L-37 Surveillance Panel Teleconference Minutes
Thursday 09/04/2008

Attendees:

Dana -	**Basset, Sullivan, Fett, Guzikowski, Horvath**
SwRI –	**Koehler**
Lubrizol –	**Bartlett, Gropp, Graziano, Greene**
Afton -	**Koglin**
Park -	**Smith and Manager**
TMC -	**Lind**
DA Stuart	**Vettel**

L-37 Surveillance Panel teleconference call was directed to convene at this time by the Panel at its August 28th teleconference meeting to review testing options and progress to date.

Agenda:

- Approve the August 28, 2008 SP meeting minutes.
- Review pending action items.
- Review Afton's results on TMC 153-1 using modified axle build.
- Review SwRI results on TMC 153-1 as a result of lengthening the test at a lower stress.
- What next?

Approval of Minutes

Mr. Koglin motioned/Second Mr. Smith. – That the August 28, 2008 meeting minutes be approved as written. Motion passed unanimously with a vote count of 7-0-0.

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. He will pursue internal discussions and report back in the next couple of weeks. **Open.**

→ **Dana/Fett/Guzikowski/Miller –** Dana to perform some mag particle inspection on test gears to determine if stress fractures are occurring. Is this occurring on the unbroken gears? **Open.**

→ **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 now conduct two runs on TMC 153-1. We reviewed the data and question/suspect that the modified build pattern is not doing the job either. During this teleconference consensus was for Fett and Miller to confirm if there is some other build option to explore. **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:

- Run Miners calculation of equivalent damage w/ 9% stress reduction (Line 3 of attachment # 2).
- Conduct one run on TMC 153-1 and post the data.
- 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.
     - Test length will be 70 hours of on-test time.
     - Axle will not be modified and no mid test inspections will be performed.
     - Results to report the results prior to continuing to a second test.

SwRI reported that the first test was aborted around 8 hours and not oil or axle related. There was a stand problem where the driveshaft U-joint sheared off. Posttest inspection revealed that there was no evidence of tooth cracking, pitting, spalling, ridging, just slight rippling. The Ring and Pinion looked good.

SwRI started another test on a new axle and at about 61 hours the stand shut down on alarm. Inspection revealed the large pinion bearing shelled out the rollers. Posttest inspection revealed some cracks/chips on gear teeth. Pinion showed severe pitting/spalling on every tooth. Was the spalling there before the bearing problem, don't know. SwRI is using an impulse type vibration sensor (screwed directly into one of the vent ports) of the axle tube for bearing analysis and failure. It did show that the axle became noticeably noisier at around 49 hours.

SwRI has decided to start another 153-1 run, prepared a third axle and modified it with an inspection port and started the test. It currently has about 22 hours. The test will be manually stopped and a pinion borescope inspection will be performed (looking for cracks and/or evidence of pitting/spalling). Will make the decision to end or continue. Does not favor running past 40 hours? May inspect around 32? Goal is to stop before a crack or spall, get ratings, and run a repeat test on TMC 134? **Open.**

Attachment # 1 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.

ftp://ftp.astmtmc.cmu.edu/refdata/gear/l37/data/V1L500_P4L870A_Lubrited_Retrofit/

→ **Dana/Fett** – New action item – Summary on Metallurgical findings to date. There were some questions about the failure mode for both types of hardware. Mr. Fett was asked to summarize.

Chairman's note: *The following was provided via email by Mr. Fett shortly after the conference call ended: "I have examined the Lubrited and the Lubrited retrofit samples including the 18 and 20 hour tests. The failure mode is completely different from the majority of the non-Lubrited gears we have seen so far. The failure on the pinion is predominantly pitting followed by spalling and even case crushing (horizontal cracks) at the central-to-central toe position. The pitting is near the bottom of contact and the spalling and case crushing is occurring just above that still below the pitchline. The pinions do not visually show the pinching or hard contact at the tooth tip that we saw with the non-Lubrited parts. Judging by the failure the high contact stress region on the Lubrited pinions appears to end up at the central-to-central toe position below the pitchline. However, the rings still show hard contact at the heel end below the pitchline just like the non-Lubrited rings. In fact the rings show relatively little wear or damage at the top of contact. In contrast the high contact stress area or hot spot on the non-Lubrited parts is at the tooth tip at the central heel position.*

It appears that getting this gear set to live under the test conditions is a balancing act. It has to be perfect and cannot have a localized high contact stress at any given area. The load has to be evenly distributed over the entire tooth surface. Any hot spots or high contact stress regions will cause the part to fail before the 24 hours is up. In years past the high contact stress region on the gear set was always the heel end of the pinion tooth. It appears we have now moved the hot spot to the areas noted above.

The 18 and 20-hour pinions are nearly the same. Both have pitting at the bottom of contact near the toe and case crushing cracks near the pitchline. It's just that the failure on the 18-hour sample has progressed further than the 20-hour sample which is counterintuitive. However, it is likely this is just normal fatigue variation and this sample just had a shorter fatigue life than the 20-hour sample.

We have done a metallurgical analysis on a non-Lubrited set and everything appears to be normal. We will also do the same on a Lubrited set." **Open.**

There was much discussion with respect to what direction to take from here. Some labs reported that they are/have been out of lubrited hardware. With respect to non-lubrited hardware, Afton and Lubrizol reported that they have shortage concerns as well. Running out of hardware is not an option and we need hardware that provides results consistent with past performance.

Other options discussed were:

Bartlett – consider running a 16-hour test with elevated axle temperature and/or modified torques.
Gropp - Option 1, look at running tests on TMC 152-1 or 155 a different oil? But, in the end, doesn't the solution have to work on all oils?
Koehler - The SwRI work is not done yet. We are looking to properly rank the oils.
Gropp - Option 2, walk away from the hardware.

Motion #1: Gropp/ Koglin - Based upon the results of extensive testing to date, the L-37 Surveillance Panel has determined that the V1L500/P4L870A batch of lubrited hardware is not suitable for use in the L-37 test procedure. The Surveillance Panel does not intend to conduct any additional testing on this batch of hardware. This batch of hardware is hereby rejected.

Discussion on Motion:

- Koehler - can't vote right now. Still need two tests on reduced load to a specific test length with no broken teeth and acceptable rating results.
- Koglin – will two runs from SwRI be acceptable. The inconsistency is the issue, no smoking gun. Need to run many more tests to build confidence.
- Gropp – Expressed concern that we are getting into new test development. We need to be focusing on obtaining an acceptable batch of hardware for the existing test. Koglin - we had three successful non-lubrited batch and now this happens.
- Fett - this is a severe test to get through. The contact on the tooth has to be spread out evenly. If it gets concentrated on the tooth, it does not survive. Normally, load moving to heel end of the tooth is where the problem went. We moved that high heel contact stress from the heel to somewhere else.
- Bartlett/others – perspective that at this point in time, there is a need to fist discuss and seek direction from laboratory management.
- **Vote:**
  - DA Stuart – Voted yes
  - Dana and Lubrizol - voted no
  - Afton, Intertek-Parc, SwRI, and TMC - abstained.
  - Final tally, 1-2-4, failed

Motion #2: Gropp/ Vettel - The L-37 Surveillance Panel is requesting Dana to immediately begin the process of manufacturing a new batch of ring and pinions to be used in the manufacture of lubrited hardware for use in the L-37 test. This hardware should be manufactured using the same specifications (for metallurgy, hardness, case depth, surface profile, etc.) as was used in the V1L417/P4L792 batch of non-lubrited hardware, and then lubrited using the "alternate" process (per Dana's recommendation). All companies who intend to purchase a portion of this batch of hardware are to provide Dana with an initial indication of the size of their order no later than the end of the business day on Friday, September 12. Formal purchase orders are to be provided to Dana no later than the end of the business day on Friday, September 26. Dana is to provide the Surveillance Panel with a projected date for the availability of this hardware no later than the end of the business day on Friday, September 19.

Discussion on Motion:

- Koglin – should we require a pilot batch? Consensus no for past outcomes, but consider producing all the ring and pinions and only assembly a small portion for the pilot batch run.
- Smith - Do we just produce ring and pinions to allow the retrofit process to move forward?
- Koglin – needs management direction. Also, still looking for the information we have requested from Dana.
- Gropp – We must separate the commercial side from the technical side.

- **Vote:**
  - DA Stuart – Yes, from a formulator point of view, the test modifications and attempts to use the hardware is wandering to far away from where it historically has been.
  - Afton - voted no
  - Dana, Intertek-Parc, Lubrizol, SwRI, and TMC abstained.
  - Final tally, 1-1-5, failed

→ **Action item:** After much more discussion, the labs were directed to convene later in the day to draft a letter to Dana representatives specific to laboratory issues and concerns. The answers to the questions should help the laboratories to make final and informed decisions with respect to the hardware. **Open.**
Chairman note: *Attachment # 2 is the letter that was sent to Dana representatives.*

New Lubrited Hardware – Discussion

Continued testing was put on hold until further direction by the panel. Panel direction is that we focus the attention on the retrofit hardware first.

Non- Lubrited Hardware – Discussion

Continued testing was put on hold until further direction by the panel. Panel direction is that we focus the attention on the retrofit hardware first.

Lastly, Mr. Lind of the ASTM TMC informed the Panel that he has updated the targets for the Non-Lubrited hardware P4L792/V1L417 gear batch. This will be added to the agenda for the below Surveillance Panel Teleconference. Please review the data, collect your thoughts and comments, and come prepared to take action. Here is the link to the TMC website:

ftp://ftp.astmtmc.cmu.edu/refdata/gear/l37/data/Updated_Nonlubrited_V1L417_Targets/

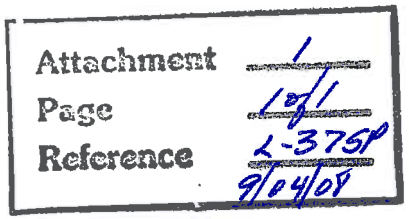
- **Next Meetings will be a Surveillance Panel Teleconference**
  - **Teleconference Meeting Wednesday, September 10, 2008 at 10:00 a.m. EDT.**
  - **Call in info is 608-250-0194, code 324160.**

Meeting adjourned at 11:51 p.m.

Donald T. Bartlett, L-37 SP Chairman

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	New Contact Pattern / Broken Teeth
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	New Contact Pattern



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September 4, 2008

Dear Gentlemen, (Brazeau, Ramsey, Miller, Fett, Guzikowski)

At the suggestion of the L-37 Surveillance Panel during its September 4, 2008 teleconference call, the four labs were asked to teleconference later that afternoon to detail specific laboratory questions to Dana representatives. The labs did and our questions are included with this letter. We call upon Dana representatives to provide a timely response to these questions before the projected **Thursday September 18, 2008** Surveillance Panel teleconference meeting.

The labs certainly appreciate all of the Industry and Dana efforts to work together to make modifications to the build and test procedure in efforts to salvage the batches. Of course, the concern is that we may be running out of valuable time based on laboratory current supply of approved hardware.

Dana Corporation can certainly appreciate that, between the industry labs, we have invested approximately 3.2 million dollars to purchase new hardware yet to be approved for ASTM testing. All batches are exhibiting variability on known reference fluids (two fluids are approved factory fluids) with testing results that exhibit excessive pitting/spalling and/or broken teeth. Additionally, testing across the four labs in an attempt to qualify the hardware for industry use (2007 and 2008 approval matrix testing) has now been approximately 102 tests (~ $ 500,000).

The answers to these questions will certainly help laboratory management make informed decisions with respect to the three hardware batches currently being evaluated. We sense that there is growing Panel support to reject the hardware should timely attempts to make the hardware work fail.

Our questions are as follows:

1) **2008 Retrofit-lubrited P4L870A/V1L500** - replacing rejected batch 2007- P4L816/B6L566.
   Note: There is an existing warrantee agreement to bench build all axles at Maumee previously approved by Dana which the labs are appreciative.
   a. We request a root cause failure analysis and a final report summarizing all findings.
   b. Will Dana again warrantee this hardware should the panel decide to reject the hardware?
   c. We ask Dana to provide a quote for the cost of new ring and pinion gears to finish out the retrofitting of the axles currently under warrantee.

d. Is there any heat of steel used for this ring & pinion batch left or available?
e. Please provide a timeline to procure the steel, forgings, and produce and reassemble the hardware for testing?
f. What are the possibilities and/or probabilities of recycling the retrofit ring and pinions into a new development of ring and pinions?

2) 2008 new-lubrited P4L870A/V1L500

a. We request a root cause failure analysis and a final report summarizing all findings.
b. Will Dana warrantee the hardware should the panel decide to reject the hardware?
c. We ask Dana to provide a quote for the cost of new ring and pinion gears to finish out the retrofitting of the axles.
d. Please provide a timeline to procure the steel, forgings, and produce and reassemble the hardware for testing?

3) 2008 non-lubrited P4T813/V1L500 - Note: The labs, at the request of Dana, reluctantly agreed to the Ft. Wayne request to use an older batch of 2007 rings to reduce Dana's costs.

a. We request a root cause failure analysis and a final report summarizing all findings.
b. Will Dana warrantee the hardware should the panel decide to reject the hardware?
c. We ask Dana to provide a quote for the cost of new ring and pinion gears to finish out the retrofitting of the axles.
d. Please provide a timeline to procure the steel, forgings, and produce and reassemble the hardware for testing?

4) General questions related to making new axle assemblies -

a. Please provide a cost for new axle assemblies, both new and non-lubrited.
b. Please provide a timeline to procure the steel, forgings, and produce and assemble the hardware for testing?
c. We would like to know the changes and/or differences between the 2008 batches and the 2005 (P4L792/V1L417) batch of hardware that was produced, approved, and met all ASTM needs (same reference fluids being used to day) with out variability and requiring no correction factors.
d. What is the possibility of obtaining a prototype ring and pinion and Dana running L-37 proto type tests prior to the axle build out (say 6 tests).

In closing, a Dana response to these questions for review and discussion on the proposed September 18, 2008 Surveillance Panel teleconference meeting would be most appreciated.

Donald Bartlett	The Lubrizol Corporation Laboratory, L-37 Surveillance Panel Chairman
Brian Koehler	Southwest Research Institute Laboratory
Dale Smith	Intertek-Parc Laboratory
Cory Koglin	Afton Chemical Laboratory

Cc: L-37 Surveillance Panel Teleconference meeting minutes of September 4, 2008