Report of Meeting
L-37 Next Generation Task Force Meeting
AAM Mexico/SwRI/Intertek

January 10-12, 2012

Attendees:
In Mexico: Angela Trader (Intertek), Kevin Hobson (Afton), Thomas Gottwald (Afton), Galen Greene (Lubrizol), Brian Koehler (SwRI)
In San Antonio: Same from above, additionally: Tom Boschert (Afton), Jerry Gropp (Lubrizol), Brian Decker (SwRI), Mike Lochte (SwRI), Dale Smith (Intertek), and on teleconference: Scott Parke (TMC), Bruce McGlone (Meritor), Joe Guzikowski (Dana)

1.0 AAM Mexico Plant Visit

The 4 labs travelled to the American Axle Mexico plant in order to discuss the requirements of the pilot batch of hardware. The visit generated valuable discussion regarding the manufacturing and build of the axle units. The document in attachment 1 was created to summarize the group's requirements:

In addition to the items specified in the document there were several other discussion points from the plant visit:

- Bearings:
  - One lab had recently performed some testing on normal production axles purchased through a dealer
  - They had seen some bearing distress on the large pinion bearing and noticed that the manufacturer of the bearing was different when compared with the original pilot batch produced in December 2010.
  - A bearing change was confirmed by the plant, and therefore, the group decided to revert back to the bearings that were used in December of 2010. The bearings used in December of 2010 were Timken bearings.
  - The plant confirmed that these Timken bearings were used on another assembly and therefore, they could easily get Timken bearings for the test hardware.
  - The plant has confirmed the part numbers for bearings and they are included in attachment 1.
  - It was stressed that we would want to continue using the same bearings for each build of this test hardware.
- The plant will be doing all things possible to ensure a consistent batch
- Due to the requirement to not charge the axles with oil, two steps at the end of the build are not possible. The first is an NVH tester that spins the axle up and checks for abnormal vibration and the second is a pinion balancing step which drills small holes in the pinion flange to help balance the unit. These steps need oil and charging the unit with oil would contaminate it with factory fill oil and potentially effect test results.
- We also discussed the cleaning of non-Lubrited gears to remove the pattern paint applied as part of the pattern check. For production parts, this marking compound is usually cleaned off during the Lubrite process. One consideration was to use the parts washer that is used just after lapping. There was also discussion around not washing the parts after the pattern check, because the build pattern check should just go over top. All of these marking compounds would then be removed when the lab cleans the unit. The only concern is whether the build line can get an accurate pattern with two layers of marking compound on the gear. The plant is going to attempt to build the axles without washing the first marking compound off and determine if it's possible. If all looks good, they will proceed with this method.

2.0 Task Force Meeting in San Antonio

The task force next performed two lab visits and held a meeting. The purpose of the lab visits was to view the test stands used for the next generation L-37 development and begin to discuss standardization. Also along these lines, we highlighted any differences and discussed common practice. The meeting was held at the end of the visits and the agenda included developing a plan the initial round of pilot batch testing and a wrap up from the visits.

2.1 Lab Visits / Test Stand Standardization

During the lab visits, the group inspected SwRI's and Intertek's test stand and held a discussion. The bullets below summarize the key items:

- The following differences were observed between the labs:
    - Absorbers: One lab uses a fully regenerative stand with motoring absorbers, while the other three labs use Midwest 3232 eddy current dynamometers. This didn't concern the group very much and the group decided that this difference should not have any effect on results.
    - Rubber isolation coupler: 2 labs use the GM rubber isolation coupler on the axle input, while 2 labs do not use this coupler. The group did think it was possible that this could affect the severity of the test. The idea is that the rubber coupler provides some isolation between the input motor and the axle. This isolation could lead to less vibration in the axle. After the discussion, the group decided that all labs will include this coupler.
    - Spray nozzle locations: It appears that each lab has similar but slightly different spray nozzle locations. The group agreed that this was a key standardization point. The labs will work to standardize this.
    - Thermocouple depth: All labs placed the thermocouple in the drain plug, but the exact depth into the axle was not standardized. The labs agreed that they will standardize the thermocouple depth.
    - Output flanges: the splined output flanges appeared to the slightly different at each of the labs. It was decided that this was likely not an area that needed to be exactly standardized, and the current setup at each lab was sufficient.
- Each lab briefly discussed their test condition ramping strategy. It appeared similar but not identical. The Chairman is to solicit the ramping strategy from each lab and summarize in a single document for review.
- The group discussed cooling strategy during the test. As mentioned above, one lab had seen severe large pinion bearing distress on dealer axles. While there are several possible causes being investigated, one area of investigation is the location and biasing of the pinion cooling water spray nozzle.
    - The labs will look into the exact location of the pinion spray nozzle. One thought was to spray the bearing from the bottom, but after discussion it was decided that it would be best to come from the top such that water trickles down the sides and eventually to the bottom of the housing. This effectively provides cooling to most of the outer bearing area.
    - It was also thought that we could bias the pinion nozzle such that most of the cooling water would go to the pinion area. SwRI volunteered to run some experiments with the pinion nozzle spraying most of the cooling water. One such strategy could be to have only the pinion nozzle spray for the first 50% of controller output and then have the rear nozzles kick in at over 50% controller output. SwRI will report out progress.
- Axle prep was also discussed. It appeared that most labs already had a similar prep strategy. One lab had found that filling the axle through the fill hole after it was installed into the stand caused differential bearing failures during some experimental runs. It was decided that labs are to follow the standard L-37 cleaning process and then fill the axle nose down before installation into the stand. When filling, the oil is to be poured over the differential bearings and all of the gears in order to ensure good oil coverage especially for initial startup. The fill volume was agreed to be 950 mL.

Summary of ACTION ITEMS:
ACTION ITEM #1: It was agreed that all labs will use the rubber isolation coupler. This coupler can be purchased from a GM dealership.
ACTION ITEM #2: The labs are to document their spray nozzle locations and report them to the chairman. Before starting the test matrix, the labs will agree on common locations. The rear nozzles will be located in such a way that standardization is simple (ie. 90 degree angle).
ACTION ITEM #3: The labs are to report their thermocouple depth to the chairman. The depth should be reported from the machined surface of the housing that the drain plug tightens down to. Then the group will agree on a standard depth.
ACTION ITEM #4: The Chairman is to solicit the ramping strategy from each lab and summarize in a single document for review.
ACTION ITEM #5: SwRI will be investigating a cooling strategy that biases cooling towards the large pinion bearing. SwRI will report findings to the Task Force before the start of any pilot batch testing.
ACTION ITEM #6: The axles are to be prepped with the standard L-37 cleaning process and filled nose down. When filling the axle the oil should be poured over the diff bearings and all of the gears. The fill volume is 950 mL.

2.2 Initial Test Matrix for Pilot Batch

The group discussed the testing to be performed when the first pilot axles arrive.

- It was agreed that all of the standardization items above should be complete before beginning any of the industry testing.
- It was decided that initially, each lab is to run a TMC155 and TMC134 to give a quick view of the results from each stand. The TMC155 run is to be Lubrited because it is thought to be the most severe for the pass oil. The TMC134 run is to be non-Lubrited because it is thought to be the mildest for the fail oil. After running these oils, the task force will meet via teleconference to discuss.
- The test matrix in attachment 2 shows a tentative proposal after the initial testing described above. The group will discuss this after the initial testing is complete to see if it still makes sense.
- After running the TMC reference oils, the group agreed that we should include commercially available oils with known performance in the field as part of the evaluation of this new test.
    - The group will solicit oils from the industry for this. It was decided that this solicitation should go out to all of subcommittee B and the PRI mailing list. This is to ensure that all interested parties have a chance to provide input.
    - The oils need to have either SAE J2360 or API GL-5 credentials
        - For J2360 oils, a QPL number is to be provided
        - For GL-5 oils, sufficient field and rig test data is to be provided in order to prove the oils performance. This is because the task force needs to have good confidence that the oil will perform well in the historic L-37 as well as the field.
    - It was decided that any company submitting an oil for evaluation would be asked to sponsor a minimum of 4 tests
    - A proposed letter was provided by Mr. Boschert and this is shown in attachment 3. Mr. Gropp suggested that the letter include a worksheet that would be a uniform way for each company to submit data. An initial draft of a questionnaire shown in attachment 4. The group will work towards finalizing the letter/questionnaire at the surveillance panel meetings in February. Scott Parke agreed to be the collector of information from this solicitation. The oils would be shown to the group in a blind coded summary.

Respectfully submitted,

Digitally signed by Galen Greene
Date: 2012.01.23 09:55:22 -05'00'

Galen Greene
L-37 Surveillance Panel Chairman

Attachement 1

ASTM Zeta 218 (L-37-1) Requirements

Overall comments:

- Every effort to create a consistent RDM is to be made. This includes limiting within batch variation and batch to batch variation
- Target as close as possible to mid specification on all production parameters, unless otherwise specified
- No production process changes are to be incorporated into our test axles without ASTM approval.
- Build sheet to be generated for each axle produced (electronic)
- Housings must be uniquely serialized and the outside of the axle must state Lubrited and non-Lubrited

Ring and Pinion Manufacture:

- Gears are to be 4320 steel
- Same heat of steel is to be used for an entire batch of parts
- Only one furnace line is to be used for the ring gears and the pinion gears (but can be one for each)
- Drive side contact pattern is to be toe heavy through lapping (can compromise coast side pattern)
- Lubriting:
    - Only one line is to be used.
    - When Lubriting, the tanks are to be topped up with chemicals just before the parts start through and the tanks are to be checked after every 2 hours per normal plant procedure
    - Total Acid and Free Acid are to be kept as consistent as possible during the run
    - No major changes to be made to the Lubrite tanks mid run
    - A gear is to be analyzed when Lubriting, the grain size should be in the 2-3 micron range
- Non-Lubrited:
    - Parts cleaning after flanking is to be determined

Assembly Build:

- Target 0.003” (0.0762mm) to 0.005” (0.127mm) backlash, important that backlash is not less than 0.003” (0.0762mm)
- Target toe heavy drive side contact pattern (can compromise coast side)
- Use the following bearings during assembly (Timken head, Koyo for all others)

457108	HEAD PINION BEARING, RACE AND CONE
454459	HEAD PINION BEARING, CONE
457258	HEAD PINION BEARING, RACE
40057334	TAIL PINION BEARING, RACE AND CONE
40057338	TAIL PINION BEARING, CONE
40057337	TAIL PINION BEARING, RACE
40040071	DIFFERENTILA BEARING, RACE AND

Attachement 1

	CONE
40040073	DIFFERENTIAL BEARING, CONE
40040072	DIFFERENTIAL BEARING, RACE

- Do not fill RDMs with oil
- Perform leak check
- No NVH
- No Balancing

Additional Considerations:

- Can we create unique part number for Lubrited and non-Lubrited assemblies? This part number would document all changes from normal production. This may already be done be needs to be confirmed.
- Friction plates – Can we get them dry?
- Axle Batch Labeling – Can we have a batch 'identifier' stamped into gears?
- Rust preventative for non-Lubrited parts – Can we have the assembly line spray special non-additized rust preventive oil on non-lubrited gears at the end of production?
- Potentially specify case depth
- Can we include a part number on the sticker for the outside of the housing (this is the label with the serial number)? This will help with identifying Lubrited versus non-Lubrited axles

Attachment 2

Proposed Reference Oil Test Plan

Test Oil	Test Type	Lab A	Lab B	Lab C	Lab D
TMC 152	Standard, non-lubrited	X X	X	-	-
	Standard, lubrited	-	X X	X	-
	Canadian, non-lubrited	-	-	X X	X
	Canadian, lubrited	X	-	-	X X
TMC 155	Standard, non-lubrited	X X	X	-	-
	Standard, lubrited	-	X	X X	-
TMC 134	Standard, non-lubrited	X	X	X	X X
	Standard, lubrited	X	X	X	X X

An "X" indicates that testing is required

Attachment 3

To ASTM Section D02.B0.03 member list
Section D02.B0 list???

ASTM standard test method D6121-09 commonly known as the L-37 test is an important industry standard test which has been in existence for over 30 years and is used in qualifying oils worldwide against performance criterias:
American Petroleum Institute (API) Publication 1560.8
STP-512A.9
SAE J308.
Military Specification MIL-PRF-2105E.
SAE J2360
Additionally many OEM gear oil specifications reference one of the above specifications or specifically the L-37 test.

The L-37 Surveillance panel is in the midst developing a change of test hardware used in qualifying test fluids from Dana Model 60 axles to an AAM Zeta 218 axle. This effort is being performed by a task group formed in May 2011, and is expected to conclude in early 2013.

The scope of the L-37 Hardware Replacement Task Group is:

- To develop an equivalent hardware replacement for the L-37 test that can be incorporated into ASTM D6121 and maintains the identical discrimination of oil performance as the current hardware.

To this end the L-37 panel is soliciting field proven oils of different chemistries and viscosities to demonstrate the L-37 replacement hardware will meet the task force's scope of maintaining historic severity and precision levels. Guidelines for an oil submission include:

- The oil must have demonstrated field performance and be currently in field service
    - Field demonstration must include
        - Oil viscosity
        - Type of vehicles
        - Type of service
        - Oil drain intervals
        - Axle inspection and ratings
        - Any other information the sponsor believes will demonstrate field performance such as OEM approvals etc.
- The oil must have demonstrated L-37 test performance
        - The performance must be in a referenced stand and full test ratings should be submitted
        - Additional testing such as required for API-GL-5 or SAE J2360 or information the oil meets these standards will help in assessing oil performance

- The submitter must be willing to sponsor up to four L-37 replacement hardware tests to help assess the replacement test's response to the oil.
    - Tests can be run at one of the four labs that are part of the task force
- The submitter must have sufficient oil quantity for the 4 tests noted above, but is advised that oil for up to 10 tests should be considered. The submitter may also be asked if the oils is available to be an ASTM reference oil.
- All Data submission will be made to the ASTM TMC for confidentiality
    - Data submission must be made by March 1, 2012
        - The TMC will code the oils and submit data to the task force for consideration
    - Earlier submissions are encouraged since much of the work for any test modifications must occur early in the 1 year development cycle left to ensure the timeline can be met
    - Address for submission is:

Attention: Scott Parke
ASTM Test Monitoring Center
Carnegie Mellon University
6555 Penn Avenue
Pittsburgh, PA 15206 USA
Phone: 412-365-1036

Any questions or comments can be addressed to:
Attention: Scott Parke
ASTM Test Monitoring Center
Carnegie Mellon University
6555 Penn Avenue
Pittsburgh, PA 15206 USA
Phone: 412-365-1036

Sincerely
Galen Greene
L-37 Surveillance Panel Chairman

Attachment 4

Company Name _____

Oil Code _____

Viscosity Grade _____

Level of Performance - Check appropriate box: API GL-5 ☐ For API GL-5 oils, please see the Note below

SAE J2360 ☐ PRI Qualification Number _____

Summary of ASTM D 6121 (L-37) Test Results

	Pinion	Ring
Wear		
Rippling		
Ridging		
Pitting		
Spalling		
Pitting/Spalling		
Scoring		

Hardware Batch _____ Lubrited ☐

Non-Lubrited ☐

Test Lab _____

Stand Number / Run Number _____

End-of-test Date _____

Note: If submitting an API GL-5 quality oil for consideration, please provide information on the performance of this lubricant in the field