L-37 Surveillance Panel Teleconference Minutes
Thursday, 09/18/2008

Attendees:

Dana -	Basset, Miller, Guzikowski, Horvath, Okamuro, Ramsey
SwRI –	Koehler, Lochte, Jackson
Lubrizol –	Bartlett, Gropp, Greene
Afton -	Koglin, Bell
Park -	Smith
TMC -	Lind
BP	Ivan Joseph
Arvin Meritor	Bruce McGlone (joined 30 minutes into the teleconference call)

7 voting members

The L-37 Surveillance Panel teleconference call was directed to convene at this time by the Panel at its September 10th teleconference meeting to review testing options and progress to date.

Agenda:

- Approve the September 10, 2008 SP teleconference meeting minutes.
- Review pending action items.
- Review the SwRI modified test condition matrix information.
- Lyle Bowman - use of SI units wherever possible

Approval of Minutes

Motion #1: Mr. Koglin motioned/Second Smith Mr. – That the September 11, 2008 meeting minutes be approved as written. Motion passed unanimously with a vote count of 6-0-0.

Retrofit Lubrited Hardware – Review and Discussion

Prior Action Item Review & Update:

→ **Ramsey**– Mr. Ramsey to work with chairman to address a Dana refund to the industry labs since the hardware has already been paid for. We are short 32 units. **Open**

→ **Miller** – Discussions with Mr. Brazeau, director of engineering from Dana, is evaluating the option of contracting with Mr. Okamuro to be brought on as a consultant. We welcomed Ken Okamuro at today's teleconference call. Ken has a gearing, metallurgy, inspection, product design background (product engineer) **Closed.**

→ **Miller –** Bartlett asked about the whereabouts of the Okamuro (retired) documentation book that was passed on to Kreinbring, who recently retired. Miller confirmed he has the documents and passed them on to Mr. Okamuro. **Closed.**

→ **Dana/Afton/Fett/Miller** – see SP meeting minutes August 13, Action item # 2 – Afton received 6 axles with the new build patterns (L2/3F+2). Afton has completed and posted results for two runs on TMC 153-1. Upon review of the data consensus was that the modified build pattern is not doing the job either.

During the September 4th Panel teleconference consensus was for Fett and Miller to confirm if there is some other build option to explore. Miller reported that sifting pinion axial position and moving the stress points around will not be successful. There is no other option for movement. **Closed.**

→ **Dana/Labs -** At the September 4 panel teleconference call the labs were directed to convene and draft a letter to Dana representatives specific to laboratory questions and issues. The labs teleconferenced on September 4, drafted and sent the letter to Dana representatives Brazeau, Miller, Ramsey, Fett and Guzikowski. Letter was also included as attachment # 2 of the September 4 panel meeting minutes. Dana was asked to respond to the questions by September 18th panel teleconference meeting. **Open**

→ **Ramsey** to quote for ring and pinion only, will work with labs. **Open**

→ **Dana/SwRI**– See SP meeting minutes August 13, Action item # 3. SwRI received 10 axles with standard build pattern and was to initially conduct two runs on TMC 153-1 with modified test conditions:

- Actual test conditions are:
  1. **Gear Conditioning Phase** will be conducted per the Standard, no change.
  2. **Gear Test Phase -** Test conditions will be:
     - 80 wheel rpm and 1441 lbf-ft torque per wheel.
     - Axle oil temperature will be the same as a standard test.
     - Initial test length will be 70 hours of on-test time.
- **Koehler** reported the following progress on testing with 9 % reduced load and varied test lengths. Torque calculations per Miller.
  - 1st aborted at 8 hours, lost driveshaft U-joint on 153-1. Passing result
  - 2nd, restart on 153-1, to run 70, made 60 hours, pinion bearing fail, extreme pitting/spalling.
  - 3rd, restart on 153-1, modified axle, 24 hrs, 8.0 spall, surface cracks
  - 4th, restart on 134, modified axle, 24 hrs, fail rippling
  - 5th, restart on 153-1, modified axle, 24hrs, just EOT, 3 fractured pinion teeth. Note though that the Test was stopped at 7 hours to replace a speed sensor and restarted.
  - 6th, TMC 152, 24 hrs, no broken teeth, no cracks, failed ridging 7
  - 7th, TMC 155, 24 hrs, no broken teeth, no cracks on teeth, J2360.

Discussion and Comments

Chairman – reported that Mr. Fett was unable to make the meeting but did provide a document (chairman had previously emailed the document to the panel for pre-review) and is included as *Attachment # 1*. He summarized the Magnafluxing work to date, proposed a trial build with the next batch, and summarized his ASTM LRI experiences over many gear batches.

Miller– *Attachment # 2* is a document Miller provided to the panel announcing Dana's hiring of Ken Okamuro to assist with the hardware and his initial review of the situation.

Okamuro – He commented that he is surprised about tooth breakage. Previously we learned that we had to increase the case depth to get away from case crush. That mechanism is straightforward from a stress point, but not true for ridging, rippling, wear, and some degree to pitting.

At the point of contact lines during mesh, there is normal force, and a 1st principle stress. The 2nd is at 90 degrees that is due to the sliding action. There are only two stresses involved to concentrate on, orthogonal and maximum sheer stress along the 45 sheer planes. We are seeing cracks, surface spalling, teeth break out at the heel and or mid tooth. All are a result of the 2 sheer stresses previously described.

Tooth Breakage issue –sub surface sheer stress creating a crack at the case core interface. Torque is constant. The variation comes from what the pattern is doing. The pattern is consistent with the FEA model and a good predictor. Second, is the orthogonal sheer stress in the principle plain. That is a function of the friction and a function of the lubricant (viscosity, formulation, temperature the axle is running at). Friction is the controlling factor and a function of the oil.

In the 1st principle of stress, the gear profile will control magnitude of stress. In the 2nd principle or stress, there is a function of load and coefficient of friction, both acting on the gear set. The more friction you have, the higher the sheer stresses. Tooth breakage is not from the lubrication process.

Ken indicated that he still needs to look at metallurgical reports from this batch compared to the P4L792/V1L417 2005 hardware batch. He is hearing that the metallurgy (steel, heat treat, case depth) is to specification and will be working with Dana metallurgist. With respect to the pre test pattern, those seem to indicate that the pattern looks to be consistent with what is the FEA model. Gear sets are general consistent.

From here where do we go? The 151/155 and 152 are more severe than the 129. The 153 is more severe than all. Friction gets higher as more distress happens.

He shared that he has some concern and may need a lubricant engineer input. This is a severe test with higher temperature than in the field. He questioned if the 75w90 fluids gave a sheer down? Have you ever done a viscosity test to determine if there was sheer down and if the oils are in grade? Particulates can play a role as does water in the amount of friction. Also additives and viscosity are contributive type things.

Gropp - with respect to LRI investigation into shear stability, a few years ago, the LRI asked those organizations who were presenting L-37 and L-42 test data to determine the end-of-test viscosity of the oils evaluated in these tests. The LRI wanted to determine if this information might provide some indication of the oils' resistance to shear. The results of this investigation indicated that these tests did not cause the oil to shear to any significant/measurable extent.

With respect to the TMC database on non-lubrited hardware, TMC 151/155 evaluated in the last 4 batches has not encountered tooth breakage. With respect to lubrited hardware– the oil was in the previously approved 2 batches and we were not seeing tooth breakage. Now we are seeing tooth breakage in all of these oils. We have 8-10 years of experience, some even recent. We recently updated targets and there is no tooth breakage. What is the constant over the last 10 years? It is the oil. What is the variability, it is the hardware.

Lind – when TMC receives the oil, they perform ICP drop out and all three oils were checked in March of 08. The oils looked fine.

Okamuro - if the production oils are less robust, what that does is leave less room for variability of the hardware. Hardware mean to the high side would result in passes. Hardware mean to low side would could possible result in a fail. The variability tolerance of the hardware is taken away. With respect to the new oil targets, TMC 153 looks less robust and is taking away the variability that the hardware can have.

He is suggesting that variability, whether in the test oils, hardware, raters, procedure, and the change in torques, can be made to produce the level of damage that you want. Are you maintaining your anchor from the past and maintaining discrimination? You can control the torque to keep the anchor.

Gropp stated that, with respect to adjusting the torques, while this is not a desirable answer, it is one that he would be willing to accept if it must be done. That is why we are currently looking at modifying the torque as one possible way to salvage this batch of hardware. He does not believe, however, that we should plan on doing this on a routine basis (to compensate for variability in the test hardware). Our emphasis should be on manufacturing consistent batches of hardware so that we may continue to use a fixed set of test operating conditions.

The perception is that with the last few batches of lubrited hardware, we have made little tweaks to address either ridging or pitting/spalling and have tweaked ourselves into a position where we do not know where we are. The 2005 was exemplarity. He still has the impression from Dana comments that there were differences in the hardware and we could go back and produce the hardware based on the 2005 batch. He again asked for a simultaneous effort, i.e., make new ring and pinions and continue to evaluate changes to the test conditions.

Koehler - SwRI willing to run one more reduced load test. Dana needs to tell us what reduced value to run at.

Okamuro - Need more metallurgical data and Ft Wayne's involvement. Miller confirmed that the Ft. Wayne metallurgy group is ready to assist and evaluate the variation.

The suggestions were that we attempt to keep it at a 24-hour test, back off the torque only enough from theoretical standpoint (get out of case crush and surface stress issue). Some felt a little longer test is somewhat acceptable.

Horvath – the Maumee facility should consider building 40 axles using the initial build pattern and ship 10 to each lab. Miller will be the contact to review the patterns.

Motion #2, Gropp, second Koglin - Once Dana provides the alternate running conditions, ask SwRI to run one test each on TMC 134, 152-1, 153, 155, one test each. The motion passed, with a count of 6-0-1. SwRI currently has 3 axles left and Intertek-Parc was asked to ship their one remaining axle back to SwRI. Dana agrees to move quickly to provide axels and alternate running.

The following attachments are included for communication and information, some received before the teleconference, some after.

Attachment # 3 is a PDF document from Mr. Bassett – Met Lab report on the panels and scrap pinions run at Custom Coatings during the July 2008 Manganese phosphate run.

Attachment # 4 is a PDF document from Mr. Miller – Met summary of pinion comparison.

Attachment # 5 is a PDF document from Mr. Miller – Gear Engineering PPAP Data.

Attachment # 6 is an email received from Mr. Horvath received on September 19th documenting the estimation when the 40 axles (10 per lab) will be assembled and shipped.

Attachment # 7 is an email from the Chairman. It details the request from Mr. Miller and the direction to the labs based on his request. The dates of the email are September 24 and 25.

Attachment # 8 is a summary of all Lubrited Retrofit testing to date. Also, below is the link to the TMC website for the Retrofit lubrited data for everyone's viewing pleasure. It will be expanded to include all other associated test results as we move forward in our matrix work.

New Lubrited Hardware – Discussion

Continued testing was put on hold by Panel as we focus the attention on the retrofit hardware first.

Non- Lubrited Hardware – Discussion

Continued testing was put on hold by Panel as we focus the attention on the retrofit hardware first.

ASTM Directive to Use SI units Wherever Possible

Attachment # 9 is an email trail and proposal from the D02.BO.10 Facilitator, Lyle Bowman. The panel discussed the issues and concerns and directed Mr. Lind and the Chairman to consult with Mr. Bowman and report back to the panel. The chairman did have a subsequent discussion with Mr. Bowman and the indication is that this is an ASTM international directive and many tests to address. There is time to address the issue with an expectation to go to ballot in June 2009. This item will be on future Agenda's until completion.

Next Meetings will be a Surveillance Panel Teleconference

- **Teleconference Meeting Tuesday, September 30, 2008 at 10:00 a.m. EDT.**
- **Call in info is 608-250-0194, code 324160.**

Meeting adjourned at 12:28 p.m.

Donald T Bartlett

Donald T. Bartlett, L-37 SP Chairman

GREG FETT
9/17/08

1. We have completed Magnafluxing the Lubrized retrofit pinions, however the report is not completed yet. Many of the pinions have crack indications at the tooth tip at the central heel position. This is the same location where the tooth breakage originated at on the non-Lubrized sets. However, the primary failure mode of the Lubrized pinions is pitting at the bottom of contact near the central toe position which leads to spalling and finally tooth breakage. This indicates there is high contact stress at both the top of contact and at the bottom of contact. This does agree precisely with the model that Kenny Miller presented. The high contact stress at the top of the pinion tooth is visually evident due to metal deformation. It is also evident at the bottom of contact on the rings. The high contact stress at the bottom of contact on the pinion is not visually evident except for the pitting that occurs. Some pitting did occur on the non-Lubrized sets at the same location but it did not lead to tooth breakeage.

The bottom line is I believe the teeth are being loaded the same way on the Lubrized and non-Lubrized sets. The failure mode is likely different because of the Lubrizing. It appears to lower the pitting resistance of the teeth so this becomes the failure mode on the Lubrized sets. On the non-Lubrized sets the top of the pinion tooth is the failure mode because of the better pitting resistance at the bottom of contact.

I think we all know from many years of dealing with the L37 test that it is more difficult to pass with the Lubrized gears. Lubrizing is good for the L42 test but it is bad for the L37 test. This brings up the question of whether or not it is necessary to even run non-Lubrized L37 gears. This may be a way to simplify this test in the future.

2. If we do end up making another batch of L37 gears I don't believe that Dana or the ASTM Labs can afford to fail again. To address this I believe it is a must that a trial batch be made and tested before the main batch is completed. All of the gears can be blanked but a trial quantity of 12 sets or so should be made. The gears should be Zeiss Flankform measured and the pattern checked as well as metallurgy to document what has been produced. Half should be Lubrized and the other half left as is. They should then be tested on a good reference oil such as 155 and on a bad oils such as 127 or 134. If the results are good the remainder can be produced and a sample again dimensionally and metallurgically measured and compared to the original test batch. Pass fail limits must be agreed upon ahead of time. This is really the only means that Dana has to determine whether a gear is good or bad at the time of production.

I realize this will mean the gears will not all be made and built at the same time. However, I think this is the way it must be to protect Dana and the Labs. I think the latest round of testing has shown us that the build is not real critical to the outcome of the test. I think it is the gear geometry that is king.

3. I have been on the LRI and various ASTM committees since 1983. Over the years there have been several good batches of ASTM L37 even back in the 1980's. However, there have been more marginal or poor batches. The test is very severe and difficult to pass unless everything is optimal. To put it in perspective a very severe trailer tow test in a vehicle could load a gear to approximately 24,000 psi bending stress. The L37 test is

Attachment 1
Page 1 & 2
Reference L-37
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about three times this stress for 24 hours at 275 F. It is more like a continuous full throttle clutch dump test where the wheels slip for 24 hours.

Back in the late 1980's or early 1990's we had a poor performing batch that pitted and spalled at the heel end. The prior batch was a good batch. We ended up measuring the tooth form of both batches with the Zeiss and copying the prior batch. The next batch was successful even with the standard metallurgy. I believe this is the key and this is what I would recommend for the next batch.

Bartlett, Donald

From: Kenny.Miller@dana.com

Sent: Tuesday, September 16, 2008 4:24 PM

To: Bartlett, Donald

Cc: Allan Comfort ; Rajakumar, Allison; Bill.Ramsey@dana.com; bkoehler@swri.edu; Bob.Brazeau@dana.com; Bob.Sullivan@dana.com; Bruce.McGlone@ArvinMeritor.com; Prengaman, Christopher; Chris Barker; Schenkenberger, Chris; Koglin, Cory; Dale Smith (Dale.Smith@intertek.com); Martin, Dan; Derek.Ottley@dana.com; Dhartej@aam.com; dml@astmtmc.cmu.edu; Bartlett, Donald; Don Bell (don.bell@aftonchemical.com); fmf@astmtmc.cmu.edu; Greene, Galen; Gene.Lawrence@dana.com; greg.fett@dana.com; John Huron (HURO@chevrontexaco.com); Juan Buitrago (jabu@chevrontexaco.com); james.l.linden@gm.com; Jami Pole (jami.pole@aam.com); Jack Zakarian (jaza@chevrontexaco.com); Gropp, Jerrold; Joe.Guzikowski@dana.com; josei1@bp.com; Kerry Hess (Kerry.hess@dana.com); Keith Purnell (kpurnell@sae.org); Lou.Pappademos@dana.com; Mark.Bassett@dana.com; NON-LZ JACKSON MATT; Mike Haire; Mike Horvath (Mike.Horvath@dana.com); Percy Kanga (percy.r.kanga@exxonmobil.com); pvettel@dastuart.net; Rachel Agusti (rachel.agusti@us.army.mil); Graziano, Ricki; Salvetore Rea (salvatore.rea@infineum.com); Higuchi, Samuel; Stephen Eliot (stephen.w.eliot@exxonmobil.com); thelmaemarougy@eaton.com; Tom Bryson (thomas.bryson@volvo.com); Inc William Sullivan (wtsullivan@comcast.net)

Subject: Re: Next L-37 SP Teleconference, Minutes and doc links

Attachments: K. Okamuro TALKING POINTS Sep-15-2008.doc

To all:

I am sending this email to present some agenda discussion items from Dana Off-highway Eng for this Thursday's SP telecon. I would also like to say in response to the panel's request, that we have now hired Ken Okamuro to assist with understanding the issues with the hardware and help determine the way forward. Toward that end, Ken has taken an intial look at the situation and formulated some discussion points for the Thursday meeting. Please see the attached for the discussion topics.

Kenny Miller
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Ken Okamuro Sep 15, 2008

TALKING POINTS FOR L37 SURVIELLANCE PANEL TELECONFERENCE CALL, SEP-18-2008

1) V1L500/P4L870A batch has a problem with tooth breakage and does not discriminate between pass and fail oils.

2) What happened to the current hardware?

a) I am requesting an audit of the test oil at TMC. This means that I want an IR or FTIR analysis of the oil now being distributed. A quantitative and qualitative analysis of, in particular, the additives in formulation for boundary lubrication, typically phosphorus and sulfur but could be others depending on formulation. These should be compared to the formulator's base IR during development. Report to SP high, low, mean with respect to base IR. Are the oil deliveries certified by the blender with IR analysis and records kept by TMC so they know what they are distributing?

b) Dana will request further metallurgical examinations on pinion material chemical segregation, forging defects, non-metallic inclusions, surface carbon, case hardness profile, photomicrographs of structure, and possibly heat treat load density, agitation, and quench speed. We need to compare this data with that of V1L417/P4L792 batch.

3) I believe that the new "off the shelf" pass oils are less robust than previous pass oil. Although the best hardware can provide adequate discrimination, my belief is that the less robust oil has reduced the amount of variation in the hardware that can be tolerated and has reduced discrimination. This does not count the variation in the blending of the test oils, which must have variation, by definition.

4) Multiple failure modes observed in the matrix testing are consistent with expected results and the stress levels that each distress would occur.

5) Comparisons to and requests for V1L417/P4L792 performance may not be possible. It is possible that this batch of material was a 3 sigma batch. Although the mean level of performance of the hardware was increased by the metallurgical and FEA engineering done, you still have the normal manufacturing variation that will occur, regardless.

6) The similarities between the L37 test and a production application is about like a NHRA funny car compared to the family van. The anchors to the past are dependent on maintaining the relative distress ratings to the test oils. While I would argue, as stated before, there has been a change in the pass oil that has "unintended consequences", nevertheless, if the test results on the test oils fall in the historical ranges for all acceptable hardware and the test shows discrimination as in the past, I would argue that fixed test parameters are not necessary, i.e. L42.

7) A reduction in test load will probably be necessary to pass the current and much of the future hardware with any degree of certainty. We have to accommodate variations in the gear sets, steel that they are made from, assembly variation, variations in the test and ratings, and variations in the test oils. In the past 20 years, there have been maybe 2 really good lots of hardware. This should tell you something about the magnitude of all sources of variation.

8) For the future, we can minimize some of the variation through further action now.

Bartlett, Donald

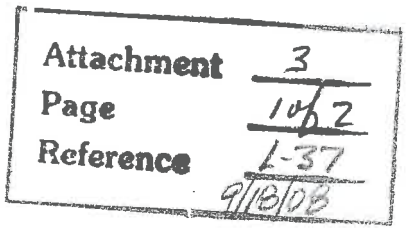
From: Mark.Bassett@dana.com
Sent: Wednesday, September 17, 2008 11:13 AM
To: Bartlett, Donald; Kenny.Miller@dana.com
Subject: FW67-2008 Report on Panel Weights from Custom Coating Run
Attachments: FW67-2008.pdf

Don & Kenny,

Please find attached the Met Lab report on the panels and scrap pinion run at Custom Coating during the July 2008 manganese phosphate run. Please accept my apologies for the delay in formally documenting the results. Our image analysis system was just recently repaired and returned.

Thanks.

Mark Bassett



METALLURGICAL ENGINEERING LAB REPORT
DANA CORPORATION – TORQUE TRACTION TECHNOLOGIES GROUP
FT. WAYNE PLANT
2100 W. STATE BLVD.
FORT WAYNE, INDIANA 46808

LAB NO.	:	FW67-2008	**PART NO.**	:	060GP104
PRINT REV.	:	C	**BUILD DATE**	:	N/A
MARKINGS	:		**HEAT CODE**	:	V1L500
VENDOR	:	Custom Coating, Inc.			
MATERIAL	:	Pinion - 8625	**NO. OF PAGES**	:	1
CUSTOMER	:	ASTM Labs	**MFG. DATE**	:	N/A
REQ. FACILITY	:	Dana FWP	**TAG NO.**	:	N/A
REQUESTED BY	:	Mark Bassett	**REC'D DATE**	:	17July08
REPORTED BY	:	Mark Bassett	**REP. DATE**	:	17September08
ADD. COMMENTS	:				

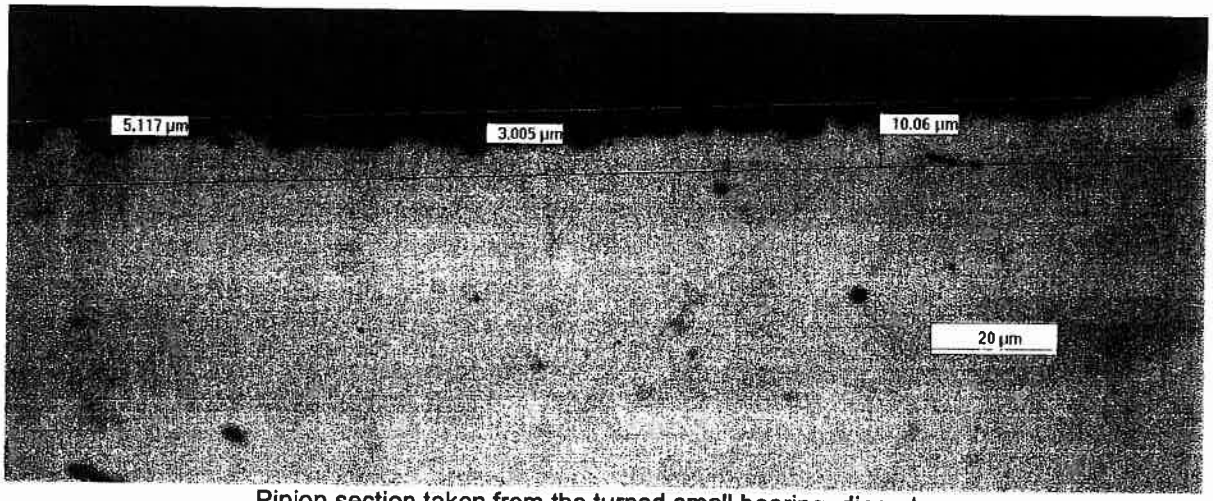
REQUEST: Manganese phosphate coating weights on panels and pitting characterization of a pinion.

REASON: Dana and ASTM request.

COPIES: Miller, Bartlett, Hines

RESULTS: Panel Weight per D059C-005

Panel #	Panel Identification	Coating Weight
1	July 1, 2008 @ 7:00 AM (Beginning of Run)	779.8 mg/ft^2
2	July 1, 2008 @ 11:00 AM (Middle of Run)	812.2 mg/ft/^2
3	July 1, 2008 @ 3:00 PM (End of Run)	789.3 mg/ft^2



Pinion section taken from the turned small bearing diameter.

Conclusion:
Panel weights are very similar to panel weights measured by Henkel. Custom Coating showed panel weights slightly higher. Pitting due to phosphate coating was measured at 3-6 microns. Both measured parameters are as expected.

Attachment 3
2 of 2
Reference L-37
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Met summary of pinion comparison

	2005 V1L417	current V1L500	spec
Case depth PL	0.062	0.063	.050 - .065
Case depth root	- - -	0.036	.025 - .065
Core hardness PL	- - -	43	25-43 HRC
Core hardness root	34	35	25-43 HRC
Surface hardness PL	62	59 - 61	61-63 HRC

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

LAB NO.	: 2008-0531	**PART NO.**	: 060GP105
PART NAME	: HYPOID DRIVE PINION GEAR	**PRINT REVISION**	: F
REPORT TITLE	: PINION, HYPOID DRIVE FINISHED	**MODEL**	: 60
MARKINGS	: DANA D5, 060GP105, V1L500, 41-7 non-Lubrite	**HEAT CODE**	: V1L500
MATERIAL	: STEEL, SAE 8625 PER ES-PM-FW0001	**MFG. DATE**	: UNKNOWN
VENDOR	: DANA – FORT WAYNE	**SAMPLE REQ.**	: N/A
CUSTOMER	: ASTM (SWRI, LUBRIZOL, AFTON)	**VIN**	: N/A
TAR NO.	: N/A	**MAR NO.**	: MAR-3470
TEST ENG.	: N/A	**RECEIVED DATE**	: 7/14/08
REQUEST BY	: JOE GUZIKOWSKI	**REPORT DATE**	: 7/17/08
REPORT BY	: GREG TROEMNER	**NO. OF PAGES**	: 14

ADDITIONAL COMMENTS : EVALUATION WAS PERFORMED ON THE PINIONS FROM FOUR HYPOID DRIVE GEAR SETS, PART #060GA105X, THAT WERE UTILIZED IN ASTM L-37 GEAR LUBRICANT TESTS. THE TESTING WAS CONDUCTED BY SOUTHWEST RESEARCH INSTITUTE (SWRI), LUBRIZOL, AND AFTON (TWO SETS) TO VALIDATE THIS BATCH OF GEAR SETS FOR SUBSEQUENT ASTM TESTS. THESE PINIONS WERE SHOT PEENED, BUT NOT PHOSPHATE COATED. THE MATING RING GEARS WERE SPECIFIED AS PART #060GR105, BUT WERE ACTUALLY MARKED AS PART #060GR104.

ASTM L-37 GEAR LUBRICANT TEST – GEAR SET SAMPLE IDENTIFICATION

TEST LAB	TEST KEY	STD	RUN	OIL TYPE	PSPIT	KUSA
SWRI *	64181	4	219	153-1	9.8	?
LUBRIZOL	61848	191	2637	155	9.6	5143
LUBRIZOL	63270	191	2642	153-1	2	5401
AFTON	58892	3A	926	155	2	4933

** A COMPLETE METALLURGICAL ANALYSIS WAS PERFORMED ON THE GEAR SET FROM SWRI. THE OTHER THREE GEAR SETS WERE ONLY PHOTO-DOCUMENTED.*

COPIES : JOE GUZIKOWSKI, DANA COMBS, GREG FETT

REQUEST : PERFORM METALLURGICAL ANALYSIS OF THE SWRI TESTED HYPOID PINION TO VERIFY PART MEETS SPECIFICATION REQUIREMENTS.

REASON : THESE GEAR SETS PERFORMED INCONSISTENTLY IN THE L-37 EVALUATION AT THE VARIOUS TESTING FACILITIES. SOME OF THE GEAR SETS YIELDED GOOD RESULTS WHILE OTHERS DID NOT PASS.

RESULTS : **VISUAL INSPECTION**

SWRI SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON BOTH DRIVE AND COAST SIDES WITH HEAVIER POLISH ON THE DRIVE SIDE AND LIGHTER POLISH ON THE COAST SIDE. ON THE DRIVE SIDE THERE APPEARED TO BE A DARKER REGION OF RIDGING AND POLISH TOWARD THE HEEL END, WHILE AT THE TOE END THE RIDGING AND POLISH WAS SOMEWHAT LIGHTER. THE COAST SIDE EXHIBITED SOME EVIDENCE OF LIGHT SCORING IN THE CENTRAL UPPER FLANK REGION OF THE TOOTH (FIGURES 1 – 4).

LUBRIZOL 155 SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON THE TEETH, LIGHTLY POLISHED, AND UNIFORM IN APPEARANCE (FIGURES 8 – 10).

LUBRIZOL 153 SAMPLE: THE GEAR CONTACT PATTERNS WERE SHIFTED SLIGHTLY TOWARD THE TOOTH TOE END WITH HEAVY POLISH PRESENT ON THE DRIVE SIDE AND LIGHT POLISH FOUND ON THE COAST SIDE. ONE OF THE TEETH WAS FRACTURED IN THE CENTRAL UPPER FLANK REGION (FIGURES 11 – 13).

AFTON SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON THE TEETH, POLISHED, AND UNIFORM IN APPEARANCE. THERE WAS HEAVIER POLISH ON THE DRIVE SIDE AND MULTIPLE TEETH WERE FRACTURED IN THE CENTRAL UPPER FLANK REGION (FIGURES 14 – 16).

MAGNETIC PARTICLE INSPECTION ASTM E709-01

THERE WERE NO INDICATIONS OF ANY FRACTURES OBSERVED IN THIS ~~PINION~~.

Attachment 4
Page 2 of 12
Reference L-37 9/18/08

CASE MICROHARDNESS MEASUREMENTS – GEAR TEETH

ASTM E384-06

CASE HARDNESS VALUES WERE OBTAINED BY CONVERTING THE 500G VICKERS CASE MICROHARDNESS MEASUREMENT DATA FROM THE GEAR TEETH TO HRC. HARDNESS TRAVERSE WAS TAKEN ON THE TOOTH COAST SIDE.

CASE MICROHARDNESS – GEAR TEETH (HV CONVERTED TO HRC)		
LOCATION	PITCH	ROOT
TRAVERSE DEPTH (in.)	HRC RESULT	HRC RESULT
0.002	63.1	60.8
0.004	61.3	59.4
0.006	61.1	59.4
0.008	60.1	59.1
0.010	60.0	59.5
0.020	59.3	58.0
0.030	58.7	55.2
0.040	56.5	47.5
0.050	52.8	44.4
0.060	51.2	38.4
0.070	48.5	36.8
0.080	45.5	36.4
0.090	44.4	30.9
0.100	45.9	34.5
0.110	45.3	31.6

EFFECTIVE CASE DEPTH OF GEAR TEETH – MEASURED AT 50 HRC

SAE J423 FEB. 1998

CASE DEPTH VALUES WERE OBTAINED BY INTERPOLATING THE CASE MICROHARDNESS MEASUREMENT DATA TO 50 HRC.

EFFECTIVE CASE DEPTH – GEAR TEETH (in. @ 50 HRC)		
LOCATION	DEPTH (in.)	SPECIFICATION
PITCH	0.063" (1.60 mm)	0.050" - 0.065" (1.27 mm - 1.65 mm)
ROOT	0.036" (0.91 mm)	0.025" - 0.065" (0.64 mm - 1.65 mm)

SURFACE HARDNESS – GEAR TEETH

ASTM E384-06

SURFACE HARDNESS VALUES WERE OBTAINED BY CONVERTING THE 500G VICKERS CASE MICROHARDNESS DATA AT 0.004" AND 0.006" BELOW THE SURFACE TO HRC.

SURFACE HARDNESS – GEAR TEETH (HRC)		
LOCATION	HRC RESULT (0.004", 0.006")	SPECIFICATION
PITCH	61, 61	57 - 66 HRC (ES-HT-FW0204)
ROOT	59, 59 *	61 - 63 (PART PRINT)

** OUTSIDE OF SPECIFIED RANGE FOR PART PRINT (NOTE DRIVE SIDE ROOT MEASURED 62, 61 HRC)*

CORE HARDNESS – GEAR TEETH

ASTM E18-05

CORE HARDNESS MEASUREMENTS IN HRC WERE OBTAINED DIRECTLY FROM THE METALLOGRAPHIC MOUNT.

CORE HARDNESS – GEAR TEETH (HRC)		
LOCATION	HRC RESULT	SPECIFICATION
PITCH	43	--
ROOT	35	25 - 43 HRC (ES-HT-FW0204)
1/8" BELOW ROOT	32	--

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CORE HARDNESS – PINION OUTBOARD BEARING

ASTM E18-05

CORE HARDNESS MEASUREMENTS IN HRC WERE OBTAINED FROM THE MID-RADIUS OF A TRANSVERSE SECTION TAKEN AT THE OUTBOARD BEARING OF THE STEM.

CORE HARDNESS – PINION OUTBOARD BEARING (HRC)		
LOCATION	HRC RESULT	SPECIFICATION
MID-RADIUS	29, 30, 29, 28	--

CHEMICAL ANALYSIS

ASTM E415-99 (2005)

CHEMICAL ANALYSIS WAS DETERMINED BY OPTICAL EMISSION SPECTROSCOPY.

CHEMICAL ANALYSIS			
ELEMENT	PINION SAMPLE (%)	SPECIFICATION SAE 8625 (%)	SPECIFICATION DANA ES-PM-FW0001 (%)
C	0.26	0.23 – 0.28	--
Mn	0.80	0.70 – 0.90	--
P	0.011	0.035 MAX	--
S	0.016	0.040 MAX	--
Si	0.23	0.15 – 0.35	--
Ni	0.48	0.40 – 0.70	--
Cr	0.50	0.40 – 0.60	--
Mo	0.20	0.15 – 0.25	--
Cu	0.19	--	0.35 MAX
Al	0.021	--	0.015 – 0.050
Sn	0.009	--	0.025 MAX
V	0.003	--	0.020 MAX
Nb	0.001	--	0.010 MAX
Zr	0.001	--	0.010 MAX
B	0.0002	--	0.0005 MAX
Ti	0.002	--	0.010 MAX
Pb	0.001	--	0.010 MAX
Ca	0.0006	--	0.0030 MAX
N	0.007	--	0.015 MAX
As	0.005	--	0.010 MAX
Zn	0.002	--	0.030 MAX
Sb	0.000	--	0.010 MAX
D.I. *	2.52	2.10 – 2.60	--

** FOR REFERENCE ONLY*

MICROSTRUCTURE – GEAR TEETH

MICROSTRUCTURE WAS DETERMINED FROM A GEAR TOOTH CROSS-SECTION SAMPLE TAKEN PERPENDICULAR TO THE TOOTH AXIS AT A LOCATION MIDWAY BETWEEN THE TOE AND HEEL (FIGURES 5 – 7).

MICROSTRUCTURE ANALYSIS – GEAR TEETH	
LOCATION	MICROSTRUCTURE
TOOTH CASE	TEMPERED MARTENSITE
TOOTH CORE	TRANSFORMATION PRODUCTS
SURFACE – IGO DEPTH (in.)	0.0004" – 0.0008"
SURFACE – NMTP DEPTH (in.)	0.0002" – 0.0006"

CONCLUSION : THE SWRI PINION MET ALL METALLURGICAL SPECIFICATION REQUIREMENTS.

THE SWRI AND LUBRIZOL 153 PINIONS EXHIBIT HARD CONTACT AND RIDGING AT THE HEEL END RUNNING UP OVER THE TOP OF THE TOOTH AT MID TOOTH. THIS CORRESPONDS TO THE HARD CONTACT AREA FOUND ON THE MATING RING GEARS AT THE BOTTOM OF CONTACT ON THE FLANK. THE LUBRIZOL 155 PINION APPEARS TO BE IN GOOD CONDITION WITH UNIFORM WEAR. THE AFTON PINION EXHIBITS SOME METAL DEFORMATION AT THE TOP OF CONTACT AT THE CENTRAL HEEL POSITION. THIS APPEARS TO BE AN AREA OF HIGH CONTACT STRESS ON ALL FOUR PINIONS. THE LUBRIZOL 153 AND AFTON PINIONS BOTH HAD FATIGUE FRACTURES, WHICH INITIATED AT THIS POSITION.

RELATED REPORT :

MAT LAB REPORT	MAR	PART NUMBER	PART NAME
2008-0532	3470	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0571	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0572	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0589	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0590	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0668	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0669	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0703	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0704	2880	060GR105	GEAR – HYPOID DRIVE FINISHED

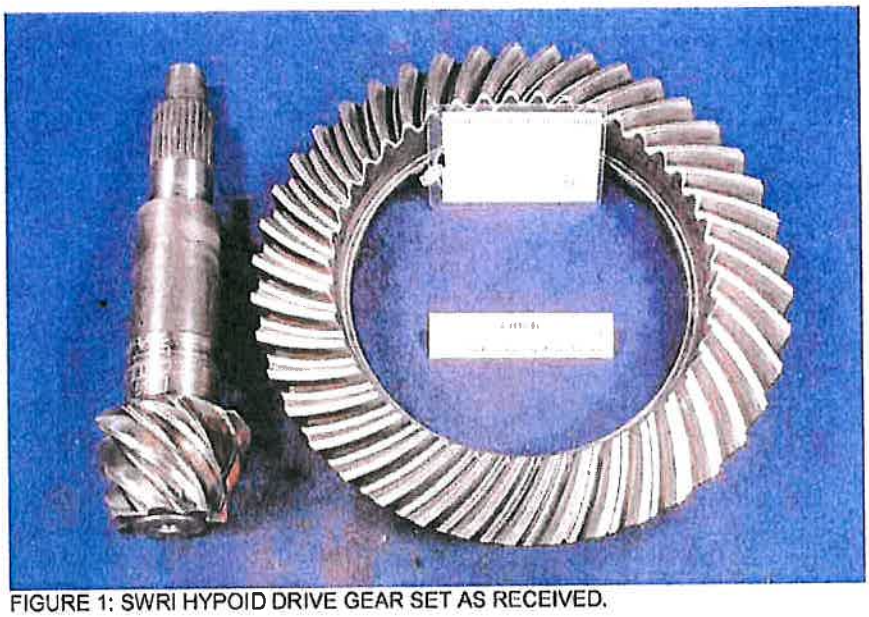

FIGURE 1: SWRI HYPOID DRIVE GEAR SET AS RECEIVED.

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

LAB NO. : 2008-0532
PART NAME : HYPOID DRIVE RING GEAR
REPORT TITLE : GEAR, HYPOID DRIVE FINISHED
MARKINGS : DANA D, 060GR104, P4T813, 41-7 non-Lubrite
MATERIAL : STEEL, SAE 8615 PER ES-PM-FW0001
VENDOR : DANA – FORT WAYNE
CUSTOMER : ASTM (SWRI, LUBRIZOL, AFTON)
TAR NO. : N/A
TEST ENG. : N/A
REQUEST BY : JOE GUZIKOWSKI
REPORT BY : GREG TROEMNER

PART NO. : 060GR105
PRINT REVISION : D
MODEL : 60
HEAT CODE : P4T813
MFG. DATE : 10/3/06
SAMPLE REQ. : N/A
VIN : N/A
MAR NO. : MAR-3470
RECEIVED DATE : 7/14/08
REPORT DATE : 7/17/08
NO. OF PAGES : 16

ADDITIONAL COMMENTS : EVALUATION WAS PERFORMED ON THE RING GEARS FROM FOUR HYPOID DRIVE GEAR SETS, PART #060GA105X, THAT WERE UTILIZED IN ASTM L-37 GEAR LUBRICANT TESTS. THE TESTING WAS CONDUCTED BY SOUTHWEST RESEARCH INSTITUTE (SWRI), LUBRIZOL, AND AFTON (TWO SETS) TO VALIDATE THIS BATCH OF GEAR SETS FOR SUBSEQUENT ASTM TESTS. THESE RING GEARS WERE SPECIFIED AS PART #060GR105, BUT WERE ACTUALLY MARKED PART #060GR104. THEY WERE SHOT PEENED, BUT NOT PHOSPHATE COATED. THE MATING PINIONS WERE PART #060GP105.

ASTM L-37 GEAR LUBRICANT TEST – GEAR SET SAMPLE IDENTIFICATION

TEST LAB	TEST KEY	STD	RUN	OIL TYPE	PSPIT	KUSA
SWRI *	64181	4	219	153-1	9.8	?
LUBRIZOL	61848	191	2637	155	9.6	5143
LUBRIZOL	63270	191	2642	153-1	2	5401
AFTON	58892	3A	926	155	2	4933

** A COMPLETE METALLURGICAL ANALYSIS WAS PERFORMED ON THE GEAR SET FROM SWRI. THE OTHER THREE GEAR SETS WERE ONLY PHOTO-DOCUMENTED.*

COPIES : JOE GUZIKOWSKI, DANA COMBS, GREG FETT

REQUEST : PERFORM METALLURGICAL ANALYSIS OF THE SWRI TESTED RING GEAR TO VERIFY PART MEETS SPECIFICATION REQUIREMENTS.

REASON : THESE GEAR SETS PERFORMED INCONSISTENTLY IN THE L-37 EVALUATION AT THE VARIOUS TESTING FACILITIES. SOME OF THE GEAR SETS YIELDED GOOD RESULTS WHILE OTHERS DID NOT PASS.

RESULTS : **VISUAL INSPECTION**

SWRI SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON BOTH DRIVE AND COAST SIDES WITH HEAVIER POLISH ON THE DRIVE SIDE AND LIGHTER POLISH ON THE COAST SIDE. ON THE DRIVE SIDE THERE WAS AN UNEVEN PATTERN OF RIDGING AND HEAVY POLISH TOWARD THE HEEL END, WHICH TAPERED TO A LIGHTER POLISH TOWARD THE TOE END. A BAND OF HARD CONTACT WAS OBSERVED ON THE DRIVE SIDE UPPER FLANK AT THE EDGE OF THE TOP LAND. ALTHOUGH THERE WAS LITTLE TO NO CONTACT IN THE MID FLANK AREA AT THE TOE END, THERE WAS HEAVIER CONTACT TOWARD THE ROOT (FIGURES 1 – 6).

LUBRIZOL 155 SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON THE TEETH, LIGHTLY POLISHED, AND UNIFORM IN APPEARANCE (FIGURES 10 – 12).

LUBRIZOL 153 SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON THE TEETH, HEAVILY POLISHED ON THE DRIVE SIDE, AND MORE LIGHTLY POLISHED ON THE COAST SIDE. THERE WAS SIGNIFICANT RIDGING PRESENT ON THE DRIVE SIDE OVER MUCH OF THE FLANK, WITH THE HEAVIEST AT THE HEEL END AND SLIGHTLY LESS AT THE TOE END. A BAND OF HARD CONTACT WAS OBSERVED ON THE DRIVE SIDE UPPER FLANK AT THE EDGE OF THE TOP LAND TOWARD THE TOE END (FIGURES 13 – 15).

AFTON SAMPLE: THE GEAR CONTACT PATTERNS WERE CENTERED ON THE TEETH, LIGHTLY POLISHED, AND UNIFORM IN APPEARANCE (FIGURES 16 – 18).

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MAGNETIC PARTICLE INSPECTION

ASTM E709-01

THERE WERE NO INDICATIONS OF ANY FRACTURES OBSERVED IN THIS RING GEAR.

CASE MICROHARDNESS MEASUREMENTS – GEAR TEETH

ASTM E384-06

CASE HARDNESS VALUES WERE OBTAINED BY CONVERTING THE 500G VICKERS CASE MICROHARDNESS MEASUREMENT DATA FROM THE GEAR TEETH TO HRC. HARDNESS TRAVERSE WAS TAKEN ON THE TOOTH COAST SIDE.

CASE MICROHARDNESS – GEAR TEETH (HV CONVERTED TO HRC)		
LOCATION	PITCH	ROOT
TRAVERSE DEPTH (in.)	HRC RESULT	HRC RESULT
0.002	60.7	62.4
0.004	61.3	61.7
0.006	60.4	61.1
0.008	60.0	60.2
0.010	60.1	59.5
0.020	58.5	55.2
0.030	55.4	48.2
0.040	51.9	40.3
0.050	48.3	29.4
0.060	45.2	30.0
0.070	45.9	30.5
0.080	44.0	30.5
0.090	43.2	29.6
0.100	40.4	27.3
0.110	42.5	27.0

EFFECTIVE CASE DEPTH OF GEAR TEETH – MEASURED AT 50 HRC

SAE J423 FEB. 1998

CASE DEPTH VALUES WERE OBTAINED BY INTERPOLATING THE CASE MICROHARDNESS MEASUREMENT DATA TO 50 HRC.

EFFECTIVE CASE DEPTH – GEAR TEETH (in. @ 50 HRC)		
LOCATION	DEPTH (in.)	SPECIFICATION
PITCH	0.045" (1.14 mm)	0.040" - 0.055" (1.02 mm - 1.40 mm)
ROOT	0.027" (0.68 mm)	0.020" - 0.055" (0.51 mm - 1.40 mm)

SURFACE HARDNESS – GEAR TEETH

ASTM E384-06

SURFACE HARDNESS VALUES WERE OBTAINED BY CONVERTING THE 500G VICKERS CASE MICROHARDNESS DATA AT 0.004" AND 0.006" BELOW THE SURFACE TO HRC.

SURFACE HARDNESS – GEAR TEETH (HRC)		
LOCATION	HRC RESULT (0.004", 0.006")	SPECIFICATION
PITCH	61, 60 *	57 - 66 HRC (ES-HT-FW0204) 61 - 63 (PART PRINT)
ROOT	62, 61	

** OUTSIDE OF SPECIFIED RANGE FOR PART PRINT (NOTE DRIVE SIDE PITCH MEASURED 62, 61 HRC)*

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CORE HARDNESS – GEAR TEETH

ASTM E18-05

CORE HARDNESS MEASUREMENTS IN HRC WERE OBTAINED DIRECTLY FROM THE METALLOGRAPHIC MOUNT.

CORE HARDNESS – GEAR TEETH (HRC)		
LOCATION	HRC RESULT	SPECIFICATION
PITCH	41	--
ROOT	33	25 - 43 HRC (ES-HT-FW0204)
1/8" BELOW ROOT	27	--

CHEMICAL ANALYSIS

ASTM E415-99 (2005)

CHEMICAL ANALYSIS WAS DETERMINED BY OPTICAL EMISSION SPECTROSCOPY.

CHEMICAL ELEMENT	RING GEAR SAMPLE (%)	SPECIFICATION SAE 8620 (%)	SPECIFICATION SAE 8620A (%)	SPECIFICATION DANA ES-PM-FW0001 (%)
C	0.18	0.18 – 0.23	0.18 – 0.23	--
Mn	0.88	0.70 – 0.90	0.80 MIN	--
P	0.008	0.035 MAX	0.035 MAX	--
S	0.032	0.040 MAX	0.040 MAX	--
Si	0.26	0.15 – 0.35	0.15 – 0.35	--
Ni	0.42	0.40 – 0.70	0.40 – 0.70	--
Cr	0.56	0.40 – 0.60	0.50 MIN	--
Mo	0.16	0.15 – 0.25	0.20 MIN	--
Cu	0.25	--	--	0.35 MAX
Al	0.030	--	--	0.015 – 0.050
Sn	0.011	--	--	0.025 MAX
V	0.002	--	--	0.020 MAX
Nb	0.001	--	--	0.010 MAX
Zr	0.001	--	--	0.010 MAX
B	0.0002	--	--	0.0005 MAX
Ti	0.002	--	--	0.010 MAX
Pb	0.000	--	--	0.010 MAX
Ca	0.0004	--	--	0.0030 MAX
N	0.008	--	--	0.015 MAX
As	0.005	--	--	0.010 MAX
Zn	0.002	--	--	0.030 MAX
Sb	0.000	--	--	0.010 MAX
D.I. *	1.89	1.80 – 2.30	2.05 – 2.55	--

** FOR **REFERENCE** ONLY*

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MICROSTRUCTURE – GEAR TEETH

MICROSTRUCTURE WAS DETERMINED FROM A GEAR TOOTH CROSS-SECTION SAMPLE TAKEN PERPENDICULAR TO THE TOOTH AXIS AT A LOCATION MIDWAY BETWEEN THE TOE AND HEEL (FIGURES 7 – 9).

MICROSTRUCTURE ANALYSIS – GEAR TEETH	
LOCATION	MICROSTRUCTURE
TOOTH CASE	TEMPERED MARTENSITE
TOOTH CORE	TRANSFORMATION PRODUCTS
SURFACE – IGO DEPTH (in.)	0.0004" – 0.0006"
SURFACE – NMTP DEPTH (in.)	0.0004" – 0.0008"

CONCLUSION : THE SWRI RING GEAR MET ALL METALLURGICAL SPECIFICATION REQUIREMENTS. THE CHEMISTRY APPEARS TO INDICATE THE STEEL IS SAE 8620 RATHER THAN 8620A. HOWEVER, THE CORE HARDNESS IS WELL WITHIN SPECIFICATION.

THE SWRI AND LUBRIZOL 153 RING GEARS EXHIBITED HARD CONTACT AT THE HEEL END TOWARD THE BOTTOM OF THE CONTACT AREA ON THE FLANK. CONTACT AT THE TOE END WAS MISSING IN SPOTS. THE LUBRIZOL 155 AND AFTON RING GEARS APPEARED TO BE IN GOOD CONDITION WITH FULL EVEN CONTACT.

RELATED REPORT :

MAT LAB REPORT	MAR	PART NUMBER	PART NAME
2008-0532	3470	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0571	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0572	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0589	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0590	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0668	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0669	2880	060GR105	GEAR – HYPOID DRIVE FINISHED
2007-0703	2880	060GP105	PINION – HYPOID DRIVE FINISHED
2007-0704	2880	060GR105	GEAR – HYPOID DRIVE FINISHED

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Lou
Pappademos/SAD/Dana
09/17/2008 03:30 PM

To Kenny Miller/SOHPD/Dana@DanaCorp
cc
bcc
Subject Met Lab Reports for 060GP105 / 060GR105

Dana Corporation
Fort Wayne Plant
Metallurgical Lab
P.O. Box 750
Fort Wayne, IN 46801

PPAP Metallurgical Test Report

Part Name: Pinion	**Lab No:** A879
Part No: 060GP105	**Chem No:**
Vendor: Dana Fort Wayne	**Date:** 12/8/05
Heat Code: V1L417 2005 non-Lubrite	**Revision Level:** C 5/2/03

Reasons for PPAP

New Part #:	**Print or Specification Change:** List:
New Vendor:	**Process Change:** List:
Routine Check: Yes	**Other:** List:

PPAP Test Results

Test Name/#	Test Performed	Test Data	Pass/Nonconforming
SAE J423-Feb 98	Case Depth @ 50 HRC .05"/.065"	.062"	P
ASTM E18-00	Root Core Hardness - 25-43 HRC	34RC	P
D059M-001	Case Hardness @ .003" - 61-63 HRC	62RC	P
D059-114 NSTP-E	No network carbides in case.	None	P
D059-114 NSTP-E	10% max ferrite in core.	OK	P
ASTM E-415	C - .19/.25	.27	
ASTM E-415	Mn - .70/1.05	.78	
ASTM E-415	Ni - .35/.75	.42	

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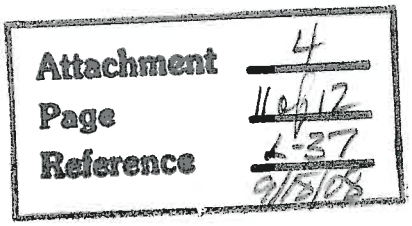
ASTM E-415	Cr - .35-.65	.50	
ASTM E-415	Mo - .30/.40	.15	
ASTM E-415	S - .020/.040	.019	P
ASTM E-415	P - .035 max	.009	P
ASTM E-415	Al - .015/.050	.026	P
D059-114 NSTP-E	Bainite Depth - .001" max	.0006"	P
D059-114 NSTP-E	Oxide Depth - .001 max	.0006"	P
D059-114 NSTP-E	% Retained Austenite - 10% maximum (aim)	5%	P
D059M-001	Case hardness @ .050" - 50 HRC min	54RC	P
D059M-001	Case hardness @ .065" - 50 HRC min	47RC	P
	Shot Peen - 7.5-9 C	8.0/8.0	P
ASTM E384-99	Thread Carburized Case Hardness 30-45 HRC per FW-306	40RC	P
ASTM E18-00	FW-306 Thread Core Hardness 25 Rc max.	20RC	P

Conclusion: These parts are made from 8625 per print specification. This test plan shows chemical range for 8822. THe parts meet the metallurgical requirements of the print. Parts were processed on CZ3 cycle Carb#5 with Z1-Z3 10 degrees lower (12 hour total cycle).

Metallurgist: David R. Duffy



Dana Corporation
Fort Wayne Plant
Metallurgical Lab
P.O. Box 750
Fort Wayne, IN 46801

PPAP Metallurgical Test Report

Part Name: Ring Gear	**Lab No:** A878
Part No: 060GR105	**Chem No:**
Vendor: Dana Fort Wayne	**Date:** 12/9/05
Heat Code: P4L792	**Revision Level:** C 4/8/04

Reasons for PPAP

New Part #:	**Print or Specification Change:** **List:**
New Vendor:	**Process Change:** **List:**
Routine Check: Yes	**Other:** **List:**

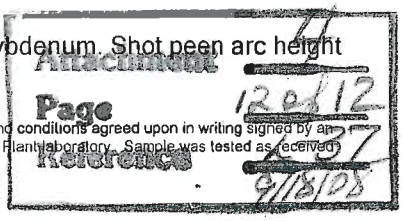
PPAP Test Results

Test Name/#	Test Performed	Test Data	Pass/Nonconforming
SAE J423-Feb 98	Case Depth @ 50 HRC .040"/.055"	.045"	P
ASTM E18-00	Root Core Hardness - 25-43 HRC	30RC	P
D059M-001	Case Hardness @ .003" - 58-60 HRC	58RC Top of Tooth	P
D059-114 NSTP-E	No network carbides in case.	None	P
D059-114 NSTP-E	10% max ferrite in core.	OK	P
ASTM E415	C- .18/.23	.22	P
ASTM E415	Mn - .80 minimum	.86	P
ASTM E415	Ni - .40/.70	.35	F
ASTM E415	Cr - .50 minimun	.52	P
ASTM E415	Mo - .20 minimum	.15	F
ASTM E415	S - .040 maximum	.027	P
ASTM E415	P - .035 maximum	.015	P
ASTM E415	Al - .015-.050	.018	P
D059-114 NSTP-E	Bainite Depth - .001" max	.0000"	P
D059-114 NSTP-E	Oxide Depth - .001 max	.0006"	P
D059-114 NSTP-E	% Retained Austenite - 30% maximum (aim)	20%	P
D059M-001	Case hardness @ .040" - 50 HRC min	52RC	P
'D059M-001	Case hardness @ .055" - 50 HRC max	44RC	P
	Part Weight	13.085#	
	Shot Peen	Arc Height 7.5-9.0 Spec. Achieved 7.6,7.5,7.8,7.6,7.3,7.6	
		Parts Run Carb#2 14.11 Timer for 8 hr cycle and tempered 360 F for 2 hr.	

Conclusion: Parts do not meet chemical requirements for nickel and molybdenum. Shot peen arc height is at or below minimum specified on print.

Metallurgist: David R. Duffy

We certify: The product on the above certification substantially conforms to the SAE, ASTM or customer specifications and conditions agreed upon in writing signed by an authorized representative The above data accurately represents values generated in the Dana Spicer Axle Fort Wayne Plant laboratory. Sample was tested as received.



NOTE: Reid Miller APPROVAL TO ATTACH TO MINUTES

UNCONTROLLED 9/17/2008 3:10 PM

Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking # 060GA105x-B-11-May-28-2008

Manufacturing Facility	11	T T Group USA - Ft. Wayne
Gear Set Part #	060GA105x	Engineering Drawing Change Level: B
Pinion Part #	060GP105	Engineering Drawing Change Level: D
Ring Gear Part #	060GR105	Engineering Drawing Change Level: Rel.

Pinion Heat Code V1L500
RG Heat Code P4T813

Gear Set # or Serial #	2A	
Etch Position	0	Thousanths of an inch
Report Date	May 28, 2008	Enter MM/DD/YY (Month/Day/Year)
Customer (User Facility)	13	SOH Axle Div USA - Statesville
Gear PPAP Reason	19	Other - Please Explain in Box Below.
Explain Reason Other	"Hard" Gear Master Development for 4th fire distortion - #2 Carburizer: **Final Development**	
Gear PPAP Type	2	New/Original Submission

General Summary Data:

Summary #	S060586B

	Pinion	Gear	
Number of Teeth	7	41	
Face Width		1.438	In
Pinion Offset	1.125		In
Gear Pitch Diameter		9.750	In

Note: Enter angles as Deg.Min (Example: 15 deg. And 3 min. enter as 15.03)

Pitch Angle	10.55	Deg.Min (Ex. 15.03)	78.41	Deg.Min
Mean Spiral Angle	45.09	Deg.Min	29.51	Deg.Min

Gear ES Spec's.

MTE	2	None
Precision Index	2	None

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	Leave Blank

	Pinion	Gear
	Leave Blank	Leave Blank
	Leave Blank	Leave Blank
	Leave Blank	Leave Blank

Continue to Input F

Attachment 5
Page 1 of 3
Reference 9/18/08

Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking # 060GA105x-B-11-May-28-2008 **Report Date** May 28, 2008

Tester Backlash @ Mounting Distance | 3 | (Units are thousandths of an inch, Example: .003" = 3)

Tester Pattern Position @ Etch Per Dana In-Contact Workbook

Position @ Etch	Gear Convex	Gear Concave
Lengthwise	2	3
Flank	3	10

V & H Values: (Units are thousandth's of an inch, Example: 0.003" = 3)

Summary

	Etch	Toe	Heel	Total
Gear Convex V:	0	1	-18	19
Gear Convex H:	-4	-6	22	28
Gear Concave V:		-2	26	28
Gear Concave H:		2	-39	41

Actual (Toe & Heel Values are from Etch Position)

	Etch	Toe	Heel	Total
Gear Convex V:	0	7	-17	24
Gear Convex H:	0	-10	16	26
Gear Concave V:		-7	7	14
Gear Concave H:		-1	-24	23

Bold |Actual - Summary| ≥ 2 **Bold** |Actual - Summary| ≥ 4

Attachment 5
Page 2 of 9
Reference L-27
9/18/08

Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking # 060GA105x-B-11-May-28-2008
Report Date May 28, 2008

V & H Pictures

1) Highlight Appropriate Picture Cell and Then ***Insert -- Picture -- From File***
2) PRESS ***Ctrl S*** to Automatically re-size Picture

Gear Convex at Etch	Gear Convex at Toe	Gear Convex at Heel
		

Gear Concave at Etch	Gear Concave at Toe	Gear Concave at Heel
		

Please Note!!! -- (To minimize data file size)

1) Save pictures as **.jpg** files before inserting.
2) Use the **INSERT -- PICTURE -- FROM FILE** function to insert pictures.

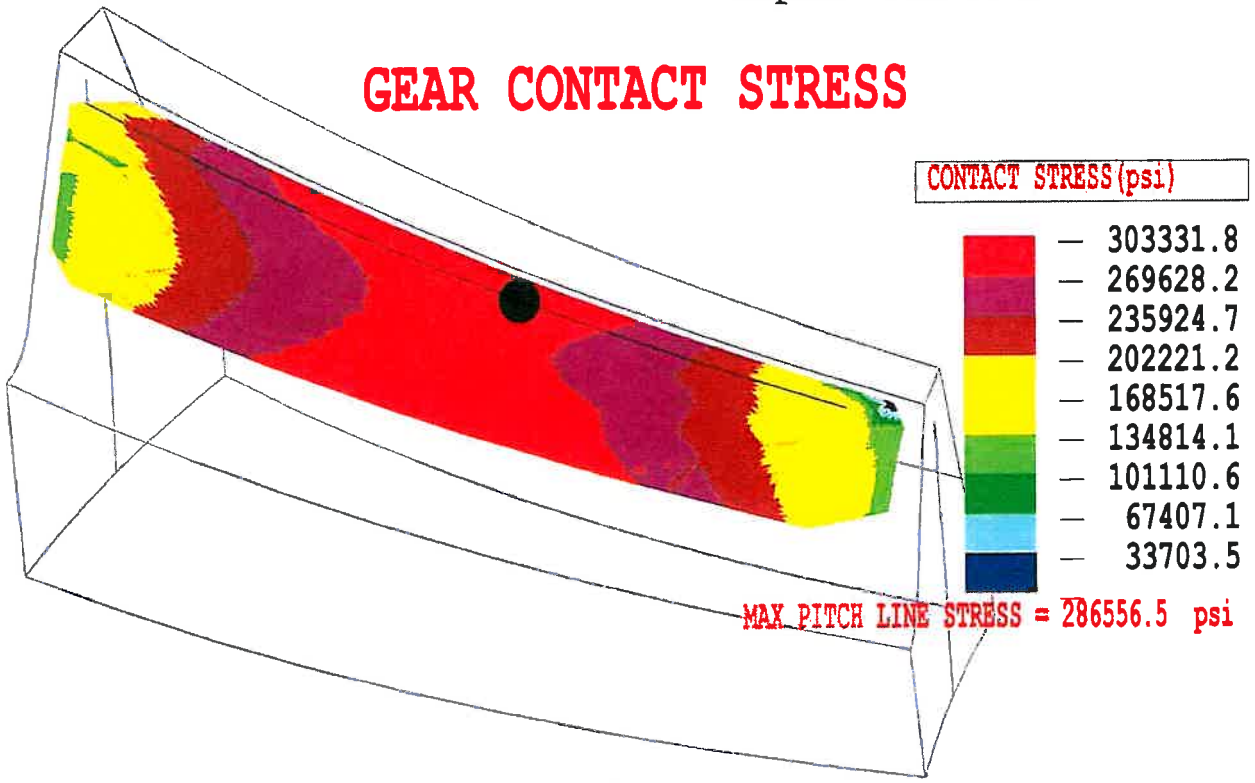
Attachment 5
Page 30 of 8
Reference L-37
9/15/08

V1L500 / P4T813

INPUT FILE: S060586B-7N.SPA
OUTPUT FILE: S060586B-7N.out
GEAR TORQUE: 3480.000 lb-ft
09\17\2008 VERSION 8.19 time:10:01am

V= -.0050 in E= -.01295 in
H= -.0080 in P= 0.00907 in
G= 0.0000 in G= 0.00392 in
cmf= 0.9500 A= 0.00071 ra
Separation factor= 0.00025

GEAR CONTACT STRESS



Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking #	060GA105x-B-11-Mar-20-2008

Manufacturing Facility	11	T T Group USA - Ft. Wayne
Gear Set Part #	060GA105x	
Pinion Part #	060GP105	
Ring Gear Part #	060GR105	

Engineering Drawing Change Level	B
Engineering Drawing Change Level	C
Engineering Drawing Change Level	C

Pinion Heat Code: V1L417
Ring Gear Heat Code: P4L792

Gear Set # or Serial #	7H	
Etch Position	0	Thousanths of an inch
Report Date	March 20, 2008	Enter MM/DD/YY (Month/Day/Year)
Customer (User Facility)	13	SOH Axle Div USA - Statesville
Gear PPAP Reason	19	Other - Please Explain in Box Below.
Explain Reason Other	V&H w/ photographs of lapped, finished gear set @ FWP for SOHAD S060586	
Gear PPAP Type	2	New/Original Submission

General Summary Data:

Summary #	S060586

	Pinion	Gear	
Number of Teeth	7	41	
Face Width		1.438	In
Pinion Offset	1.125	In	
Gear Pitch Diameter		9.750	In

Note: Enter angles as Deg.Min (Example: 15 deg. And 3 min. enter as 15.03)

Pitch Angle	10.55	Deg.Min (Ex. 15.03)	78.41	Deg.Min
Mean Spiral Angle	45.09	Deg.Min	29.51	Deg.Min

Gear ES Spec's.

MTE	2	None
Precision Index	2	None

Leave Blank
Leave Blank

	Pinion	Gear
	Leave Blank	Leave Blank
	Leave Blank	Leave Blank
	Leave Blank	Leave Blank

Continue to Input F

Attachment 5
Page 5 of 8
Reference L-37
9/18/08

Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking # 060GA105x-B-11-Mar-20-2008 **Report Date** March 20, 2008

Tester Backlash @ Mounting Distance | 3 | (Units are thousandths of an inch, Example: .003" = 3)

Tester Pattern Position @ Etch Per Dana In-Contact Workbook

Position @ Etch	Gear Convex	Gear Concave
Lengthwise	2	2
Flank	-2	-1

V & H Values: (Units are thousandth's of an inch, Example: 0.003" = 3)

Summary

	Etch	Toe	Heel	Total
Gear Convex V:	0	2	-18	20
Gear Convex H:	0	-3	20	23
Gear Concave V:		-17	14	31
Gear Concave H:		24	-17	41

Actual (Toe & Heel Values are from Etch Position)

	Etch	Toe	Heel	Total
Gear Convex V:	0	**7**	**-20**	**27**
Gear Convex H:	0	-3	**26**	**29**
Gear Concave V:		**-10**	15	**25**
Gear Concave H:		**8**	**-19**	**27**

Bold |Actual - Summary| ≥ 2 **Bold** |Actual - Summary| ≥ 4

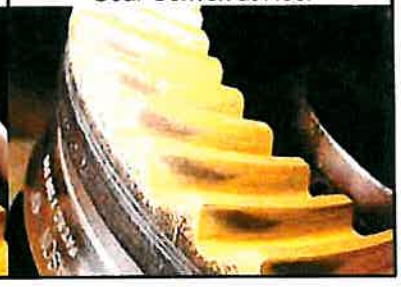
Attachment 5
Page 6 of 8
Reference K-37
9/18/08

Gear Engineering PPAP Data

** CONFIDENTIAL FOR INTERNAL USE ONLY! **

Tracking # 060GA105x-B-11-Mar-20-2008
Report Date March 20, 2008
V & H Pictures

1) Highlight Appropriate Picture Cell and Then ***Insert -- Picture -- From File***
2) PRESS ***Ctrl S*** to Automatically re-size Picture

Gear Convex at Etch	Gear Convex at Toe	Gear Convex at Heel
		

Gear Concave at Etch	Gear Concave at Toe	Gear Concave at Heel
		

Please Note!!! -- (To minimize data file size)

1) Save pictures as **.jpg** files before inserting.
2) Use the **INSERT -- PICTURE -- FROM FILE** function to insert pictures.

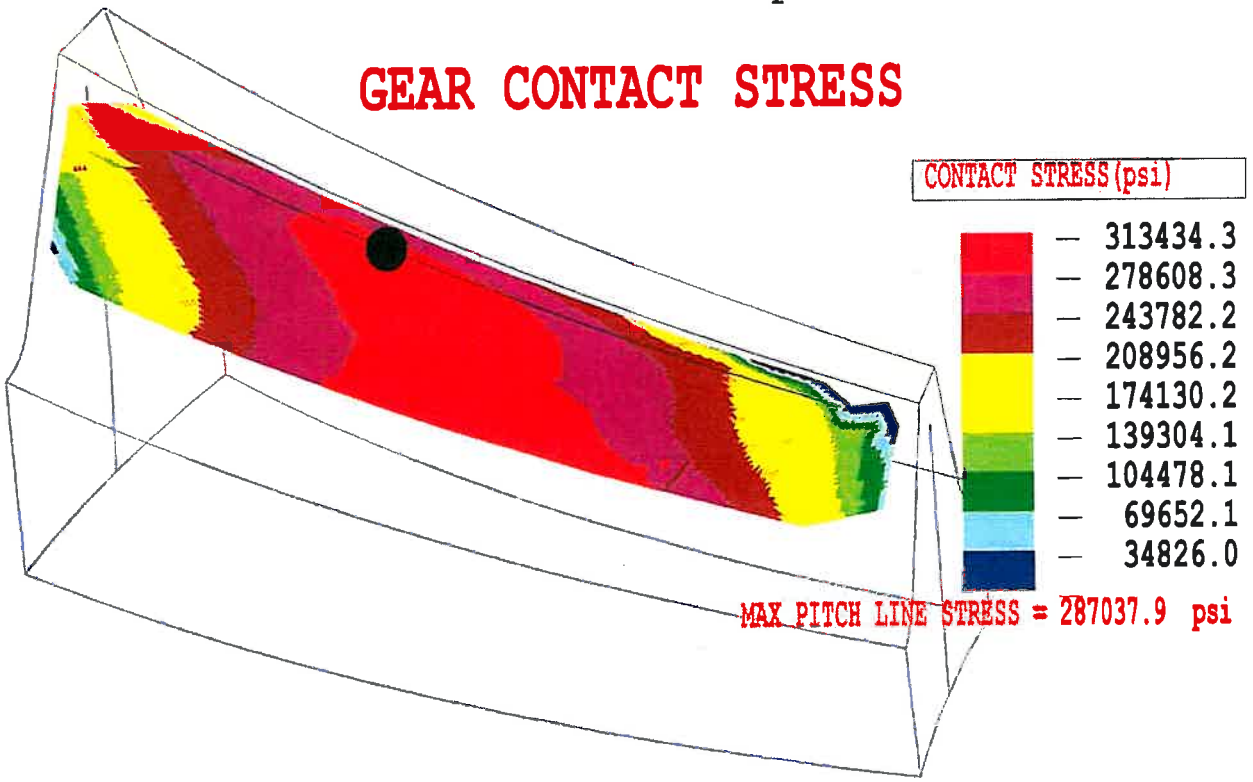
Attachment 5
Page 206
Reference 1-37
9/18/08

VIL417 / P4L792

INPUT FILE: S060586-7H
OUTPUT FILE: S060586-7Hout
GEAR TORQUE: 3480.000 lb-ft
09\10\2008 VERSION 8.07 time:11:34am

V= 0.0000 in E= -.01295 in
H= -.0060 in P= 0.00907 in
G= 0.0000 in G= 0.00392 in
cmf= 1.0000 A= 0.00071 ra
Separation factor= 0.00025

GEAR CONTACT STRESS



Bartlett, Donald

From: Bartlett, Donald

Sent: Friday, September 19, 2008 10:18 AM

To: bkoehler@swri.org; Koglin, Cory; Dale Smith Intertek; X-Don M. Lind

Cc: Mike Horvath (Mike.Horvath@dana.com); Allan Comfort ; Bartlett, Donald; bkoehler@swri.edu; Bruce.McGlone@ArvinMeritor.com; Dhartej@aam.com; james.l.linden@gm.com; Juan Buitrago (jabu@chevrontexaco.com); Ken Miller; pvettel@dastuart.net; Salvetore Rea (salvatore.rea@infineum.com); thelmaemarougy@eaton.com; Tom Bryson (thomas.bryson@volvo.com); Chris Barker; Don Bell (don.bell@aftonchemical.com); fmf@astmtmc.cmu.edu; Graziano, Ricki; Greene, Galen; greg.fett@dana.com; Gropp, Jerrold; Higuchi, Samuel; Inc William Sullivan (wtsullivan@comcast.net); Jack Zakarian (jaza@chevrontexaco.com); Jami Pole (jami.pole@aam.com); Joe.Guzikowski@dana.com; John Huron (HURO@chevrontexaco.com); Keith Purnell (kpurnell@sae.org); Kerry Hess (Kerry.hess@dana.com); Martin, Dan; NON-LZ JACKSON MATT; Mike Haire; Percy Kanga (percy.r.kanga@exxonmobil.com); Prengaman, Christopher; Rachel Agusti (rachel.agusti@us.army.mil); Rajakumar, Allison; Schenkenberger, Chris; Stephen Eliot (stephen.w.eliot@exxonmobil.com)

Subject: L-37 Retrofit Axle Build per direction from the September 18 SP meeting

FYI all,

Please see the note from Mike Horvath below with respect to the build of 10 retrofit lubrited axles each lab (40 total) using the preferred build contact pattern as discussed on yesterdays SP teleconference.

Thanks,

Don

Office Phone: 440-347-2388 **Mobile**: 440-220-0843 **E-mail to: dtb@lubrizol.com**

From: Mike.Horvath@dana.com [mailto:Mike.Horvath@dana.com]
Sent: Thursday, September 18, 2008 12:46 PM
To: Bartlett, Donald
Subject: Fw: ASTM Meeting

Mr. Bartlett,

Tom has a few other jobs to finish but should be able to start again next Tuesday. Conservatively we estimate that all axles will be built and shipped prior to October 10th. We will continue with the randomizing process and ship in the standard wood racks as soon as each labs order is complete. Let me know if there are any additional requests for this build.

Sincerely,
Michael J. Horvath

Office: 419.887.3411
Mobile: 419.350.7230
Dana-net: 8.887.3411

Attachment 6
Page 10/1
Reference L-37
9/15/08

Bartlett, Donald

From: Bartlett, Donald
Sent: Thursday, September 25, 2008 6:56 AM
To: 'Dale Smith Intertek'; bkoehler@swri.org; Kenny.Miller@dana.com; Koglin, Cory; X-Don M. Lind
Cc: okamuro@roadrunner.com; Mark.Bassett@dana.com; Bob.Sullivan@dana.com; Greene, Galen; Graziano, Ricki; NON-LZ JACKSON MATT; Gropp, Jerrold; Martin, Dan; 'Bill.Ramsey@dana.com'; 'Greg.Fett@dana.com'; Joe.Guzikowski@dana.com; 'Mike.Horvath@dana.com'
Subject: RE: Update and request, ref. L37.
Importance: High

Note to all;

Four Things:

1) There is no L-37 SP teleconference call today, it is set for Tuesday, September 30 at 10:00 am, same call in number. Minuets almost complete. Please keep that date set aside.

2) Thanks for the quick communication response Brian and Dale. With the current three axles at SwRI and the one coming to SwRI from Intertek-Parc, please tag/identify all four as "initial build with questionable corner polish of the toplands". Please set them aside pending future decision/direction to come from the panel and Dana.

3) Brian, you are correct. We are waiting for two things: 1) Kenny and Ken to provide the reduced load value to test under. 2) We will use axles from the 40 new axle builds from Maumee after the Ft. Wayne reworking the corner polish of the toplands.

4) I have not had any further update or discussions with Bill Ramsey on our lab questions. Bill, would you please give me a call.

Thanks everyone for keeping this most important work moving forward. Timing and success is most critical.

Thanks,

Don Bartlett

L-37 SP Chairman

Office Phone: 440-347-2388 **Mobile**: 440-220-0843 **E-mail to: dtb@lubrizol.com**

From: Dale Smith Intertek [mailto:Dale.Smith@intertek.com]
Sent: Wednesday, September 24, 2008 8:10 PM
To: bkoehler@swri.org; Bartlett, Donald; Kenny.Miller@dana.com; Koglin, Cory; X-Don M. Lind
Cc: okamuro@roadrunner.com; Mark.Bassett@dana.com; Bob.Sullivan@dana.com; Greene, Galen; Graziano, Ricki; NON-LZ JACKSON MATT
Subject: RE: Update and request, ref. L37.

Hi Brian,
Tag your it. Sorry. I had it sent Monday per the committee's request. You should receive it any time now. The way things are going that axle will see all of the labs before it finds a test stand to run in. Does this imply there is a smoking gun in the top land area? I hope?

Dale

From: Brian Koehler [mailto:bkoehler@swri.org]
Sent: Wednesday, September 24, 2008 2:09 PM
To: 'Bartlett, Donald'; Kenny.Miller@dana.com; Dale Smith Intertek; 'Koglin, Cory'; 'X-Don M. Lind'
Cc: okamuro@roadrunner.com; Mark.Bassett@dana.com; Bob.Sullivan@dana.com; 'Greene, Galen'; 'Graziano, Ricki'; Matt Jackson
Subject: RE: Update and request, ref. L37.

This is all acceptable to SwRI.

Based on the below, SwRI will still be waiting for the reduced load value and will now also be waiting for the 10 each axles from Maumee going to SwRI. (I am assuming that the recent findings may mean that the 3 or 4 axles now at SwRI should not be used for the next round of testing).

Dale: If you have not yet shipped that single L-37 axle to us, put it back on hold.

Regards,
Brian P. Koehler
Principal Engineer
Southwest Research Institute
P.O. Drawer 28510, Zip: 78228-0510
9503 West Commerce, Zip: 78227
San Antonio, TX USA
Building 209
Tel: 210-522-3588
Fax: 210-684-7523
Cell: 210-213-2761

From: Bartlett, Donald [mailto:Donald.Bartlett@lubrizol.com]
Sent: Wednesday, September 24, 2008 11:17 AM
To: Kenny.Miller@dana.com; bkoehler@swri.org; Dale Smith Intertek; Koglin, Cory; X-Don M. Lind
Cc: okamuro@roadrunner.com; Mark.Bassett@dana.com; Bob.Sullivan@dana.com; Greene, Galen; Graziano, Ricki
Subject: RE: Update and request, ref. L37.
Importance: High

Kenny,

Thank you for the update. It is decision time and you can all shoot me later. Last week during our September 18 Panel teleconference we changed the Thursday, September 25 teleconference to Tuesday, September 30. With that said, I see no value in calling an improptu teleconference that all would not be able to participate in.

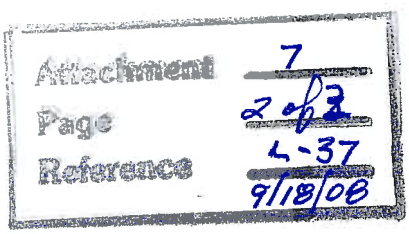
Therefore Kenny;

1. Please call Greg, Joe and/or Mike Horvath and let them know that I support stopping the 40 axle build for this very short term as you outlined below.
2. Secondly, please contact the same individuals and, with my permission, take four ring and pinion gear sets from the retrofit lubrited hardware for destructive analysis work as you need and described below. The four labs will/should share in the loss of another axle build and we will work those details out later.

Again, I thought we should keep moving forward, please contact me if there are any further querstions. Good Luck.

Thanks,

Don Bartlett



Office Phone: 440-347-2388 Mobile: 440-220-0843 E-mail to: dtb@lubrizol.com

From: Kenny.Miller@dana.com [mailto:Kenny.Miller@dana.com]
Sent: Wednesday, September 24, 2008 10:54 AM
To: Bartlett, Donald
Cc: okamuro@roadrunner.com; Mark.Bassett@dana.com; Bob.Sullivan@dana.com
Subject: Update and request, ref. L37.

Don,
We have been analyzing the EOT gearsets and are finding a number of pinion teeth with cracks through the tooth topland normal to the tooth flank. Ken Okamuro has examined this and come up with a cause and effect scenario that we need to test to determine if this is the major contributing issue with the current lot. Unfortunately, the testing needed to get the information needed is destructive to the pinion. We believe we need (4) gearsets from the loose sets inventory at Maumee to do this testing on. We are asking to acquire these and do the destructive testing. Moreover, we are pulling back 40 gearsets for reworking the corner polish of the toplands and will proceed with the 40 axle build beginning tomorrow morning. This is in response to the new information we've gleeend. Thank you.

Kenny Miller
Gear Engineer
Heavy Vehicle Systems Group
Dana Holding Corporation
139 East Broad Street, Statesville, NC 28677
phone: (704) 878-5762
fax: (704) 878-5633
email: kenny.miller@dana.com

Attachment 7
Page 3 of 3
Reference L-37
9/18/08

V1L500/P4L870A NEW LUBRITED RETROFIT MATRIX RESULTS

Testkey	Lab	STD	Run	Oil	VAL	Pinbat	DTCOMP	Pwear	Pridg	Pripp	Pspit	Rwear	Rridg	Rripp	Rspit	fpcrat	lpcrat	Mfg. Min B/Lash	KUSA	COM1
63271	B	191	2658	155	AG	V1L500	20080801	7	9	8	9.5	7	10	10	9.8	0	2	0.005	ASTM-0002	
58906	D	3A	945	155	AG	V1L500	20080805	7	8	10	9.9	8	10	10	9.9	1	2	0.005	ASTM-0007	
58912	A	4	225	155	MG	V1L500	20080803	6	9	8	2	8	10	9	9.9	0	2	0.008	ASTM-0009	Broken Tooth
61857	E	1	912	155	MG	V1L500	20080808	7	9	9	2	7	9	9	9.9	1	2	0.006	ASTM-0016	Broken Teeth
63638	B	191	2659	127	AG	V1L500	20080802	6	5	9	9.9	7	6	10	9.9	1	2	0.006	ASTM-0010	
59291	D	3A	944	127	AG	V1L500	20080803	7	8	7	9.9	8	10	10	9.9	1	2	0.005	ASTM-0003	
49193	E	1	910	127	LG	V1L500	20080801	7	9	7	9.9	7	9	9	9.9	1	2	0.004	ASTM-0012	Stand Not Calibrated
67366	A	4	224	127	AG	V1L500	20080801	7	8	5	9.9	8	9	8	9.9	1	2	0.006	ASTM-0013	
67304	B	191	2662	152-1	AG	V1L500	20080806	7	8	8	2	8	9	10	9.9	0	2	0.005	ASTM-0006	
63260	D	3A	946	152-1	MG	V1L500	20080806	7	8	9	2	8	10	9	9.9	1	2	0.005	ASTM-0011	Broken Tooth
67385	A	4	227	153-1	AG	V1L500	20080805	7	8	7	3	7	10	10	9.9	0	2	0.005	ASTM-0001	
67314	B	191	2663	153-1	AG	V1L500	20080807	6	5	8	4	6	5	9	9.9	1	2	0.006	ASTM-0014	
64143	D	3A	948	153-1	AG	V1L500	20080811	7	8	9	9.9	8	9	10	9.9	1	2	0.007	ASTM-0015	
63279	E	1	915	153-1	NN	V1L500	20080815	7	9	9	9.9	7	10	9	9.9	0	2	0.006	ASTM-0004	20 HR Test/Cracked Tooth
63280	E	1	916	153-1	NN	V1L500	20080820	6	8	8	2	6	7	9	9.9	0	2	0.005	ASTM-0008	18 HR Test/Broken Teeth
64145	D	3A	960	153-1	NN	V1L500	20080827	7	8	8	2	8	10	9	9.9	3	2	0.006	ASTM-0031	Modified Build / Broken Tooth
67348	D	3A	961	153-1	NN	V1L500	20080903	7	8	7	9.9	8	10	10	9.9	2	2	0.007	ASTM-0035	Modified Build
67367	A	4	236	134	NN	V1L500	20080906	7	9	5	8	8	9	10	9.9	2	2	0.007	ASTM-0033	9% reduced load/24 hr. test
67387	A	4	234	153-1	NN	V1L500	20080904	6	9	8	8	8	10	10	9.9	2	2	0.008	ASTM-0029	9% reduced load/24 hr. test
67388	A	4	237	153-1	NN	V1L500	20080910	7	9	8	7	7	10	10	9.9	2	1	0.005	ASTM-0037	9% reduced load/24 hr. test / Broken teeth / Surface cracks
61862	A	4	238	152	NN	V1L500	20080912	6	7	8	9.9	6	9	9	9.9	2	2	0.005	ASTM-0041	9% reduced load/24 hr. test
67386	A	4	233	153-1	XN	V1L500	20080901	6	9	8	2	6	9	9	9.9	1	2	0.007	ASTM-0025	9% reduced load / 60 hr. test aborted
64182	A	4	232	153-1	XN	V1L500	20080829	7	9	8	9.9	8	10	10	10	1	2	0.006	ASTM-0021	9% reduced load / 8 hr. test aborted. Shaft U joint failure
61865	A	4	239	155	NN	V1L500	20080916	7	9	9	9.8	7	10	9	9.9	2	2	0.008	ASTM-0045	9% reduced load/24 hr. test

Attachment B
Page 1-37
Reference 1 of 1
9/18/08

Bartlett, Donald

From: Bartlett, Donald
Sent: Friday, September 26, 2008 10:18 AM
To: Bartlett, Donald
Subject: L-37 request by Lyle Bowman directive to switch to SI Units

Panel,

The below is the email trail and documentation for all to review and prepare for as we will have this on the agenda for our next SP teleconference meeting on Tuesday, September 30, 2008.

Don Bartlett

From: Don Lind [mailto:dml@astmtmc.cmu.edu]
Sent: Monday, September 22, 2008 8:43 AM
To: Gropp, Jerrold; Lyle Bowman
Cc: NON-LZ FRANKLIN JOE; John Zalar; Bartlett, Donald
Subject: RE: WK20838/D 6121/8-08

Jerry,

Don Bartlett and I were to contact Lyle on the matter of rating. The issue to switch to SI units is another matter and needs to be discussed with the surveillance panel.
I believe Don Bartlett will need to put this on his agenda.

Don

From: Gropp, Jerrold [mailto:Jerrold.Gropp@lubrizol.com]
Sent: Monday, September 22, 2008 8:20 AM
To: Lyle Bowman
Cc: NON-LZ FRANKLIN JOE; John Zalar; Bartlett, Donald; Don Lind; Gropp, Jerrold
Subject: RE: WK20838/D 6121/8-08

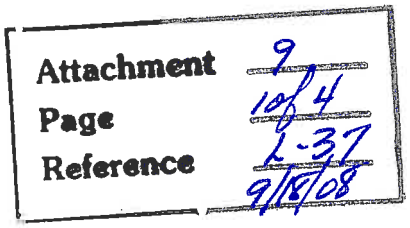
Lyle,

The L-37 Surveillance Panel has been holding a weekly teleconference in an attempt to address the severity problem (and associated shortage of hardware) which has been encountered with the last two batches of lubrited hardware which is used in this test. The Panel did enter into a discussion of revising the measurement units during their last teleconference (on Thursday of last week), but found that they needed answers to several questions in order to reach a consensus on how to proceed. The outcome of the discussion was that Don Lind (the ASTM Test Monitoring Center representative on the Panel) and Don Bartlett (the Chairman of the Panel) were asked to contact you to discuss this matter and obtain the information required for the Panel to act upon your request. I would expect them to contact you within the next couple of days to discuss this matter.

Jerry

From: Lyle Bowman [mailto:jbfoodie@comcast.net]
Sent: Sunday, September 21, 2008 6:41 PM
To: Gropp, Jerrold
Cc: NON-LZ FRANKLIN JOE; John Zalar
Subject: FW: WK20838/D 6121/8-08

Jerry,



I've just re-reviewed D 6121 (after revising the measurement units in several other test methods), and it appears to me that D 6121 should be SI units only, rather than the current 'inch-pounds'. I saw nothing in the text or figures that indicates that 'inch-pounds' has any special merit (other than that's probably been the past practice of test labs to date). Switching to SI units as standard, automatically solves the problem with the measurement units (now SI) used in rating the spalling and pitting of the gear. Unless there's a convincing rationale for staying with 'inch-pounds' as standard, my recommendation is to revise D 6121 with SI units as standard. Your comments are requested.

Lyle.

From: Lyle Bowman <jbfoodie@comcast.net>
Date: Tue, 12 Aug 2008 10:37:37 -0700
To: "Gropp, Jerrold" <Jerrold.Gropp@lubrizol.com>
Cc: Joe Franklin <joe.franklin@intertek.com>, John Zalar <jlz@astmtmc.cmu.edu>
Conversation: WK20838/D 6121/8-08
Subject: WK20838/D 6121/8-08

Jerrold,

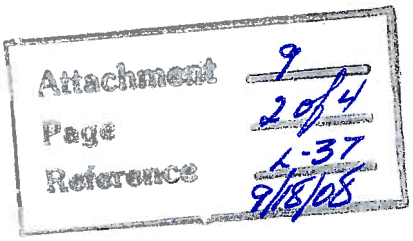
ASTM Board of Directors has issued a directive that requires addressing the measurement units in all standards. The emphasis is on the use of SI units wherever possible. As you are aware from Joe Franklin's email (7-28-08), I've been assigned the responsibility for making these revisions for standards that are the responsibility of Subcommittee B.

Prior to balloting, I'd appreciate your review of one of the standards in Section 3's responsibility (D 6121 revision attached). If you have any concerns about the proposed changes, please discuss with me. You'll note that it's proposed to ballot Sub. B and D02 concurrently. This is only done if there is confidence that there will be no negative votes or comments for technical changes from Subcommittee B members.

Anticipating that there may be concern about making the proposed changes in Table A9.1, there is an optional possibility; i.e., the 'Combined Standard'. This units system requires that there be both SI units and inch-pound units shown for each measurement value, with SI units shown first, followed by inch-pound units in brackets. Either units system can be considered standard for each measurement value, unless there is a value that only one units system is the standard for, and a suitable note then is added at that place in the text.

For D 6121, and Table A9.1, that note would read something like the following: "The SI units are the standard for the Pitting and Spalling measurements."

Lyle Bowman.



D02 AND D02.B0 CONCURRENT BALLOT ITEM

To: ASTM D02 and D02.B0 Members

From: Lyle Bowman, D02.B0.10 Facilitator

Subject: Revision of D 6121 (L-37)

WK No.: 20838

Rationale: Update the standard's units per the ASTM Units Project directive.

6.2.4.3 *Axle Cooling*

(2) Use a single control valve to control the cooling water supply. The control shall be a 1/2 in. (12.7 mm) two-way, C linear trim, ...See A6.3.2.2 for L-37 Canadian Version test.

(3) Use only 3/8 or 1/2 in. (9.5 or 12.7 mm) line material to the spray nozzles.

(4) Use a minimum supply water pressure of 25 psi (172 kPa) to the control valve.

TABLE A9.1 Gear Rating Guidelines

Use for Pitting/Spalling Distress Only	
Level of Distress	Corresponding CRC 21 Spalling Scale
None	

Trace Pitting—Pit size up to 9.5 mils (0.24 mm) diameter

Trace-Light Pitting

Light Pitting—Pit size 19.7 mils (0.50 mm) diameter

Light-Medium Pitting

Medium Pitting—Pit size 29.1 mils (0.74 mm) diameter

Medium-Heavy Pitting

Heavy Pitting—Pit size 38.6 mils (0.98) mm diameter

Trace Spalling	0.04 $in.^2$ (1 mm^2)
Trace-Light Spalling	0.16 $in.^2$ (4 mm^2)
Light Spalling	0.35 $in.^2$ (9 mm^2)
Light-Medium Spalling	0.63 $in.^2$ (16 mm^2)
Medium Spalling	0.98 $in.^2$ (25 mm^2)
Medium-Heavy Spalling	1.42 $in.^2$ (36 mm^2)
Heavy Spalling	1.93 $in.^2$ (49 mm^2)