
Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

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September 11, 2007

Reply to:

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ASTM D02.B0.03 L-37 Surveillance Panel

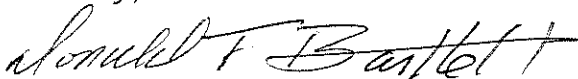
Members and Guests:

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

- o **August 8, 2007 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
PRI Headquarters, Warrendale, Pa.
August 8th, 2007

Sign-in/Review of Agenda & Membership: The meeting was called to order at 8:15am. The sign in sheet is included as Attachment #1. Mr. Fett, Mr. Guzikowski, and Mr. Steve Bird from Dana joined 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 following meeting were presented for review and approval:

- June 27, 2007 meeting at Dana
- July 3, teleconference meeting
- July 24, 2007 teleconference meeting

Motions:

Motion 1 ⇒ Mr. Koglin, Second ⇒ Mr. Smith) - Move to accept the slate of minutes (June 27th panel meeting and the July 3 and July 24, 2007 teleconference call meetings as written with no additions or corrections. The motion passed unanimously with a vote of 7-0-0.

Motion 2 ⇒ Mr. Koglin, Second ⇒ Mr. Smith) - To accept proposed changes per discussion, update CRC 21 manual accordingly, include an updated revision date, corrected page numbers, clear template and laminated template to be exact duplicates, and all comments added per previous discussions

Motion 3 ⇒ Mr. Gropp, Second ⇒ Mr. Koglin) - Require that the raters get together (either do it before January or at the January 2008 workshop in Richmond Va.) and rate some RCMS pinions (Chairman and TMC to discuss/choose). The panel and raters to officially meet immediately after rating to review the data and determine if the repeatability and reproducibility is acceptable. The motion carried with a vote of 5-0-2.

Action Items:

1. Mr Bartlett will hold weekly Lab/Hardware TF (HTF) teleconference calls, the first one starting on Thursday, August 23rd of, Thursday 10am EDT. The teleconference call will include TMC, Labs, & Dana. The goal is to have a plan for modified procedure matrix testing defined within a month.
2. Dana was asked to quote the cost of axles using the alternate lubrited process for Novembers meeting (could be less, could be more \$\$). Dana should use the last non-lubrited order volume as a guideline 700-900 pieces.
3. November 7th SP meeting is the conclusion date for all of the B6L566 gear batch testing activity. If no modified procedure has been developed, then a new / rebuilt batch must be ordered.
4. With respect to CRC Manual 21 changes, the Chairman will work with the labs for the documented letter to be sent to CRC co-approved by the L-37, L-42, and L-60-1 chairmen.
5. Mr. Koehler volunteered Mr. Sanchez (chairman of the GORTF) to send an update out to all known raters that will help the labs 'audit' their respective manual 21 templates in use.
6. The GO RTF proposed we make 8 total molds (4 wear and 4 ridging boards to be made at a cost of approximately \$160 per lab) giving one of each to each lab. The chairman was directed to order the boards and call a Panel meeting to discuss options for the raters to use for their rating exercise and timing to complete the task.

Summary of Meeting Discussions

2006 Lubrited Hardware Order Timeline, questions & actions, - B6L566/P4L816

For simplicity, please see Power Point document, see Attachment # 2 and the respective slides numbers for discussion points from this meeting.

- o Slides 4 and 5 details timeline of panel and task force work since the hardware order was placed in May, 2006.
- o Slide 6 - details discussion and concerns with respect to L1 contact patterns. It is left tabled until the main batch's fate is determined.
- o Slide 7 - discussion:
 - 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 Guzikowski update on hardware analysis: There are discrepancies on the analysis, however Dana personal believes that the amount of pitting due to the lubrifying process is the cause of current results. Minor metallurgical issues, hardness not in specification. Drawing specs are very tight and may not be achievable. The impact from the etching process / pitting is higher than expected and is the real issue driving distress concerns.
- **Slide 8** - details the Dana metallurgical analysis of the previous lubrified hardware batches supplied by Lubrizol. The amount of pitting was considerably less than the B6L566 hardware batch. See Attachments # 3 and 4. Mr. Bartlett reminded the groups that all lubrified hardware was lubrified at the Ft. Wayne facility except the 2004 T58A/L247 hardware batch which was done at the Dana, Glasgow KY facility.
- **Slide 9 and 10** - Modified Test Conditions
 - Lubrizol has conducted 3 tests @ shortened length & reduced horsepower. Results look promising at were included in the June 27th meeting minutes.
 - Afton has two oils assigned from TMC to run with an extended length break-in that consists of 100min normal break in plus 60 min @ 1.5 times load at same speed.
 - Parc is currently in L-42 mode and unable to participate.
 - SWRI will be looking at some break-in methods in the next couple weeks.
- **Slide 11** - Modified Lubrifying Process - (see Attachment # 5 that details the hardware information and the two different processes used for lubrifying.
 - 3 labs have received their hardware and their TMC 153 oil assignments.
 - EOT ring and pinion should go to Dana for analysis, Attn: Joe Guzikowski
 - Mr Guzikowski expressed urgency for completing this work to aid in the decision and direction for a future batch on which method is preferred.
- **Slide 12** - Dana update on Axle Batch Replacement / proposed fix, see Attachment # 6, which is a quote from Dana, Gary Schmalbach.
 - **Option 1:** Replace entire axle batch. Quote \$964 per axle. This is the same price as the previous batch. This is using the standard industrial (Ft. Wayne) phosphate coating. Pricing may change if new phosphate coating process is used. Timing: 6 months from order.
 - **Option 2:** Rebuild of existing axles at the Lugoff facility with new ring and pinion gear sets. Lugoff has declined to quote this due to the fact that the facility is not conducive to this large-scale rebuild.
 - **Option 2 Alternate:** Rebuild of existing axles at Great Lakes Power, authorized Dana Service Center in Cleveland, Ohio. Quote is \$227.03 per axle, replacing only the ring and pinion that is coated using the standard Ft. Wayne industrial phosphate coating. Pricing may change if the new/alternate phosphate coating is used. Timing: 6 months from order.
 - **Option 3:** Obtain ring and pinion gear sets only 060GA104X. Quote \$133.28 per axle. This would be done with the standard Ft. Wayne industrial phosphate coating. Pricing may change if the new phosphate coating is used. Timing: 5 months from order.

- **Other general comments with respect to the options:**
 - Steve Bird stated that *Great Lakes Power* comes highly recommended & is very good with record keeping.
 - With respect to the Volvo phosphate coating spec, Mr Koglin asked if Dana can update would provide the panel a summary of what the previous batches are relative to this spec & open some discussion on what the next batch should be. Mr Guzikowski indicated that the Volvo spec has limits for both small and large pits; the previous axles do not have the large pits, however, and have a large number of small pits. The current batch is 100+ pits per area, the previous batches fall within the standard ~9-39 per area. The 626A batch only has 39 per area.
 - Mr Koglin would like to see this type of spec placed in the specifications for a new batch.
 - Mr Gropp commented that the labs should informally talk and be on the same page to coordinate efforts to develop a new test.

- **Slide 13 - Next Hardware Order**
 - Mr Bartlett comments that the 2-year roll over for the non-lubrited order is due shortly after this meeting.
 - Lubrizol is ready to tender a non-lubrited order.
 - Afton is ready to tender a non-lubrited order.
 - Intertek-Parc is not ready to tender a future order - direction needs set on the current order - may have direction by November meeting.
 - SwRI is almost ready to tender an order (16-18 months away from needing hardware). SWRI would be ready for an order in November.

- **Action Items from Slides 9 - 13:**
 - Mr Bartlett will hold weekly Lab Hardware Task Force (HTF) teleconference calls, the first one commencing **23rd of August Thursday 10 am EDT** and running through the end of October. The teleconference call will include TMC, Labs, & Dana. The goal is to have a plan for alternate procedure matrix testing defined within a month.
 - Mr. Koglin requested that Dana quote the cost of axles using the alternate lubrited process for Novembers meeting (could be less, could be more \$\$). Dana should use the last non-lubrited order volume as a guideline 700-900 pieces.
 - November 7th SP meeting is the conclusion date to all of this activity on this gear batch. Mr Gropp comments that without having a deadline for decision on the current batch is probably needed to keep things moving. If no modified procedure has been developed, then a new / rebuilt batch must be ordered.

Coordinating Research Council, Inc (CRC) - Attachment 2, Slide 14 - There was much discussion with respect to Manual 21 Template Revisions.

- Attachment # 7 represents communication from CRC to the respective surveillance panel chairman addressing CRC manual 21 issues (pages 39, 41, & 43). The panel chairman had agreements with CRC to hold off template replacements until after the panels individually addressed the issues at this meeting. Long story short, at some point in time after 12/2001 there were changes made to the manuals, and the manuals in the industry do not all match. The clear/transparent template was inadvertently changed as well. It is not known who authorized change.
- Another company bought a new manual in the 2004/5 time frame and discovered that the new templates were not the same size as the original. Mr Lind commented that a rater came to the July 2007 workshop with a spalling template that was sized incorrectly.
- Mr Guzikowski recently purchased a manual 21. The templates are dated 04 and match the white page, however don't match the original documents in size.
- Mr Gropp commented that before we implement the new change, the panels need to verify that the new sheets are actually correct. He also communicated that the old templates be taken out of service and that we address insuring that the correct templates are being used.
- Mr Lind is and will continue inspecting the current templates in use at lab during lab visits & at the workshops.

- **Motion 2** ⇒ Mr. Koglin, Second ⇒ Mr. Smith) - To accept proposed changes per discussion, update CRC 21 manual accordingly, include an updated revision date, corrected page numbers, clear template and laminated template to be exact duplicates, and all comments added per previous discussions. The motion passed unanimously by a hand vote with 7-0-0.

Secretary's note: Attachment # 8 summarizes full details of changes to the templates and the final letter sent to CRC on September 10, 2007.

- **Action Item:** Mr Koehler volunteered Mr. Sanchez (chairman of the GORTF) to send an update out to all known raters that will help the labs 'audit' their respective manual 21 templates in use and address some of Mr Gropp's concerns. This email will occur by August 17th 2007.

Secretary's note: For convenience and the capturing of this action item, please see Attachment # 9 summarizing full details and instructions for labs to use to audit their templates.

GO RTF Ridging and Wear Mold Board Proposal - Mr. Sanchez, GORTF chairman

At this point the following rating TF members joined the panel via teleconference call:

Art Sanchez, Marty Rose, Wes 'Stocks, Pete Radonich, Brian Foecking, and Ralph Kozlowski.

Also note that Attachment # 10 is the most recent GO RTF proposal stemming from the July 2007 workshop.

o RTF Mold Board Proposal

- Mr. Foecking proposed we make 8 total molds (4 wear and 4 ridging boards to be made at a cost of approximately \$160 per lab) giving one of each to each lab. The labs are to bring them to January's workshop. The chairman was directed to order the boards and call a Panel meeting to discuss options for the raters to use for their rating exercise. He also reminded the panel that at this point Lubrizol has fronted a little over \$ 5000 for all of the activity to date (three phases). He will be presenting a bill to the labs to split the cost four ways soon, as previously agreed.
- Don Lind - valuable to have everyone present in lieu of send around.
- Mr Gropp comments that if we allow more than one rating aid, it allows for different results that could be both argued to be correct. Some raters shared an opposite view stating that the more tools the rater has to verify the result is better.
- Panel will support if data shows good results.
- Some discussion on adding an additional day to the January workshop, meeting of raters either at or before January workshop to look at pinions using new rating aids, to determine if the repeatability and reproducibility is acceptable,

Motion 3 ⇒ Mr. Gropp, Second ⇒ Mr. Koglin) - Require that the raters get together (either do it before January or at the January 2008 workshop in Richmond Va.) and rate some RCMS pinions (Chairman and TMC to discuss/choose). The panel and raters to officially meet immediately after rating to review the data and determine if the repeatability and reproducibility is acceptable The motion carried with a vote of **5-0-2**.

o GO RTF Workshop Review - TMC - no time.

o Axle Backlash Resolution - no time. Chairman to address through and email ballet to the surveillance panel.

A motion for adjournment was made by Mr. Koehler and seconded by Mr. Dharte. The meeting was adjourned at 11:00 am.

Respectfully submitted,



Donald T. Bartlett

L-37 Surveillance Panel Chairman

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: August 8, 2007

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* Initial to indicate attendance at subject meeting

Attachment /
Page Page 1 of 5
Reference 1-37

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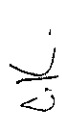
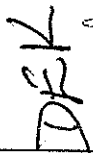
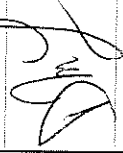
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Attachment /
Page 2 of 5
Reference L-37

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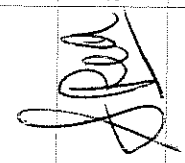
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Page 3 of 5
Reference L-37

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Attachment
 Page 4 of 5
 Reference 4-37

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Meeting Date: August 8, 2007

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				Phone: Fax: E-Mail:
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Attachment 1
Page 5 of 5
Reference 6-37

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L-37 Surveillance Panel
 PRI Headquarters,
 Warrendale, Pa.
 August 8, 2007

Donald Bartlett

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L-37 SP Agenda

- I. Call to Order, Agenda & Membership Review
- II. SP Minutes to Approve:
 - ✓ June 27, 2007 meeting at Dana
 - ✓ July 3, 2007 teleconference
 - ✓ July 24, 2007 teleconference
- III. 2006 B6L566 Lubrited Hardware Update
- IV. Next Hardware Order
- V. CRC Manual 21 Template Revisions
- VI. GO RTF Workshop Review – TMC
- VII. GO RTF Mold Board Proposal - Sanchez
- VIII. Axle Backlash Resolution
- IX. LTMS Change Proposal With Respect to Pitting/Spalling
- X. New Business
- XI. Adjournment

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L-37 Surveillance Panel Voting Members

Donald Bartlett	The Lubrizol Corporation (Chairman)
Tom Bryson	Volvo Power Train Corporation
Juan Buitrage	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

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Attachment 2
 Page 1026
 Reference L-37

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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
- ✓ May 3 and May 10, 2007 SP Teleconference calls to discuss issues with the L1 build contact patterns.

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2006 (P4L816/B6L566) Lubrited Hardware Update

- ✓ 44-Test Matrix Completed June, 2007
- ✓ Review of Data and Options at Dana, Maumee, Ohio on June 27, 2007
- ✓ July 3, 2007 SP Teleconference Call
- ✓ July 24, 2007 SP Teleconference Call
- ✓ August 8, 2007 SP Meeting

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May 3 and 10 SP Meeting Outcomes - Update

- 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, FD 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 ?

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ITEM LEFT TABLED

Attachment 2
 Page 2 of 6
 Reference L-37

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June 27 SP Meeting Outcomes - Update

- 1) Hardware currently deemed not approved for testing due to severe Pitting/Spalling, the number of tests exhibiting broken teeth, and Ridging severity concerns.
- 2) Mr. Fett/Guzikowski kept Lubrizol sets CMIR 058195 and CMIR 058292 to perform further metallurgical analysis.
- 3) Review of analysis – Fett/Guzikowski

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FACT: Consensus
Bottom line: The
AMOUNT OF PITTING FROM
THE PHOSPHATE PROCESS
IS THE REAL ISSUE

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June 27 SP Meeting Outcomes - Update

- 4) The labs to send lubrified ring and pinion EOT hardware to Dana for metallurgical analysis:
 - » Lubrizol sent hardware from gear batches T758A/L245; P4L626A/V1L686, and P4L514A/V1L303.
 - » Other older hardware batches not available at any labs.
- 5) Review of analysis – Fett/Guzikowski

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June 27 SP Meeting Outcomes - Update

- 6) The labs support continued experimenting with a modified test procedure to allow the axle batch to be approved for use.

Focus will be on both gear conditioning and gear test phase conditions/variations.

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Attachment	<u>2</u>
Page	<u>3 of 6</u>
Reference	<u>L-37</u>

Modified Test Procedure Tests - 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)

July 3 SP Teleconference Meeting Outcomes - Update

The four labs sent two complete axle assemblies from the non-lubricated hardware gear batch P4L792/V1L417 to Dana.

- » All 8 axles were disassembled and all parts kept together as a unit.
- » 4 Axles lubricated using existing Ft. Wayne method.
- » 4 axles lubricated using a new alternate supplier method.
- » The axles were all reassembled and built to specification (proper position and preload) after the gears were phosphated.
- » The labs in process of conducting two tests on TMC 153.
- » The labs agreed to save/send the End of Test ring and pinion back to Dana for further destructive analysis.

July 24 SP Teleconference Meeting Outcomes - Update

Dana to have internal discussions and report back to the August Surveillance panel meeting:

- » Cost and timing of providing a new batch.
- » Quote a price for a new ring and pinion sets.
- » Let's evaluate an option of acquiring an outside source to rebuild the axle in a controlled environment since it appear that Dana is unable to perform this specific task at this time.

Attachment	<u>2</u>
Page	<u>4 of 4</u>
Reference	<u>L-37</u>

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Next Hardware Order – 2007 or 2008

When Do We Place an Order ?

- » Order Non-Lubrited Only
- » Order Both Non-Lubrited and Lubrited giving us the same ring and pinion heat code?

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CRC Manual 21 Template Revisions

- November 28, 2001 the SP adopted CRC Rating Manual 21
- December 12, 2001 the CRC Corrected Pages 29, 41, and 43
- CRC is correcting the rating scale for Spalling
 - » The revision is due to size problems with Page 43
 - » The transparencies were made via copy of the laminated pages thus producing distortion of the actual images on the transparent pages
 - » Corrections will have a new implementation date

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MOTION FOLLOWED

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L-37 Rating Update

- » Review July 2007 Calibration Workshop – Lind
- » Pitting/Spalling vs. Chipping on RCMS Pinions 44 and 45 - Lind
- » Rating TF Rating Proposal - Sanchez

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→ *NO TIME*

→ *NO TIME*

→ *50 ATTACH #98 MINUTE*

Attachment	<u>2</u>
Page	<u>50/6</u>
Reference	<u>L-37</u>

Lubrizon

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)?

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NO TIME - CHAIRMAN

ASKED TO DO EMAIL

BALLOT

Lubrizon

Proposed Revision to D6121

- 8.2.3 - Record the backlash reported from the manufacturer. The reading shall be between 0.004 and 0.009 in.
- 8.2.3.1 - Remove the cover plate. Measure and record backlash at four equally spaced locations.
- 8.3.2.2 - Report the average and the four readings.
- 8.3.2.3 - No backlash measurement shall be greater than 0.07? in. (Note L-42 is 11)
- Record and report the MFG Axle Serial Number (xUSAxxxxx)?

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NO TIME - CHAIRMAN

ASKED TO DO AN EMAIL

BALLOT

Lubrizon

LTMS Control Charting Question

➤ EWMA and Shewhart Chart Precision and Severity:

- Is Pitting/Spalling parameter precise enough to control chart?
- Should the Panel take any action to modify or suspend the Pitting/Spalling requirements?
- Critical vs. non-critical parameter?
- All gear batches?

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NO TIME

Attachment 2

Page 6 of 6

Reference L-37



MATERIALS ENGINEERING LAB REPORT
DANA CORPORATION – AUTOMOTIVE SYSTEMS GROUP
3939 TECHNOLOGY DR.
MAUMEE, OHIO 43537

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE CONSENT OF THE MATERIALS ENGINEERING DEPARTMENT.

LAB NO.	: 2007-0469	PART NO.	: 060GP104, 060GP105
PART NAME	: (PINION) HYPOID DRIVE FIN	PRINT REV.	: D
REP. TITLE	: GEAR, PINION	MODEL	: 60
MARKINGS	: SEE COMMENTS	HEAT CODE	: L247, V1L686, VIL303
MATERIAL	: SAE 8625	MFG. DATE	: 7/23/03, 12/01/99
VENDOR	: FWP/STATESVILLE/GLASGOW	SAMP. REQ.	: N/A
CUSTOMER	: OFF HIGHWAY	VIN	: N/A
TAR NO.	: N/A	MAR NO.	: MAR-2809
TEST ENG.	: N/A	REC'D DATE	: 07/18/07
REQ. BY	: JOE GUZIKOWSKI	REP. DATE	: 07/30/07
REP. BY	: MATT SCHAUBLIN	NO. OF PAGES	: 11

COMMENTS : SET #1- DANA, G, 060GP104, 41-7, L247, 07-21-03 – GLASGOW PHOSPHATED.
 SET #2- DANA, S, 060GP105, 41-7, VIL686, 12-01-99 – STATESVILLE MACHINED & HEAT TREATED, FT. WAYNE PHOSPHATED.
 SET #3- CO, DANA, D5, 060GP104, 41-7, V1L303, 658KP – FT. WAYNE MACHINED, HEAT TREATED, & PHOSPHATED.

COPIES : GREG FETT, DANA COMBS, JOE GUZIKOWSKI

REQUEST : EVALUATE PITTING, CASE DEPTH, MICROHARDNESS, AND MICROSTRUCTURE.

REASON : AS PART OF THE PHOSPHATE COATING PITTING ISSUE, WE RECEIVED THREE OLD GEARSETS THAT HAVE BEEN TESTED AT LUBRIZOL TO THE L-37 TEST CRITERIA. TWO OF THE SETS SHOW SPALLING (#1 AND #3) WHILE THE THIRD (#2) DOES NOT. HOWEVER, CODE V1L686 (#2) WAS KNOWN AS THE "CODE FROM HELL" DUE TO PERFORMANCE ISSUES.

RESULTS :

VISUAL INSPECTION

FIGURES 1-3 SHOWS THE AS-RECEIVED PINION GEARS. GEAR SETS #1 AND #3 HAD SOME SPALLING ON THE TEETH AT THE HEEL END (FIGURE 4-5). THE WEAR PATTERNS ARE SHOWN IN FIGURES 6-11.

MAGNETIC PARTICLE INSPECTION

ASTM E709-01

THERE WAS NO VISUAL EVIDENCE OF MAGNETIC PARTICLE INDICATIONS.

MICROHARDNESS MEASUREMENTS

ASTM E384-05

500 gf LOAD CONVERTED TO HRC.

LOCATION	SET #1		SET #2		SET #3	
	PITCH (HRC)	ROOT (HRC)	PITCH (HRC)	ROOT (HRC)	PITCH (HRC)	ROOT (HRC)
0.002"	60.3	62.0	60.9	62.3	60.4	59.3
0.004"	60.7	60.2	60.0	60.9	60.7	59.7
0.006"	60.2	60.1	59.5	60.7	60.2	60.4
0.008"	60.9	61.3	60.2	59.6	60.8	60.2
0.010"	60.9	60.4	59.6	59.8	61.1	61.1
0.020"	59.1	58.2	59.8	59.8	57.6	57.6
0.030"	58.2	50.2	59.3	57.9	54.8	48.6
0.039"	56.9	40.7	57.4	55.6	48.8	39.4
0.049"	54.9	35.9	55.4	51.7	44.8	36.2
0.059"	52.1	31.0	52.5	47.0	39.7	28.9
0.069"	51.0	35.0	51.0	40.3	40.2	30.4
0.079"	50.2	34.2	48.9	43.3	36.1	25.3
0.089"	48.7	--	48.9	--	38.9	--

Attachment 3
 Page 1 of 11
 Reference L-37

LAB REPORT
2007-0469

SURFACE HARDNESS

ASTM E384-05

GEAR TOOTH SURFACE HARDNESS. 500g VICKERS CONVERTED TO HRC, MEASURED AT 0.004" AND 0.006".

	RESULTS
SET #1	60.7*, 60.2* (PITCH) 60.2*, 60.1* (ROOT)
SET #2	60.0*, 59.5* (PITCH) 60.9*, 60.7* (ROOT)
SET #3	60.7*, 60.2* (PITCH) 59.7*, 60.4* (ROOT)
SPECIFICATION	61-63 HRC

* OUT OF SPECIFICATION; 57-66 HRC TYPICAL FOR SHOT PEENED GEARS PER ES-HT-FW0204.

EFFECTIVE CASE DEPTH MEASURED AT 50 HRC

SAE J423 FEB. 1998

500g VICKERS CONVERTED TO HRC.

	PITCH	ROOT
SET #1	*0.080"	0.030"
SET #2	*0.074"	0.053"
SET #3	*0.038"	0.028"
SPECIFICATION	0.050" – 0.065" (1.27-1.65 mm)	0.025" – 0.065" (.635-1.40 mm)

*OUT OF SPECIFICATION

CORE HARDNESS

ASTM E18-05

DIRECT HRC ON MICRO SAMPLE.

	PITCH	ROOT	1/8 BELOW	BEARING DIA.
SET #1	40.0	29.8	27.8	26.3
SET #2	47.0	40.0	35.6	29.8
SET #3	34.3	29.0	26.3	25.6
SPECIFICATION	N/A	25-43	N/A	33HRC MAX

Attachment	<u>3</u>
Page	<u>2/11</u>
Reference	<u>L-57</u>

LAB REPORT
2007-0469

CHEMICAL ANALYSIS

ASTM E415-99 (2005)

ELEMENT	SET #1	SET #2	SET #3	SAE-8625	ES-PM-FW0001
C	0.21*	0.21*	0.24	0.23 - 0.28	--
Mn	0.80	0.80	0.88	0.70 - 0.90	--
P	0.006	0.006	0.011	0.035 Max	--
S	0.018	0.017	0.019	0.040 Max	--
Si	0.23	0.23	0.22	0.15 - 0.35	--
Ni	0.47	0.47	0.47	0.40 - 0.70	--
Cr	0.55	0.53	0.51	0.40 - 0.60	--
Mo	0.21	0.20	0.19	0.15 - 0.25	--
Cu	0.18	0.18	0.19	--	0.35 MAX
Al	0.018	0.018	0.018	--	0.015-0.050
Sn	0.008	0.008	0.008	--	0.025 MAX
V	0.003	0.003	0.003	--	0.020 MAX
Nb	0.001	0.001	0.001	--	0.010 MAX
Zr	0.001	0.001	0.001	--	0.010 MAX
B	0.0001	0.0001	0.0002	--	0.0005 MAX
Ti	0.001	0.001	0.001	--	0.010 MAX
Pb	--	--	--	--	0.010 MAX
Ca	0.001	0.001	0.001	--	0.0030 MAX
N	0.004	0.013	0.007	--	0.015 MAX
As	0.006	0.006	0.006	--	0.010 MAX
Zn	0.002	0.002	0.002	--	0.030 MAX
Sb	--	--	--	--	0.010 MAX
**D.I.	2.15	2.10	2.43	--	2.10-2.60"

*OUT OF SPECIFICATION BUT ACCEPTABLE TO PRODUCT TOLERANCES PER ES-CHA0501
**FOR REFERENCE ONLY

PHOSPHATE COATING PICKLING PITS RATING

VOLVO STD 5742,104

PHOSPHATE COATING PICKLING PITS WERE MEASURED FOR DEPTH AND COUNTED WITHIN A 20 MM LENGTH ALONG A SECTION IN THE MIDDLE OF THE RING GEAR TOOTH FLANK.

SET #1 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 µM – 30 µM	13	21 MAX
31 µM – 50 µM	0	7 MAX
> 50 µM	0	--

SET #2 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 µM – 30 µM	39*	21 MAX
31 µM – 50 µM	0	7 MAX
> 50 µM	0	--

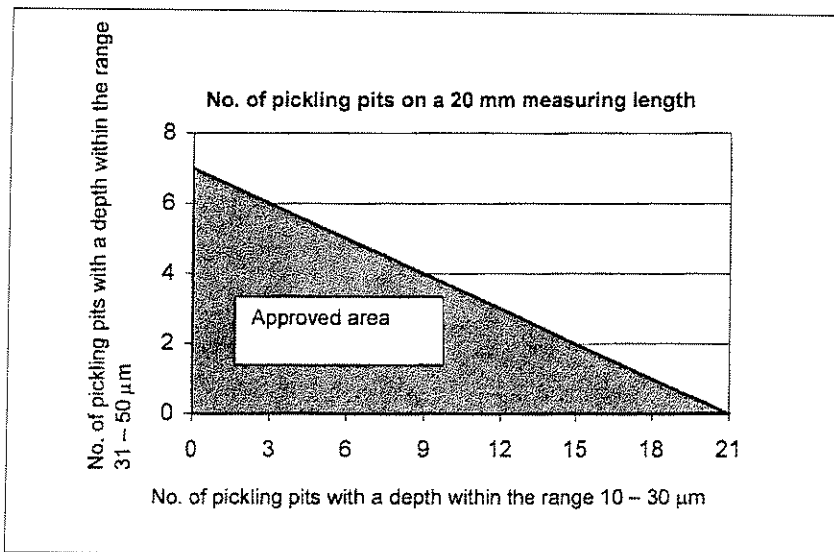
*OUT OF SPECIFICATION

Attachment 3
page 3 of 11
reference L-37

LAB REPORT
2007-0469

SET #3 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 μ M – 30 μ M	9	21 MAX
31 μ M – 50 μ M	0	7 MAX
> 50 μ M	0	--

TABLE 1: PHOSPHATING PITS REFERENCE TABLE (VOLVO - STD 5742,104)



MICROSTRUCTURE

THE MICROSTRUCTURE CONSISTED OF A MARTENSITIC CASE WITH A CORE OF TRANSFORMATION PRODUCTS (FIGURE 10-27). GEAR SET #1 HAD IGO OF 0.0010" AND NMTP OF 0.0006". GEAR SET #2 HAD IGO OF 0.0007" AND NMTP OF 0.0004". GEAR SET #3 CONTAINED NO EVIDENCE OF IGO BUT IT HAD NMTP OF 0.0005".

CONCLUSION : ALL THREE PINION GEARS FAILED TO MEET CASE DEPTH SPECIFICATIONS AT THE PITCH LINE (TWO EXCEED, ONE BELOW). THE SURFACE HARDNESS IS ALSO OUT OF SPECIFICATION BUT 61-63 HRC IS NOT A REALISTIC SPECIFICATION. GEAR SET #1 AND #2 HAD CARBON SLIGHTLY BELOW SPECIFICATION. GEAR SET #2 EXCEEDED THE VOLVO PICKLING PIT SPECIFICATIONS. THE SPALLING ON SETS #1 AND #3 WAS LIMITED TO THE HEEL END OF THE TOOTH. THIS IS LIKELY A RESULT OF THE TOOTH GEOMETRY ALLOWING THE CONTACT PATTERN TO MOVE TO THE HEEL END UNDER LOAD.

RELATED MET REPORTS : 2007-0471

Attachment	<u>3</u>
Page	<u>4 of 11</u>
Reference	<u>1-37</u>

LAB REPORT
2007-0469

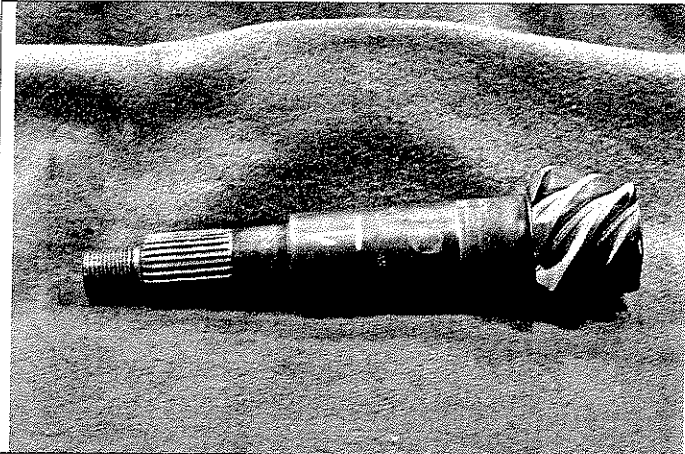


FIGURE 1: PINION GEAR SET #1-AS RECEIVED.

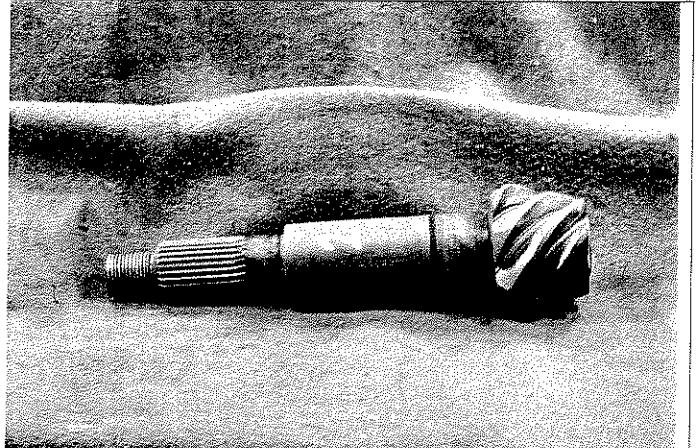


FIGURE 2: PINION GEAR SET #2-AS RECEIVED.

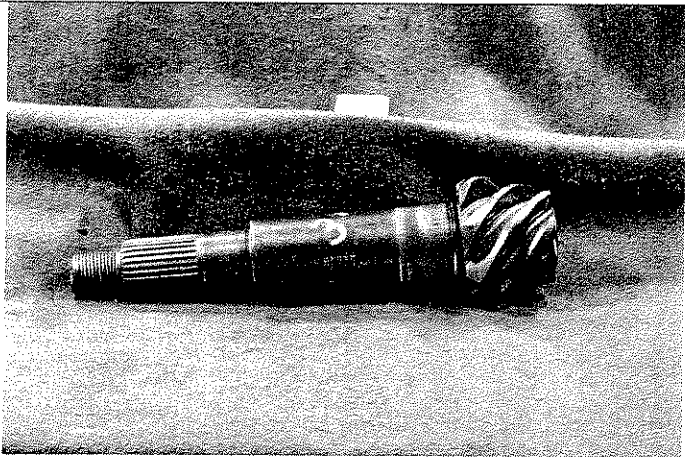


FIGURE 3: PINION GEAR SET #3-AS RECEIVED

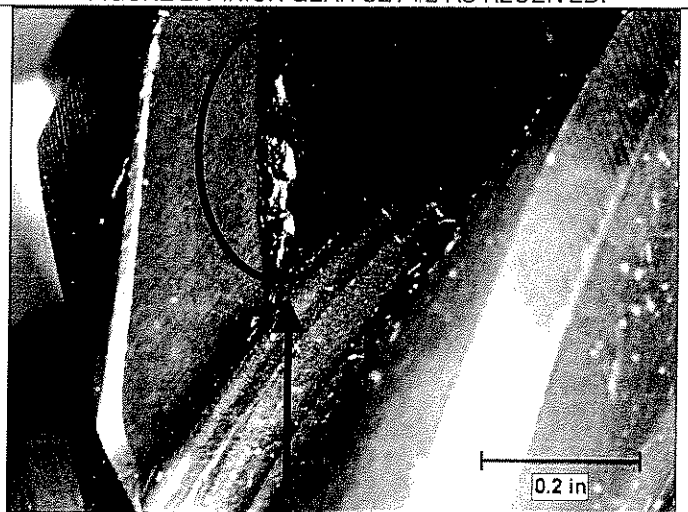


FIGURE 4: ARROWS INDICATE SPALLING AT THE HEEL END ON GEAR SET #1 @ 5X.

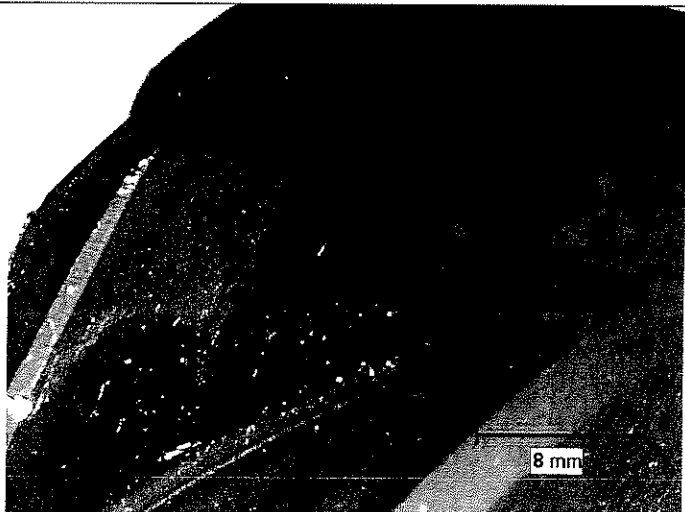


FIGURE 5: HEEL END OF GEAR SET #2 @ 5X.



FIGURE 6: ARROWS INDICATE SPALLING AT THE HEEL END ON GEAR SET #3 @ 5X.

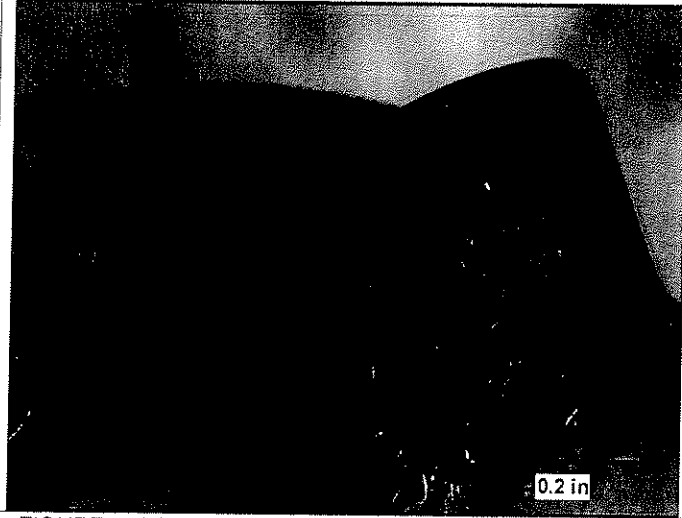


FIGURE 7: CONCAVE WEAR PATTERN-SET #1 @ TOE END.

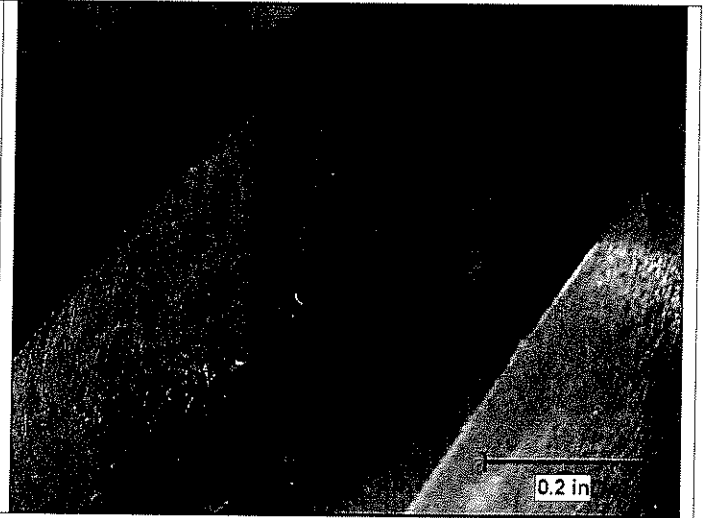


FIGURE 8: CONVEX WEAR PATTERN-SET #1 @ MID TOOTH.

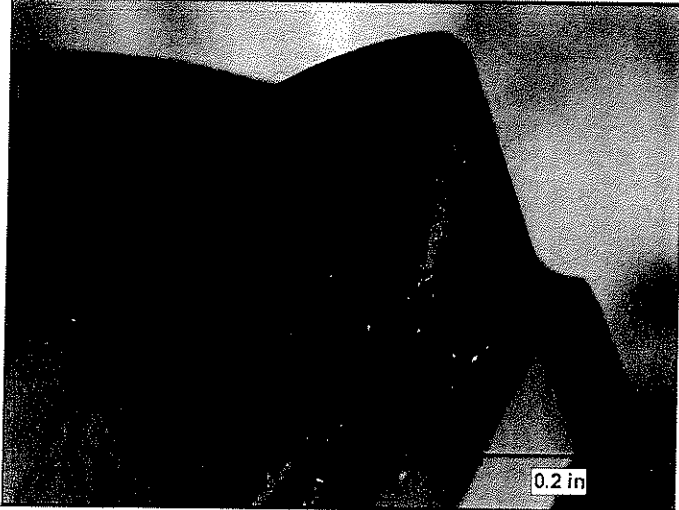


FIGURE 9: CONCAVE WEAR PATTERN-SET #2 @ TOE END.

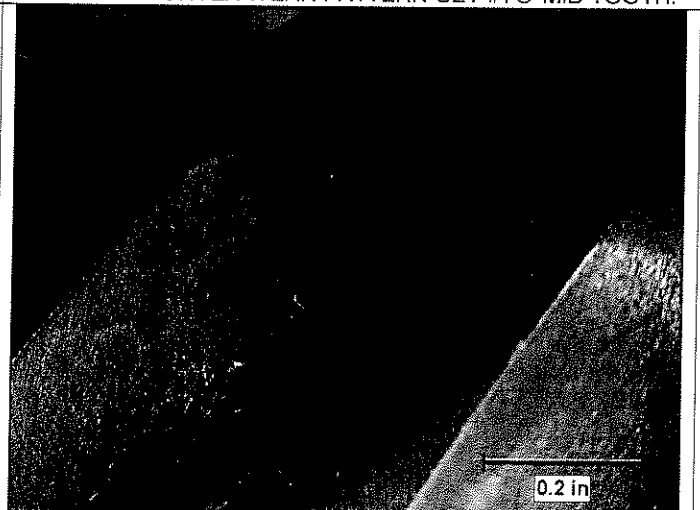


FIGURE 10: CONVEX WEAR PATTERN-SET #2 @ MID TOOTH.

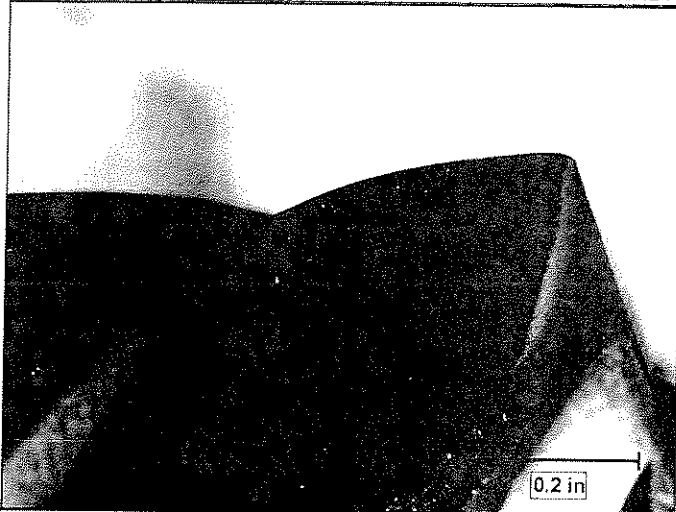


FIGURE 11: CONCAVE WEAR PATTERN-SET #3 @ TOE END.



FIGURE 12: CONVEX WEAR PATTERN-SET #3 @ HEEL END.

Attachment	<u>3</u>
Page	<u>6 of 11</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0469

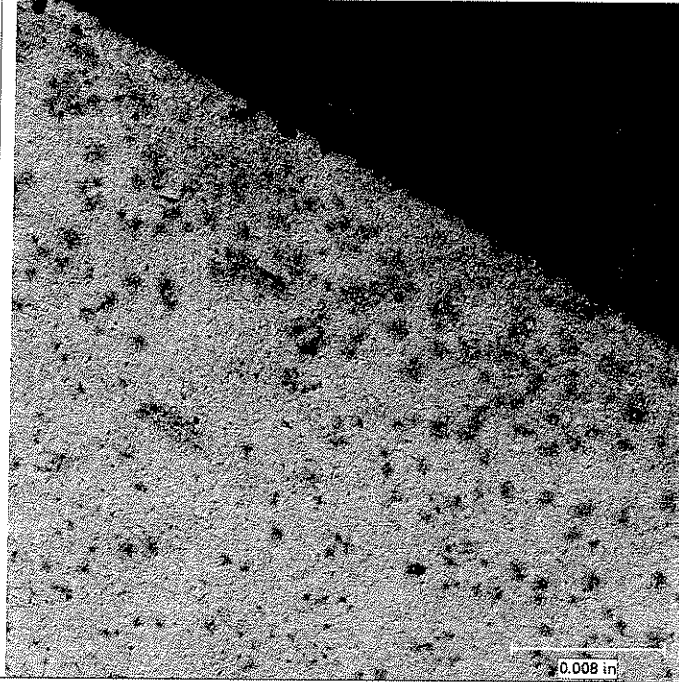


FIGURE 13: PITCH CASE MICROSTRUCTURE @ 100X-SET #1.

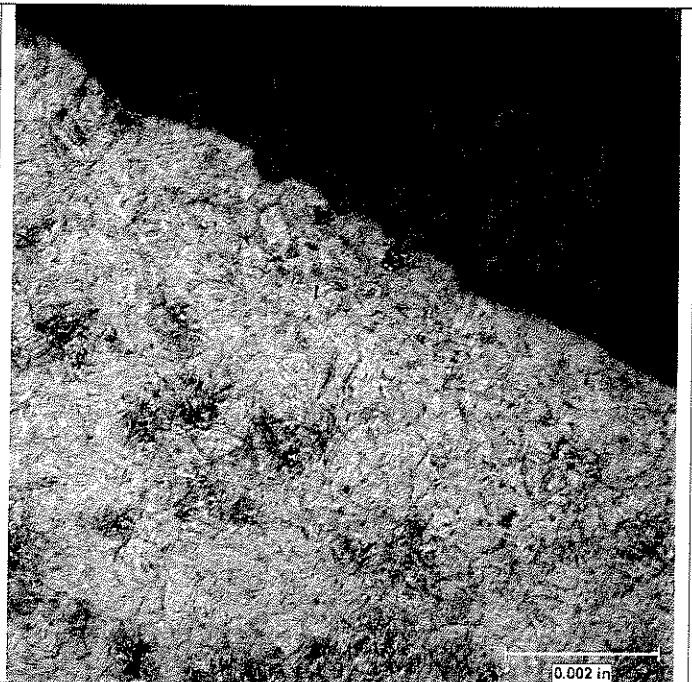


FIGURE 14: PITCH CASE MICROSTRUCTURE @ 400X-SET #1.

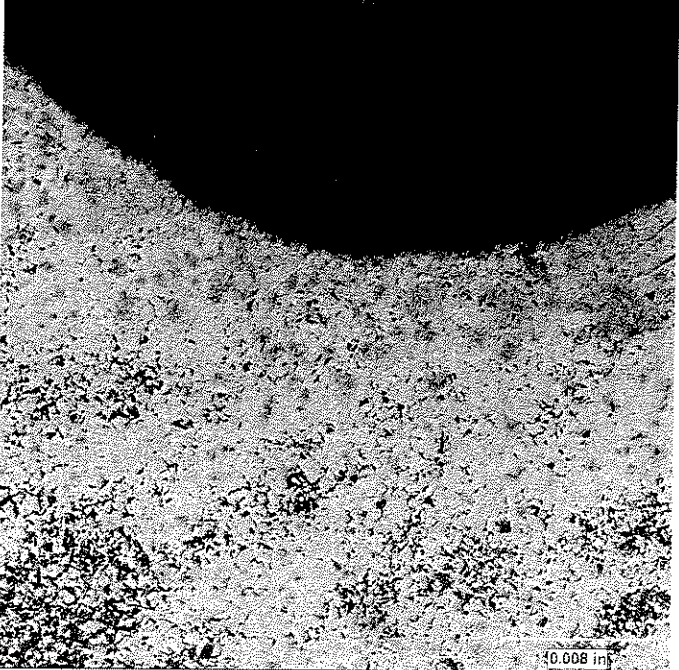


FIGURE 15: ROOT CASE MICROSTRUCTURE @ 100X-SET #1.

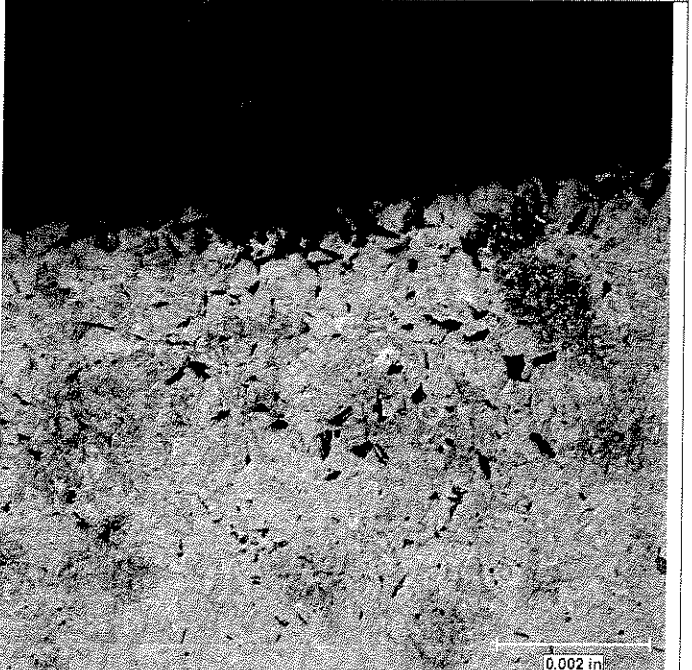


FIGURE 16: ROOT CASE MICROSTRUCTURE @ 400X-SET #1.

Attachment	<u>3</u>
Page	<u>7 of 11</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0469

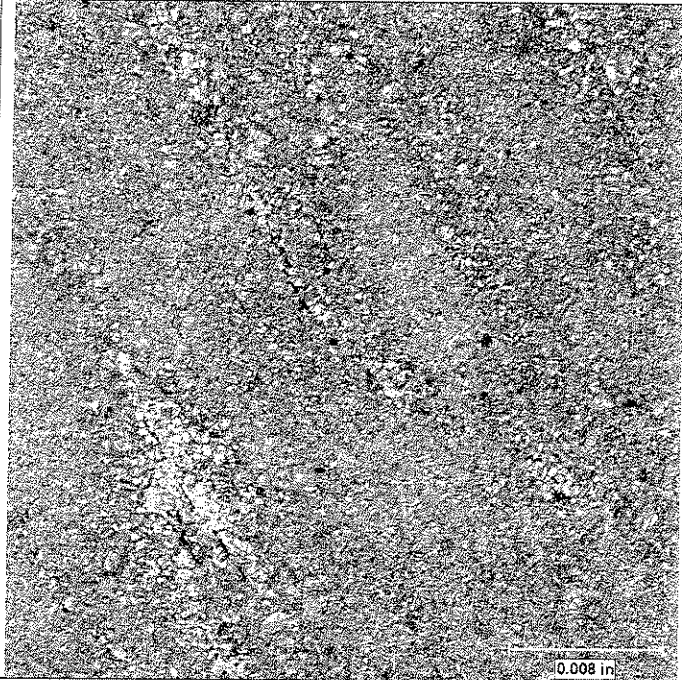


FIGURE 17: CORE MICROSTRUCTURE @ 100X-SET #1.

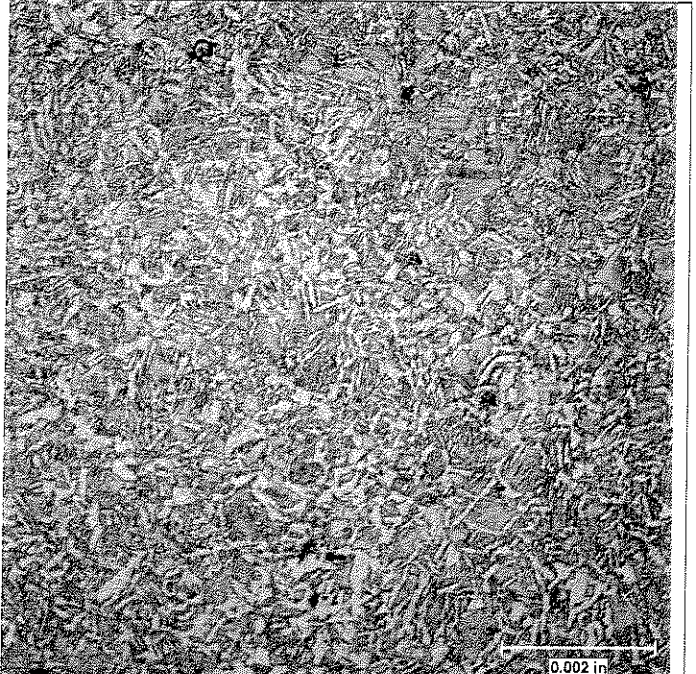


FIGURE 18: CORE MICROSTRUCTURE @ 400X-SET #1.

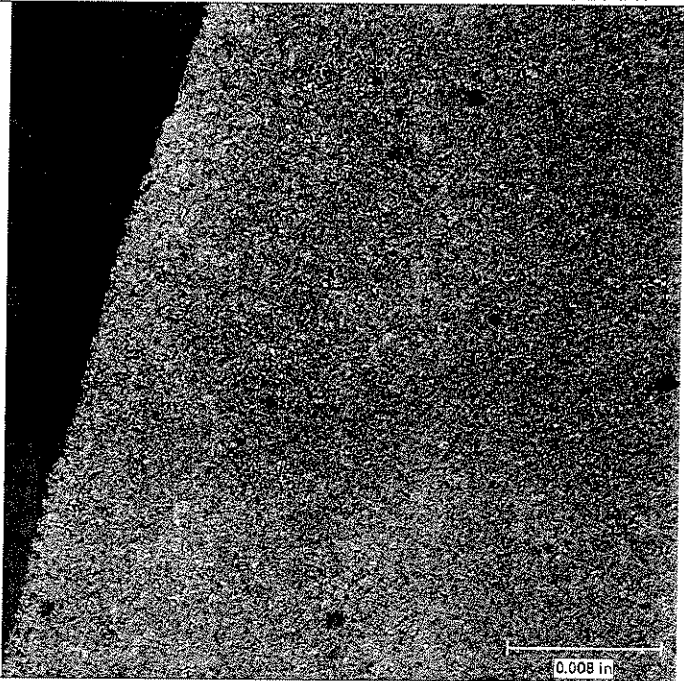


FIGURE 19: PITCH CASE MICROSTRUCTURE @ 100X-SET #2.

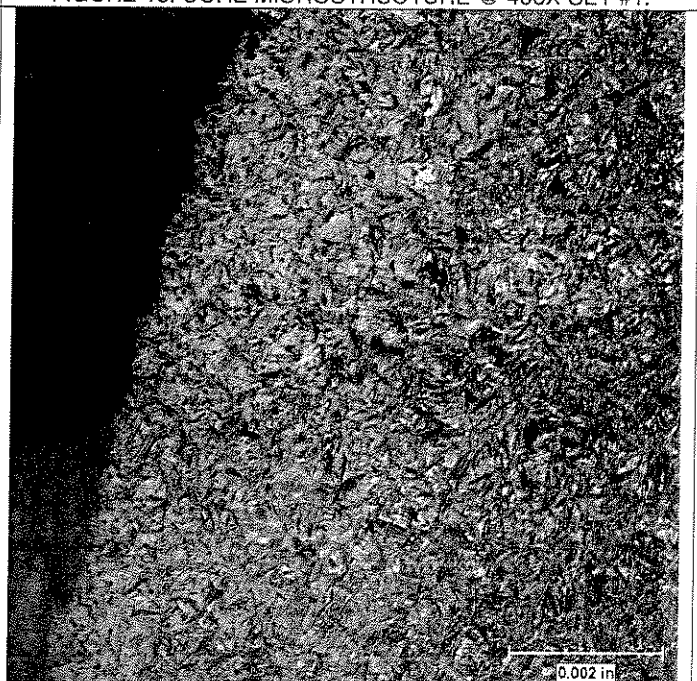


FIGURE 20: PITCH CASE MICROSTRUCTURE @ 400X-SET #2.

Attachment	<u>3</u>
Page	<u>8 of 11</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0469

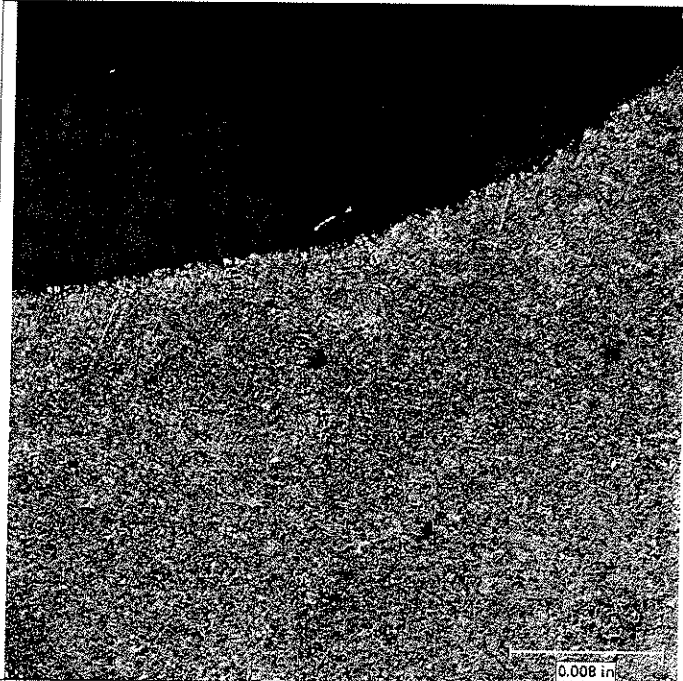


FIGURE 21: ROOT CASE MICROSTRUCTURE @ 100X-SET #2.

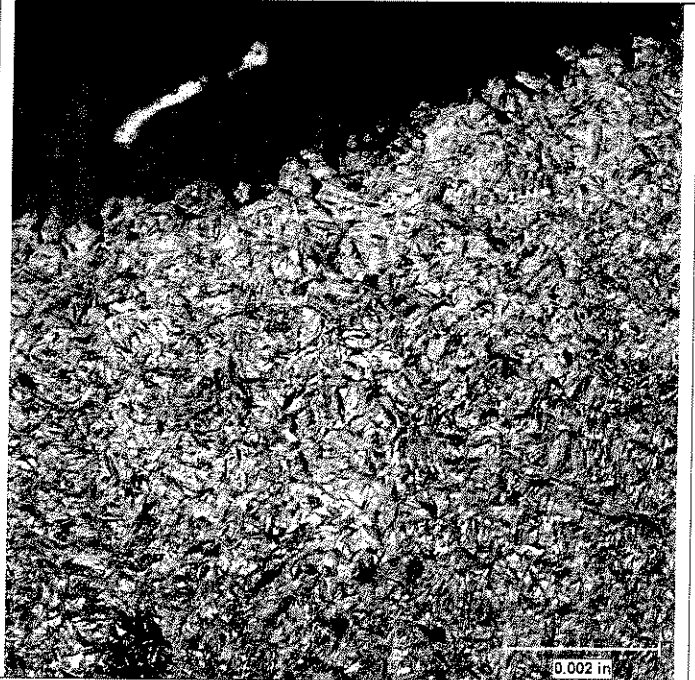


FIGURE 22: ROOT CASE MICROSTRUCTURE @ 400X-SET #2.

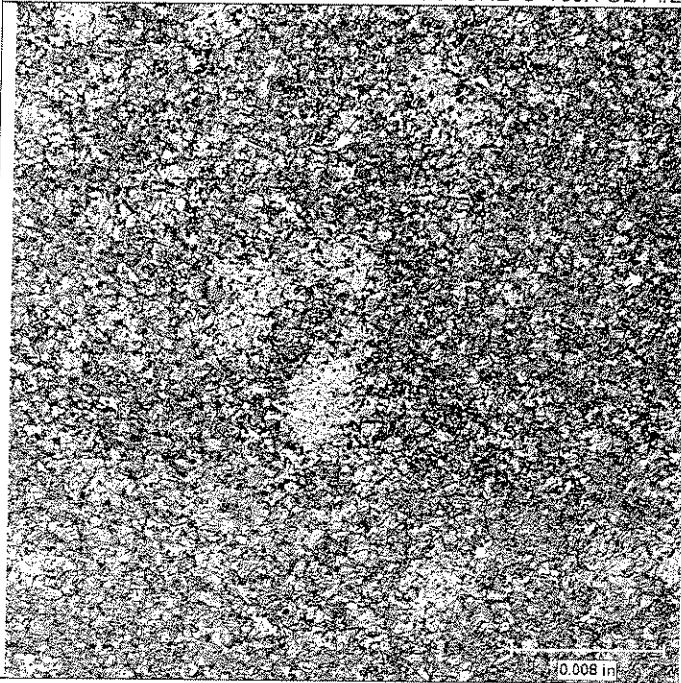


FIGURE 23: CORE MICROSTRUCTURE @ 100X-SET #2.

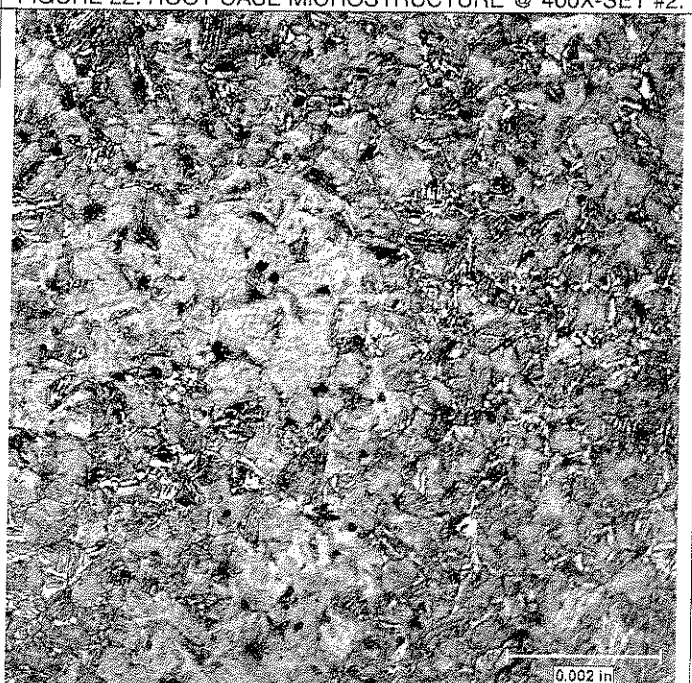


FIGURE 24: CORE MICROSTRUCTURE @ 400X-SET #2.

Attachment	<u>3</u>
Page	<u>9/11</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0469

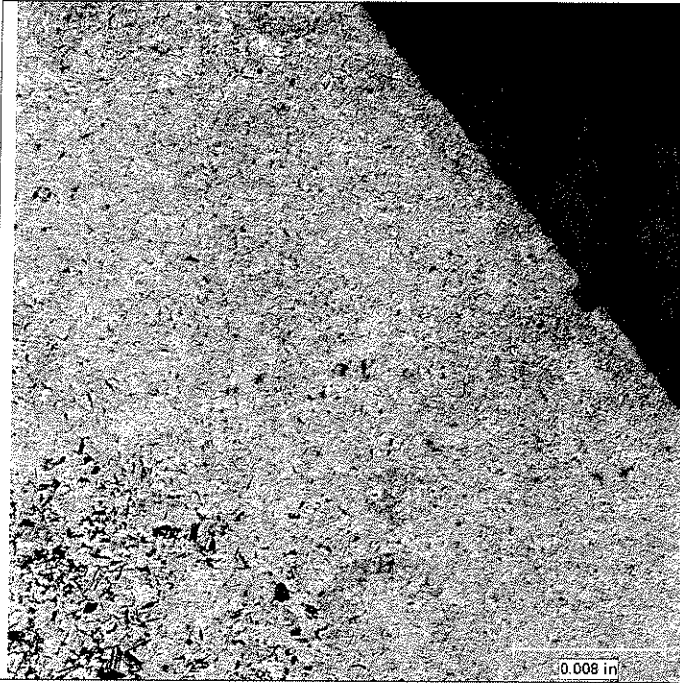


FIGURE 25: PITCH CASE MICROSTRUCTURE @ 100X-SET #3.

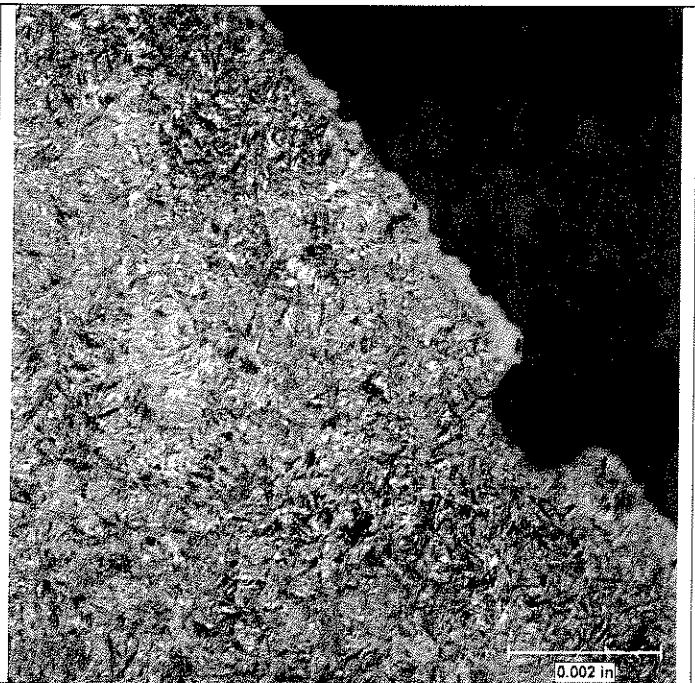


FIGURE 26: PITCH CASE MICROSTRUCTURE @ 400X-SET #3.

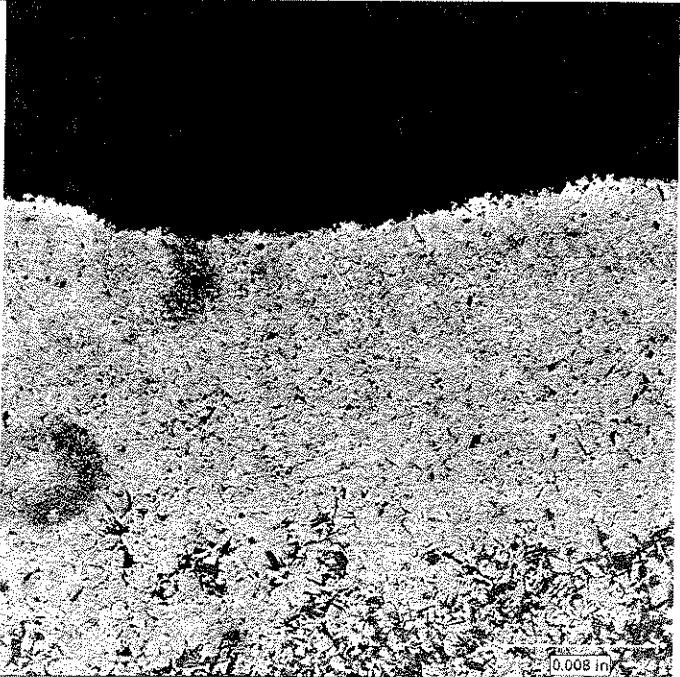


FIGURE 27: ROOT CASE MICROSTRUCTURE @ 100X-SET #3.

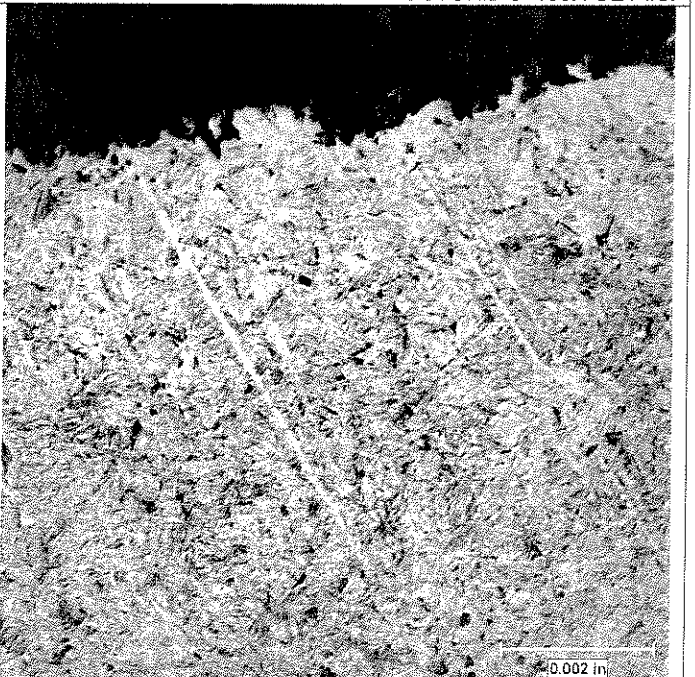


FIGURE 28: ROOT CASE MICROSTRUCTURE @ 400X-SET #3.

Attachment	<u>3</u>
Page	<u>10 of 11</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0469

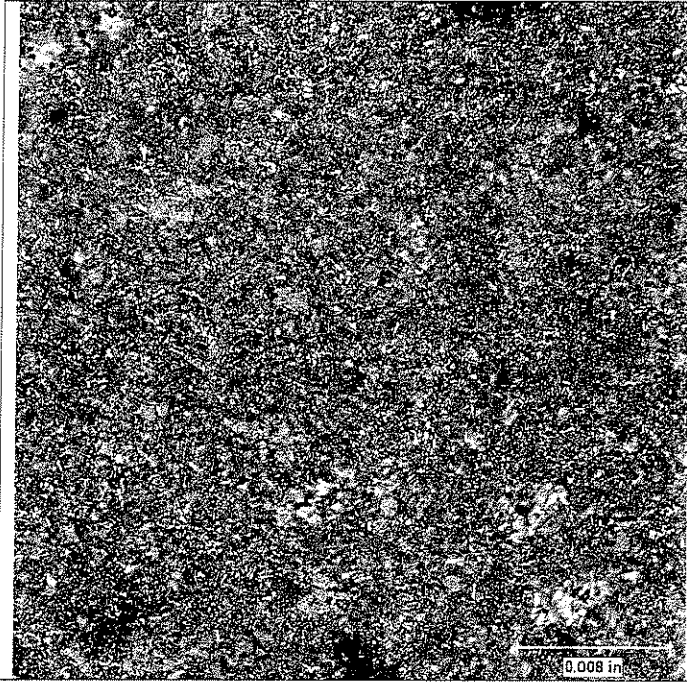


FIGURE 29: CORE MICROSTRUCTURE @ 100X-SET #3.



FIGURE 30: CORE MICROSTRUCTURE @ 400X-SET #3.

Attachment	<u>3</u>
Page	<u>11 of 11</u>
Reference	<u>L-37</u>



MATERIALS ENGINEERING LAB REPORT
DANA CORPORATION – AUTOMOTIVE SYSTEMS GROUP
3939 TECHNOLOGY DR.
MAUMEE, OHIO 43537

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE CONSENT OF THE MATERIALS ENGINEERING DEPARTMENT.

LAB NO. :	2007-0471	PART NO. :	060GR104, 060GR105
PART NAME :	RING - HYPOID DRIVE FIN	PRINT REV. :	C
REP. TITLE :	GEAR, RING	MODEL :	60
MARKINGS :	SEE COMMENTS	HEAT CODE :	T753A, P4L626A, P4L514A
MATERIAL :	SAE 8620A	MFG. DATE :	7/24/03, 12/4/99, 6/98
VENDOR :	FWP/STATESVILLE/GLASGOW	SAMP. REQ. :	N/A
CUSTOMER :	OFF HIGHWAY	VIN :	N/A
TAR NO. :	N/A	MAR NO. :	MAR-2809
TEST ENG. :	N/A	REC'D DATE :	07/18/07
REQ. BY :	JOE GUZIKOWSKI	REP. DATE :	07/26/07
REP. BY :	MATT SCHAUBLIN	NO. OF PAGES :	10

COMMENTS : SET #1- DANA, G, 060GP104, 41-7, L247, 07-21-03 – GLASGOW PHOSPHATED.
 SET #2- DANA, S, 060GP105, 41-7, VIL686, 12-01-99 – STATESVILLE MACHINED & HEAT TREATED, FT. WAYNE PHOSPHATED.
 SET #3- CO, DANA, B5, 060GP104, 41-7, V1L303, 658KP – FT. WAYNE MACHINED, HEAT TREATED, & PHOSPHATED.

COPIES : GREG FETT, DANA COMBS, JOE GUZIKOWSKI

REQUEST : EVALUATE PITTING, CASE DEPTH, MICROHARDNESS, AND MICROSTRUCTURE.

REASON : AS PART OF THE PHOSPHATE COATING PITTING ISSUE, WE RECEIVED THREE OLD GEARSETS THAT HAVE BEEN TESTED AT LUBRIZOL TO THE L-37 TEST CRITERIA. TWO OF THE SETS SHOW SPALLING (#1 AND #3) WHILE THE THIRD (#2) DOES NOT. HOWEVER, CODE V1L686 (#2) WAS KNOWN AS THE "CODE FROM HELL" DUE TO PERFORMANCE ISSUES.

RESULTS :

VISUAL INSPECTION

FIGURES 1-3 SHOWS THE AS-RECEIVED RING GEARS. NO APPEARENT VISUAL DAMAGE WAS FOUND ON THE RING GEARS. THE WEAR PATTERNS ARE SHOWN IN FIGURES 4-9.

MAGNETIC PARTICLE INSPECTION

ASTM E709-01

THERE WAS NO VISUAL EVIDENCE OF MAGNETIC PARTICLE INDICATIONS.

MICROHARDNESS MEASUREMENTS

ASTM E384-05

500 gf LOAD CONVERTED TO HRC.

LOCATION	SET #1		SET #2		SET #3	
	PITCH (HRC)	ROOT (HRC)	PITCH (HRC)	ROOT (HRC)	PITCH (HRC)	ROOT (HRC)
0.002"	65.0	63.9	62.4	61.2	61.4	61.2
0.004"	64.0	61.8	61.1	61.0	61.1	60.4
0.006"	63.5	62.1	60.9	60.6	60.5	60.9
0.008"	62.1	61.8	60.2	60.7	61.2	60.4
0.010"	62.8	61.5	--	60.9	60.5	60.8
0.020"	60.9	59.3	60.0	59.9	58.0	56.8
0.030"	58.7	56.5	57.7	57.0	53.2	50.6
0.039"	56.1	52.8	54.5	52.3	49.7	48.0
0.049"	52.8	44.8	50.4	45.0	47.3	42.3
0.059"	50.9	39.8	46.8	38.8	47.7	37.8
0.069"	48.5	37.0	45.5	33.8	46.3	39.1
0.079"	47.4	36.3	43.4	36.9	45.2	41.4

Attachment H
 Page 10/10
 Reference L-37

LAB REPORT
2007-0471

SURFACE HARDNESS

ASTM E384-05

GEAR TOOTH SURFACE HARDNESS. 500g VICKERS CONVERTED TO HRC, MEASURED AT 0.004" AND 0.006".

	RESULTS	SPECIFICATION
SET #1	64.0*, 63.5* (PITCH) 61.8*, 62.1* (ROOT)	58-60
**SET #2	61.1, 60.9 (PITCH) 61.0, 60.6 (ROOT)	58-63
SET #3	61.1*, 60.5* (PITCH) 60.4*, 60.9* (ROOT)	58-60

* OUT OF SPECIFICATION; 57-66 HRC TYPICAL FOR SHOOT PEENED GEARS PER ES-HT-FW0204

** SET #2 HAS A DIFFERENT SPECIFICATION.

EFFECTIVE CASE DEPTH MEASURED AT 50 HRC

SAE J423 FEB. 1998

500g VICKERS CONVERTED TO HRC.

	PITCH	SPECIFICATION	ROOT	SPECIFICATION
SET #1	*0.063"	0.040"-0.055"	0.043"	0.020"-0.055"
**SET #2	*0.050"	0.025"-0.045"	0.043"	0.013"-0.045"
SET #3	*0.038"	0.040"-0.055"	0.032"	0.020"-0.055"

*OUT OF SPECIFICATION

** SET #2 HAS A DIFFERENT SPECIFICATION.

CORE HARDNESS

ASTM E18-05

DIRECT HRC ON MICRO SAMPLE.

	PITCH	ROOT	1/8" BELOW ROOT
SET #1	44.2	37.6	30.7
SET #2	40.3	35.1	33.7
SET #3	43.7	40.1	35.4
SPECIFICATION	NONE	25 - 43 HRC	NONE

Attachment	<u>4</u>
Page	<u>20/10</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0471

CHEMICAL ANALYSIS

ASTM E415-99 (2005)

ELEMENT	SET #1	SET #2	SET #3	SAE-8620A	ES-PM-FW0001
C	0.19	0.20	0.19	0.18 - 0.23	--
Mn	0.85	0.88	0.93	0.80 Min	--
P	0.008	0.010	0.012	0.035 Max	--
S	0.025	0.033	0.021	0.040 Max	--
Si	0.24	0.18	0.17	0.15 - 0.35	--
Ni	0.42	0.47	0.45	0.40 - 0.70	--
Cr	0.54	0.51	0.56	0.50 Min	--
Mo	0.21	0.25	0.25	0.20 Min	--
Cu	0.21	0.20	0.18	--	0.35 MAX
Al	0.024	0.017	0.021	--	0.015-0.050
Sn	0.010	0.010	0.008	--	0.025 MAX
V	0.003	0.003	0.003	--	0.020 MAX
Nb	0.001	0.001	0.001	--	0.010 MAX
Zr	0.001	0.001	0.001	--	0.010 MAX
B	0.0001	0.0001	0.0001	--	0.0005 MAX
Ti	0.002	0.001	0.001	--	0.010 MAX
Pb	--	--	--	--	0.010 MAX
Ca	0.0001	0.001	0.001	--	0.0030 MAX
N	0.006	0.007	0.005	--	0.015 MAX
As	0.005	0.006	0.006	--	0.010 MAX
Zn	0.002	0.002	0.002	--	0.030 MAX
Sb	--	--	--	--	0.010 MAX
**D.I.	*2.04	2.24	2.30	--	2.05-2.55"

*OUT OF SPECIFICATION

**FOR REFERENCE ONLY

PHOSPHATE COATING PICKLING PITS RATING

VOLVO STD 5742,104

PHOSPHATE COATING PICKLING PITS WERE MEASURED FOR DEPTH AND COUNTED WITHIN A 20 MM LENGTH ALONG A SECTION IN THE MIDDLE OF THE RING GEAR TOOTH FLANK.

SET #1 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 μM – 30 μM	22*	21 MAX
31 μM – 50 μM	0	7 MAX
> 50 μM	0	--

*OUT OF SPECIFICATION

SET #2 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 μM – 30 μM	21	21 MAX
31 μM – 50 μM	0	7 MAX
> 50 μM	0	--

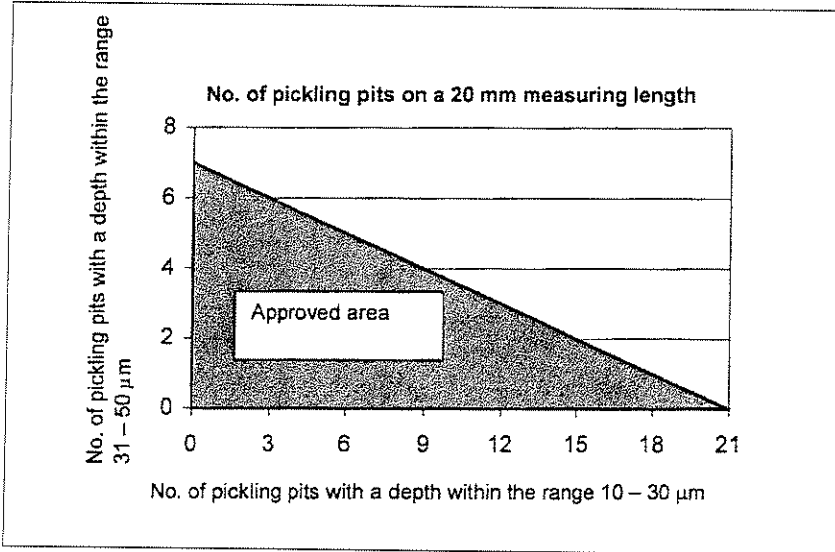
Attachment
page
reference

4
3/10
L-37

LAB REPORT
2007-0471

SET #3 PHOSPHATING PITS RATING – GEAR TEETH (NUMBER PER 20 MM LENGTH)		
PHOSPHATING PITS SIZE (DEPTH OF PIT) RANGE	NUMBER OF PITS DETECTED (VISUAL)	SPECIFICATION (VOLVO STD 5742,104) (SEE TABLE 1)
10 μ M – 30 μ M	10	21 MAX
31 μ M – 50 μ M	0	7 MAX
> 50 μ M	0	--

TABLE 1: PHOSPHATING PITS REFERENCE TABLE (VOLVO - STD 5742,104)



MICROSTRUCTURE

THE MICROSTRUCTURE CONSISTED OF A MARTENSITIC CASE WITH A CORE OF TRANSFORMATION PRODUCTS (FIGURE 10-27). THERE WAS NO EVIDENCE OF IGO FOUND IN GEAR SET #1 BUT NMTP OF 0.0003". GEAR SET #2 HAD NO EVIDENCE OF IGO AND NMTP. GEAR SET #3 HAD NO EVIDENCE OF IGO BUT NMTP OF 0.0003".

CONCLUSION : ALL GEAR SETS EXCEEDED THE PRINT SPECIFIED SURFACE HARDNESS OF 58-60HRC. HOWEVER THIS IS NOT A REALISTIC SPECIFICATION. GEAR SETS #1 EXCEEDED THE CASE DEPTH SPECIFICATION WHILE #3 WAS BELOW. GEAR SET #1 ALSO SLIGHTLY EXCEEDED THE VOLVO PICKLING PIT SPECIFICATION.

RELATED MET REPORTS : 2007-0469

Attachment	<u>4</u>
Page	<u>4 of 10</u>
Reference	<u>L-37</u>

LAB REPORT
2007-0471

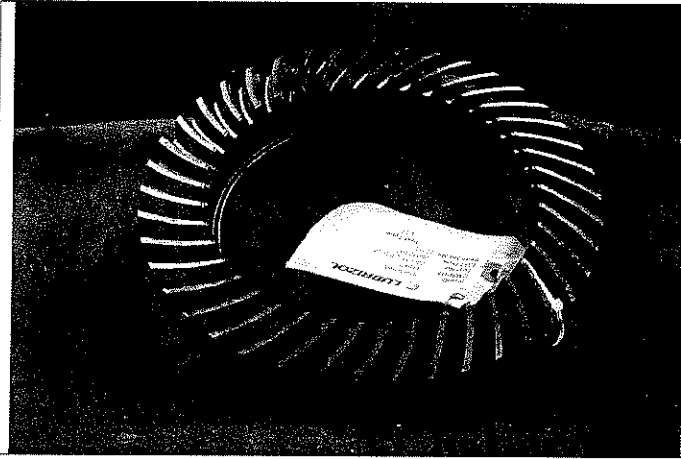


FIGURE 1: RING GEAR SET #1-AS RECEIVED.

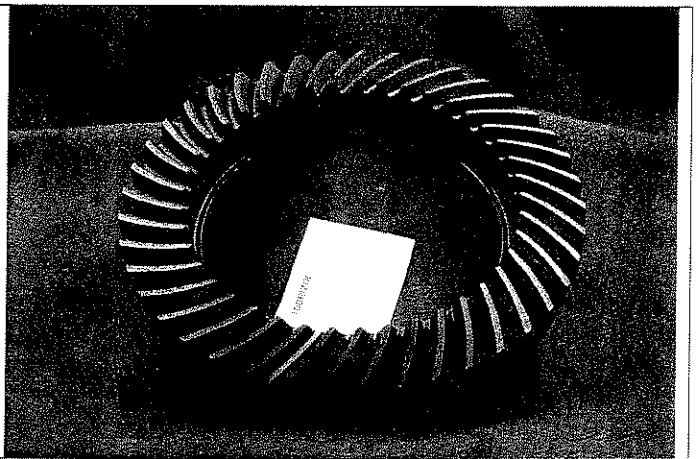


FIGURE 2: RING GEAR SET #2-AS RECEIVED.

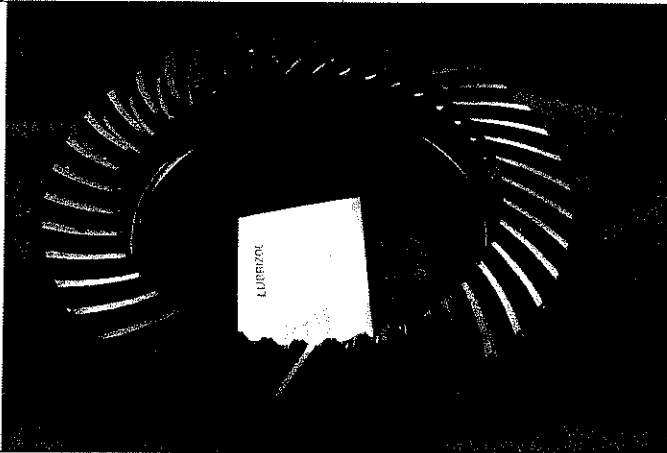


FIGURE 3: RING GEAR SET #3-AS RECEIVED



FIGURE 4: CONCAVE WEAR PATTERN-SET #1.

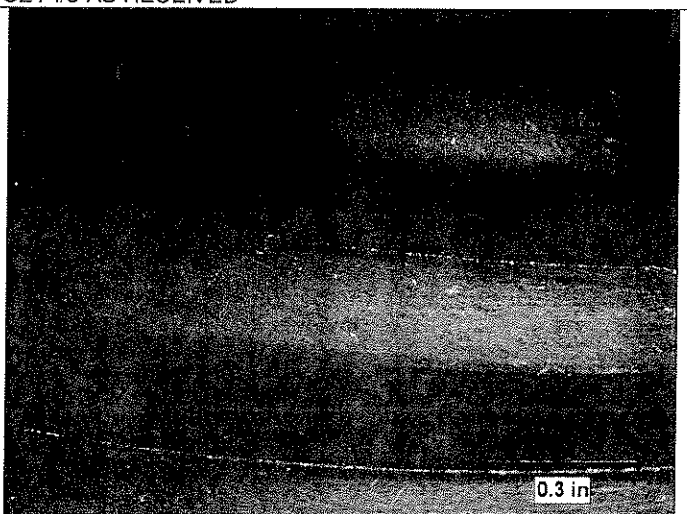


FIGURE 5: CONVEX WEAR PATTERN-SET #1.

Attachment	<u>4</u>
Page	<u>56/10</u>
Reference	<u>6-37</u>

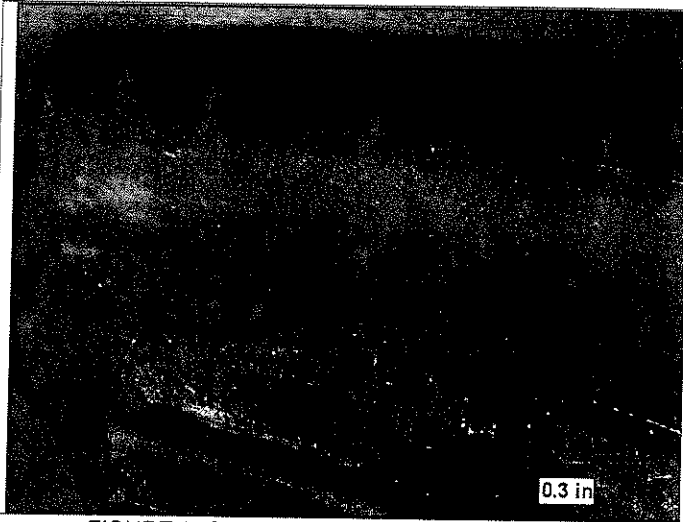


FIGURE 6: CONCAVE WEAR PATTERN-SET #2.

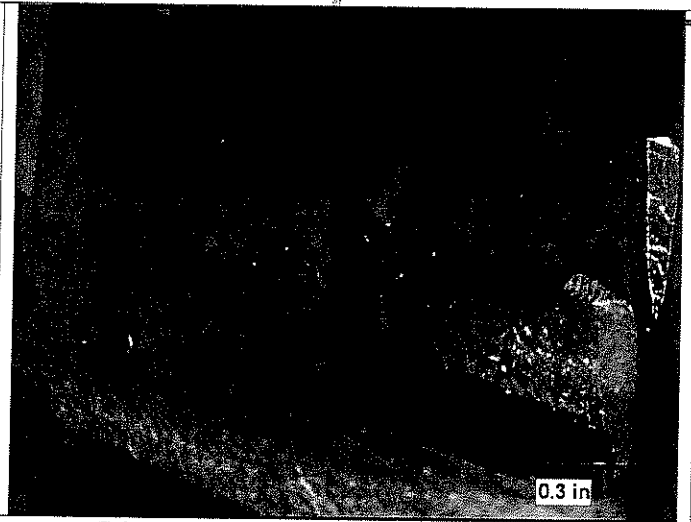


FIGURE 7: CONVEX WEAR PATTERN-SET #2.



FIGURE 8: CONCAVE WEAR PATTERN-SET #3.



FIGURE 9: CONVEX WEAR PATTERN-SET #3.



FIGURE 10: PITCH CASE MICROSTRUCTURE @ 100X-SET #1.

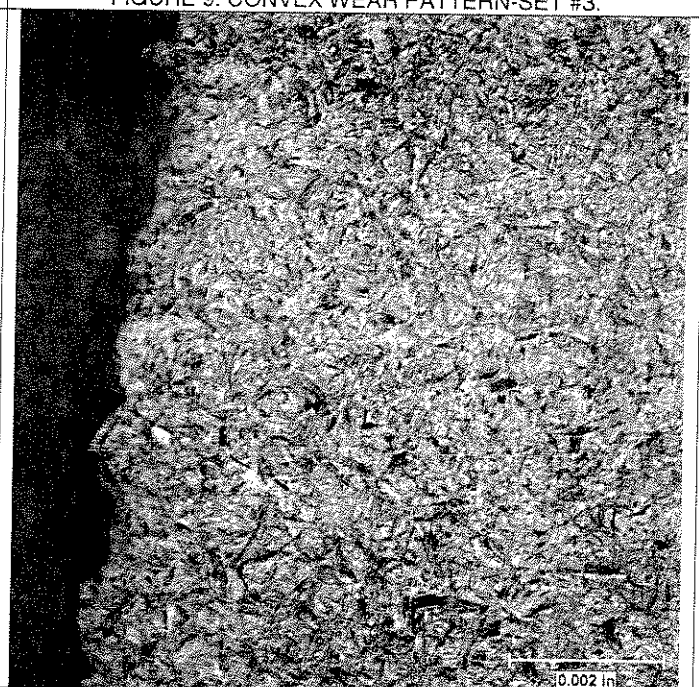


FIGURE 11: PITCH CASE MICROSTRUCTURE @ 400X-SET #1.

LAB REPORT
2007-0471

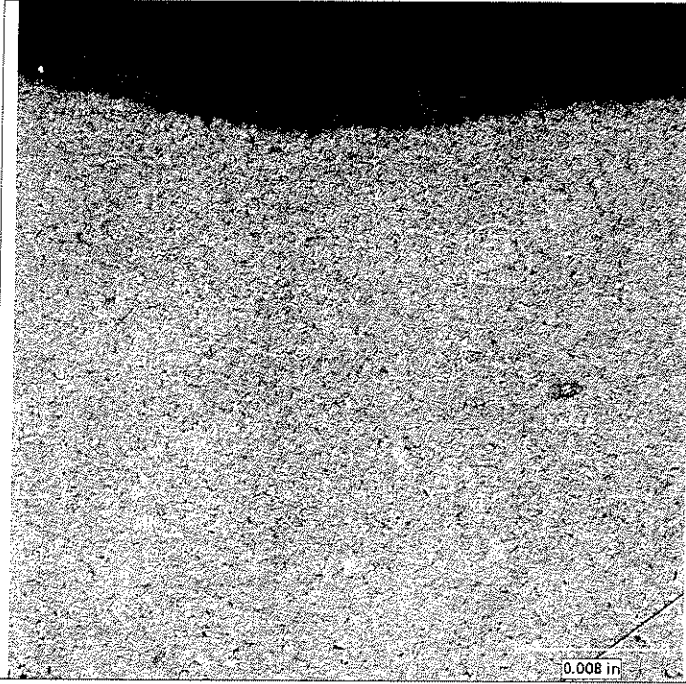


FIGURE 12: ROOT CASE MICROSTRUCTURE @ 100X-SET #1.

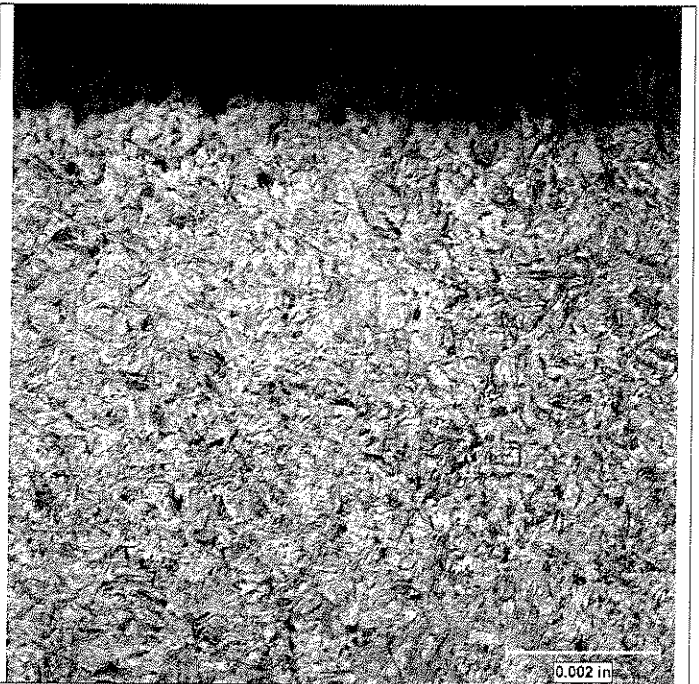


FIGURE 13: ROOT CASE MICROSTRUCTURE @ 400X-SET #1.

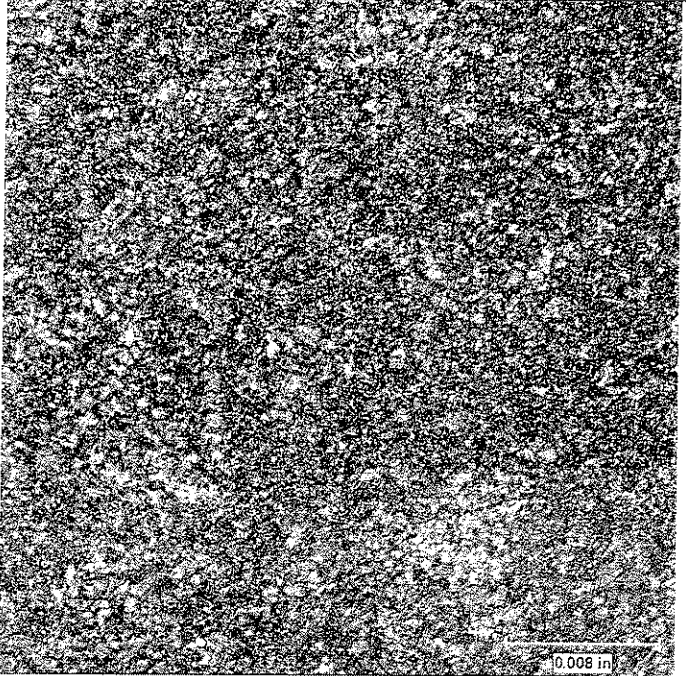


FIGURE 14: CORE MICROSTRUCTURE @ 100X-SET #1.

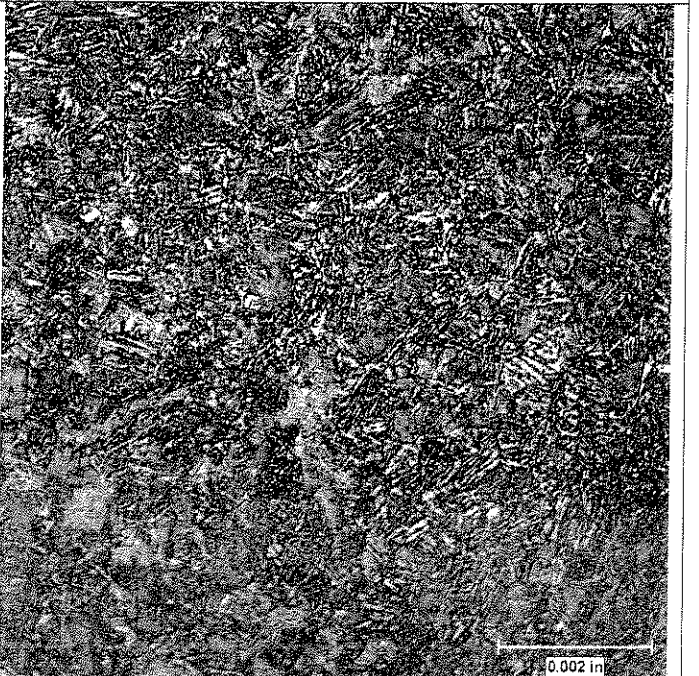


FIGURE 15: CORE MICROSTRUCTURE @ 400X-SET #1.

Attachment	<u>4</u>
Page	<u>70K10</u>
Reference	<u>L-37</u>

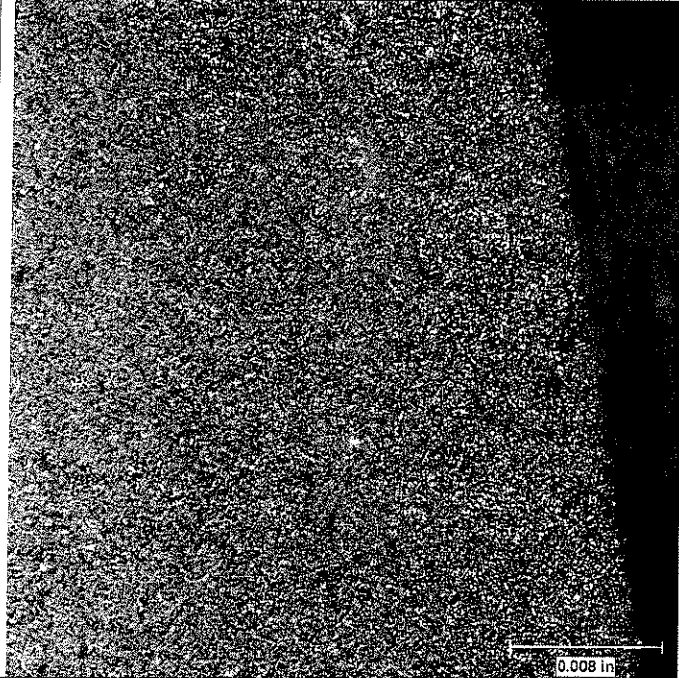


FIGURE 16: PITCH CASE MICROSTRUCTURE @ 100X-SET #2.

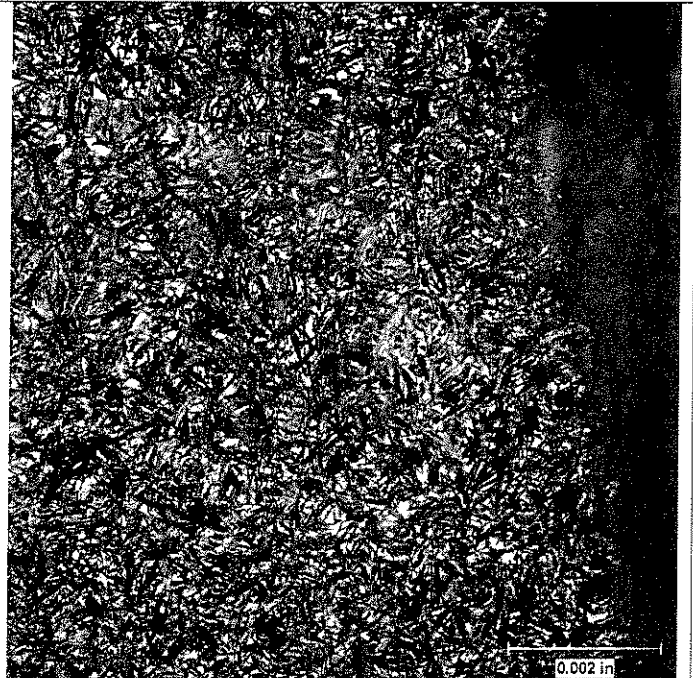


FIGURE 17: PITCH CASE MICROSTRUCTURE @ 400X-SET #2.

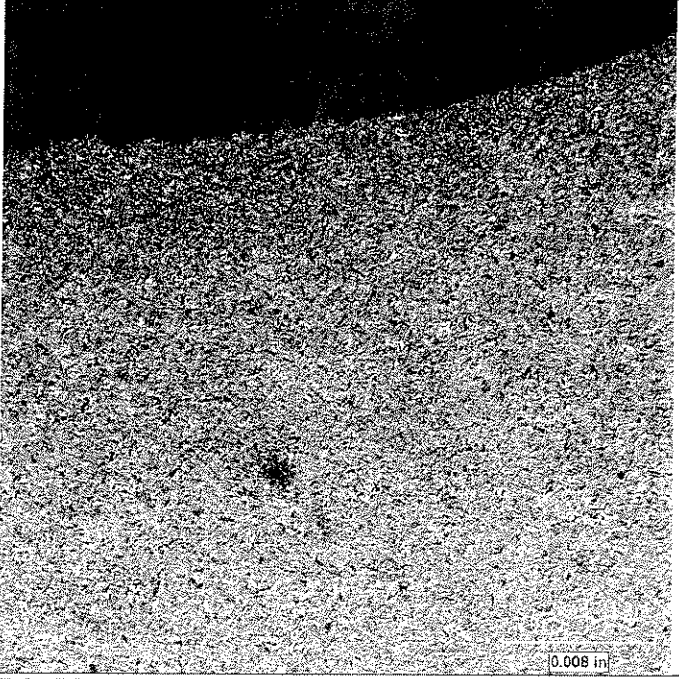


FIGURE 18: ROOT CASE MICROSTRUCTURE @ 100X-SET #2.

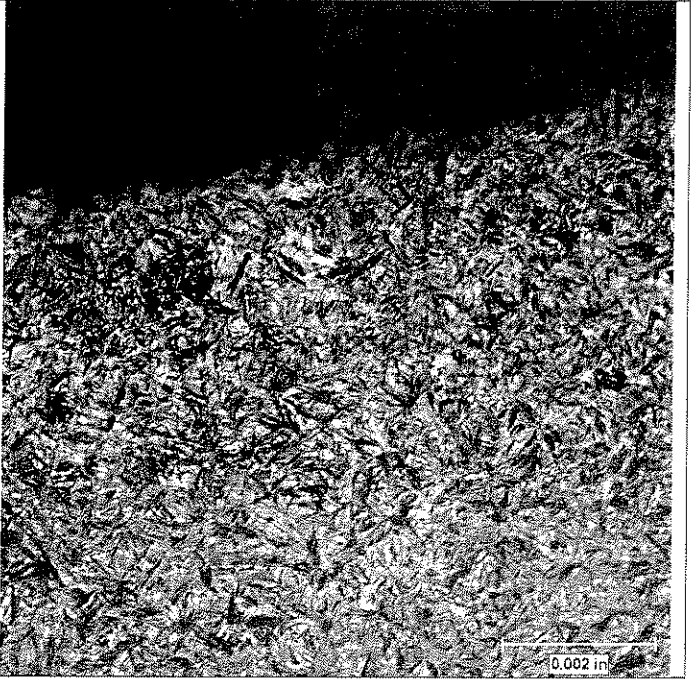


FIGURE 19: ROOT CASE MICROSTRUCTURE @ 400X-SET #2.

Attachment	<u>4</u>
Page	<u>8 of 10</u>
Reference	<u>1-37</u>

LAB REPORT
2007-0471

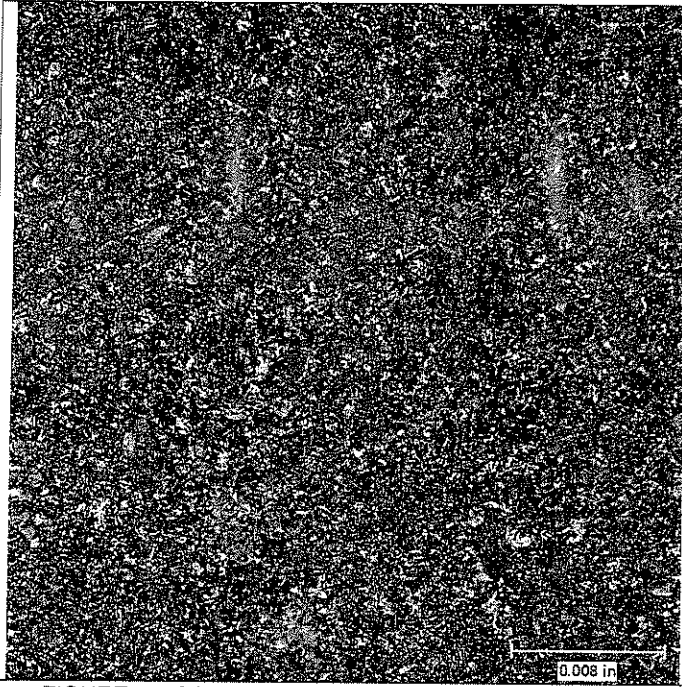


FIGURE 20: CORE MICROSTRUCTURE @ 100X-SET #2.



FIGURE 21: CORE MICROSTRUCTURE @ 400X-SET #2.

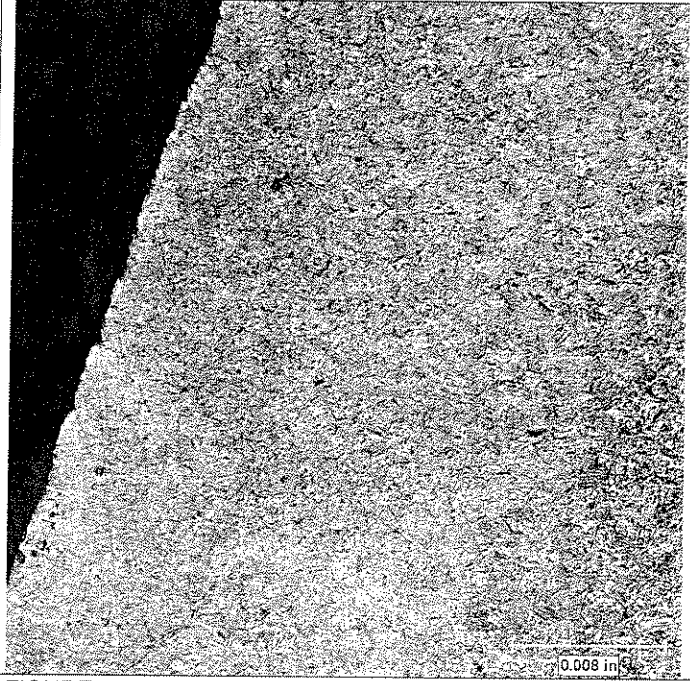


FIGURE 22: PITCH CASE MICROSTRUCTURE @ 100X-SET #3.



FIGURE 23: PITCH CASE MICROSTRUCTURE @ 400X-SET #3.

Attachment	<u>4</u>
Page	<u>7/10</u>
Reference	<u>1-37</u>

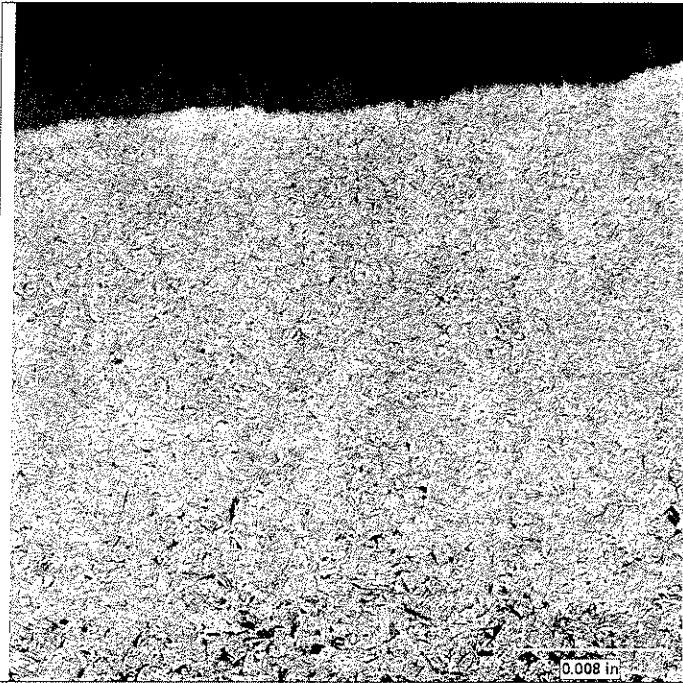


FIGURE 24: ROOT CASE MICROSTRUCTURE @ 100X-SET #3.

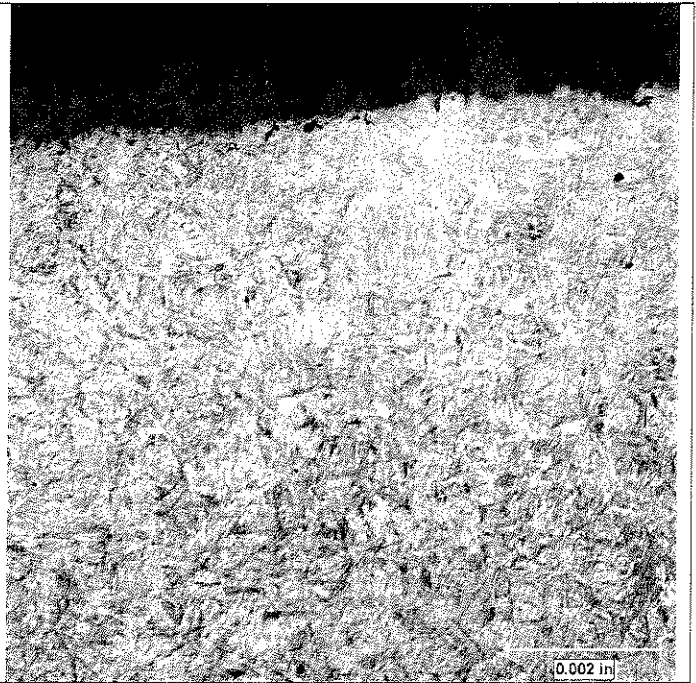


FIGURE 25: ROOT CASE MICROSTRUCTURE @ 400X-SET #3.

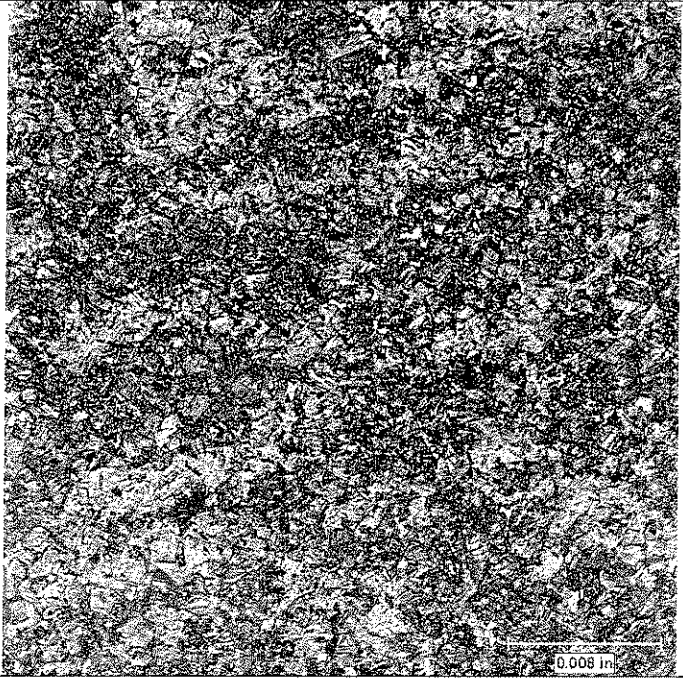


FIGURE 26: CORE MICROSTRUCTURE @ 100X-SET #3.



FIGURE 27: CORE MICROSTRUCTURE @ 400X-SET #3.

Attachment	<u>4</u>
Page	<u>10 of 10</u>
Reference	<u>L-37</u>

GUSA 15511
 semi/rec'd
 GUSA16219
 GUSA 15515
 semi/rec'd
 GUSA15515

	Gear Set	Dana Assembly *Backlash (1/1000 inches)	Alternate	Fort Wayne	Coating as Received
Lubrizol Corporation	1V	5, 5, 5	X		
Lubrizol Corporation	5H	7, 7, 8		X	
Southwest Research Institute	5V	6, 5, 6		X	
Southwest Research Institute	1X	8, 8, 8	X		
Intertek	2N	5, 5, 5			X
Intertek	5P	5.5, 5.5, 5.5			X
Afton Chemical	7J	7, 8, 7		X	
Afton Chemical	7X	6, 6, 6	X		

Notes:

* Backlash is measured using a dial indicator and probe.

The gear tooth that is parallel to the cover plate is measured for backlash.

The is rotated 120 degrees.

The second reading is taken.

The is rotated 120 degrees.

The third reading is taken.

Dana used a backlash specification of 0.005 - 0.008 inches

Attachment	<u>5</u>
Page	<u>16/1</u>
Reference	<u>4-37</u>

Bartlett, Donald

From: Gary.Schmalbach@dana.com
Sent: Tuesday, August 07, 2007 3:18 PM
To: Bartlett, Donald
Cc: Steve.Bird@dana.com
Subject: Quotes

Don,

As requested, I am supplying the following pricing information. A formal quote will be supplied if requested.

1. Complete axle model 060AA100-4

Price FOB Lugoff, SC with standard industrial phosphate coating \$964.00

2. Rebuild of existing axles at Lugoff facility with new ring and pinion gear sets No quote

2. Alternate: Rebuild of existing axles at Great Lakes Power, authorized Dana Service Center

Price FOB Great Lakes in Northern Ohio with standard industrial phosphate coating \$227.03

3. Ring and Pinion Gear set 060GA104X

Price FOB Fort Wayne Indiana with standard industrial phosphate coating \$133.28

Please note that we believe Great Lakes to be the preferred rebuild site for these axles. The Lugoff line build arrangement is not conducive to this large scale rebuild. Great Lakes has proven to be an excellent Service Center and is highly recommended by our Field Service organization.

Kind regards,

Gary Schmalbach
Sales Operations Manager, NA

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<http://www.dana.com/overview/EmailDisclaimer.shtm>

Attachment	6
Page	10/1
Reference	1-37

09/10/2007



COORDINATING RESEARCH COUNCIL, INC.

3650 MANSELL ROAD, SUITE 140
ALPHARETTA, GA 30022
TEL: 678/795-0506 FAX: 678/795-0509
WWW.CRCAO.ORG

June 21, 2007

To Whom It May Concern:

Please be advised that the CRC Manual No. 21 currently has some pages under revision. The pages under revision are page(s) 39, 41 and 43. This revision is due to size problems with those pages in the 2004 version of the Manual.

CRC is working to update these pages with correct content and we will send you the replacement pages as soon as they are ready for distribution.

Should you have any questions or need further assistance, please contact either Jan Tucker or Pam Kennedy at jtucker@crcao.org or pkennedy@crcao.org.

Sincerely,

Brent K. Bailey
Executive Director

X107

Attachment	<u>7</u>
Page	<u>102</u>
Reference	<u>1-37</u>



COORDINATING RESEARCH COUNCIL, INC.

3650 MANSELL ROAD, SUITE 140
ALPHARETTA, GA 30022
TEL: 678/795-0506 FAX: 678/795-0509
WWW.CRCAO.ORG

June 25, 2007

Dick Norcini,
Don Bartlett,
Cory Koglin,
Dale B. Smith,
Don Lind,

Gentlemen:

As some of you are aware issues have been identified with three (3) of the pages in the current CRC Manual 21 - pages 39, 41 and 43 to be exact. It appears that the transparencies were made via copy of the laminated pages thus producing distortion of the actual images on the transparent pages.

CRC worked with the original printer to correct these pages and we have included printing proofs for your review and approval. Note that the dates at the bottom of the pages have not been updated - we have made note of this and the final pages will include a current revision date. Additionally, a note will be added to page 43 indicating that reproduction will distort sizes.

Please review the enclosed and send us your approval of the proof via e-mail and please include any comments/suggestions. Please return email to Pam Kennedy's attention.

Your response is requested by July 3rd.

Should you have any questions or need further assistance, please contact either Jan Tucker or Pam Kennedy at jtucker@crcao.org or pkennedy@crcao.org.

Sincerely,

Brent K. Bailey
Executive Director

Attachment	<u>7</u>
Page	<u>2 of 2</u>
Reference	<u>1-37</u>

9/10/2007

To: Mr. Bailey, Executive director, CRC Inc.
Fm: - Don Bartlett, L-37 Surveillance Panel Chairman
- Cory Koglin, L-42 Surveillance Panel Chairman
- Chris Schenkenberger, L-60-1 Surveillance Panel Chairman
Topic: Your June 21, 2007 and June 25, 2007 CRC Manual No. 21 and subsequent discussions

With respect to the above letter, there was a series of questions and subsequent discussions with your office and respective ASTM sub-panels reporting under DO.2.B0.03. We appreciate your proactive efforts to correct the replacement pages identified in your letter as well as your patience and willingness to work with us to resolve other questions and concerns.

As was the plan all along, the above three Surveillance Panels took action on August 8, 2007 to fully support CRC moving forward with their proposed corrections to CRC Manual 21 and request that the proposed modifications detailed below be incorporated too for clarity and the ability to provide template verification. The agreed changes include:

1. Pages 39, 41, and 43 are the only revisions being updated to CRC manual 21.
2. All CRC 21 manuals currently released from the beginning of the issue date are to be updated with the new revisions. A letter is to be sent to the individual parties that purchased manuals detailing this action.
3. All individual templates in current inventory for sale also need to be replaced / updated.
4. The laminated documents are to be exact duplicates in every sense to the clear template.
5. The correct page numbers are to appear on all documents.
6. All documents are to have the same revised 2007 issue date.
7. All documents will have a note: "reproduction may cause enlargement or reduction in size."

Attachment	<u>8</u>
Page	<u>10/10</u>
Reference	<u>L-37</u>

8. All documents will have a note: "Each template has a 20 mm line indicating the specific length. This scale bar measurement is to be used to confirm that the template has not been inadvertently altered and that the template is correct and suitable for use.
9. The attached PDF document is provide to detail where to place the scale bar information (noted in red for clarity of what changed, not exactly to scale) and should only be used as an example. The printer is to modify the master documents accordingly and black and white/clear is acceptable.

In closing, the laboratories recognize that they will now be asked / required to replace all of their current rating templates in use by their lab raters, technicians, and field test raters. This outcome, due to the Manual 21 inconsistencies, will effectively cost the labs double (their original investment plus the replacement investment).

To that end and making it a little more palatable, we respectfully request that CRC give strong consideration and support to providing each lab (Southwest Research, Afton, Lubrizol, & Intertek-Parc) 12 clear template sets (pages 39, 41, and 43) to help defray some of our costs.

Included in this email as attachments are:

- o Your June 21, 2007 letter
- o Your June 25, 2007 letter
- o An Adobe PDF document detailing item number 9.

Again we thank you for your proactive support and due diligence as we worked through this necessary update for Manual 21. Please move forward with your action items and don't hesitate to contact me with any questions.

Respectfully submitted,

Don Bartlett, L-37 Surveillance Panel Chairman, Lubrizol
Cory Koglin, L-42 Surveillance Panel Chairman, Afton
Chris Schenkenberger, L-60-1 Surveillance Panel Chairman, Lubrizol

Attachment	<u>8</u>
Page	<u>2 of 10</u>
Reference	<u>L-37</u>

Summary of Comments on CRCTemplates_dtb.pdf

Page: 1

Author: dtb
Subject: Line
Date: 09/04/2007 3:11:45 PM
20 mm red line, butt ends

Author: dtb
Subject: Line
Date: 09/04/2007 3:12:04 PM
20 mm red line, butt ends

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:53:59 PM
20mm

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:48:01 PM
20mm

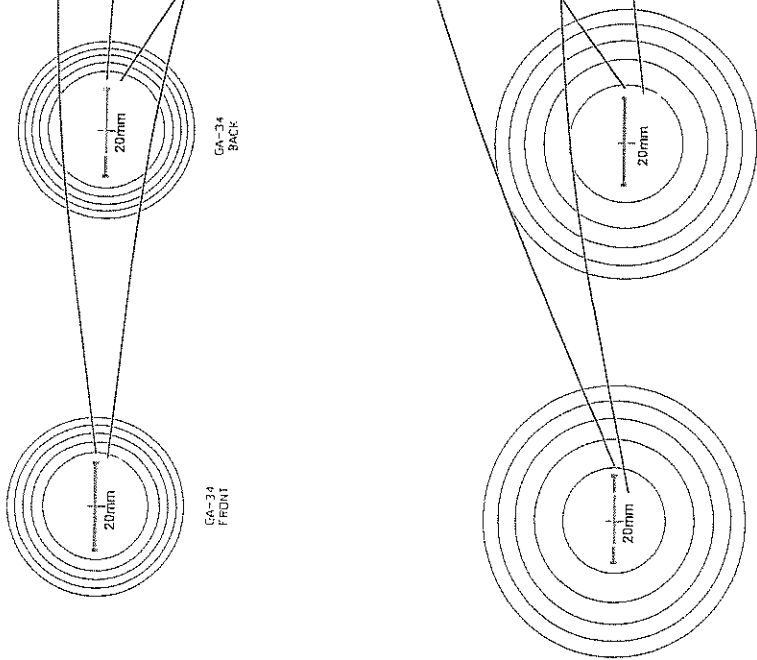
Author: dtb
Subject: Line
Date: 09/04/2007 3:12:00 PM
20 mm red line, butt ends

Author: dtb
Subject: Line
Date: 09/04/2007 3:11:54 PM
20 mm red line, butt ends

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:49:59 PM
20mm

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:41:51 PM
20mm

Template for Percent Area Breakdown



GA-50
FRONT

GA-50
BACK

This template for use only on Boston Models GA-34 and GA-50 gears. Template areas must be recalculated for other applications.

Reproduction may cause enlargement or reduction in size.

Attachment	<u>B</u>
Page	<u>31/10</u>
Reference	<u>A-37</u>

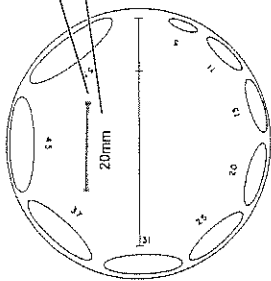
Page: 2

Author: ddb
Subject: Line
Date: 09/04/2007 2:52:47 PM
20 mm red line, but ends

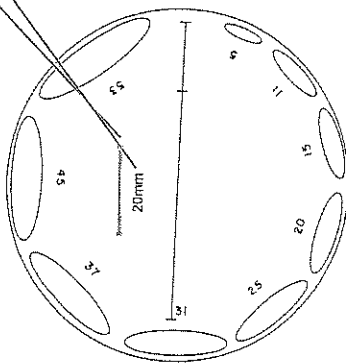
Author: ddb
Subject: Text Box
Date: 09/04/2007 2:53:45 PM
20mm

Author: ddb
Subject: Line
Date: 09/04/2007 3:17:17 PM
20 mm red line, but ends

Author: ddb
Subject: Text Box
Date: 09/04/2007 3:20:32 PM
20mm, but ends



Ring Gear Template



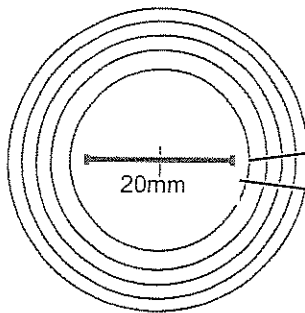
Pinion Template

These templates for use only on Dana Model 44-1 axle units with a 4.5:1 gear ratio.
Template areas must be recalculated for other applications.

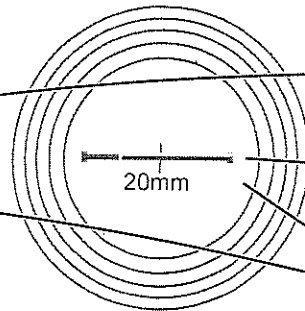
Reproduction may cause enlargement or reduction in size.

Attachment	<u>B</u>
Page	<u>40/10</u>
Reference	<u>2-37</u>

Template for Percent Area Breakdown

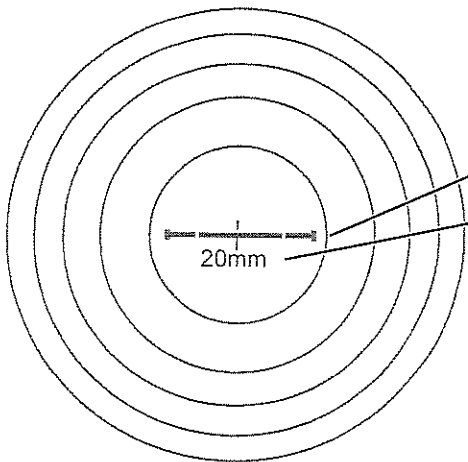


GA-34
FRONT

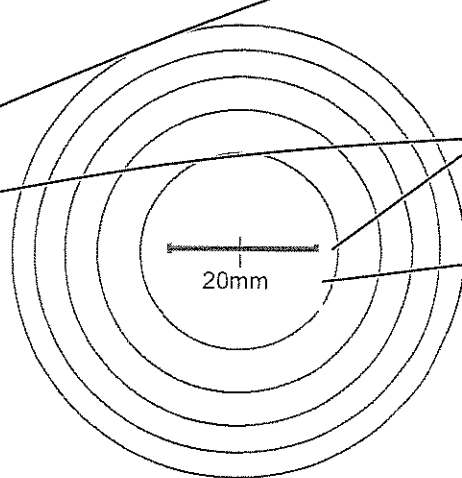


GA-34
BACK

Attachment	<u>B</u>
Page	<u>5010</u>
Reference	<u>L-37</u>



GA-50
FRONT



GA-50
BACK

This template for use only on Boston Models GA-34 and GA-50 gears. Template areas must be recalculated for other applications.

Reproduction may cause enlargement or reduction in size.

Summary of Comments on CRCTemplates_dtb.pdf

Page: 1

Author: dtb
Subject: Line
Date: 09/04/2007 3:11:45 PM
20 mm red line, butt ends

Author: dtb
Subject: Line
Date: 09/04/2007 3:12:04 PM
20 mm red line, butt ends

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:53:59 PM
T+20mm

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:48:01 PM
T+20mm

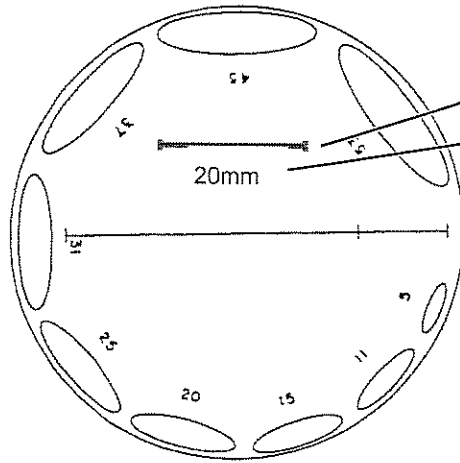
Author: dtb
Subject: Line
Date: 09/04/2007 3:12:00 PM
20 mm red line, butt ends

Author: dtb
Subject: Line
Date: 09/04/2007 3:11:54 PM
20 mm red line, butt ends

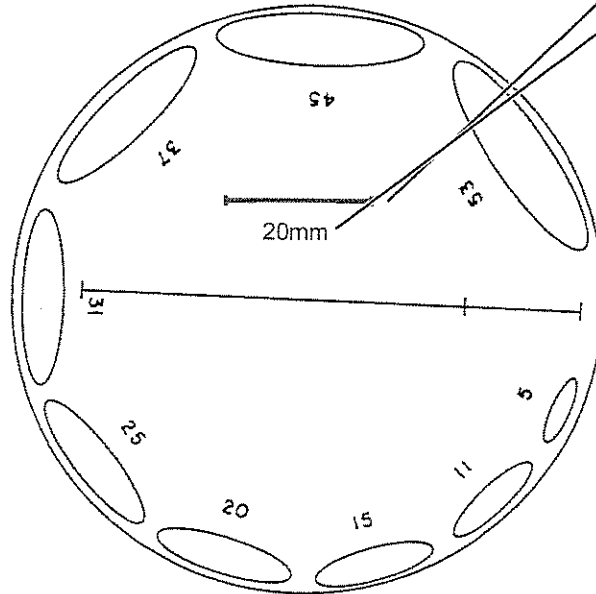
Author: dtb
Subject: Text Box
Date: 09/04/2007 2:49:58 PM
T+20mm

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:41:51 PM
T+20mm

Attachment	<u>8</u>
Page	<u>6 of 10</u>
Reference	<u>L-37</u>



Ring Gear Template



Pinion Template

These templates for use only on Dana Model 44-1 axle units with a 45:11 gear ratio.
 Template areas must be recalculated for other applications.

Reproduction may cause enlargement or reduction in size.

Attachment	<u>8</u>
Page	<u>7 of 10</u>
Reference	<u>L-37</u>
12/10/01	

Page: 2

Author: dtb
Subject: Line
Date: 09/04/2007 2:52:47 PM
20 mm red line, butt ends

Author: dtb
Subject: Text Box
Date: 09/04/2007 2:53:45 PM
T+ 20mm

Author: dtb
Subject: Line
Date: 09/04/2007 3:17:17 PM
20 mm red line, butt ends

Author: dtb
Subject: Text Box
Date: 09/04/2007 3:20:32 PM
T+ 20mm, butt ends

Attachment	<u>8</u>
Page	<u>8 of 10</u>
Reference	<u>J-37</u>

RATING SCALE FOR SPALLING

ME00039

DISTRESS	MERIT RATING	TEMPLATES	AREA
NONE	10		NONE
TRACE	9		1 sq. mm
TRACE TO LIGHT	8		4 sq. mm
LIGHT	7		9 sq. mm
LIGHT TO MEDIUM	6		16 sq. mm
MEDIUM	5		25 sq. mm
HEAVY TO HEAVY	4		36 sq. mm
HEAVY	3		49 sq. mm
	2		64 sq. mm
	1		81 sq. mm
	0		100 sq. mm

NOTE: AREAS SHOWN ARE MAXIMUM VALUES FOR EACH LEVEL OF DISTRESS

Page: 3

Author: db
Subject: Text Box
Date: 09/04/2007 3:22:31 PM
T: 20mm, butt ends

Author: db
Subject: Line
Date: 09/04/2007 3:33:44 PM
T: 20 mm red line, butt ends

Author: db
Subject: Text Box
Date: 09/04/2007 3:34:17 PM
T: 20mm, butt ends

Author: db
Subject: Line
Date: 09/04/2007 3:40:45 PM
T: 20 mm red line, butt ends

Author: db
Subject: Text Box
Date: 09/04/2007 3:31:55 PM
T: 20mm, butt ends

Author: db
Subject: Text Box
Date: 09/04/2007 3:30:11 PM
T: 20mm, butt ends

Author: db
Subject: Line
Date: 09/04/2007 3:33:40 PM
T: 20 mm red line, butt ends

Author: db
Subject: Text Box
Date: 09/04/2007 3:32:04 PM
T: 20mm, butt ends

Author: db
Subject: Line
Date: 09/04/2007 3:40:49 PM
T: 20 mm red line, butt ends

Author: db
Subject: Text Box
Date: 09/04/2007 3:34:48 PM
T: 20mm, butt ends

Author: db
Subject: Line
Date: 09/04/2007 3:39:43 PM
T: 20 mm red line, butt ends

Author: db

Attachment B
Page 9 of 10
Reference L-37

Comments from page 3 continued on next page

RATING SCALE FOR SPALLING

DISTRESS	MERIT RATING	TEMPLATES	AREA
NONE	10 		NONE
TRACE	9 	□	1 sq. mm
TRACE TO LIGHT	8 	□ □	4 sq. mm
LIGHT	7 	□ □ □	9 sq. mm
LIGHT TO MEDIUM	6 	□ □ □ □	16 sq. mm
MEDIUM	5 	□ □ □ □ □	25 sq. mm
MEDIUM TO HEAVY	4 	□ □ □ □ □ □	36 sq. mm
HEAVY	3 	□ □ □ □ □ □ □	49 sq. mm
	2 	□ □ □ □ □ □ □ □	64 sq. mm
	1 	□ □ □ □ □ □ □ □ □	81 sq. mm
	0 	□ □ □ □ □ □ □ □ □ □	100 sq. mm

NOTE: AREAS SHOWN ARE MAXIMUM VALUES FOR EACH LEVEL OF DISTRESS

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 Date: 09/04/2007 3:32:18 PM
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 Subject: Line
 Date: 09/04/2007 3:39:45 PM
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 Date: 09/04/2007 3:35:05 PM
 Author: db
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 Author: db
 Subject: Text Box
 Date: 09/04/2007 3:32:58 PM
 Author: db
 Subject: Line
 Date: 09/04/2007 3:33:08 PM

Attachment	8
Page	106/110
Reference	L37

FROM ART SANCHEZ - GO RTF CHAIR 8/16/07

The ASTM Surveillance Panel held a conference call on 8/8/07. It was determined that there are some CRC Manual 21 L-42, L-37 and possibly L-60-1 rating templates in the industry that are in error. They are of the incorrect surface area. The ASTM TMC Representative (Mr. Don Lind) and ASTM Surveillance Panel have been informed of the error. CRC has also been contacted.

At the request of the above, all laboratories are asked to immediately audit all L-42, L-37, and L-60-1 rating templates which they may have. Please audit those still uncut in the manuals and those which have been cut out and are used for rating. Be sure all Manual copies are audited.

The ACCEPTABLE rating templates have the following characteristics:

L-37 Spalling Rating Template

For each spalling level measure a side of the square figure in mm. Each side must be within 0.1 mm of the square root of the area listed. Example: 9 sq. mm area = 3 +/- 0.1 mm square side length.

L-60-1 Gear Percent Area Breakdown Rating Template

Measure the diameter of the inner circle of each of the 4 figures. Inside diameter measurement of inner circle of the large and small front side templates should be 0.923 +/- 0.050 inches.

Inside diameter measurement of the inner circle of the large and small back side templates should be 1.020 +/- 0.050 inches.

L-42 Percent Scoring Rating Template

Each template (ring and pinion) has a straight line drawn across its face with small cross marks at each end of the line. Use a Caliper and measure the length of each line. The results should be:

For the Pinion: 2.630 +/- 0.050 inches

For the Ring: 2.015 +/- 0.050 inches

If your lab has been using an unacceptable template for referenced L-37, L-42, or L-60-1 ratings it is suggested that you notify the TMC.

Additional discussion:

Note: The templates should all be closer to the target value than the +/- ranges listed above would suggest. These ranges were just picked to quickly screen out those templates known to be in error.

Most unacceptable templates are too small.

Also be warned that making copies of an acceptable CRC template page can easily change its size larger or smaller. Copying is not allowed.

Manual 21 comes with pages 39, 41, & 43 that are the template and a "non see through" page pair. Never make a template from the "non see through" page. It may not be scaled properly.

Please contact the ASTM TMC L-37, L-42 OR L-60-1 Representative or the respective S.P. Chairman if you need further information. CRC will soon take action to replace all templates.

Attachment	<u>9</u>
Page	<u>10/1</u>
Reference	<u>L-37</u>

To: Mr. Don Bartlett

From: Arthur Sanchez
ASTM Gear Rating Task Force Chairman

After review of the Ridging and Wear molds the ASTM Gear Rating Task Force would like to move forward by proposing to accept the Ridging and Wear molds as a rating aid for the L-37 gear test.

At the Gear Rating Workshop held in Pittsburgh the modified Ridging mold reproduction was evaluated by all raters present. The tooth surface glare or reflectivity of each tooth mold surface was reduced to a dull finish and the color of the board was changed from white to gray. The cost for this modification was \$80.

After much discussion the Gear Rating Task Force decided not to accept the modified Ridging mold with the dull tooth surface finish. The dull finish made the ridging on most of the different distress levels difficult to see. The final decision was to accept the Ridging mold with the initial bright tooth surface finish and with a gray board instead of a white board.

The Gear Rating Task Force feels that the Ridging and Wear molds along with the L-37 photo rating aid would help the raters with reproducibility for rating Ridging and Wear of the L-37 gear test.

TMC feels that according to the data produced at the rating exercise in Cleveland the mold boards did not improve the reproducibility among raters present. Comparing rating data of eight L-37 pinions that were rated using the L-37 photo rating aid and wear definition only, and then rating the same eight L-37 pinions using only the Ridging and Wear molds, the molds did not improve reproducibility.

The Gear Rating Task Force feels the lack of reproducibility using the Ridging and Wear molds could be due to raters not having enough experience using the molds as rating aids and also feels that the combination of Mold boards and L-37 photo rating aid and Wear definitions could help raters with reproducibility.

The Gear Rating Task Force suggest having a rating exercise at the January Gear Rating Workshop in Richmond using the L-37 photo rating aid and Wear definition and the Ridging and Wear molds. Another Ridging mold with the bright tooth surface and gray board would have to be made at a cost of \$80.

Price of this project is \$4,400 for the original Wear and Ridging mold casting and \$80 for the modified Ridging mold reproduction with a dull tooth surface and gray board.

The life of the original casting is best guessed to be one year, which is March 28, 2008. A 20 board reproduction maximum per casting is the limit to assure good quality. Each Ridging or Wear board reproduction will cost \$75.

Attachment	<u>12</u>
Page	<u>1 of 2</u>
Reference	<u>L-37</u>

Wear Mold: Wear molds are acceptable. The 7 wear has a slight wear step. There is a need to change the 7 wear and 6 wear definition to match the board.

Change suggested

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.

Ridging Mold: Ridging Molds may be acceptable with a bright surface finish and gray board. A new casting will have to be made.

Since there are different ridging levels on some of the Ridging mold teeth, a suggestion was made to photograph the complete Ridging board. An arrow would then be added to the photo for each tooth to pinpoint the specific ridging distress level on each tooth. Each rater would receive a copy of the photo to help choose the correct ridge on each of the different levels of ridging.

Attachment	<u>10</u>
Page	<u>2 of 2</u>
Reference	<u>L-37</u>