GROUP Torque Traction Technologies Advanced Prototypes		CONTROL PLAN		Page 1 of 4	
Prototype <input type="checkbox"/> Pre-launch <input type="checkbox"/> Production <input type="checkbox"/>	Key Contact: Phone Mike Horvath 419-857-3411		Date Orig: 07-JAN-2008		Date Rev:
Customer: Latest Change Level A100-AM	Key Team Mike Horvath, Tom Maloney, Chad Coffey, Key Herdman		Customer Engineering Approval (Date/ID Req'd): N/A		
Name: Description ATF TEST LAB AXLE ASSEMBLY	Supplier Part Approval Date:		Customer Quality Approval (Date/ID Req'd): N/A		
Part Name TECHNICAL CENTER, MAUMEE, OHIO	Supplier Code: N/A	Other Approval (Date/ID Req'd):		N/A	

Part / Process Number	Process Name / Operation Description	Equipment	Characteristics			Special Char Class	Methods				Reaction Plan	
			No.	Product	Process		Product / Process Specification / Tolerance	Evaluation Measurement Technique	Sample Size	Sample Freq		Control Method
00	Receiving Fabricated Components			Part Number / Quantity			Labeling and Packing Slip Agree	Visual	All	100%	Ref (DIVWI-0100)	Reprocess or Scrap ref (DIVWI-0100)
01	Paint ID on Carrier			Part # Ratio Type of Diff Case Serial #			Per Drawing and Build Sheet	Visual	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)
01	Verify Mating of Bearing Caps to Carrier			Numbers, Alignment and Position			Per Information Stamped on Carrier	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
02	Disassemble all center section components and retain for re-assembly			Contamination Damage			None Allowed	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
03	Compare arch information to determine shim adjustment and Record on Build Sheet			Position			Per Etch on Pinion	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)

Attachment 5
 Page 4 of 6
 Reference 5/7/08

ATT #1
 3/5/08
 6-37 HTF

Part / Process Number	Process Name / Operation Description	Equipment	Characteristics			Special Char. Class	Methods					Reaction Plan
			No.	Product	Process		Product / Process Specification / Tolerance	Evaluation Measurement Technique	Sample Size	Sample Freq.	Control Method	
Station #2 20 #5	Verify Pinion and Ring Gear			Correct Part Number			Per Print	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #5				Pinion numbers Ring Gear Set numbers			Set Numbers, must match	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #5				Damage			Damage must be Repairable	Visual	All	100%	Work Instructions	Rework as necessary or Scrap, ref. (DIVWI-0104)
20 #5	Install Pinion, Bearing Cone and Shim			Correct Pinion, Bearing, Cone and Shim			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
Station #3 20 #6	Install Pinion into Carrier			Seat Outer Pinion bearing			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #7	Install Shims			Correct Shims			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #8	Install Outer Pinion Cone			Correct Outer Pinion Cone			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #9	Install Slinger			Correct Slinger			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)
20 #9	Install Pinion Seal			Correct Pinion Seal			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWI-0104)

Attachment 5
 Page 5 of 6
 Reference 5/7/08

ATT #1
 3/5/08
 L-37 HTE

Part / Process Number	Process Name / Operation Description	Equipment	Characteristics			Special Char Class	Methods					Reaction Plan
			No	Product	Process		Product / Process Specification / Tolerance	Evaluation/Measurement Technique	Sample Size	Sample Freq	Control Method	
#10	Install End Yoke			Correct End Yoke			Fully Seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
#11	Assemble Washer and Pinion Nut onto Pinion Stem			Correct Washer, Pinion Nut and Pinion Stem			In Place	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
Station #4 #12	Tighten Pinion Nut (for assemblies w/ hardened pre-load shim)			Torque	< CL (if req.)		Per Print/Torque Chart Spec	Torque Star	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
#13	Mask Run Out on End Yoke (if required)			Location			Per High Measurement	Visual	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)
Station #5 #14	Measure Total End Movement and Record on Build Sheet			Diff Case			Per Measurement	Visual	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)
#15	Inspect Ring Gear			Damage			None allowed	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
#15	Press Ring Gear into Diff Case			Correct Ring Gear			Fully seated	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref (DIVWI-0104)
#15	Install Ring Gear Screws			Torque	< CL (if req.)		Per Print and Torque Spec	Torque Star	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)
#16	Measure Total End Movement w/ Ring Gears Installed and Record on Build Sheet			Diff Case			Per Measurement	Visual	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)
#17	Install Diff Bearings and Shim Arrangement			Correct Diff Bearings and Shim Arrangement			Full Contact between Bearing Cones and Case	Visual	All	100%	Work Instructions	Rework as necessary, ref (DIVWI-0104)

Attachment 5
 Page 6 of 6
 Reference 5/7/05

ATT # 1
 3/5/08
 L37 HTF

Process Carrier Assembly DANA AUTOMOTIVE SYSTEMS GROUP (ASG) Page 4 of 4
 TORQUE TRACTION TECHNOLOGIES

Process Number	Process Name / Operation Description	Equipment	Characteristics			Special Char. Class	Methods					Reaction Plan
			No	Product	Process		Product / Process Specification / Tolerance	Evaluation Measurement Technique	Sample Size	Sample Freq.	Control Method	
			Damage				None Allowed	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWL-0104)
18	Assemble Diff Bearing Caps		Correct Caps and Orientation				In Place	Visual	All	100%	Work Instructions	Segregate and Alert Process Engineer, ref. (DIVWL-0104)
	Big Cap Torqued		Torque			C1- (if req.)	Per Print and Spec	Torque Star	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
	Measure Backlash		Backlash				Per Spec	Dist Indicator	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
9	Pinion and Diff Total Torque to Rotate (if required)		Total Torque to Rotate			C1- (if req.)	Per Spec	Torque Star	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
10	Verify Gear Pattern		Tools Contact Pattern				Correct per Gear Development Dept	Digital Photograph	All	100%	Work Instructions	Return to Workstation #3
7	Part Preload and Backlash Measurements onto Axle Housing		Preload Measurement Backlash Measurement				Per Drawing and Build Sheet	Visual	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
10	Prepare for Shipment		Packaging				Per Process Engineer	Visual	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
10	Verify Information		Part Number and Inspection Results				Per Process Build Sheet, CMM Report, Gear Pattern Report	Visual	All	100%	Work Instructions	Rework as necessary, ref. (DIVWL-0104)
	Deck Audit		Audit of Shipping Paperwork				Per Procedure D29-012 Paragraph 5.5	Visual	1 Lab and 1 Customer	Once a Month	Procedure D29-012	Rework as necessary, ref. (DIVWL-0104)

**L-37 HTF Facility Visit to Dana, Ft. Wayne, IN
Thursday, 03/06/2008**

TF Attendees:

Dana - Guzikowski, Miller, Fett, Pappademos, Basset, Sullivan,
SwRI - Koehler
Lubrizol - Bartlett, Gropp, Graziano
Afton - Koglin, Hyguchi

Others representing Dana and their suppliers:

Dennis McCarthy - Plant Manager Ron Derry - Engineering Manager
Dave Duffy Kerry Hess - Scheduler
Kevin Hess - Area Manager of Gears Scott Sackschewshy - Quality Manager
Patch Hines - Custom Coatings Ed Judkins - Henkel

We met at the Ft. Wayne facility to discuss the production of the next batch of plain and lubrited L-37 test axles (Dana Model 60). The agenda and summary follows:

- **Hardware Order Change for P/N 060AA100-2 Plain Axle Count:** Dana has verbally confirmed the increase of plain axles from each of the three labs.

- **Plain Axles Ordered**

<u>Lab</u>	<u>Initial Order</u>	<u>Add On</u>	<u>Final Count</u>
Afton	450	50	500
LZ	288	96	384
SwRI	160	40	200
PARC	0	0	<u>0</u>
Total	P/N 060AA100-2		1084

- **Plain and Lubrited Ordered**

	<u>Count</u>	<u>Ring Steel</u>	<u>Pinion</u>
- New Non-lubrited Hardware	1084	P4T813	New-Y
- New Lubrited	234	New-X	New-Y
- Retrofit Lubrited	<u>975</u>	New-x	New-Y
	2293		

- **Review & Other Discussion Summary**

Status of Pinion and Ring Blanks to date – Pinions are due in the first week of March, the ring gears mid March. Ft. Wayne is projecting hardware availability for assembly around mid to end of April.

Attachment	<u>6</u>
Page	<u>1 of 13</u>
Reference	<u>5/2/08</u>

Review Alternate Lubrining Process - Custom Coatings - Mr. Heinz – Mr. Judkins

- Will lubrite all ring and pinions in one 8-12- hour day. They will equally space other products between our ring and pinion baskets.
- Baths will be measured frequently and adjust as needed. These are microprocessor-controlled baths. It is a microcrystalline coating process.
- Will run test coupons and a sectioned, rejected, test gear through the baths for destructive evaluation. Sectioned gears will go through both at beginning and the end of the coating process.
- The lubrited gears, new and retrofit will all use the alternate lubrited process.
- Gear surface pitting spec for the lubrining process is now part of the phosphate coating spec.

Design theory analysis work – Mr. Miller - gave his gear tooth modeling presentation to the group.

- He compared theoretical to good batch to bad batch. Models seemed to match the outcome.
- High heel bias "in" was a problem with our rejected lubrited batch. The heat treat does cause some heel bias in.
- After much discussion, consensus was that we will target L2 patterns and accept an L rating slightly higher or lower during assembly.
- Kenny was asked to do a model which looks at F pattern position as a variable.

Review of drawings and re-validate any changes required – Mr. Miller & Mr. Pappademos

- Will focus on the 2005 non-lubrited gear batch successes (P4L792/V1L417) and review any line changes made by Ft. Wayne since that batch.
- Sullivan - Reviewed the three flow diagrams for the ring gear (060GR104 and 105), pinion (060GP104 and 105) and gear set (060GA104X and 105X) for ASTM PN 060104 and 105 of the ring and Pinion flow diagram. ***See Attachment # 1.*** **Note that there is now a "sign off" required at identified step changes before line can move forward.**
- Miller - We reviewed proposed Dana print modifications. Most were accepted as is. Some minor changes were made. See ***Attachments # 2***

Review of the Ft. Wayne process.

- We reviewed the Dana process step by step. Talked about hardware handling damage. Talked about avoiding damage during chamfering.
- Ring gears will be machined first. Pinions will be matched then to all the rings.
- There are approximately 1100 plus rings of heat code P4T813 left from the 2007 gear production process.
- With respect to the same new heat codes, there are about 1300 rings and 2500 pinions.

Attachment	<u>6</u>
Page	<u>24/13</u>
Reference	<u>5/2/08</u>

- We discussed the shot peening of the gears to a coverage % of 200. This is the way it has been done for the three previous non-lubrited batches. Mr. Miller supports keeping it the same. Greg Fett feels this may lead to gear tooth top land chipping. 150% is normal limit. We will leave as is for now as this was a recommendation from Mr. Okamuro on 2002 that appears to have worked well.
- Lubrited hardware will be the first sent to Lugoff and Maumee for assembly and retrofitting before plain hardware.
- **Attachment # 3** is the Tooth Contact Pattern Sheet S060586 Pappademos shared that Ft. Wayne is using for production cutting & lapping processing since 2002. These came at recommendation of Mr. Okamuro. The outcome is that this document insures that the Lugoff facility will be able to build axles and provide the correct line build assembly contact patterns and flanks specified in the D 6121 standard (again, a recommendation in 2002 from Mr. Okamuro). The panel has asked the r Ft. Wayne to target contact length and flank of L2F0 and a backlash of 0.005 to 0.008.

Other Expectations discussed

- Bartlett - reiterated the importance of the '3' C's with respect to consistency.
- Miller will be afforded the time at the Ft. Wayne facilities at critical times to assist and confirm that the parts and production process meet the print requirements. Any midstream changes or issues that can impact the expected outcome are to be shared with Miller and the HTF.
- ASTM Industry has the expectation that the non-lubrited and lubrited hardware will all perform similarly on industry ASTM reference oils.

Action Items

- Miller - With respect to Design theory analysis work on gear tooth modeling was asked to do a model which looks at F pattern position as a variable.
- Miller- Pappademos – incorporate and share building a design theory analysis for gears to compare to FEA.
- Miller – Provide a contact to the chairman for the Lugoff Facility Visit and co-ordinate the HTF visit (about mid April).
- The TF confirmed that Ft. Wayne is to target contact length and flank of L2F0 and a backlash of 0.005 to 0.008.
- Sullivan - provide chairman all of the ring and pinion heat batch codes as soon as they are known.
- Lubrited hardware will be the first sent to Lugoff and Maumee for assembly and retrofitting before plain hardware.

We especially wish to thank the Dana Ft. Wayne facility for hosting the meeting, lunch, and full support on all of the production expectations to meet the ASTM needs for the industry order of Dana model 60 axles.

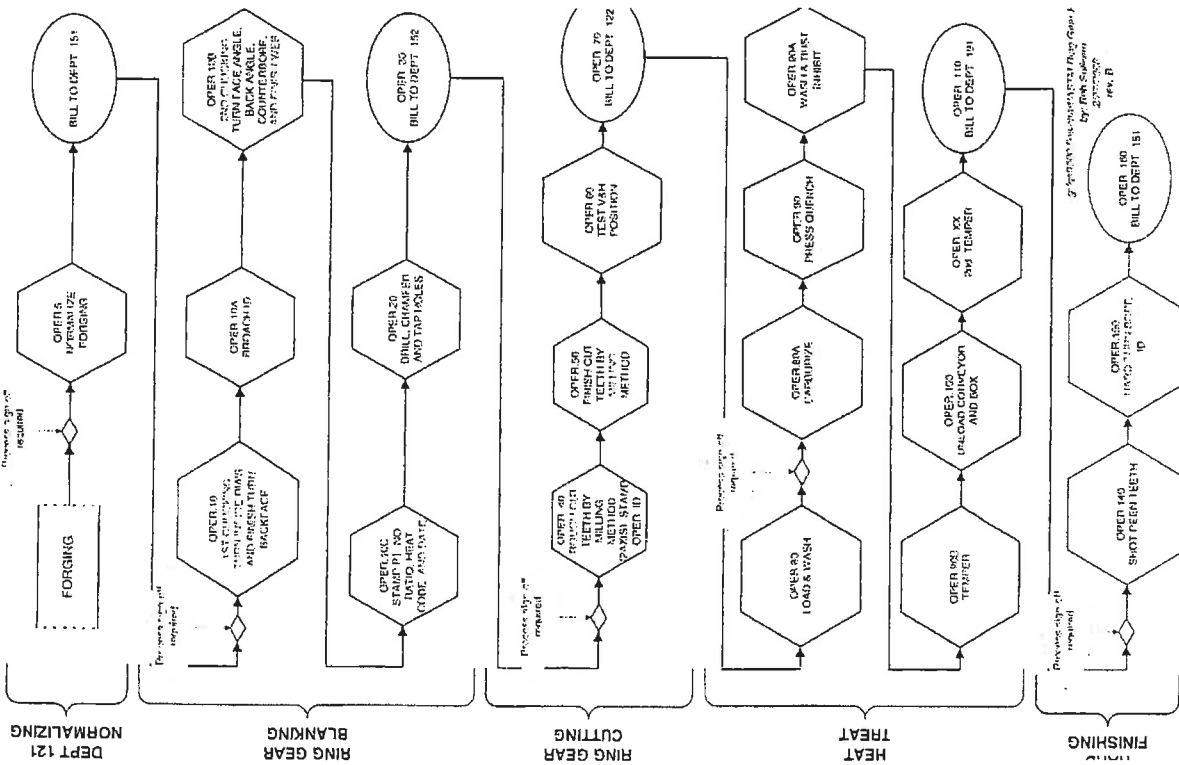
Meeting was adjourned at 3:05 p.m.


 Donald T. Bartlett,
 L-37 Surveillance Panel Chairman

Attachment	<u>6</u>
Page	<u>30/13</u>
Reference	<u>5/7/08</u>

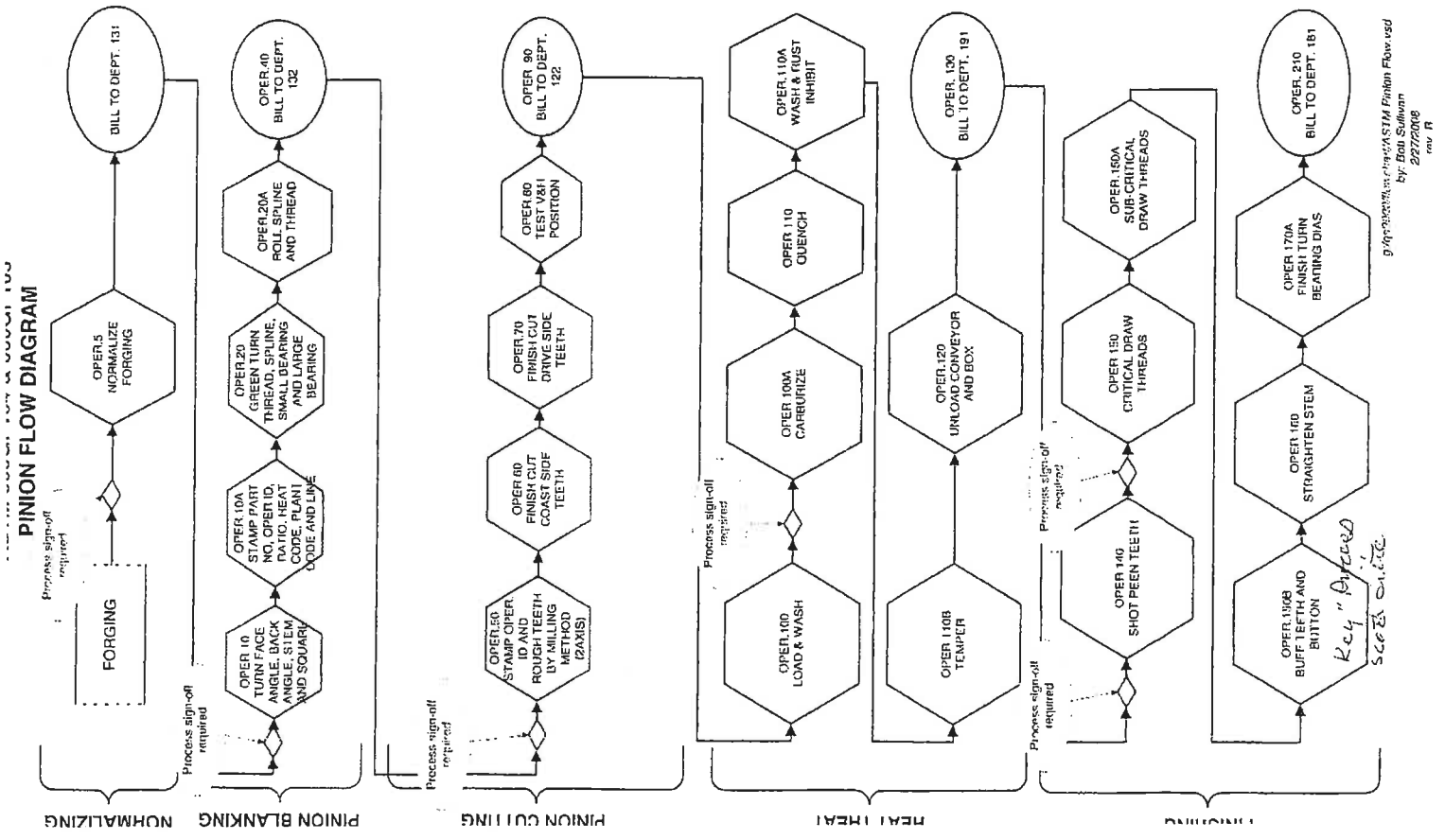
ATTACH #1
 3/6/08
 L-37 HTF - FT WAYNE
 10/3

RING GEAR FLOW DIAGRAM



Attachment 6
 Page 5 of 13
 Reference 5/7/08

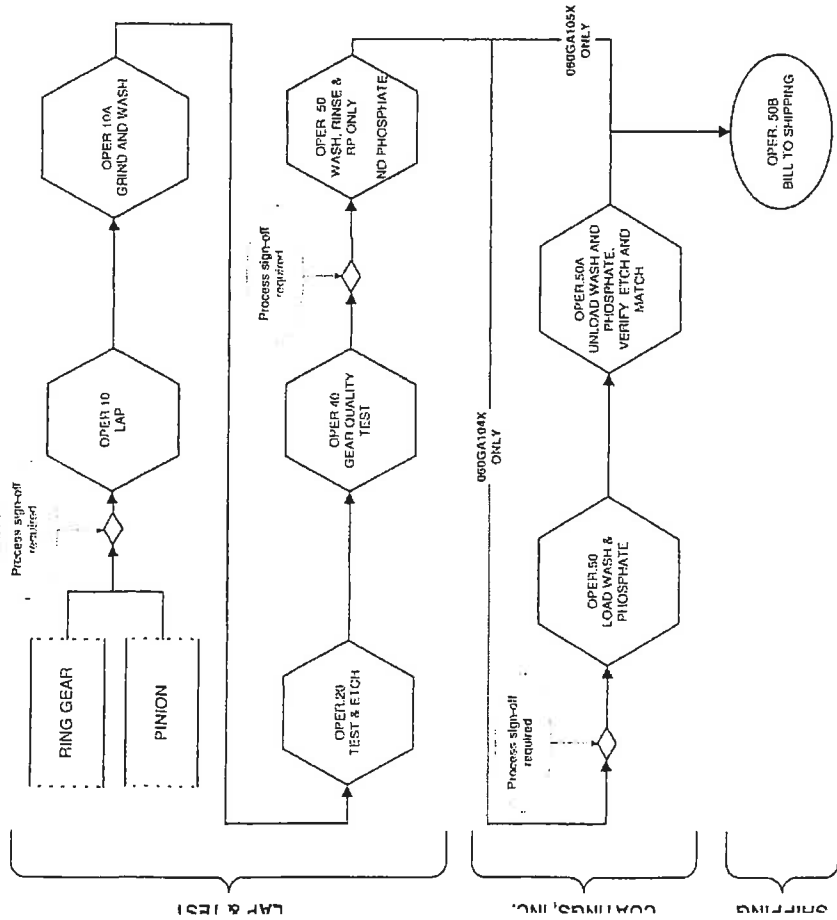
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 3/10/08
 L-37 HTF - FT WAYNE
 2 of 3

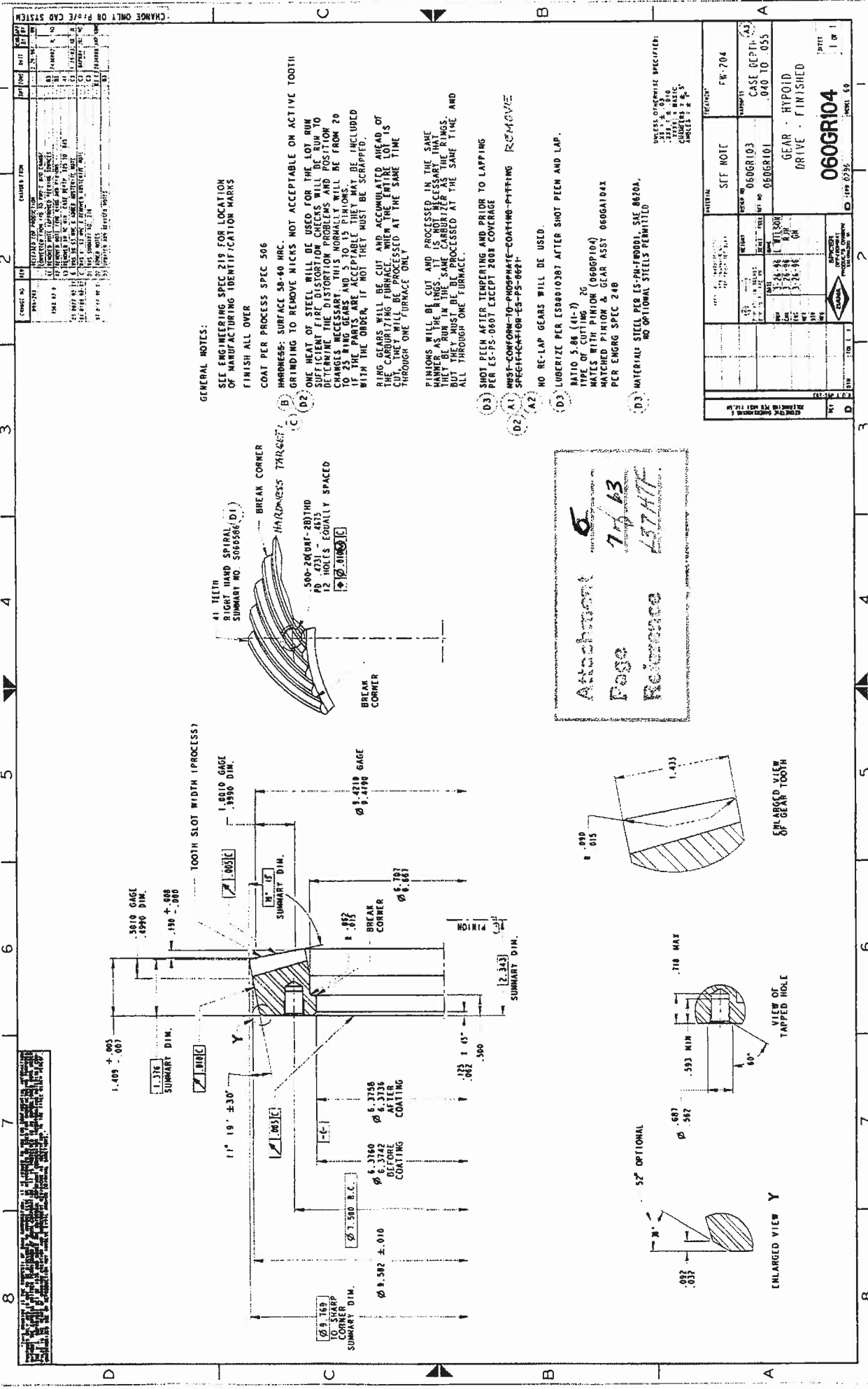


Attachment 6
 Page 6 of 13
 Reference 5/7/08

ATTACHMENT
 5-6-08
 L-37 HTF - FT WAYNE
 3 of 3

GEAR SET FLOW DIAGRAM





REV	DATE	BY	CHKD	DESCRIPTION
1	10/15/88	J. J. ...	J. J. ...	INITIAL DESIGN
2	11/15/88	J. J. ...	J. J. ...	REVISIONS
3	12/15/88	J. J. ...	J. J. ...	REVISIONS
4	01/15/89	J. J. ...	J. J. ...	REVISIONS
5	02/15/89	J. J. ...	J. J. ...	REVISIONS
6	03/15/89	J. J. ...	J. J. ...	REVISIONS
7	04/15/89	J. J. ...	J. J. ...	REVISIONS
8	05/15/89	J. J. ...	J. J. ...	REVISIONS
9	06/15/89	J. J. ...	J. J. ...	REVISIONS
10	07/15/89	J. J. ...	J. J. ...	REVISIONS
11	08/15/89	J. J. ...	J. J. ...	REVISIONS
12	09/15/89	J. J. ...	J. J. ...	REVISIONS
13	10/15/89	J. J. ...	J. J. ...	REVISIONS
14	11/15/89	J. J. ...	J. J. ...	REVISIONS
15	12/15/89	J. J. ...	J. J. ...	REVISIONS

- GENERAL NOTES:**
- SEE ENGINEERING SPEC 219 FOR LOCATION OF MANUFACTURING IDENTIFICATION MARKS FINISH ALL OVER
- COAT PER PROCESS SPEC 506
- (D1) HARDNESS: SURFACE 58-60 HRC.
- (D2) GRINDING TO REMOVE NICKS NOT ACCEPTABLE ON ACTIVE TOOTH
- (D3) ONE HEAT OF STEEL WILL BE USED FOR THE LOT. RUN SUFFICIENT FIRE TO OBTAIN UNIFORM NICKS AND POSITION CHANGES NECESSARY THIS NORMALLY WILL BE FROM 20 TO 25 RING GEARS AND 5 TO 15 PINIONS. IF THE PARTS ARE ACCEPTABLE THEY MAY BE INCLUDED WITH THE ORDER, IF NOT THEY MUST BE SCRAPPED.
- RING GEARS WILL BE CUT AND ACCUMULATED AHEAD OF THE CARBURIZING FURNACE WHEN THE ENTIRE LOT IS CUT, THEY WILL BE PROCESSED AT THE SAME TIME THROUGH ONE FURNACE ONLY.
- PINIONS WILL BE CUT AND PROCESSED IN THE SAME MANNER AS THE RINGS. IT IS NOT NECESSARY THAT THEY BE RUN IN THE SAME CARBURIZER AS THE RINGS, BUT THEY MUST BE PROCESSED AT THE SAME TIME AND ALL THROUGH ONE FURNACE.
- (D3) SHOT PEEN AFTER TEMPERING AND PRIOR TO LAPPING PER ES-PS-0601 EXCEPT 200% COVERAGE
- (D1) MUST CONFORM TO PHOSPHATE-COATING-PITTING REMOVE
- (D2) NO RE-LAP GEARS WILL BE USED.
- (D3) LUBRICIZE PER ES0010187 AFTER SHOT PEEN AND LAP.
- RATIO 5:86 (41:7) 2G
- TYPE OF CUTTING
- MATCH WITH PINION (060G104)
- MATCHED PINION & GEAR ASSY 060G104X
- PER ENGRG SPEC 248
- (D3) MATERIAL: STEEL PER ES-PH-00001, SAE 8620A, NO OPTIONAL STEELS PERMITTED
- UNLESS OTHERWISE SPECIFIED:
- STEEL: A, B, C
- CARBURIZER: E, R, S
- JARCEL: E, R, S

REV	DATE	BY	CHKD	DESCRIPTION
1	10/15/88	J. J. ...	J. J. ...	INITIAL DESIGN
2	11/15/88	J. J. ...	J. J. ...	REVISIONS
3	12/15/88	J. J. ...	J. J. ...	REVISIONS
4	01/15/89	J. J. ...	J. J. ...	REVISIONS
5	02/15/89	J. J. ...	J. J. ...	REVISIONS
6	03/15/89	J. J. ...	J. J. ...	REVISIONS
7	04/15/89	J. J. ...	J. J. ...	REVISIONS
8	05/15/89	J. J. ...	J. J. ...	REVISIONS
9	06/15/89	J. J. ...	J. J. ...	REVISIONS
10	07/15/89	J. J. ...	J. J. ...	REVISIONS
11	08/15/89	J. J. ...	J. J. ...	REVISIONS
12	09/15/89	J. J. ...	J. J. ...	REVISIONS
13	10/15/89	J. J. ...	J. J. ...	REVISIONS
14	11/15/89	J. J. ...	J. J. ...	REVISIONS
15	12/15/89	J. J. ...	J. J. ...	REVISIONS

MATERIAL	SEE NOTE	FW-704
PROCESS NO.	060G103	CASE DEPTH: .040 TO .055
REV NO.	060G101	
GEAR - HYPOID DRIVE - FINISHED		
060G104		
REV	DATE	BY
1	10/15/88	J. J. ...
2	11/15/88	J. J. ...
3	12/15/88	J. J. ...
4	01/15/89	J. J. ...
5	02/15/89	J. J. ...
6	03/15/89	J. J. ...
7	04/15/89	J. J. ...
8	05/15/89	J. J. ...
9	06/15/89	J. J. ...
10	07/15/89	J. J. ...
11	08/15/89	J. J. ...
12	09/15/89	J. J. ...
13	10/15/89	J. J. ...
14	11/15/89	J. J. ...
15	12/15/89	J. J. ...

REV	DATE	DESCRIPTION
1	10/15/88	ISSUED FOR FABRICATION
2	11/15/88	REVISION TO MATERIAL SPECIFICATION
3	12/15/88	REVISION TO DIMENSIONS
4	01/15/89	REVISION TO FINISH SPECIFICATIONS
5	02/15/89	REVISION TO HARDNESS REQUIREMENTS
6	03/15/89	REVISION TO TOLERANCES
7	04/15/89	REVISION TO WEIGHT
8	05/15/89	REVISION TO IDENTIFICATION MARKS
9	06/15/89	REVISION TO MACHINING NOTES
10	07/15/89	REVISION TO FINISH SPECIFICATIONS
11	08/15/89	REVISION TO HARDNESS REQUIREMENTS
12	09/15/89	REVISION TO TOLERANCES
13	10/15/89	REVISION TO WEIGHT
14	11/15/89	REVISION TO IDENTIFICATION MARKS
15	12/15/89	REVISION TO MACHINING NOTES
16	01/15/90	REVISION TO FINISH SPECIFICATIONS
17	02/15/90	REVISION TO HARDNESS REQUIREMENTS
18	03/15/90	REVISION TO TOLERANCES
19	04/15/90	REVISION TO WEIGHT
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25	10/15/90	REVISION TO WEIGHT
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27	12/15/90	REVISION TO MACHINING NOTES
28	01/15/91	REVISION TO FINISH SPECIFICATIONS
29	02/15/91	REVISION TO HARDNESS REQUIREMENTS
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40	01/15/92	REVISION TO FINISH SPECIFICATIONS
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52	01/15/93	REVISION TO FINISH SPECIFICATIONS
53	02/15/93	REVISION TO HARDNESS REQUIREMENTS
54	03/15/93	REVISION TO TOLERANCES
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145	10/15/00	REVISION TO WEIGHT
146	11/15/00	REVISION TO IDENTIFICATION MARKS
147	12/15/00	REVISION TO MACHINING NOTES
148	01/15/01	REVISION TO FINISH SPECIFICATIONS
149	02/15/01	REVISION TO HARDNESS REQUIREMENTS
150	03/15/01	REVISION TO TOLERANCES
151	04/15/01	REVISION TO WEIGHT
152	05/15/01	REVISION TO IDENTIFICATION MARKS
153	06/15/01	REVISION TO MACHINING NOTES
154	07/15/01	REVISION TO FINISH SPECIFICATIONS
155	08/15/01	REVISION TO HARDNESS REQUIREMENTS
156	09/15/01	REVISION TO TOLERANCES
157	10/15/01	REVISION TO WEIGHT
158	11/15/01	REVISION TO IDENTIFICATION MARKS
159	12/15/01	REVISION TO MACHINING NOTES
160	01/15/02	REVISION TO FINISH SPECIFICATIONS
161	02/15/02	REVISION TO HARDNESS REQUIREMENTS
162	03/15/02	REVISION TO TOLERANCES
163	04/15/02	REVISION TO WEIGHT
164	05/15/02	REVISION TO IDENTIFICATION MARKS
165	06/15/02	REVISION TO MACHINING NOTES
166	07/15/02	REVISION TO FINISH SPECIFICATIONS
167	08/15/02	REVISION TO HARDNESS REQUIREMENTS
168	09/15/02	REVISION TO TOLERANCES
169	10/15/02	REVISION TO WEIGHT
170	11/15/02	REVISION TO IDENTIFICATION MARKS
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172	01/15/03	REVISION TO FINISH SPECIFICATIONS
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179	08/15/03	REVISION TO HARDNESS REQUIREMENTS
180	09/15/03	REVISION TO TOLERANCES
181	10/15/03	REVISION TO WEIGHT
182	11/15/03	REVISION TO IDENTIFICATION MARKS
183	12/15/03	REVISION TO MACHINING NOTES
184	01/15/04	REVISION TO FINISH SPECIFICATIONS
185	02/15/04	REVISION TO HARDNESS REQUIREMENTS
186	03/15/04	REVISION TO TOLERANCES
187	04/15/04	REVISION TO WEIGHT
188	05/15/04	REVISION TO IDENTIFICATION MARKS
189	06/15/04	REVISION TO MACHINING NOTES
190	07/15/04	REVISION TO FINISH SPECIFICATIONS
191	08/15/04	REVISION TO HARDNESS REQUIREMENTS
192	09/15/04	REVISION TO TOLERANCES
193	10/15/04	REVISION TO WEIGHT
194	11/15/04	REVISION TO IDENTIFICATION MARKS
195	12/15/04	REVISION TO MACHINING NOTES
196	01/15/05	REVISION TO FINISH SPECIFICATIONS
197	02/15/05	REVISION TO HARDNESS REQUIREMENTS
198	03/15/05	REVISION TO TOLERANCES
199	04/15/05	REVISION TO WEIGHT
200	05/15/05	REVISION TO IDENTIFICATION MARKS

NOTES:
 SEE PROCESS SPEC 304 FOR STRAIGHTENING PROCEDURES
 SEE ENGINEERING SPEC 214 FOR IDENTIFICATION MARKS AND THEIR LOCATIONS
 SEE ENGINEERING SPEC 219 FOR LOCATION OF MANUFACTURING IDENTIFICATION MARKS
 FINISH ALL OVER
 HARDNESS TARGET: (A) SURFACE 41-63 HRC RETAINED AUSTENITE NOT TO EXCEED 10% VISUALLY
 (B) ALL ANGLES 3-5° UNLESS OTHERWISE SPECIFIED
 ONE HEAT OF STEEL WILL BE USED FOR THE LOT RUN
 SUFFICIENT FIRE DISTORTION CHECKS WILL BE RUN TO DETERMINE THE DISTORTION PROBLEMS AND POSITION CHANGES NECESSARY. THIS NORMALLY WILL BE FROM 20 TO 25 RING GEARS AND 5 TO 15 PINIONS. BE INCLUDED WITH THE ORDER. IF NOT THEY MUST BE SCRAPPED.
 RING GEARS WILL BE CUT AND ACCUMULATED AHEAD OF THE CASE HARDENING FURNACE. THE LEAVE-IN TIME THROUGH ONE FURNACE ONLY.
 PINIONS WILL BE CUT AND PROCESSED IN THE SAME FURNACE AS THE RINGS. THE CARBURIZING RINGS BUT THEY MUST BE PROCESSED AT THE SAME TIME AND ALL THROUGH ONE FURNACE.
 (F1) SHOT PEEN AFTER TEMPERING AND PRIOR TO LAPPING PER ES-PS-0607 EXCEPT 2001 COVERAGE
 (F2) MUST CONFORM TO PHOSPHATE-CORROSIVE-PIPING REMOVE SPECIFICATION ES-PS-0621
 (F3) NO RE-LAP GEARS WILL BE USED.
 (F4) LUBRIFIZE PER ES00010387 AFTER SHOT PEEN AND LAP.
 (F5) TOP LAND EDGES OF PINION TEETH ARE TO BE POLISHED, REMOVING THE SHARP EDGE.
 (E) MATERIAL STEEL PER ES-PN-FR0001, SAE B425 EXCEPT RESTRICT HARDENABILITY TO DT 2, 4, 2, 7 NO OPTIONAL STEELS PERMITTED
 (F2) GRINDING TO REMOVE WICKS NOT ACCEPTABLE ON ACTIVE TOOTH

PROTECT THREADED AREA AND THREAD TOP-OFF
 OPTIONAL: IRONATION TEMPER
 THREADED END TO 30-45 HRC
 -875-14 UMF-2A THD
 -8770 PD
 .8216
 .870
 .860
 AREA "F" .02 X 45°
 .843 MIN
 1.487 FOLL DEPTH
 1.487 OF SPLINE
 1.850
 1.000
 .046 MAX
 30°
 R .031
 ENLARGED VIEW V

ENLARGED VIEW U
 .125
 R .060
 .124
 .062
 20°
 20°
 .063

ENLARGED VIEW X
 BREAK SHARP CORNER
 R .030 MAX

ENLARGED VIEW Y
 1.151R
 LEFT HAND SPIRAL
 SUMMARY NO. 3860386 (F1)

ENLARGED VIEW Z
 TOOTH SLOT WIDTH (PROCESS)
 GAGE DIMENSIONS
 1.0010
 .0020
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THIS DRAWING IS THE PROPERTY OF DANA CORPORATION. IT IS ISSUED TO YOU FOR CONFIDENTIAL INFORMATION PURPOSES ONLY AND IS NOT TO BE DISCLOSED TO ANYONE ELSE OR REPRODUCED OR USED FOR MANUFACTURING PURPOSES WITHOUT THE EXPRESS WRITTEN PERMISSION OF DANA CORPORATION. IT IS PROTECTED AS AN UNPUBLISHED WORK UNDER THE PATENT ACT OF 1916 AND UNDER THE UNIFORM FEDERAL CONFIDENTIALITY ACT. INFORMATION CONTAINED HEREIN IS UNCLASSIFIED EXCEPT WHERE SHOWN OTHERWISE. ANY REPRODUCTION OR TRANSMISSION OF THIS INFORMATION IS UNAUTHORIZED USE OR REPRODUCTION THAT INVOLVES CIVIL AND/OR CRIMINAL SANCTIONS.

PINION & GEAR ARE MATCHED AT BEST OPERATING POSITION. SERIAL NUMBERS ARE ASSIGNED TO EACH SET & SAME NUMBER ETCHED ON PINION AND GEAR. PINION AND GEAR ARE FURNISHED IN MATCHED SETS ONLY. SHOT PEEN RING GEAR AND PINION PER ES-PS-0607 EXCEPT 200% COVERAGE (REF)

SUMMARY NO: S060586 (REF)

NO RELAPS ACCEPTABLES (REF)

MUST CONFORM TO PHOSPHATE COATING PITTING REMOVE SPECIFICATION ES-PS-0621-(REF)

LUBERIZE PER ES0010387 (REF)

GRINDING TO REMOVE NICKS NOT ACCEPTABLE ON ACTIVE TOOTH (REF)

ITEM	PART NO	QTY	NAME OF PART
101	060GI04	1	PINION-HYPOID DRIVE FIN
102	060GR104	1	GEAR-HYPOID DRIVE FIN

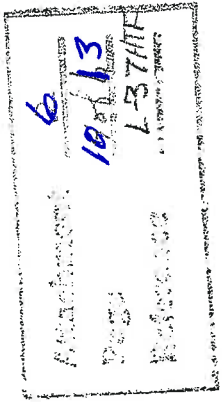
CONTACT PATTERN REQUIREMENTS:
 DRIVE SIDE: L2F0 (MEAN), L2F+1 THRU L2F-1 (MEAN TARGET)
 AND L3F+1 THRU L3F-1 (RANGE)
 COAST SIDE: L2F0 (MEAN), L2F+2 THRU L2F-2 (MEAN TARGET)
 AND L3F+2 THRU L3F-2 (RANGE)

NOTE: PATTERN REQUIREMENT IS FOR ASSEMBLED GEARSET AT ETCHED PINION MOUNTING DISTANCE AND BACKLASH AT .004-0+2 INCH. (TARGET)

.005-.008

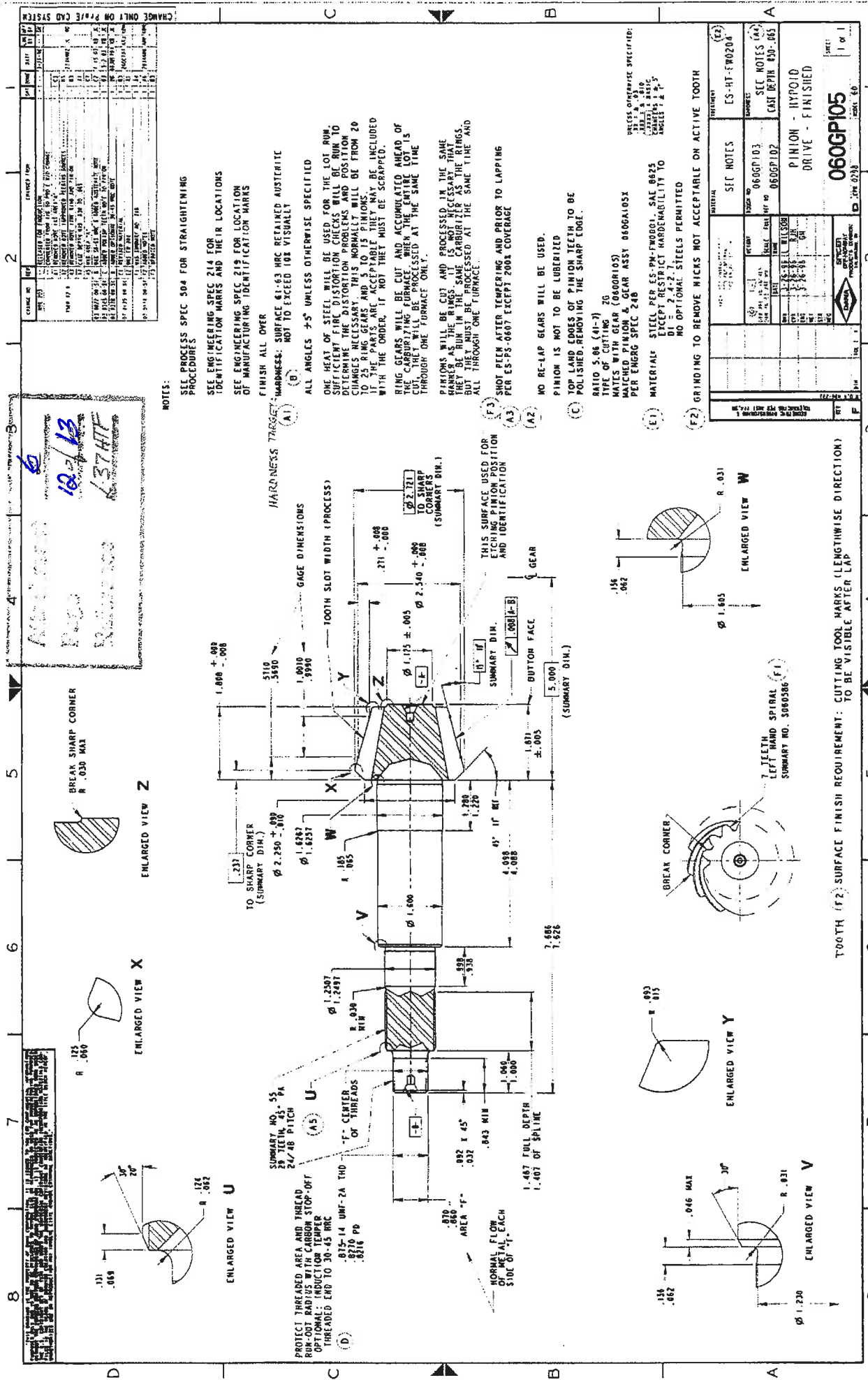
CHANGE NO.	REV	CHANGED FROM	SHT ZONE	DATE	CHG APP BY
M95-203	..	RELEASED FOR PRODUCTION	..	3-26-96	GM
7568.02.0	..	CONVERTED FROM 1/G TO PRO-E W/O CHANGE	..	23JAN02	JL KO
07.0114.00-S1	A	REMOVED APPROVED PEERING SOURCE	B2	28JAN08	AMP KDM
	B	UPDATED AND REVISED

CAUTION: THESE GEARSETS ARE FOR ASTM L37 LABORATORY TEST. THESE GEARSETS ARE FOR ASTM L37 LABORATORY TEST GAUGE, REF. LUBRICITY FORMULATION TESTING. SPECIAL PROCESSING AND MATERIAL REQUIREMENTS NECESSARY. REFER TO RING GEAR AND PINION DRAWINGS FOR DETAILS. SPECIAL ASSEMBLY PROCEDURES ARE ALSO REQUIRED. NO SUBSTITUTES PERMITTED.



KEY CHARACTERISTIC PER ENGINEERING PROCEDURE (EP-026) KEY CHAR: 3-26-96 L. WILSON DATE: 3-26-96 R.JH ENG: 3-26-96 GM MET: 3-26-96 SHT: 3-26-96 WKS: 3-26-96		MATERIAL: 060GI02X PART NO: 060GI02X
GEOMETRIC DIMENSIONING & TOLERANCING PER ANSI Y14.5M REV B		TREATMENT: none FINISH: none MODEL: 60
SPICER GEARSETS DIVISION MILWAUKEE WI		060GI04X GEAR PINION ASSY HYPOID DRIVE
W.O. # M95-203		SHEET 1 OF 1

CHANGE ONLY ON PRO/E CAD SYSTEM



CHANGE ONLY ON PAPER CAD SYSTEM

NO.	DATE	BY	CHKD.	DESCRIPTION
1	10/13
2
3
4
5
6
7
8

NOTES:
 SEE PROCESS SPEC 304 FOR STRAIGHTENING PROCEDURES
 SEE ENGINEERING SPEC 214 FOR IDENTIFICATION MARKS AND THEIR LOCATIONS
 SEE ENGINEERING SPEC 219 FOR LOCATION OF MANUFACTURING IDENTIFICATION MARKS
 FINISH ALL OVER
 HARDNESS THRESHOLD: SURFACE 61-63 HRC RETAINED AUSTENITIC HARDNESS: NOT TO EXCEED 10% VISUALLY
 ALL ANGLES ±5° UNLESS OTHERWISE SPECIFIED
 ONE HEAT OF STEEL WILL BE USED FOR THE LOT. RIM SUFFICIENT FINE DISTORTION CORREAS WILL BE RUN TO CORRECT DIMENSIONS. DIMENSIONS WILL BE FROM 20 CHANGES NECESSARY THIS NORMAL WILL BE FROM 20 TO 25 RING GEARS AND 5 TO 15 PINIONS. IF THE PARTS ARE ACCEPTABLE THEY MAY BE INCLUDED WITH THE ORDER, IF NOT THEY MUST BE SCRAPPED.
 RING GEARS WILL BE CUT AND ACCUMULATED AHEAD OF THE CARBURIZING FURNACE. WHEN THE ENTIRE LOT IS CUT, THEY WILL BE PROCESSED AT THE SAME TIME AND THROUGH ONE FURNACE ONLY.
 PINIONS WILL BE CUT AND PROCESSED IN THE SAME BURNER AS THE RINGS. IT IS NOT NECESSARY THAT THEY BE RUN IN THE SAME CARBURIZER AS THE RINGS. ALL THROUGH ONE FURNACE.
 (A1) (A2) (A3) (A4) (A5) (F1) (F2)

NO RE-LAP GEARS WILL BE USED.
 PINION IS NOT TO BE LUBRIZED
 TOP LAND EDGES OF PINION TEETH TO BE POLISHED, REMOVING THE SHARP EDGE.
 (C)
 RATIO 3.06 (41-7)
 TYPE OF CUTTING ZG
 MATES WITH GEAR (060GP103)
 MACHINING SPEC. 5. GEAR ASSY 060GAL05X PER ENG00 SPEC 648
 (E1) MATERIALS STEEL PER ES-PN-FW0001, SAC 8625 EXCEPT RESTRICT HARDENABILITY TO DI 7.22. STEELS PERMITTED NO OPTIONAL STEELS PERMITTED
 (F2) GRINDING TO REMOVE NICKS NOT ACCEPTABLE ON ACTIVE TOOTH

DEELS OTHERWISE SPECIFIED:
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 5. 100% TO 100%
 6. 100% TO 100%
 7. 100% TO 100%
 8. 100% TO 100%

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10/13
 637HTF

BREAK SHARP CORNER
 R .030 MAX

TO SHARP CORNER
 (SUMMARY DIM.)
 .237
 φ 2.230 ± .010
 φ 1.627
 φ 1.615 ± .005
 φ 1.175 ± .005
 φ 2.340 ± .008
 φ 2.721
 TO SHARP CORNERS
 (SUMMARY DIM.)

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 .237
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 TO SHARP CORNERS
 (SUMMARY DIM.)

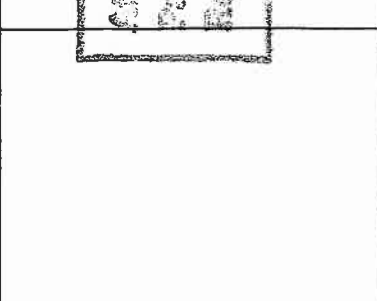
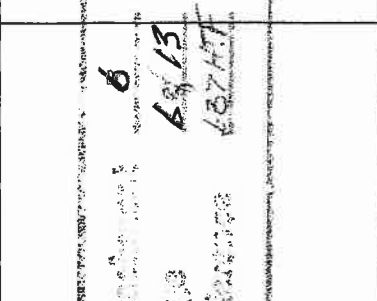
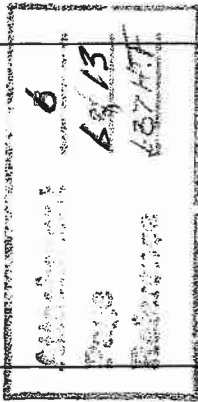
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 (SUMMARY DIM.)
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 φ 1.615 ± .005
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 φ 1.175 ± .005
 φ 2.340 ± .008
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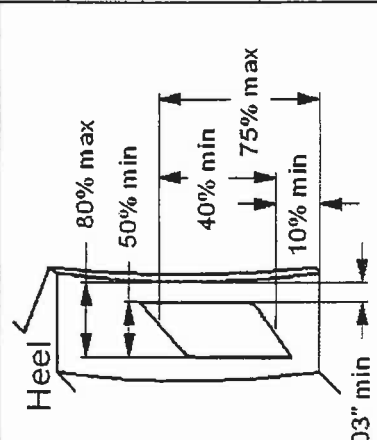
PROCESS SPECIFICATION

TOOTH CONTACT PATTERN SHEET

S060586



L2, F0 OPTIMAL L2, F-1 L2, F-2 L2, F-2 L2, F-2 L2, F-2 L2, F-2 L2, F-2 L2, F-2 L2, F0 OPTIMAL L2, F0 L2, F+2 L2, F+2

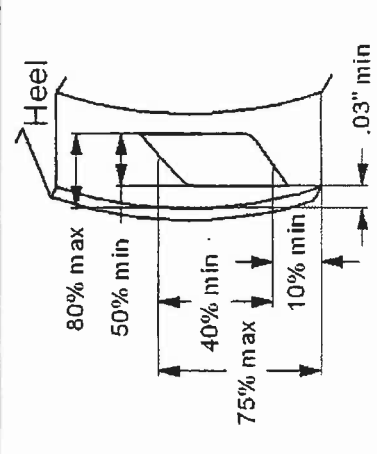


GEAR CONVEX

Tester Backlash 0.005" to 0.0055" (0.13mm)

Assembly Backlash 0.005" to 0.008" (0.13 to 0.20mm)

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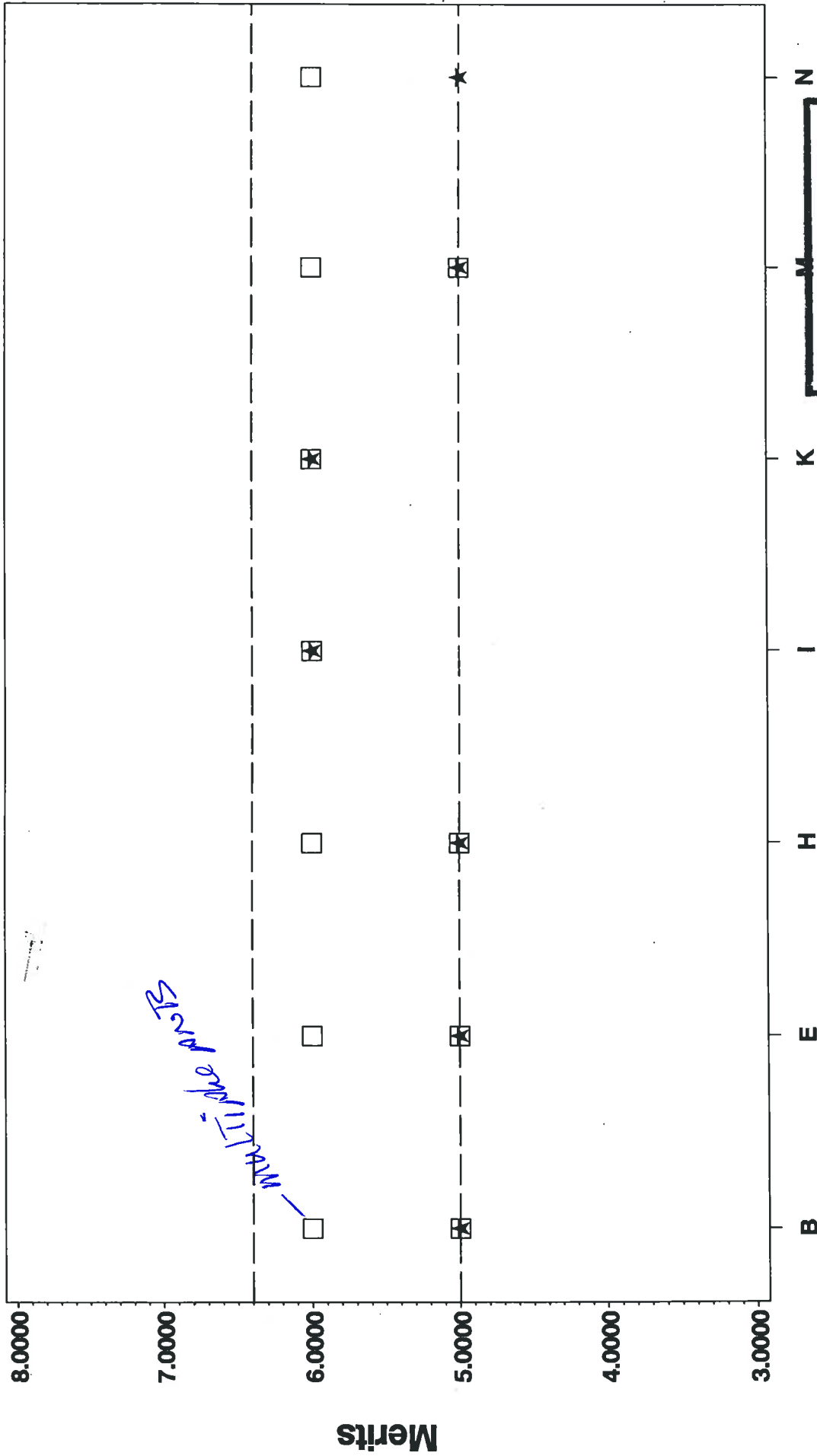
Trans. #	Rev	Change	Engr	Date
	A	SOHAD change of gear summary from 218-1 to S060586 to meet ASTM L37 test requirements.	LP	22-Nov-2006

11/17/07 # 6
2/6/08

L37RC Rater Comparison

Plinion 18

Wear



Attachment 7
Page 10/14
Reference 5/2/08

Rater
Ind □ □ LTMS ★ ★ ★ MOLD

MAXIMUM
WARRANTY

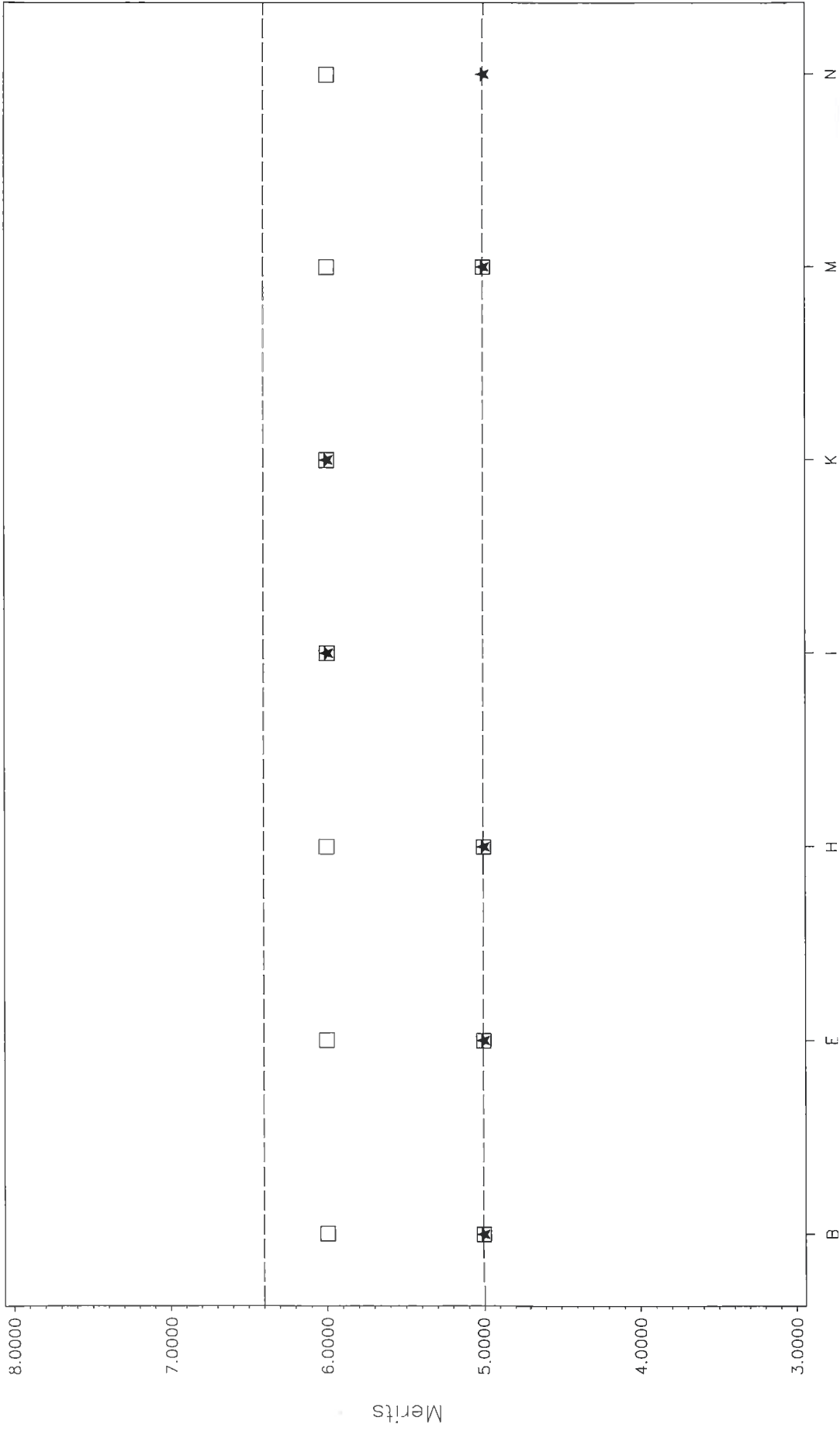
41

41

L37RC Rater Comparison

Pinton 18

Wear



Attachment 7
Page 2 of 14
Reference 5/7/08

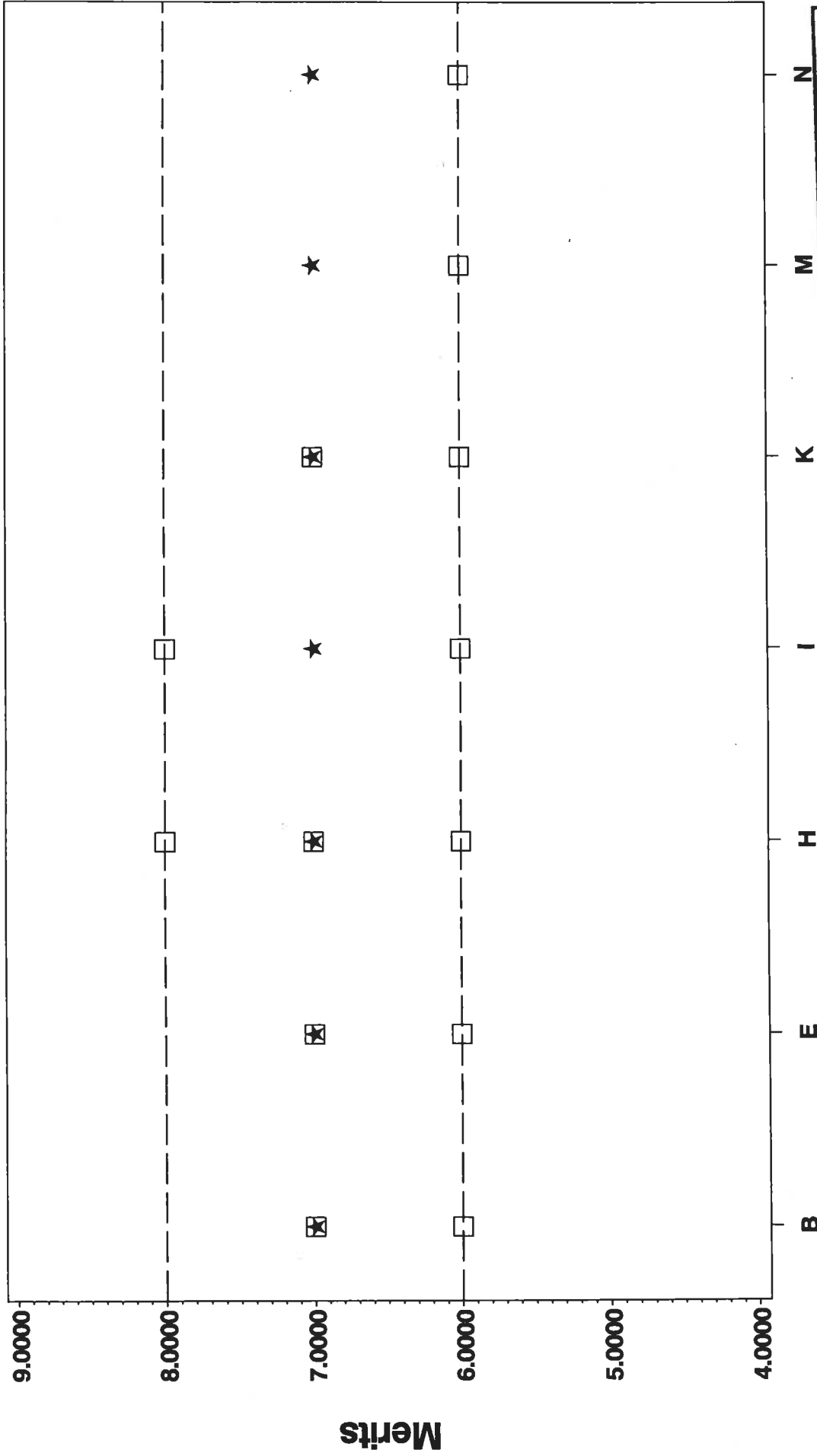
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L37RC Rater Comparison

Pinion 29

Wear

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Attachment 7
Page 3 of 14
Reference 5/7/08

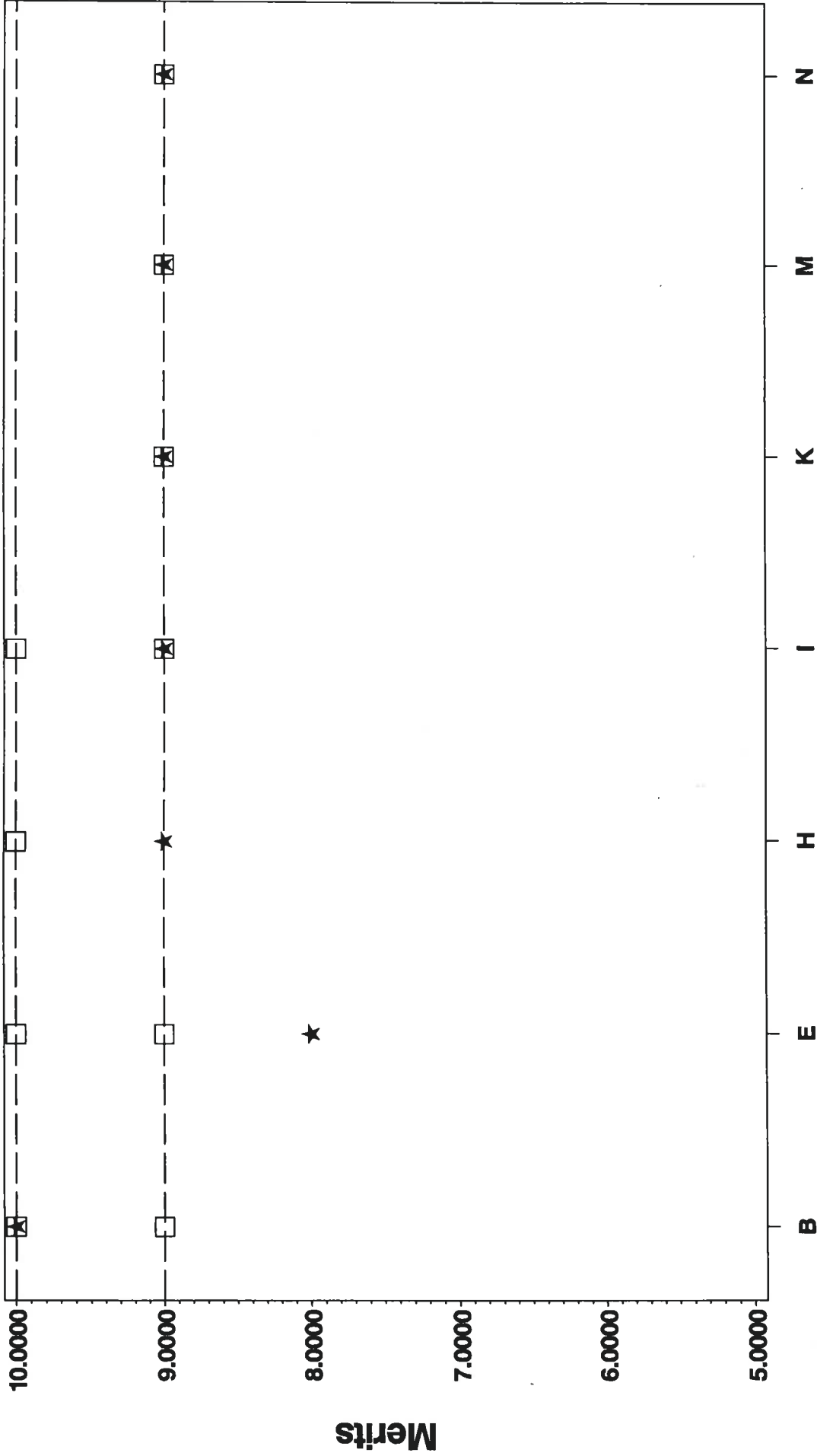
Rater
Ind LTMS ★★ MOLD

L37RC Rater Comparison

Pinlon 29

Ridging

precision degraded



Attachment 7
Page 4 of 14
References 5/7/08

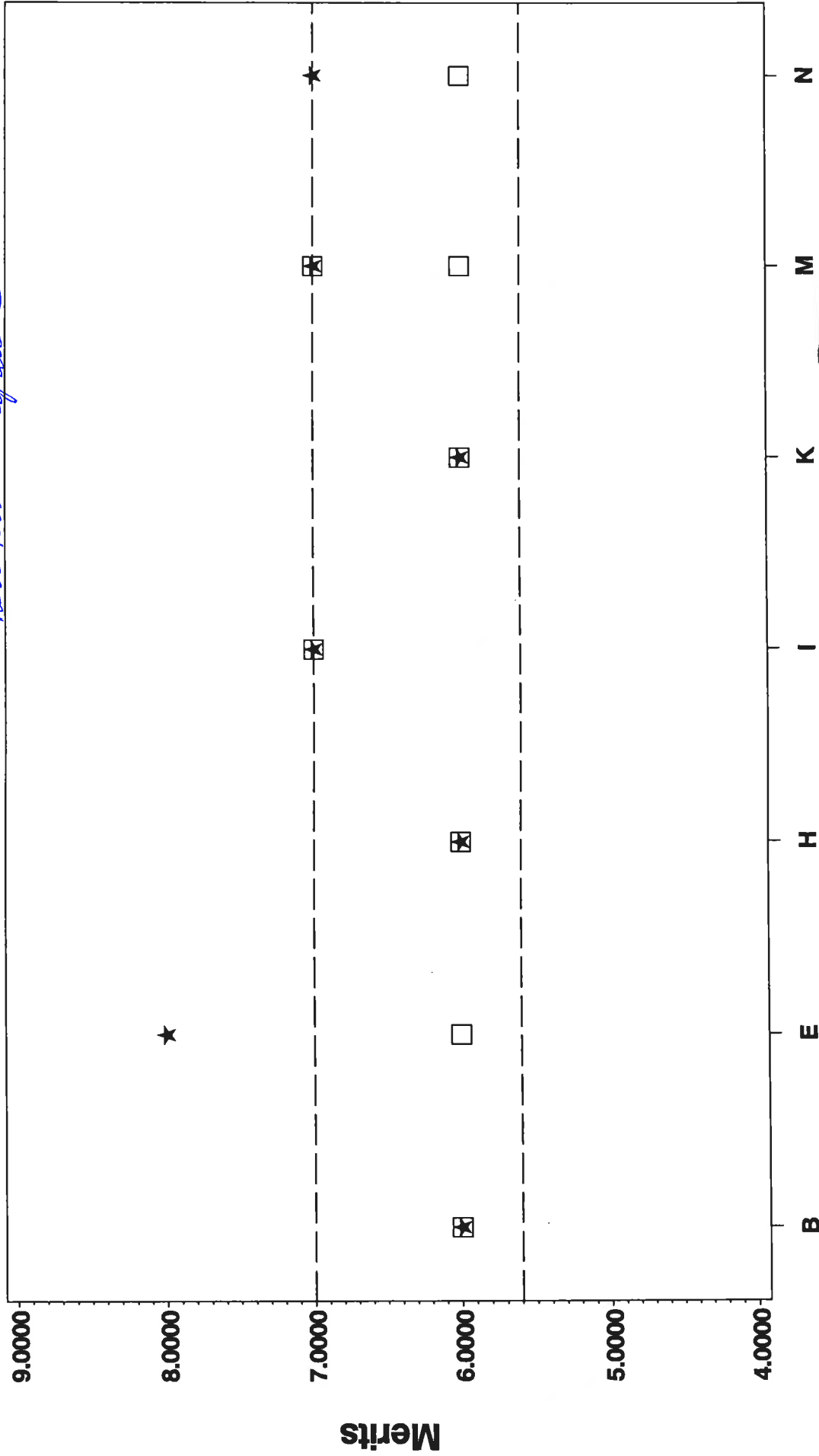
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L37RC Rater Comparison

Pinlon 40

Wear

new rules degrade



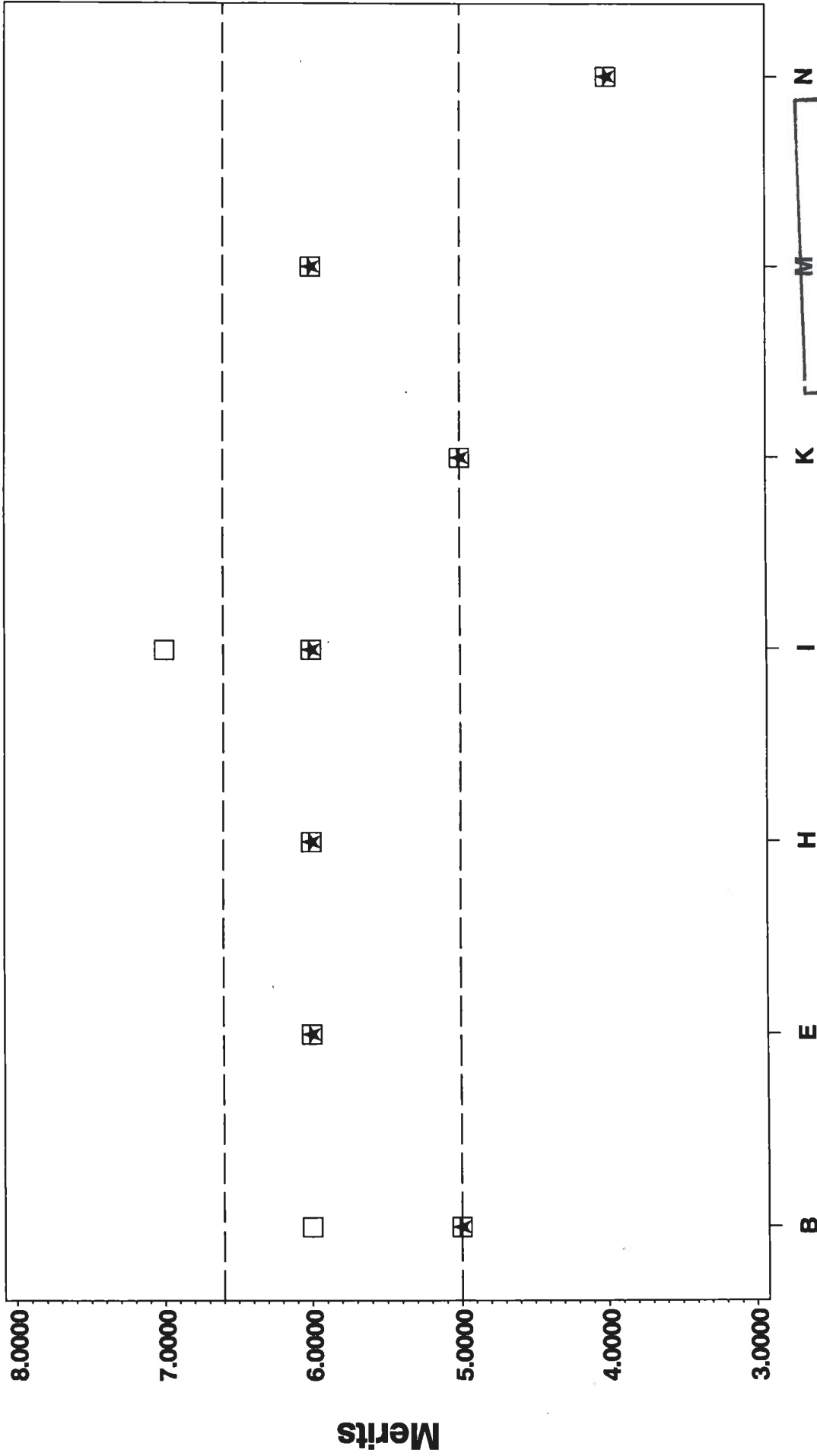
Attachment 7
Page 5 of 14
Reference 5/2/08

Rater
Ind LTMS ★★ MOLD

L37RC Rater Comparison

Pinlon 40

Ridging



Attachment 7
Page 6 of 14
Reference 5/7/08

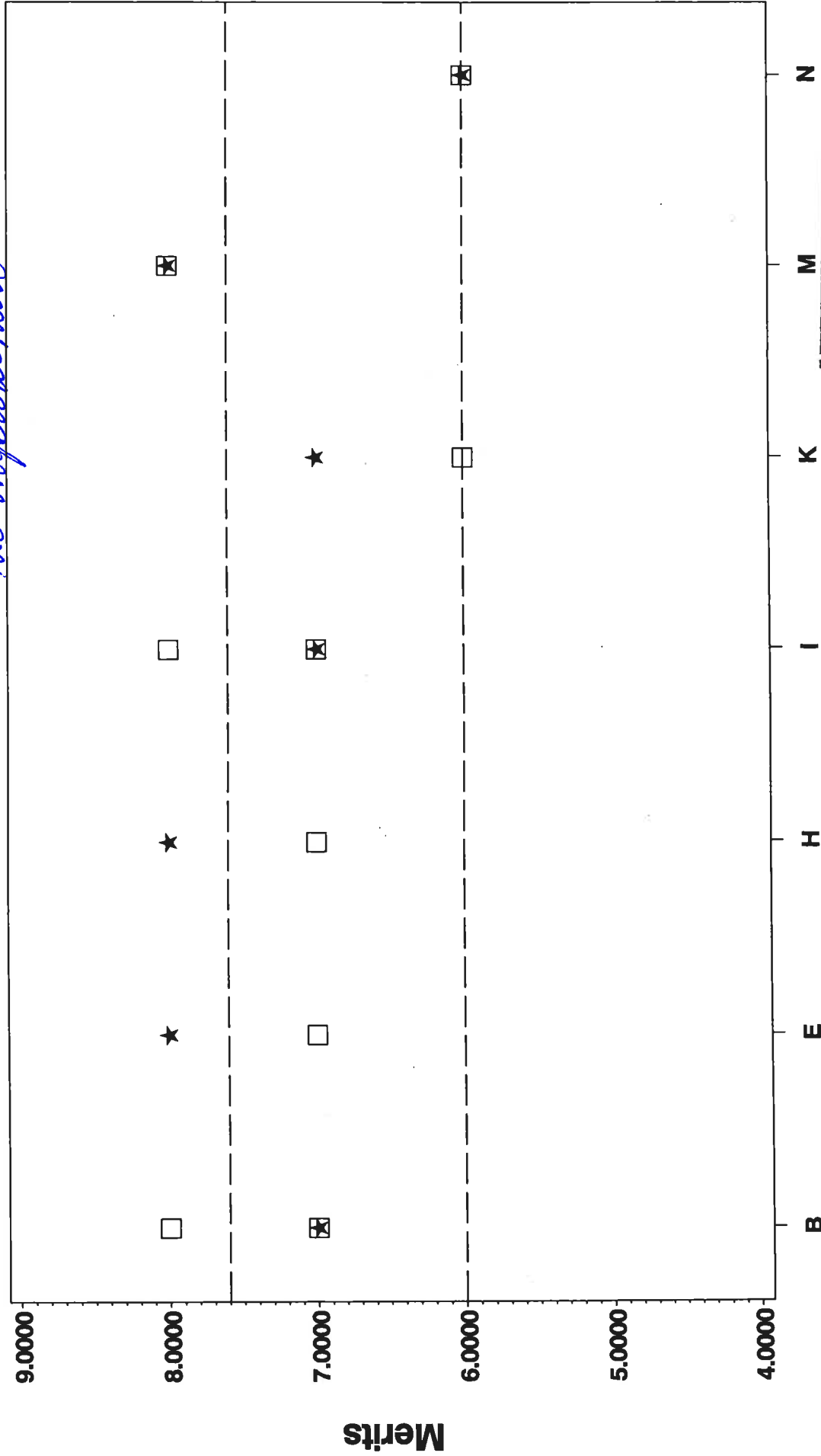
Ind LTMS MOLD

L37RC Rater Comparison

Plinon 41

Wear

no improvement



Attachment 2
Page 2 of 14
Reference 5/2/08

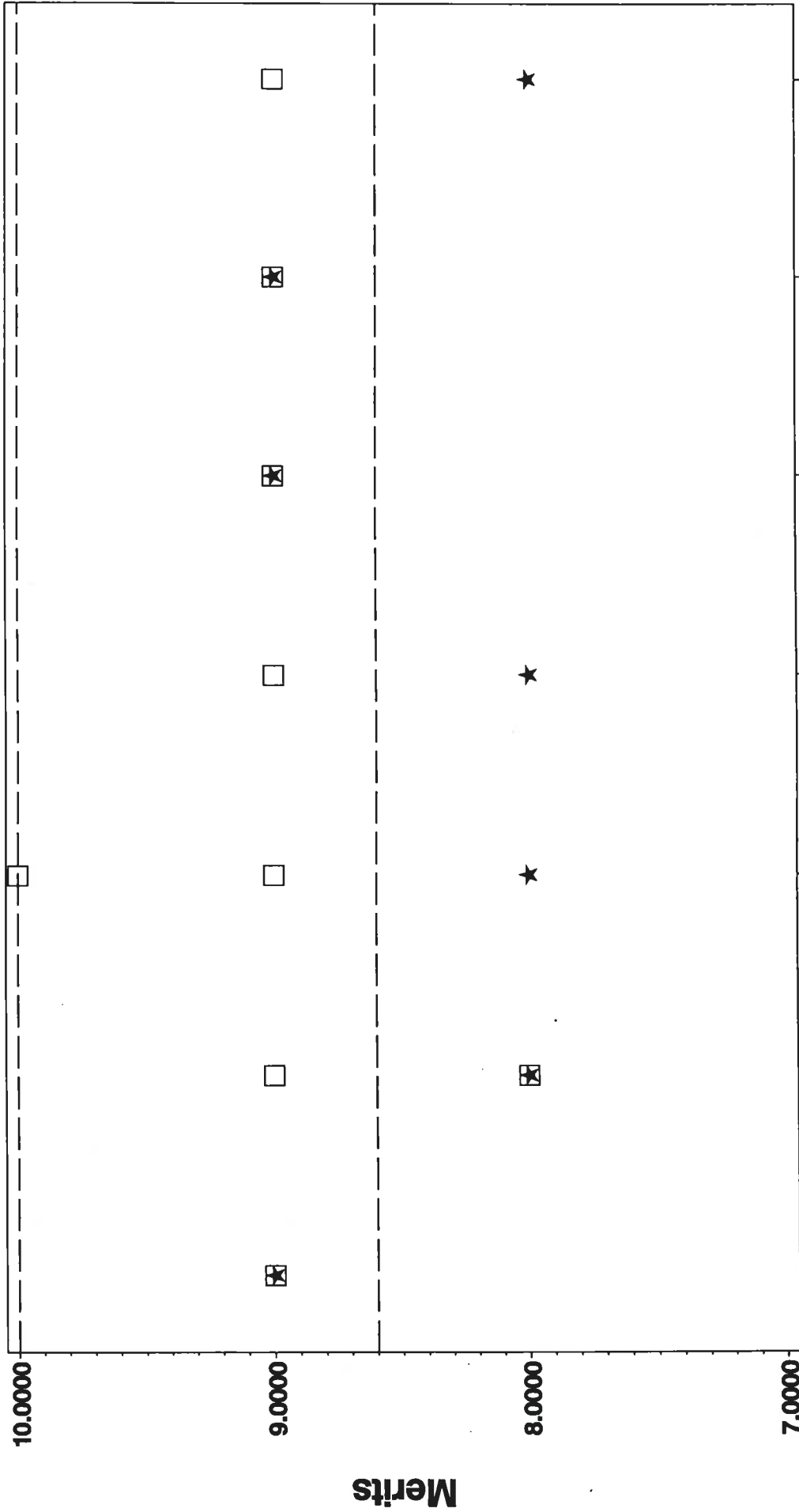
Rater
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L37RC Rater Comparison

Pinlon 41

Ridging

not much improvement



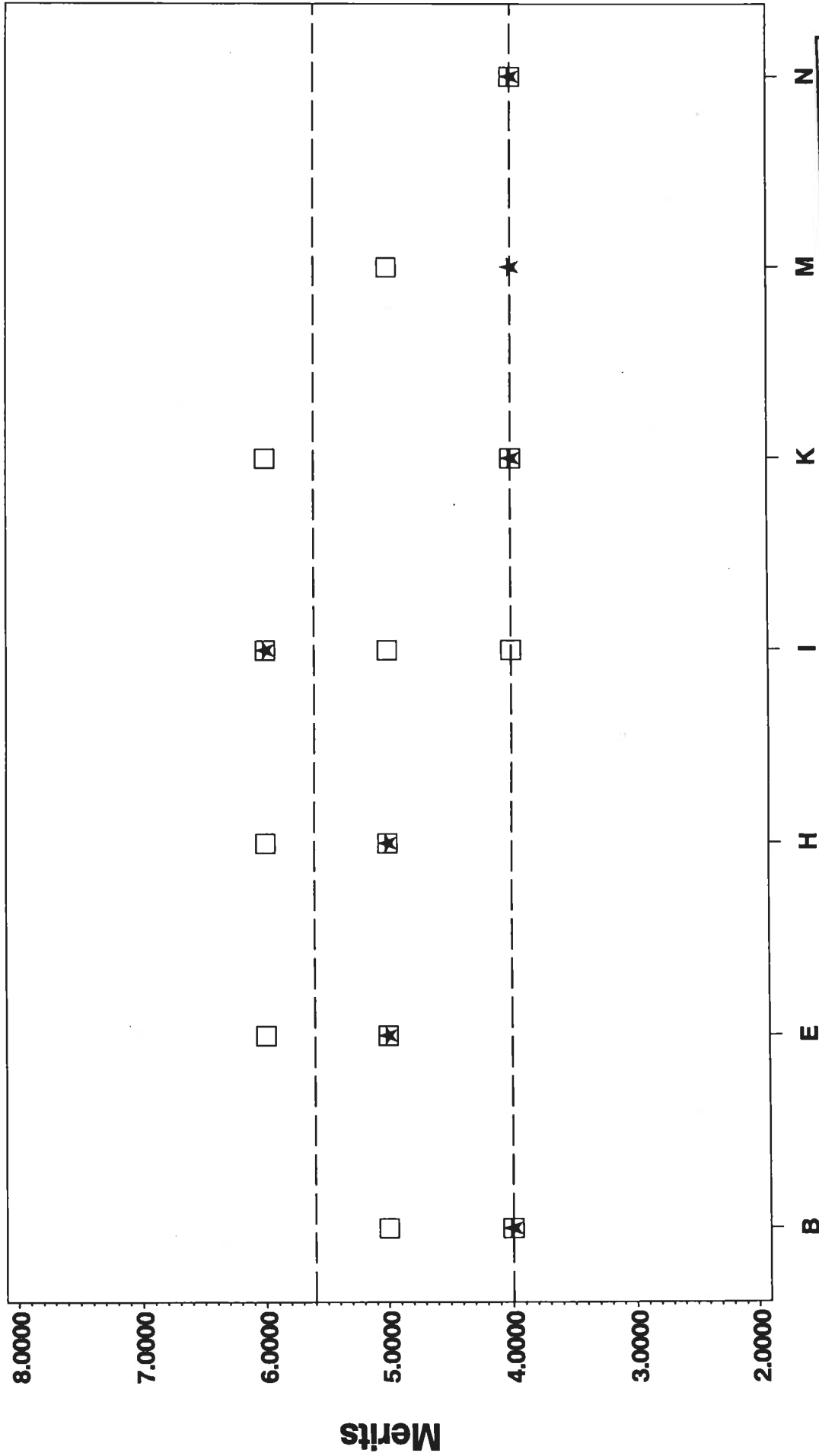
Attachment 7
Page 8 of 14
Reference 51768

Rater
Ind ☐☐☐ LTMS ★★ MOLD

L37RC Rater Comparison

Plinton 47

Ridging



Attachment
Page
Reference

7
10/2/17
5708

Rater

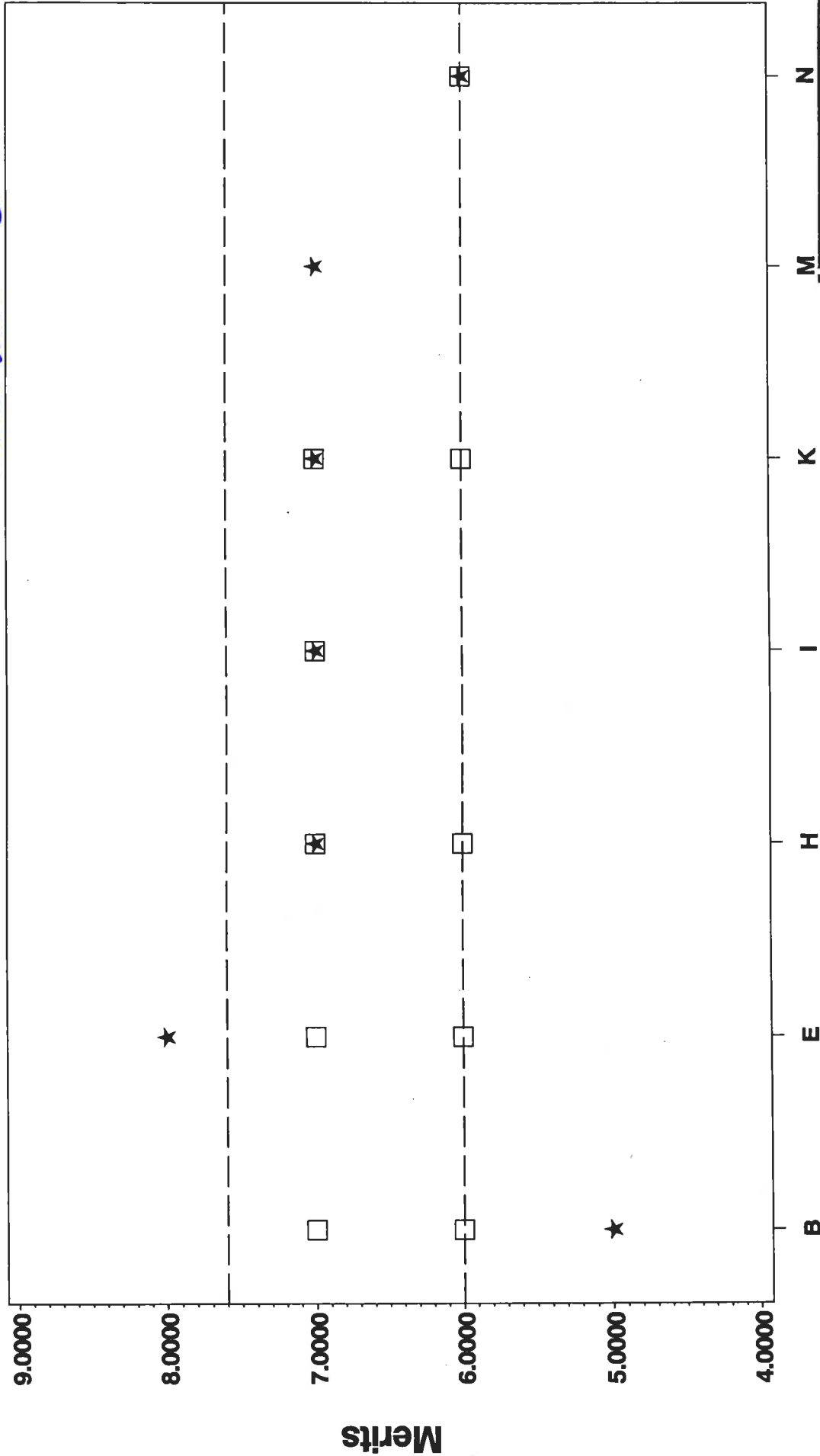
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L37RC Rater Comparison

Plinion 50

Wear

more Variable 5-8



Rater

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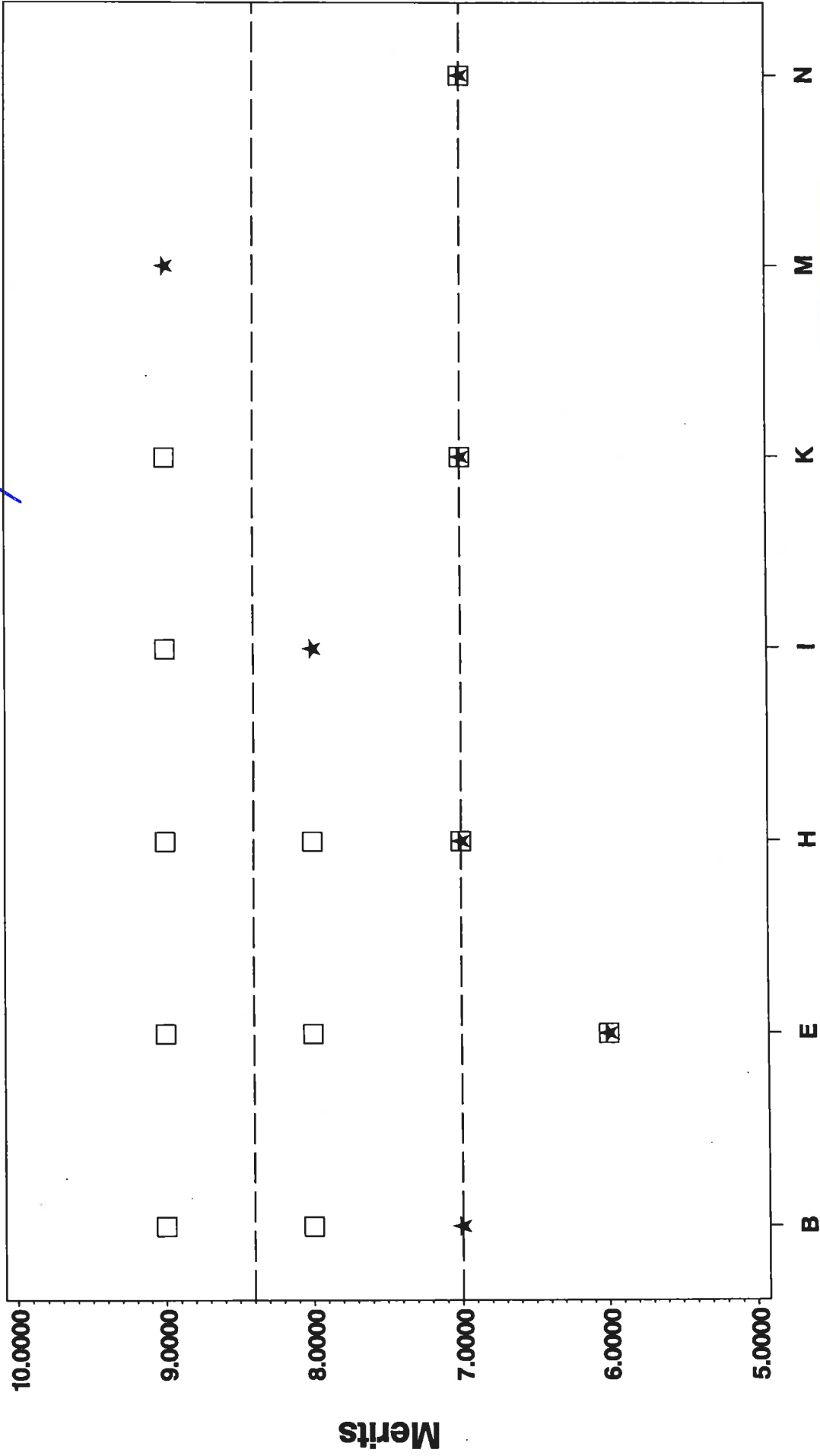
Attachment	7
Page	11 of 14
Reference	5/7/08

L37RC Rater Comparison

Pinion 50

Rldging

no help



Attachment

Page

Reference

7

18.06.14

5/7/68

Rater

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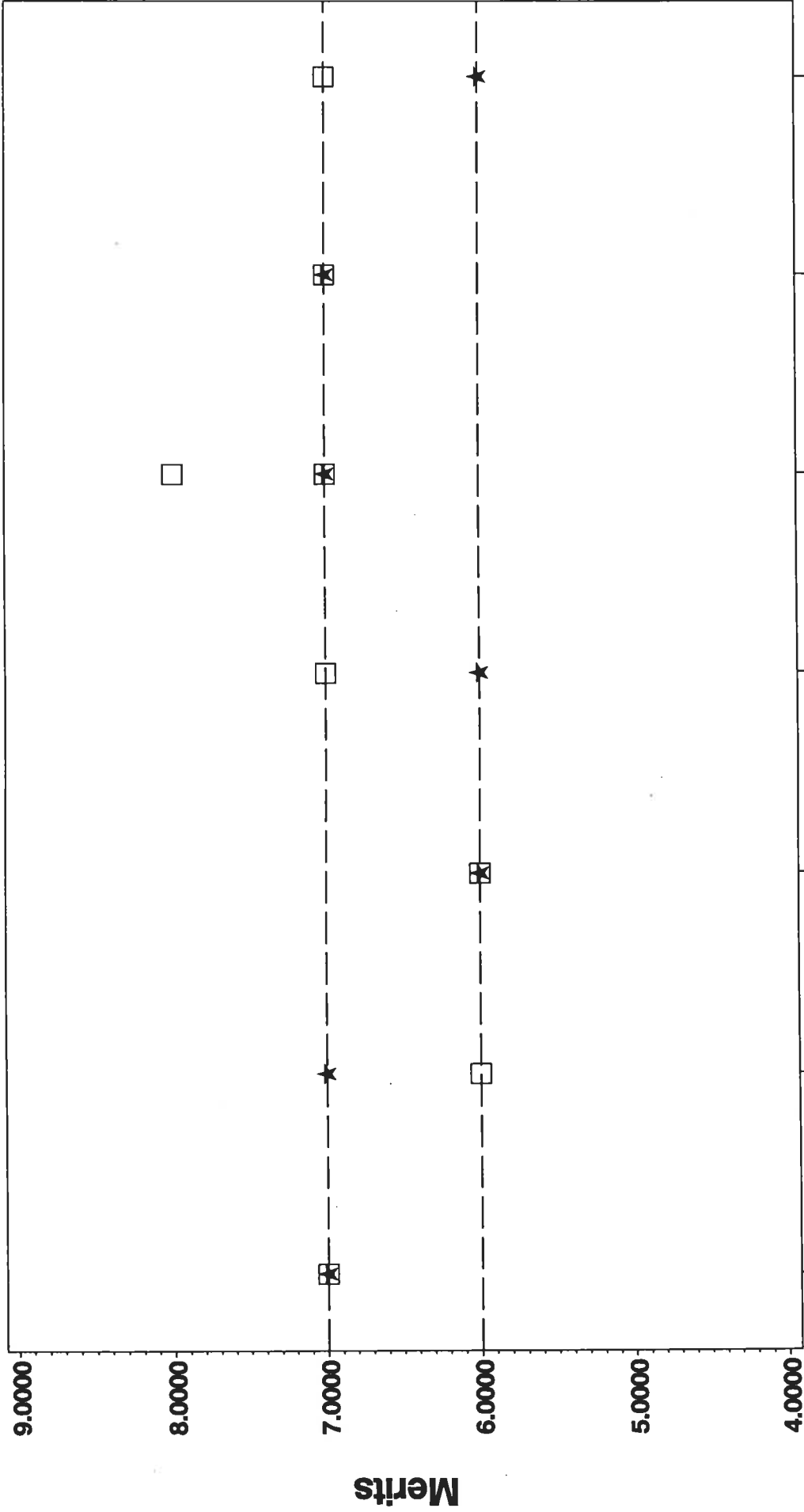
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★★★ MOLD

L37RC Rater Comparison

Pinion 54

Wear



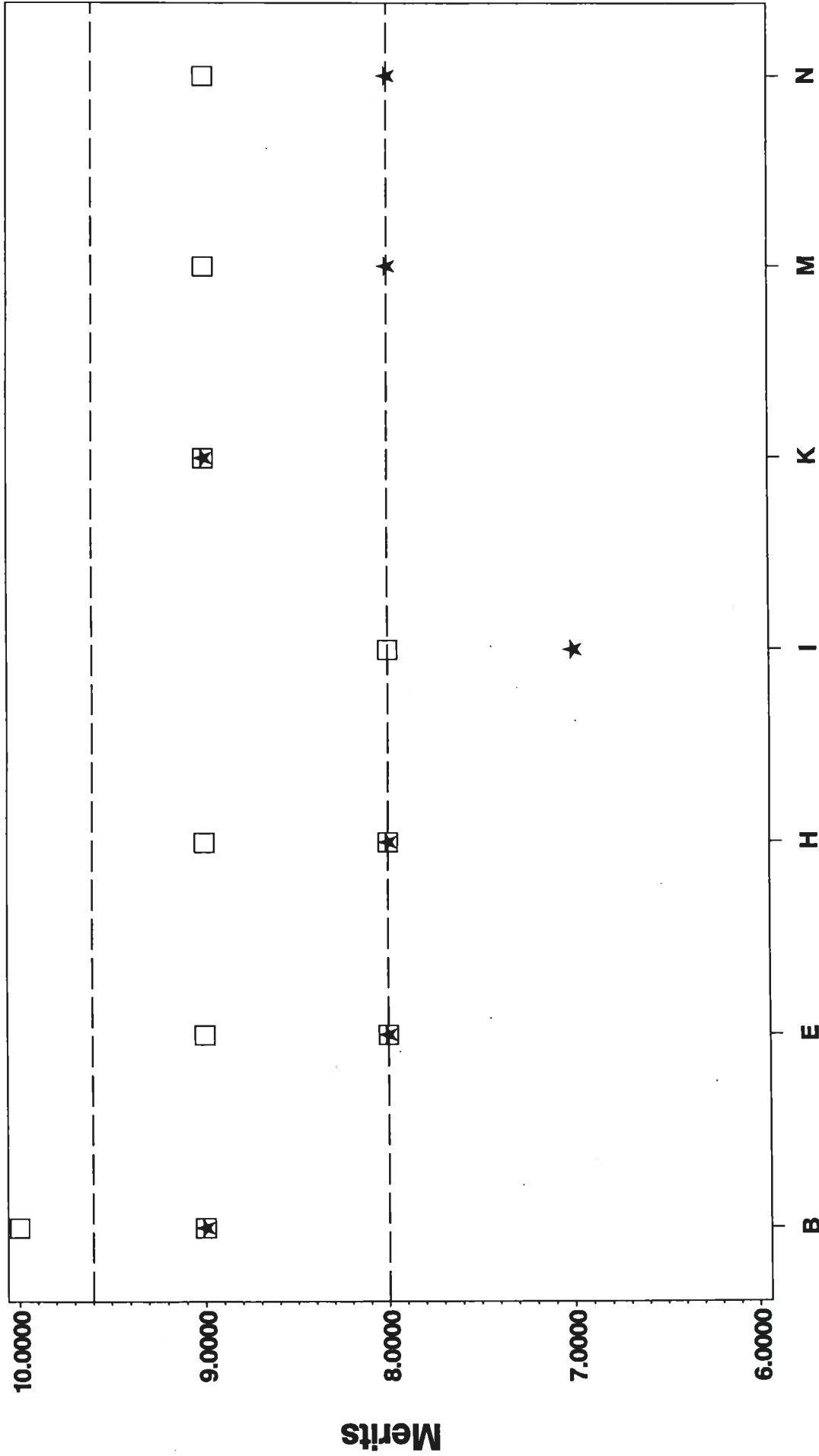
Attachment Page Reference
7/13/14
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L37RC Rater Comparison

Pinion 54

Ridgling



Attachment 7
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