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Committee D02 on PETROLEUM PRODUCTS AND LUBRICANTS

May 23, 2007

Reply to:

Donald T. Bartlett

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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:

- **February 14, 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

Donald T. Bartlett, Chairman

L-37 Surveillance Panel

Attachments

Report of Meeting
L-37 Surveillance Panel
Warrendale, PA
PRI Apollo Room
February 15th, 2007

Sign-in/Review of Agenda & Membership: The meeting was called to order at 8:35 pm. The sign-in sheet is ***Attachment #1***.

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

The chairman reviewed of the member/mailing list which is current. He questioned the membership status of Bill Sullivan who recently retired from ExxonMobil. Mr. Gropp is compiling a list of questions that will be sent to ASTM. Questions include how to handle membership changes. The chairman also recommended that all panel chairmen add the rating task force members to their panel mailing list in an effort to partnership communication.

Approval of Minutes The minutes of the November 15, 2006 Surveillance Panel Meeting were presented for review and approval.
Motion 1 ⇒ Cory Koglin, Second ⇒ Dale Smith); The minutes of the November 15, 2006 Surveillance Panel be approved with no corrections. The motion passed unanimously.

Summary of Meeting Discussions

2006 Lubrited Hardware Order Status – The chairman reviewed the Ft Wayne (attachment 2, page 4) and Lugoff (attachment 2, page 5) visits which were combined with the L-42 gear batch order. The chairman provided a handout that is the Dana, Ft. Wayne, process specification # 506, see ***Attachment # 3***.

This specification is a general process overview of the phosphate manganese coating. We had an opportunity to see the tooth cutting for face mill 2-axis rough and finish cut versus face hobbing (face milled which is a tooth geometry process change). Questions were raised whether this was a manufacturing process change or a tooth geometry change. Don Kreinbring thought that the process change would also bring geometry changes. The Task Force said that more discussion would need to be held at the panel but would suggest that a small batch of face hobbed gears be built during the next batch order. HTF also visited Lugoff on December 7th.

With respect to the Lugoff facility visit Don Kreinbring provided an update on the production of the lubrited build during December (attachment 2, pages 7, 8, & 9). Lou Pappademos stopped at lapping because of unacceptable pattern. Most patterns are central (L3) which is undesirable. Analysis indicates the pinions were an acceptable material based on the print but were low on the hardness scale. Since the L-37 requires such a deep case core depth, the extreme heat-treating process distorted the pinion pattern by twisting some of the pinion teeth. Dana has updated the specification to tighten restrictions of material type and properties for future gear sets and stating that 'No Substitutions are permitted' in future material.

To correct the existing problem, Dana will mate new rings with existing pinions. Dana feels the problem can be corrected either by making new rings or pinions. Since forgings for rings are much easier to obtain, new rings have been built. Dana has made a 1ST order change in the manufacturing of new rings. Mr. Gropp appreciates the idea to minimize the time constraint but asked the group how comfortable they are on having Dana move forward. The chairman said that Kenny Miller seems comfortable with it and is recommending that we moving forward. Mr. Gropp sited all of the correction factors associated with prior lubrited batches as being unfavorable to developing lubricants because of high test variability.

Attachment # 4 details a summary of Dana and ASTM L-37 & L-42 backlash information.

Hardware Lubrited Hardware Approval Matrix - Each of the 4 labs will equally participate in a 44-test matrix to evaluate the 2006 lubrited hardware batch. Attachment 2, pages 11 & 12, details the test types and reference oils to be used.

Gear Rating TF Update – Chairman Sanchez –

The chairman reviewed the panel request of the GORTF in January 2006 (attachment 2, page13). The following is a summary update on action items GORTF Chairman Sanchez reported on:

1. **CRC L-37 Photo Rating Aid** and conclusion, see attachment 2, pages 14 and 15.
2. **Rating of L-237 RCMS Pinions** with Spalls covering the wear step area and conclusion, see attachment 2, pages 16, 17, and 18.
3. **L-37 Wear rating in the 6 to 8 range** and conclusions, see attachment 2, pages 19, 20, and 21.

We thank the industry raters for all there suggestions, hard work, and efforts.

January 2007 Gear Rater Calibration Work Shop (RCWS) – Mr. Lind

Mr. Lind highlighted miscellaneous distress parameters on almost all gear sets that had unacceptable variability. See ***Attachment# 5 & 6***. A question was raised whether the variability seen in the RCWS data would bounce them out of the RCMS system. Mr. Lind couldn't answer this because the RCMS system charts a rater's performance based on the average of 4 pinions. This inherently allows for some variability.

The issue is that the raters are not willing to move on some of the outliers and it is a challenge to get them to come to full consensus. For the ring data, the variability seems to be improving with the exception of wear. Wear ratings are still unacceptable. The rating is a little more difficult for wear when it is in the root of the gear. Another issue is that the photos are of the pinion and there are no photos for the ring.

Old Business - TMC

- **Spitting versus chipping on some pinions** - Raters are in disagreement on making a final decision. The distress is not in the loaded area as it is partially on the crown.
  Action Item: Have Mike Follis review these pinions on the side and determine a ruling and provide guidance.

- **TMC proposal to open the Rater Calibration Monitoring System (RCMS) Bands** - See **Attachment # 7**. Mr. Gropp expressed his concerns that he is somewhat reluctant to open up bands when you have only 1 or 2 raters separating from the rest of the group.

  After discussions, the Panel agreed that:
  For Pinion # 60:
  - Opening up the bands on ridging is warranted.
  - Recommendation for rippling is to open it up slightly to allow an 8.
  - Wear is not warranted.

  For pinion # 57:
  1. Opening up ridging to allow an 8 is warranted
  2. For rippling, yes.
  3. For wear, no.
  4. For Spitting, yes.

Action Items:
- All of these decisions for opening the RCMS bands will be revisited once data is available after 20 results
- TMC to take the lead to gather and implement more pinions for the RCMS system with wear distress down in the 4 or 5 range.

Being no further business to conduct, a motion for adjournment was made by Mr. Koglin and seconded by Mr. Schenkenberger. The meeting was adjourned at 09:40 am.

Respectfully submitted,

Donald T. Bartlett

Donald T. Bartlett
L-37 Surveillance Panel Chairman

ASTM L-37 Surveillance Panel Membership/Mailing List

Meeting Date: February 14, 2007

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Attachment 1
Page Page 1 of 5
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ASTM L-37 Surveillance Panel Membership/Mailing List

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Meeting Date: February 14, 2007

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Meeting Date: February 14, 2007

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Meeting Date: February 14, 2007

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* Initial to indicate attendance at subject meeting

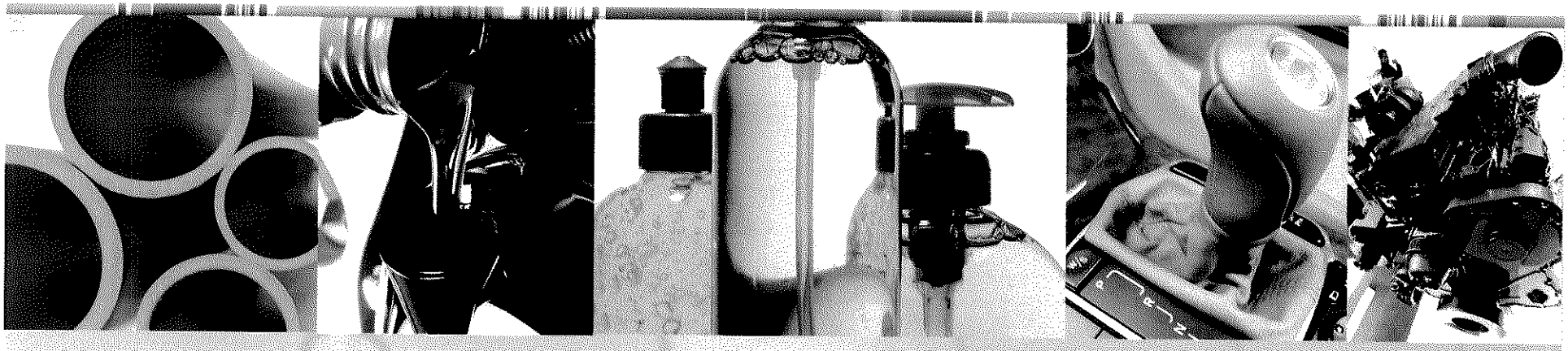
Attachment 11
Page
Reference L-37

LUBRIZOL

L-37 Surveillance Panel

PRI/ Headquarters, Apollo Room
Warrendale, PA

February 14, 2007



Attachment 2
Page 1 of 22
Reference L-37

Agenda

I. Call to Order & Review Agenda
II. Membership Review
III. Approve SP Minutes of November 15, 2006
IV. 2006 Lubrited Hardware Order Status -
V. Gear Rating TF Update - Chairman Sanchez
VI. Jan 2007 GR TF Calibration Workshop - TMC
VII. Old Business - Other Action Items - TMC:
- Gather/implement more pinions for the RCMS system with wear distress in the 4 or 5 range
- RCMS Pinion Pitting vs. Chipping

VIII. New Business
IX. Adjournment

Attachment 2
Page 2 of 22
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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 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
William Sullivan	Exxon Mobil
Paula Vettel	D.A. Stuart Company

Total 16 Voting Members

Attachment 2
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Reference L-37

2006 Lubrited Hardware Update

- ✓ HTF visit to Ft. Wayne was November 29, 2006.
  - Tour of facility with detailed focus on the lubriting process. See handout 1.
  - Discussed tooth cutting for face mill 2-axis rough and finish cut vs. face hobbing (face milled which is a tooth geometry change
    - Recommend a small batch for the panel to evaluate with the next hardware order.

Attachment 2
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Reference L-37

2006 Lubrited Hardware Update (con't)

- ✓ **HTF visit to Lugoff was December 7 2006.**
  - **Tour of assembly line which is scheduled to be moved in February.** *Note: line move completed*
  - **Good open discussion and process well documented**
  - **Backlash discussions with Kenny Miller see handout # 2**
  - **Will review procedural backlash requirements after Lubrited hardware matrix**

Attachment 2
Page 54/22
Reference L-37

2006 Lubrited Hardware Update (con't)

- ✓ 3 HTF teleconferences convened since first of the year
- ✓ Kreinbring, Koglin, Bartlett weekly teleconference discussions and updates

Attachment 2
Page 6 of 22
Reference L-37

2006 Lubrited Drive Gearing Pattern (cont)

Don Kreinbring, 2/10/07

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

Attachment 2
Page 7 of 22
Reference L-37

2006 Lubrited Drive Gearing Pattern (cont)

Don Kreinbring, 2/10/07

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

2006 Lubrited Axle Build Status

Don Kreinbring, 2/10/07

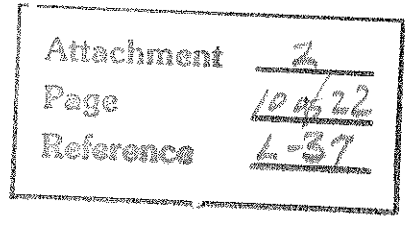
- **Drive gear forgings were obtained and blanked.**
- **Kenny Miller and Lou Pappademos developing first order position change.**
- **First recut and firecheck didn't move pattern enough from L3 to L2.**
- **Second recut and firecheck look good, PPAP will go to Kenny Miller.**
- **Timing for drive gearset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

Attachment 2
Page 9 of 22
Reference L-37

2006 Lubrited Hardware Update (con't)

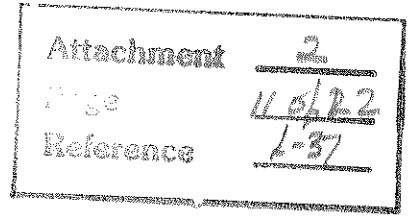
- **Anticipate hardware receipt and Matrix testing around March/April, 2007.**

✓ 44-test Standard and Low Temperature hardware approval Matrix defined.



2006 Lubrited Hardware Approval Matrix

- ✓ Each of the 4 labs will equally participate in a 44-test matrix to evaluate the 2006 lubrited hardware batch.
  - 4-test on TMC 127 (standard)
    - TMC will assign each lab one test on TMC 127 and stop to review results (to insure that this oil has performed as expected). Targeted completion date is TBD.
  - 4-tests on TMC 155 (standard)
    - TMC will assign each lab one test on TMC 151-3 and stop to review results (to insure that this oil has performed as expected). Targeted completion date is TBD.



2006 Lubrited Hardware Approval Matrix

- ✓ Each of the 4 labs will equally participate in a 44-test matrix to evaluate the 2006 lubrited hardware batch.
  - 4-tests on TMC 155 (standard)
  - 8-tests on TMC 152 (standard)
  - 8-tests on TMC 153 (standard)
  - 8-tests on TMC 152 (Canadian)
  - 8-tests on TMC 153 (Canadian)

Attachment 2
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Reference 1-37

L-37 Panel Request of the ASTM Gear Rating TF

- ✓ SP Request January, 2006:
- ✓ Looking to the Gear Oil Rating TF for rating improvements:
  - For rating pinions and rings – The difference between the vast population of raters is that a rating for any distress should not be more than 1 number.
  - The reproducibility of the number across the industry should be no worse than what it is where a lab has more than one rater.

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Reference L-37

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

1) CRC L-37 Photo Rating Aid:

- A discussion and review of the original gear metal boards for wear, ridging, and ripple took place in order to determine if any photos from the CRC Rating Photo Aids did not match or correctly represent the distresses.

- It was determined that the 5 ripple photo could be improved to better represent the original gear and improve what the raters were actually rating as medium ripple.

- Afton volunteered to provide a new digital photo and present it for review to the Rating Task Force in January 2007.

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

1) CRC L-37 Photo Rating Aid:

- Conclusion:
  - Afton provided prints of 5 ripple distress, re-photographed from original pinion rating board kept by Lubrizol, to attempt an improvement in quality of the rating aid.
  - The group reviewed the prints and agreed there was no improvement.
  - Afton continuing to search for a better example of 5 ripple to photograph for this particular distress.

Attachment 2
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Reference L-37

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

2) Rating of L-37 RCMS Pinions With Spalls Covering the Wear Step for Wear Only:

- Rating Task Force group asked the panel to change the current method of rating wear on a single marked tooth of an RCMS L-37 pinion, when spalling is present near the wear step.

- Raters are instructed to rate one marked pinion tooth for all distresses. The spalling makes it difficult to see and feel the true wear step.

Attachment 2
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Reference L-37

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

2) Rating of L-37 RCMS Pinions With Spalls Covering the Wear Step for Wear Only:

- At the 2006 July workshop in Cleveland raters were instructed to rate four RCMS pinions for wear due to the fact that a spall was present in the original area rated for wear.
- The ratings were then reviewed.
- Although the ratings were not different than the original ratings, it still makes it easier to determine and rate wear if a spall is not present in the area where wear is being rated.
- The TMC will review the data with the SP.

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

2) Rating of L-37 RCMS Pinions With Spalls Covering the Wear Step for Wear Only:

- Conclusion:
  - In the future, the tooth that will be rated for wear only can be identified with an 'X' at the heel and toe, non-contact area. The 'X' will be etched on the pinions by Don Lind.
  - SP panel motion November 2006 - For RCMS Pinions, the TMC was directed to mark an additional tooth for rating wear distress when there is a spall present in the wear step. (pinions 15, 17, 21, & 33).

Attachment 2
Page 18 of 22
Reference L-37

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

3) L-37 Wear rating in the 6 to 8 rating range:

- Since the adoption of the new wear definition, which states that raters should confirm the presence of a wear step both visually and tactilely, the wear ratings on certain pinions in the 6 to 8 rating range have not been as consistent.

- There are some pinions that have a light wear step that raters are inconsistent with.

- Other suggestions are to possibly modify the Light (7) and Light/medium (6) wear definitions.

Attachment 2
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Reference L-37

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

3) L-37 Wear rating in the 6 to 8 rating range:

- Examples:
  - 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.
  - These examples for (6) and (7) wear were discussed at the January workshop in San Antonio, TX.

Attachment 2
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Reference

ASTM Gear Rating TF Update

Chairman Sanchez, 2/5/07

3) L-37 Wear rating in the 6 to 8 rating range:

- Conclusion:
  - The combination of the new wear molds which are in the process of manufacturing, and possible change to the wear definition, should help resolve the 6 to 8 wear rating spread.
    - Note, 1st Master boards ready for rater evaluation
  - Once wear molds are manufactured one rater per Lab will meet in Cleveland at Lubrizol to review the wear molds.
  - The new wear molds and adding the words (barely discernible) to the 7 wear definition should help bring the 6 to 8 wear rating spread to a possible 7 to 8 wear rating spread.

Agenda

I. Call to Order & Review Agenda

II. Membership Review

III. Approve SP Minutes of November 15, 2006

IV. 2006 Lubrited Hardware Order Status -

V. Gear Rating TF Update - Chairman Sanchez

VI. Jan 2007 GR TF Calibration Workshop - TMC

VII. Old Business - Other Action Items - TMC:

- **Gather/implement more pinions for the RCMS system with wear distress in the 4 or 5 range**
- **RCMS Pinion Pitting vs. Chipping**

VIII. New Business

IX. Adjournment

Attachment 2
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Reference L-37

H.D. #1

DANA CORPORATION
SPICER LIGHT AXLE GROUP
FORT WAYNE, INDIANA

Process Specification No. 506 (ES-PS-0506)
Iron Manganese Phosphate Coating
(0.0001-0.0003) (Fine Crystalline)

Scope:

This specification covers a fine grained iron manganese phosphate coating produced on ferrous metal surfaces and impregnated with oil. This coating aids in break-in of moving parts without scuffing or scoring by preventing metal-to-metal contact between surfaces. The coating also provides corrosion resistance. This coating is friable and burnished down with light friction; this must be considered where dimensions are critical.

Requirements:

In order to obtain satisfactory results, all solutions and operations must be carefully controlled. The following process steps must be followed, and only the specified chemicals may be used. **Note:** No changes in process or solutions may be made without prior Chemical and Materials Engineering approval.

Process:

The complete process consists of the following steps:

1. Cleaning

   Parts must be thoroughly cleaned of all dirt, rust, grit, or oil. The bath must be suitable solvent or alkaline cleaner. For alkaline cleaner, use a concentration of 2-10% with a temperature of 120-180°F.

Rev. D

2. Rinsing

   A hot water rinse is applied after the use of an alkaline cleaner. The rinse should be overflowed continuously, and a temperature of 120-190°F should be maintained.

Rev. D

3. Conditioning

   Parts are immersed in an approved conditioner at 130-190°F for a minimum of one minute. This conditioner eliminates coarse crystalline growth and promotes the formation of a dense and fine crystalline phosphate coating.

Attachment 3
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Reference L-37

Process Specification No. 506 (ES-PS-0506)
Iron Manganese Phosphate Coating
(0.0001-0.0003) (Fine Crystalline)

4. Phosphating

Properly cleaned and conditioned parts are immersed in the bath at a temperature of 195-210°F for a period of four to eight minutes, depending on coating weight desired.

Rev. D

Target bath limits are as follows:

Rev. D

Total acid: 11.5 to 13.5 points (ml.)
Free acid: 1.5 to 3.0 points (ml.)
Iron: 0.2 to 0.55%

A. Total acid test

Obtain a 10 ml. sample of well mixed phosphate solution. Add two to three drops of Phenolthalein indicator. Titrate with 0.5 NaOH until color turns pink. Titrant (ml.) = total acid number in points.

B. Free acid test

Obtain a 10 ml. sample of well mixed phosphate solution. Add two to three drops of Methylorange-Xylene Cyanole (indicator 8). Titrate with 0.5 NaOH until color turns from deep bluish-purple to bluish-green. Titrant (ml.) = Free acid number in points.

C. Iron test

Obtain a 10 ml. sample of well mixed phosphate solution. Add ten drops of concentrated 50% sulfuric acid (H_2SO_4) to solubilize iron. Titrate with 0.18 $KMnO_4$. Titrant (ml.) x 0.1 = % iron.

5. Rinsing

Rev. D

After phosphating, parts are rinsed in ambient to 100°F water for at least one minute. This rinse should be overflowed continuously in order to avoid excessive contamination.

6. Oil

In the final step, the parts are spray rinsed or immersed in an 8-12% concentration of oil. This stage may be ambient temperature, as long as parts are air dried to remove all moisture.

Attachment 3
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Reference L-37

Process Specification No. 506 (ES-PS-0506)
Iron Manganese Phosphate Coating
(0.0001-0.0003) (Fine Crystalline)

Coating Requirements:

The coating should be of fine crystalline structure, of uniform texture and thickness, and uniformly cover the entire part. The coating will have a very thin, hard, fine grained undercoat adjacent to the substrate with a slightly coarser top coat.

1. Grain Size

   The grain size of the top coat should be a size 8 minimum, as determined by microscopically comparing to the grain size chart for classification of steels (ASTM E112 Plate 1) at 100X. A reproduction of grain size 8 is included in this specification. A sample panel may also be viewed with the Leco Image Analyzer microscope and the ASTM grain size comparator may be used for a direct comparison.

2. Coating Thickness

   The thickness of the phosphate coating should be between 0.0001-0.0003:", as measured magnetically per ASTM B499.

3. Coating Weight

Rev. D

   The coating weights may vary from 900 mg/ft^2 to 1,500 mg/ft^2, with the heavier weights occurring with larger grain sizes.

   A. Coating weight test

      Use a 3" x 5" mild steel Type R Q-panel. Take a clean panel and immerse in hot water for three minutes. Then immerse the panel in the phosphate solution for three minutes. Rinse panel in cold water. Dry panel. Weigh the panel and record weight as "A". Place panel in chromic acid solution at 180°F for ten minutes. Remove the panel, rinse in hot water, and dry. Re-weigh the panel and record the weight as "B".

      (A – B) x 4,800 = Coating weight (mg/ft^2)

Attachment 3
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Reference L-37

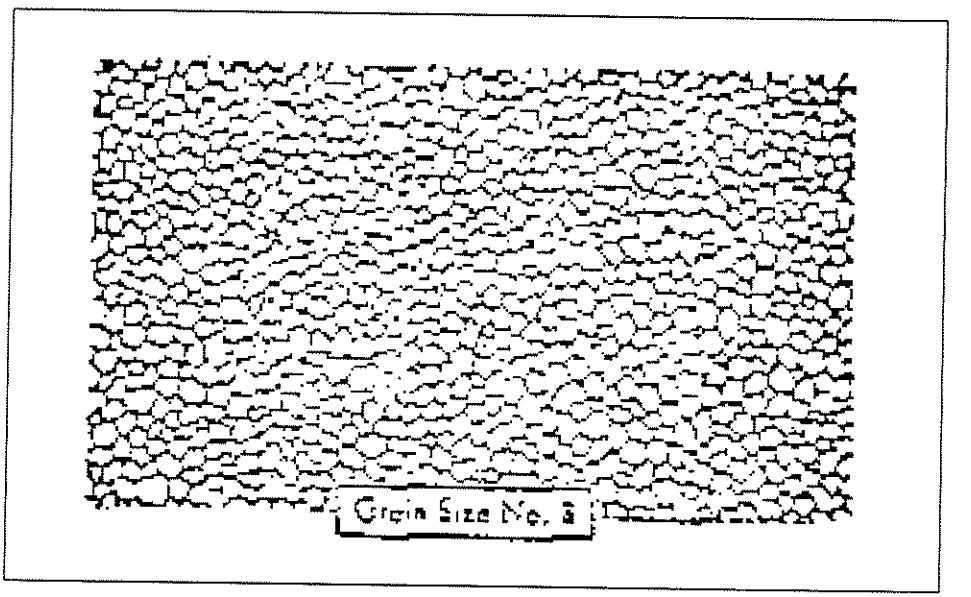
Process Specification No. 506 (ES-PS-0506)
Iron Manganese Phosphate Coating
(0.0001-0.0003) (Fine Crystalline)

Approved Sources:

Henkel Surface Technologies (Formerly Parker-Amchem)	Lubrite 2 Fixodene M	(Phosphate) (Conditioner)
Oakite Oakite	Oakite 398 Oakite 498	(Oil) (Oil)
Chemical Technologies, Inc. Marr & Associates	Tech Clean 7024 Purasol 5000	(Cleaner) (Cleaner)

Rev. D

Rev. D



Grain Size No. 8
100X Magnification

NO.	REV.	CHANGE	BY	CK	DATE
		Released	RPL		01-26-47
80001-167	C	Revised	MP	MF	06-03-98
80001-524	D	Revised	MF	TF	11-09-2001

Attachment 3
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Reference L-37

HO #2

ASTM L-37 / L-42 Backlash Requirements

1. Backlash is a tool for manipulating contact pattern for "best running position".
2. Contact pattern position is more important than backlash for building and testing.
3. Minor deviations in backlash should not result in rebuilding or scrapping.
4. There are 287 / 495 possible tooth mesh combinations with L-37 / L-42 gearsets.
5. Measure perpendicular to the tooth surface near the OD of the gear.
6. Set at the lowest position of drive gear runout.
7. Industry standards (AGMA and Gleason) are "using lowest measured value".
8.

Fort Wayne hard test	.005-.0055"	(pinion position)
Gleason design	.005-.008"	(calculations)
Lugoff axle assembly	.004-.009"	(actual build)

9. Fort Wayne allows .002" tooth-tooth and .003" total mesh variation.
10. ASTM labs measure 4 places, 90° apart, and take the mean value.
11. DANA service manual measure 3 places, 120° apart, backlash tol. .004-.009".

DANA Off Highway Recommended Backlash Procedure

1. Set at the lowest position of drive gear runout.
2. Set the dial indicator perpendicular to the gear tooth near the OD.
3. Measure backlash 2 places, 180° apart.
   (First builds begin with more places to determine that variation is acceptable.)
4. Record the lowest value as the actual backlash.

DEK 070208

Attachment 4
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Reference L-37

ASTM Gear Calibration Workshop
San Antonio, TX January 9, 10, & 11, 2007

Attachment 5
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Reference L37

L-37 RING GEARS

		RATER																
SET #	DISTRESS	1	4	6	7	10	11	22	25	27	28	29	30	31	MAX	MIN	AVG	Std Dev
1	Ridging	10.0		10.0		10.0	10.0	10.0							10.0	10.0	10.00	0.000
1	Rippling	9.0		10.0		10.0	10.0	9.0							10.0	9.0	9.60	0.548
1	Wear	7.0		9.0		7.0	7.0	7.0							9.0	7.0	7.40	0.894
1	Spitting	9.9		9.9		9.9	10.0	9.9							10.0	9.9	9.92	0.045
2	Ridging	7.0		8.0		7.0	8.0	7.0							8.0	7.0	7.40	0.548
2	Rippling	9.0		9.0		10.0	10.0	9.0							10.0	9.0	9.40	0.548
2	Wear	7.0		8.0		7.0	7.0	7.0							8.0	7.0	7.20	0.447
2	Spitting	10.0		9.9		10.0	10.0	9.9							10.0	9.9	9.96	0.055
3	Ridging	9.0		9.0		9.0	9.0	9.0							9.0	9.0	9.00	0.000
3	Rippling	9.0		9.0		10.0	10.0	9.0							10.0	9.0	9.40	0.548
3	Wear	7.0		7.0		7.0	7.0	7.0							7.0	7.0	7.00	0.000
3	Spitting	9.9		9.9		10.0	10.0	9.9							10.0	9.9	9.94	0.055
4	Ridging	8.0		9.0		9.0	9.0	9.0							9.0	8.0	8.80	0.447
4	Rippling	9.0		8.0		9.0	9.0	9.0							9.0	8.0	8.80	0.447
4	Wear	7.0		9.0		6.0	7.0	7.0							9.0	6.0	7.20	1.095
4	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000
5	Ridging	8.0		9.0		8.0	9.0	8.0							9.0	8.0	8.40	0.548
5	Rippling	9.0		9.0		9.0	10.0	9.0							10.0	9.0	9.20	0.447
5	Wear	6.0		7.0		6.0	7.0	6.0							7.0	6.0	6.40	0.548
5	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000
6	Ridging	10.0		10.0		10.0	10.0	10.0							10.0	10.0	10.00	0.000
6	Rippling	9.0		10.0		9.0	10.0	9.0							10.0	9.0	9.40	0.548
6	Wear	7.0		9.0		7.0	7.0	7.0							9.0	7.0	7.40	0.894
6	Spitting	9.9		9.9		9.9	10.0	9.9							10.0	9.9	9.92	0.045
ERATE																		
R1/1	Ridging	10.0		10.0		10.0	10.0	10.0							10.0	10.0	10.00	0.000
R1/1	Rippling	9.0		9.0		10.0	10.0	9.0							10.0	9.0	9.40	0.548
R1/1	Wear	7.0		9.0		7.0	7.0	7.0							9.0	7.0	7.40	0.894
R1/1	Spitting	9.9		10.0		9.9	9.9	9.9							10.0	9.9	9.92	0.045
R2/4	Ridging	8.0		9.0		9.0	8.0	8.0							9.0	8.0	8.40	0.548
R2/4	Rippling	9.0		8.0		9.0	10.0	9.0							10.0	8.0	9.00	0.707
R2/4	Wear	7.0		9.0		6.0	7.0	7.0							9.0	6.0	7.20	1.095
R2/4	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000
R3/6	Ridging	10.0		10.0		10.0	10.0	10.0							10.0	10.0	10.00	0.000
R3/6	Rippling	9.0		10.0		9.0	10.0	9.0							10.0	9.0	9.40	0.548
R3/6	Wear	8.0		9.0		7.0	7.0	7.0							9.0	7.0	7.60	0.894
R3/6	Spitting	10.0		10.0		9.9	10.0	9.9							10.0	9.9	9.96	0.055

A VAST IMPROVEMENT ON RING DATA

ASTM Gear Calibration Workshop
San Antonio, TX January 9, 10, & 11, 2007

Attachment 6
Page 1 of 1
Reference L-37

L-37 PINION GEARS

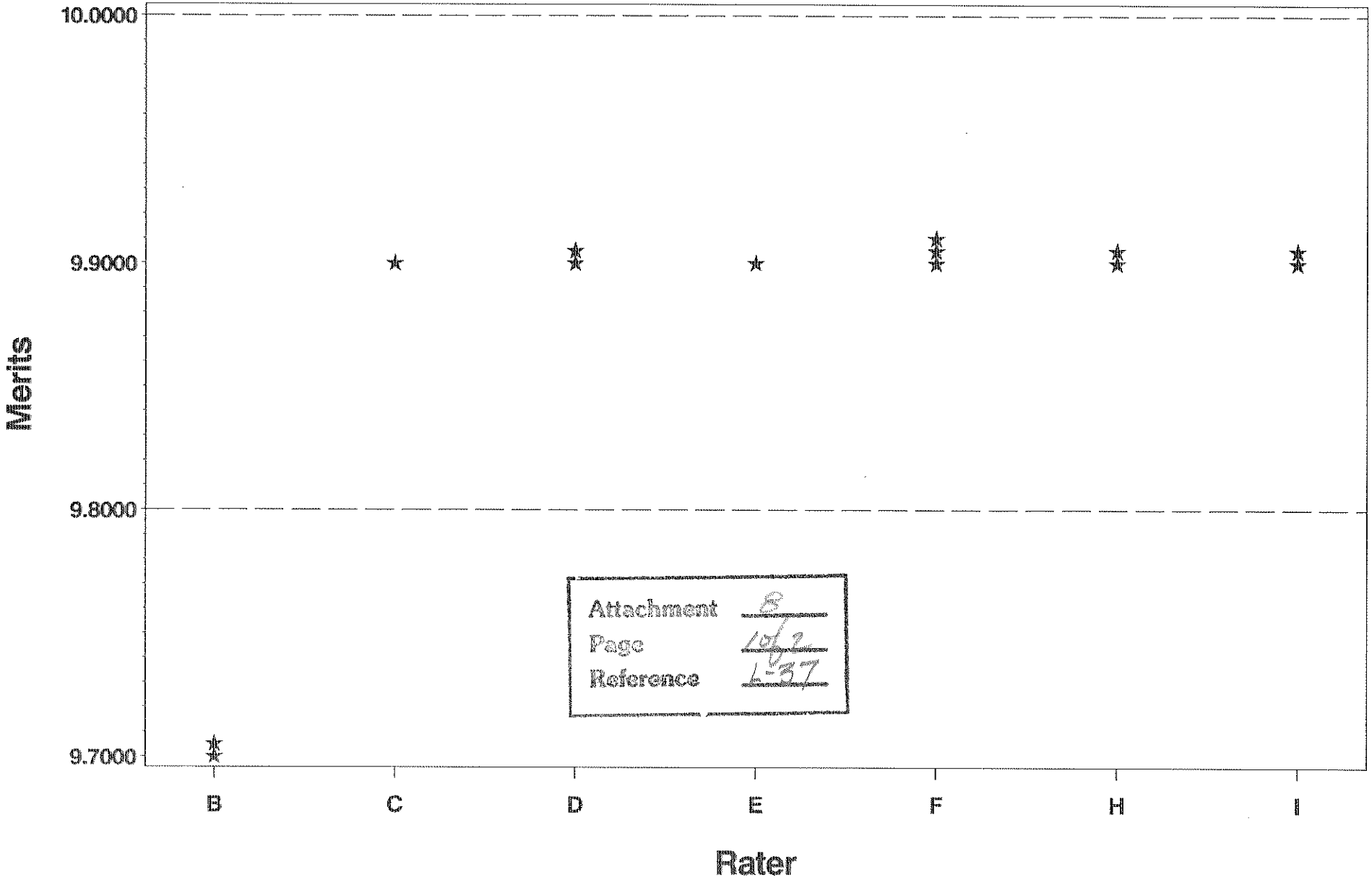
SET #	DISTRESS	RATER 1	4	6	7	10	11	22	25	27	28	29	30	31	MAX	MIN	AVG	Std Dev	Pinion #	Pinion Mean
5	Ridging	9.0		8.0		9.0	9.0	9.0							9.0	8.0	8.80	0.447		8.80
5	Rippling	7.0		8.0		7.0	7.0	7.0							8.0	7.0	7.20	0.447	42	6.80
5	Wear	6.0		6.0		6.0	6.0	6.0							6.0	6.0	6.00	0.000		6.00
5	Spitting	9.9		9.9		9.8	9.7	9.9							9.9	9.7	9.84	0.089		9.80
6	Ridging	9.0		9.0		9.0	9.0	9.0							9.0	9.0	9.00	0.000		9.20
6	Rippling	9.0		9.0		9.0	10.0	9.0							10.0	9.0	9.20	0.447	43	9.50
6	Wear	7.0		6.0		7.0	7.0	7.0							7.0	6.0	6.80	0.447		6.50
6	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.92
7	Ridging	5.0		4.0		6.0	5.0	5.0							6.0	4.0	5.00	0.707		4.80
7	Rippling	8.0		7.0		9.0	10.0	9.0							10.0	7.0	8.60	1.140	44	9.30
7	Wear	7.0		6.0		6.0	6.0	6.0							7.0	6.0	6.20	0.447		5.80
7	Spitting	9.9		9.9		9.9	9.7	9.9							9.9	9.7	9.86	0.089		9.90
8	Ridging	5.0		7.0		7.0	5.0	7.0							7.0	5.0	6.20	1.095		5.50
8	Rippling	9.0		8.0		8.0	8.0	8.0							9.0	8.0	8.20	0.447	45	8.50
8	Wear	7.0		7.0		6.0	6.0	7.0							7.0	6.0	6.60	0.548		6.30
8	Spitting	9.9		9.9		9.9	9.5	9.9							9.9	9.5	9.82	0.179		9.92
9	Ridging	4.0		4.0		6.0	4.0	5.0							6.0	4.0	4.60	0.894		4.80
9	Rippling	8.0		8.0		9.0	9.0	9.0							9.0	8.0	8.60	0.548	47	8.70
9	Wear	6.0		6.0		6.0	6.0	7.0							7.0	6.0	6.20	0.447		6.00
9	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.92
10	Ridging	10.0		10.0		10.0	10.0	9.0							10.0	9.0	9.80	0.447		9.70
10	Rippling	8.0		9.0		9.0	10.0	9.0							10.0	8.0	9.00	0.707	48	9.20
10	Wear	8.0		6.0		6.0	7.0	7.0							8.0	6.0	6.80	0.837		6.50
10	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.88
11	Ridging	10.0		9.0		9.0	10.0	9.0							10.0	9.0	9.40	0.548		9.20
11	Rippling	8.0		9.0		9.0	9.0	9.0							9.0	8.0	8.80	0.447	53	8.30
11	Wear	7.0		8.0		7.0	7.0	7.0							8.0	7.0	7.20	0.447		6.80
11	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.90
12	Ridging	9.0		8.0		9.0	10.0	8.0							10.0	8.0	8.80	0.837		8.80
12	Rippling	9.0		9.0		9.0	10.0	9.0							10.0	9.0	9.20	0.447	54	9.30
12	Wear	8.0		6.0		6.0	7.0	7.0							8.0	6.0	6.80	0.837		6.50
12	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.90
ERATE																				
R1/5	Ridging	9.0		9.0		9.0	9.0	8.0							9.0	8.0	8.80	0.447		8.80
R1/5	Rippling	7.0		8.0		7.0	7.0	7.0							8.0	7.0	7.20	0.447	42	6.80
R1/5	Wear	6.0		6.0		6.0	6.0	6.0							6.0	6.0	6.00	0.000		6.00
R1/5	Spitting	9.9		9.9		9.6	9.8	9.9							9.9	9.6	9.82	0.130		9.80
R2/7	Ridging	4.0		4.0		6.0	5.0	5.0							6.0	4.0	4.80	0.837		4.80
R2/7	Rippling	9.0		7.0		9.0	10.0	9.0							10.0	7.0	8.60	1.095	44	9.30
R2/7	Wear	7.0		6.0		6.0	6.0	6.0							7.0	6.0	6.20	0.447		5.80
R2/7	Spitting	9.9		9.9		9.9	9.7	9.9							9.9	9.7	9.86	0.089		9.90
R3/8	Ridging	5.0		5.0		7.0	5.0	6.0							7.0	5.0	5.60	0.894		5.50
R3/8	Rippling	9.0		7.0		8.0	9.0	8.0							9.0	7.0	8.20	0.837	45	8.50
R3/8	Wear	7.0		6.0		6.0	6.0	7.0							7.0	6.0	6.40	0.548		6.30
R3/8	Spitting	9.9		9.9		9.8	9.9	9.9							9.9	9.8	9.88	0.045		9.92
R4/10	Ridging	9.0		10.0		9.0	10.0	9.0							10.0	9.0	9.40	0.548		9.70
R4/10	Rippling	9.0		9.0		9.0	10.0	9.0							10.0	9.0	9.20	0.447	48	9.20
R4/10	Wear	8.0		6.0		6.0	6.0	7.0							8.0	6.0	6.60	0.894		6.50
R4/10	Spitting	9.9		9.9		9.9	9.9	9.9							9.9	9.9	9.90	0.000		9.88

L37RC Rater Comparison

TMC

Pinion 44

Spitting



Attachment 5
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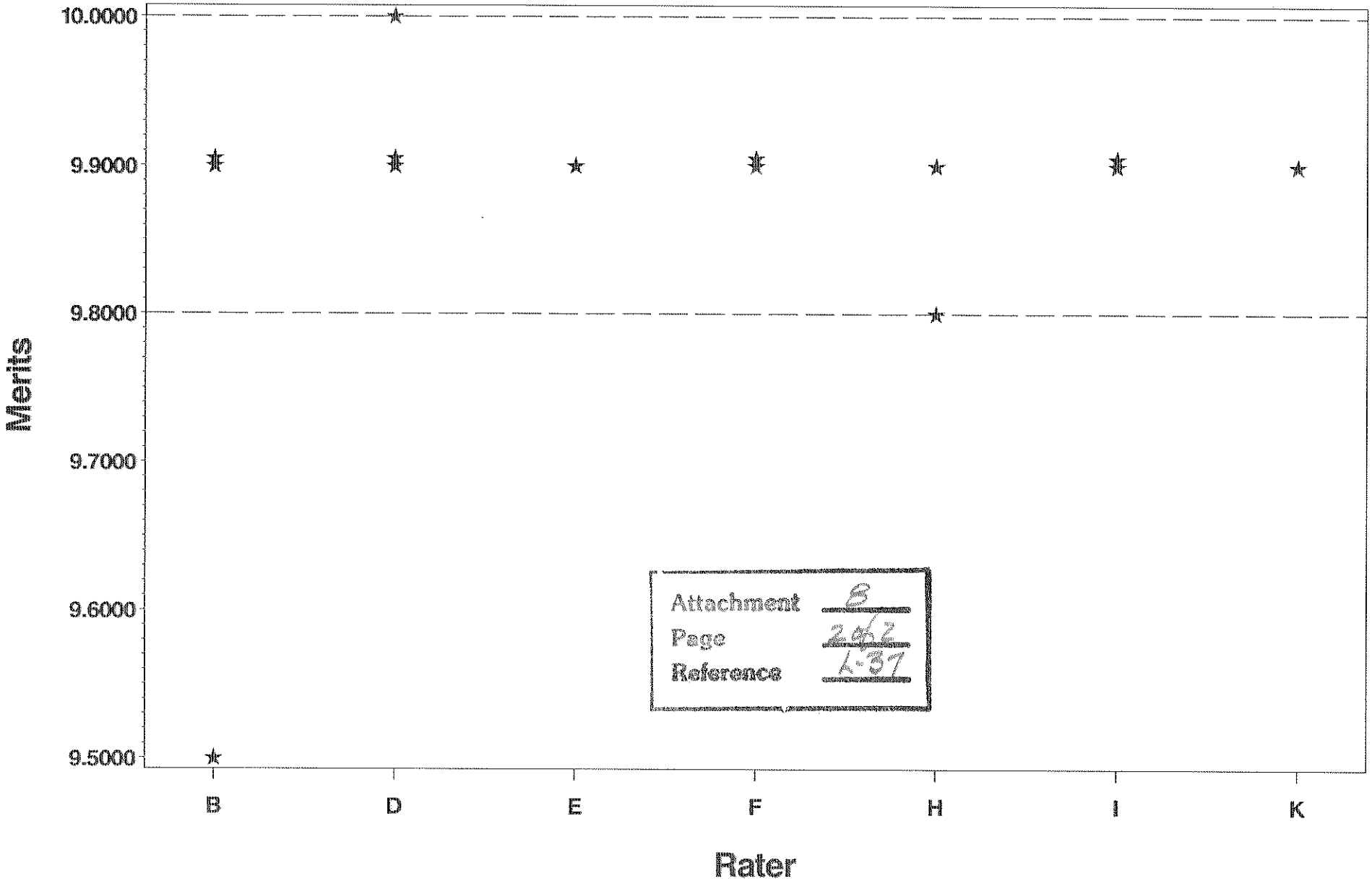
L37RC Rater Comparison

Pinion 45

Spitting



Attachment 3
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Reference L-37

ind	raterid	ridging	ridg_Upper_Limit	ridg_Lower_Limit	ridgxbar	ridgsdev	back/calc sdev	new U_L	new L-L	ridging
57	1	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	1	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	4	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	6	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	7	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	10	8	9.2	8.4	8.8	0.42	0.89	9.6	8.0	8
57	11	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	11	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	22	9	9.2	8.4	8.8	0.42	0.89	9.6	8.0	9
57	25	8	9.2	8.4	8.8	0.42	0.89	9.6	8.0	8

ind	raterid	rippling	ripp_Upper_Limit	ripp_Lower_Limit	rippxbar	rippsdev	back/calc sdev	new U_L	new L-L	rippling
57	1	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	1	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	4	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	6	9	8.6	7.8	8.2	0.42	0.89	9.0	7.4	9
57	7	9	8.6	7.8	8.2	0.42	0.89	9.0	7.4	9
57	10	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	11	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	11	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	22	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8
57	25	8	8.6	7.8	8.2	0.42	0.89	9.0	7.4	8

ind	raterid	wear	wear_Upper_Limit	wear_Lower_Limit	wearxbar	wearsdev	back/calc sdev	new U_L	new L-L	wear
57	1	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	1	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	4	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	6	5	6.2	5.6	5.9	0.32	1.00	6.8	5.0	5
57	7	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	10	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	11	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	11	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	22	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6
57	25	6	6.2	5.6	5.9	0.32	1.00	6.8	5.0	6

ind	raterid	spitting	spit_Upper_Limit	spit_Lower_Limit	spitxbar	spitsdev	back/calc sdev	new U_L	new L-L	spitting
57	1	9.6	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.6
57	1	9.5	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.5
57	4	9.7	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.7
57	6	9.7	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.7
57	7	9.5	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.5
57	10	9.6	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.6
57	11	9.6	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.6
57	11	9.6	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.6
57	22	9.6	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.6
57	25	9.7	9.68	9.54	9.61	0.074	0.100	9.70	9.52	9.7

ind	raterid	ridging	ridg_Upper_Limit	ridg_Lower_Limit	ridgxbar	ridgsdev	back/calc sdev	new U_L	new L-L	ridging
60	1	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	1	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	4	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	6	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	7	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	10	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	11	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	11	10	9.4	8.8	9.1	0.32	1.00	10.0	8.2	10
60	22	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9
60	25	9	9.4	8.8	9.1	0.32	1.00	10.0	8.2	9

ind	raterid	rippling	ripp_Upper_Limit	ripp_Lower_Limit	rippxbar	rippsdev	back/calc sdev	new U_L	new L-L	rippling
60	1	8	9.1	8.3	8.7	0.48	0.78	9.4	8.0	8
60	1	8	9.1	8.3	8.7	0.48	0.78	9.4	8.0	8
60	4	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	6	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	7	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	10	8	9.1	8.3	8.7	0.48	0.78	9.4	8.0	8
60	11	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	11	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	22	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9
60	25	9	9.1	8.3	8.7	0.48	0.78	9.4	8.0	9

ind	raterid	wear	wear_Upper_Limit	wear_Lower_Limit	wearxbar	wearsdev	back/calc sdev	new U_L	new L-L	wear
60	1	7	8.2	7.6	7.9	0.32	1.00	8.8	7.0	7
60	1	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	4	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	6	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	7	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	10	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	11	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	11	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	22	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8
60	25	8	8.2	7.6	7.9	0.32	1.00	8.8	7.0	8

ind	raterid	spitting	spit_Upper_Limit	spit_Lower_Limit	spitxbar	spitsdev	back/calc sdev	new U_L	new L-L	spitting
60	1	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	1	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	4	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	6	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	7	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	10	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	11	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	11	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	22	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9
60	25	9.9	9.90	9.90	9.90	0.000	0.050	9.95	9.86	9.9