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November 16, 2016

Reply to:
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ASTM D02.B0.03 L-37-1 Surveillance Panel
Members and Guests:

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

- **November 2, 2016, Surveillance Panel Meeting**

Please direct any corrections or comments to my attention.

Sincerely,

Matthew Umerley

Matt Umerley, Chairman
L-37-1 Hardware Taskforce Chairman

Report of Meeting
L-37-1 Surveillance Panel Meeting
November 2nd, 2016 Meeting

Attendees:
Voting Members in **BOLD**

Banas, Rob - ExxonMobil
Bell, Don - Afton
Bubonic, Brad – Lubrizol
Dharte, John – AAM
Donovan, Eric – Afton
Drlja, Kristijan – Lubrizol
Dwornick, Bridget – US Army
Goyal, Arjun – BASF
***Guzikowski, Joe – Dana**
Kanga, Percy - ExxonMobil
Kearney, Bill – Afton
Keisler, Marc – Afton
Marsic, Vera – Lubrizol
*Matthews, Brad – Afton
Minke, Andreas – BASF
Opperman, Robert - Meritor
Parke, Scott – ASTM TMC
*Reardon, Art – Gleason
Rucker, Jule – Meritor
Sattler, Eric – US Army
Smith, Dale – Intertek
Trader, Angela – Intertek
Umerley, Matt – Lubrizol
Venhoff, Wes – Lubrizol
Warden, Rebecca – SwRI

*indicates call-in

1.0 Agenda Review

2.0 Membership Review
- Jule Rucker to replace Troy Muransky for Meritor voting membership
  - **Motion** – E. Donovan
  - 2nd – W. Venhoff
  - Unanimous pass

3.0 Approval of Meeting Minutes
- 20160810
  - **Motion** – J. Dharte
  - 2nd – E. Donovan
  - Unanimous pass

4.0 L-37 Reference Test Precision
- S. Parke shows how often a deviation letter is needed for L-37 reference testing now that acceptance bands have been adopted for reference oil pass/fail.
- **Motion** to remove LTMS precision consequences for L-37 reference testing
- Unanimous pass

5.0 Axle Build Procedure
- Lab-to-lab differences discussed, see color-coded notes attached
- LZ to determine if differential gears are being thoroughly cleaned without being disassembled.

6.0 Gleason Data Review

- See spreadsheet attached, Afton's 3 runs on IND-1 have been added since the meeting
- Dana expresses concern over the inconsistency of results on IND-1, ranging from 5-10 merits on Pinion Ripple at full-load
    - Intertek comments that our build process may have improved over time therefore giving us a higher pass rate on the recent runs.
- Lubrizol expresses concern over some early signs that the test might be too mild, getting passing results on a chemistry that they feel should not pass this test.
    - Lubrizol agrees to run this fluid in the Dana test to see how closely the Gleason and Dana results relate
- **Motion** – E. Donovan – to accept the test as-is with the following correction factors applied to bring TMC 117 and IND-1 in line with historic performance: +1 ring ridging, +1 pinion ripple, +1 pinion ridging
    - 2nd – A. Goyal
    - Voting
        - 2 – for
        - 2 – against
        - 6 – abstain
    - Motion does not pass
- **Motion** – E. Donovan – to accept the test as-is with the following correction factors applied to bring TMC 117 and IND-1 in line with historic performance: +1 pinion ridging
    - No 2nd
    - Motion does not pass

7.0 Next Steps

- Lubrizol to gather and present further data justifying the opinion that the Gleason test may actually be mild. Lubrizol will look at fluid(s) that should likely not pass Dana L-37 compared to Gleason performance. Repeats to be included

8.0 Adjournment

- Motion – B. Bubonic
- 2nd - R. Warden

Respectfully Submitted
Matt Umerley

being essential

L-37

November 2nd 2016 Troy, MI

Agenda

- Membership Review
- Meeting Minute Approval
- L-37 Axle Build Procedure
- L-37 Reference Test Precision
- L-37-1 Gleason Data
- L-37-1 Next Steps
- New Business

Membership Review – Voting Members

- Rob Banas – ExxonMobil
- Allen Comfort – US Army
- John Dharte – AAM
- Eric Donovan – Afton
- Arjun Goyal – BASF
- Joe Guzikowski – Dana
- ~~Donna Mosher~~ – Eaton**
- ~~Troy Muransky~~ Jule Rucker– Meritor**
- Scott Parke – TMC
- Dale Smith – Intertek
- Matt Umerley – Lubrizol
- Rebecca Warden – SwRI
- Khaled Zreik - GM

Meeting Minutes

- L-37
  - 20160810

L-37 Reference Test Precision

L-37 Axle Build Procedure

A12.1 Axle Preparation

A12.1.2 Component Cleaning

A12.1.2.1 Using a solvent meeting ASTM D235 Type II Class C per ASTM D7452 7.2, scrub all residual oil and dirt from the disassembled test parts with a plastic bristle parts brush. Axle tubes will only be well rinsed with spray solvent. Use care not to damage wheel end seals, they will not be changed.

A12.1.2.2 Thoroughly wash the new ring, pinion, and Timken build kit parts for assembly with solvent.

A12.1.2.3 All parts are to be blown completely dry.

^The bearings shouldn't be cleaned with solvent. You need light oil on them to allow you to do the break/turn, etc. -SWRI

A12.2 Pinion Assembly

A12.2.1 Measuring For Head Bearing Shims

A12.2.1.1 Install tail bearing race, tail bearing, washer, and pinion seal.

A12.2.1.2 Install set-up head bearing outer race with OD of race slightly ground down and set-up head bearing into the housing.

A12.2.1.3 Using the Miller Special Tools 6775 or equivalent tool, measure the pinion depth and record the value. This value will equal the total head bearing shim amount.

A12.2.1.3.1 For Gleason hardware builds, subtract 0.005" from the measured pinion depth to determine the proper head bearing shim amount. For example if the pinion depth is 0.040", subtract 0.005" which makes the total head bearing shim amount of 0.035".

A12.2.1.4 Remove the pinion depth tool and set-up head bearing outer race and bearing.

^This section depends on what tools you have. Some labs have a measurement tool that don't require setup bearings on the pinion for measurements. -SWRI

A12.2.2 Final Pinion Assembly

A12.2.2.1 Stack appropriate shims equal to the value determined in A12.2.1. Use best practices when stacking shims by placing the thinnest shims towards the center of the stack and the thickest shims on the either end of the shim stack.

A12.2.2.2 Install the head bearing shims and the new head bearing outer race into the housing.

A12.2.2.3 Using a hydraulic press, install the new head bearing onto the pinion. Stop pressing when 5 tons of pressure is achieved to seat the bearing.

A12.3 Carrier Assembly

A12.3.1 Installing Side Gears and Ring Gear

A12.3.1.1 Install the side gears and thrust washers then rotate the diff pinion gears and thrust washers into place at 180° of each other.

A12.3.1.2 Slide the diff pin through the carrier and side gears.

A12.3.1.3 Align the diff pin with the roll pin hole. Drive the roll pin into place.
A12.3.1.4 Slide the ring gear over the carrier and align with new bolts from build kit. Tighten ring gear bolts to 110 ± 10 lbf-ft alternately.

This is currently not being done as the differential is not currently being disassembled at EOT. -LZ

A12.3.2 Measuring For Carrier Bearing Shims (Includes Pinion Assembly Installation)

A12.3.2.1 Install the Miller Special Tools 6770-D343 dummy carrier bearings or equivalent tool onto the assemble carrier. Insert the carrier with dummy carrier bearings into the housing.
A12.3.2.2 Using a dial indicator, measure the total carrier shim amount by sliding the carrier side-to-side. Measure in four (4) locations around the carrier and record the average total carrier shim amount. This measurement will be referred to as the “total” shim measurement.
A12.3.2.3 Remove the carrier and dummy bearings from the housing. Leave the dummy carrier bearings on the carrier assembly.
A12.3.2.5 Install the yoke and pinion nut. Torque pinion nut to 250 lbf-ft.
A12.3.2.6 Check turning torque and ensure it is between 25-50 lbf-in. Adjust tail bearing shims accordingly if necessary.
A12.3.2.7 Reinstall the carrier assembly with dummy bearings into the housing.
Note: *Be careful to make sure the gears are in mesh and do not chip during carrier installation.*
A12.3.2.8 Using a dial indicator as previously used in A12.3.2.2, zero the dial indicator with the carrier pulled fully out of mesh. With the dial indicator zeroed, slide the carrier fully into mesh and record the value shown on the dial indicator. This value will be referred to as the “into mesh” shim measurement.
A12.3.2.9 Remove the carrier assembly and dummy bearings from the housing. Remove the dummy bearings from the carrier assembly.

A12.3.3 Calculating Carrier Shim Amounts

A12.3.3.1 The measurement taken in A12.3.2.8, the “into mesh” measurement, will be for the ring side of the carrier. Subtract 0.005” from the “into mesh” measurement and the result is the total shim amount for the ring side of the carrier. This pulls the ring out of mesh by 0.005” to set backlash.
A12.3.3.2 For the non-ring side of the carrier, take the “total” shim measurement from A12.3.2.2 and subtract the “into mesh” shim measurement from A12.3.2.2. Then add 0.010” to this calculated value to account for the 0.005” subtracted in A12.3.3.1 as well as adding 0.005” preload to the carrier. The final calculated value is the total shim amount for the non-ring side of the carrier.

Table 1 – Carrier Shim Calculation Example	
“total”	0.090”
“into mesh”	0.060”
Ring side	0.060” – 0.005” = 0.055”
Non-ring side	0.090” – 0.060” + (0.005” + 0.005”) = 0.040”

A12.3.4 Final Carrier Assembly

A12.3.4.1 Stack appropriate shims equal to the values determined in A12.3.3. Use best practices when stacking shims by placing the thinnest shims towards the center of the stack and the thickest shims on the either end of the shim stack.

A12.3.4.2 Install the bearing set that will be used for pattern check using a hydraulic press, install the ring side carrier bearing and shims onto the carrier. Stop pressing when 5 tons of pressure is achieved to seat the bearing.

A12.3.4.3 Install the bearing set that will be used for pattern check using a hydraulic press, install the non-ring side carrier bearing and shims onto the carrier. Stop pressing when 5 tons of pressure is achieved to seat the bearing.

A12.3.4.4 If setup bearings are used for a preliminary pattern check, they will need to be replaced with new bearings and the pattern will need to be checked again.

A12.4 Axle Assembly

A12.4.1 Install the fully assembled carrier into the axle housing. **Note: The gears are very hard and chip easily, make certain that the gears mesh as the carrier is installed. If the carrier is loose (drops right in) carrier preload adjustments will need to be performed.**

A12.4.2 Check to see if some lash between the gears exists.

A12.4.3 Install the bearing caps and carrier bolts tighten to 85 ± 5 lbf-ft.

A12.4.4 Place the dial indicator on the axle flange and position it to test ring gear lash. It shall be between 0.004” and 0.009” inches, 0.007” is preferred.

A12.5 Pattern Check Procedure

A12.5.2 Very lightly paint pattern paste on 3 to 6 ring gear teeth. Thick coatings will cause unacceptable pattern variations.

A12.5.3 Install the L-37 ring gear loading cover using standard cover bolts and lightly tighten all 3 set screws to apply tension to the ring gear. Axle shafts with manual brake assemblies are also acceptable for applying load for the pattern check.

A12.5.4 Adjust the load applied to the ring gear to achieve 15 ± 5 lbf-ft turning torque during the first revolution of the pinion for Gleason gears, 30 ± 5 lbf-ft for Dana gears.

A12.5.5 Rotate the pinion at least 6 additional turns the same direction. Then rotate the pinion in the opposite direction at the turning torque specified in A12.5.4 for at least 6 additional turns to bring the pattern painted teeth into view. If the patterns match the pattern photos proceed to final assembly. If the pattern position is not correct on either drive or coast side, adjust pinion depth until proper pattern is achieved. **NOTE: Pinion depth adjustment changes previous settings. Pinion preload and lash may change with the depth shim change. All must be corrected before running new pattern checks.**

A12.5.6 Once an acceptable pattern is achieved, wash paint off gear teeth using solvent per A12.1.2.1. Blow dry with compressed air.

L-37-1 Gleason Data

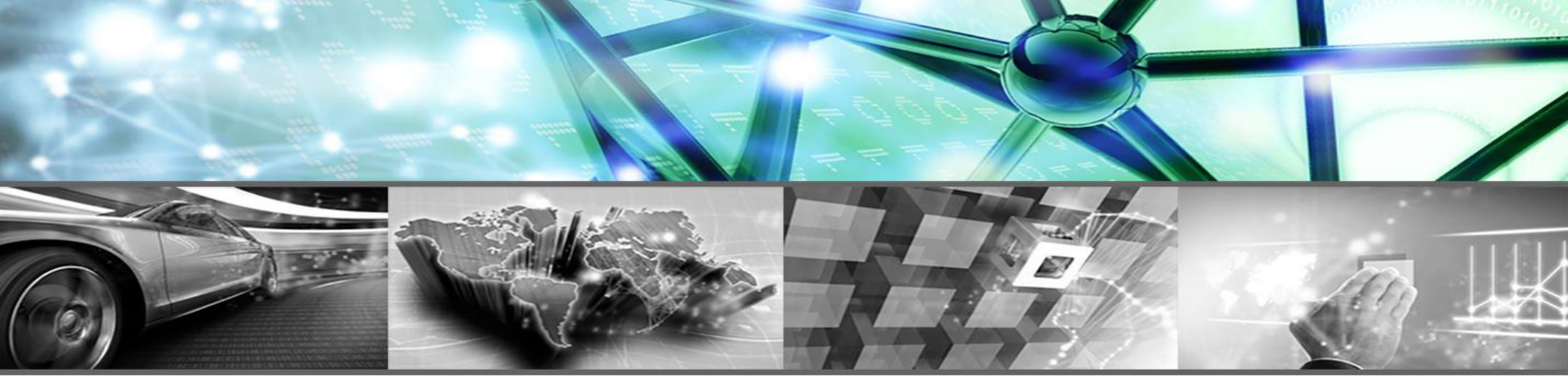
Lab	Gear Batch	Gear Number	Run Number	Test Version	Hardware Type		Oil	CMIR	EOT Date	Housing	Pinion							Ring							Comments
					Pinion Batch	Ring Batch					Case Depth	Hardness	Wear	Ripple	Ridge	Spitt	Score	Case Depth	Hardness	Wear	Ripple	Ridge	Spitt	Score	
A	Non-Lubrited		41	Standard	2115435	2116457	134	90169-L371	20150108	LAB-A0021-01	0.05	62	6	6	3	9.7	10	0.06	63	6	10	4	9.5	10	Pre-Workshop Run
A	Non-Lubrited	Matrix Axle 8	44	Standard	2116453	2115440	134	106145-L371	20150227	LAB-A0032-01	0.051	61	5	8	3	8	10	0.058	62	6	8	4	9.9	10	Chipping on pinion teeth
A	Non-Lubrited		48	Standard	2116453	2115440	134	106146-L371	20150307	LAB-A0026-01	0.051	61	4	7	4	9.8	10	0.058	62	6	9	4	9.8	10	
D	Non-Lubrited		3-186	Standard	2124465	2124399	134	99160-L371	20150213		0.06	61	6	9	6	8	10	0.083	62	6	10	6	9.9	10	
D	Non-Lubrited	Matrix Axle 3	3-184	Standard	2116453	2115440	134	99159-L371	20150212		0.051	61						0.058	62						Failed
B	Non-Lubrited	Matrix Axle 4	367	Standard	2116453	2115440	134	98239-L371	20150501		0.051	61						0.058	62						Shut down at 14 hours on Test. 5 Pinion Teeth Broken, All except 3 Ring Gear Teeth Broken (those 3 are cracked)
B	Non-Lubrited		373	Standard	2116453	2115440	134	107311-L371	20150510		0.051	61	5	8	4	5	10	0.058	62	6	10	5	9.9	10	Chipping on pinion teeth. 8 broken ring gear teeth
G	Non-Lubrited		29	Standard	2116454	2116458	134	107190-L371	20150721	LAB-G0001-01	0.052	61	3	9	3	6	10	0.053	63	7	9	4	9.9	10	Chipping on pinion teeth. 3 broken ring gear teeth
A	Non-Lubrited		46	Standard	2116454	2115440	117	96487-L371	20150303	LAB-A0024-01	0.052	61	7	7	6	9.9	10	0.058	62	8	9	7	9.9	10	Chipping on one tooth
A	Non-Lubrited		49	Standard	2116453	2115440	117	96490-L371	20150310	LAB-A0027-01	0.051	61	8	9	9	9.9	10	0.058	62	8	9	10	9.9	10	
D	Non-Lubrited		3-194	Standard	2124463	2124399	117	99167-L371	20150318		0.05	63	7	8	7	9.9	10	0.083	62	7	10	8	9.9	10	
D	Non-Lubrited		3-197	Standard	2153061	2153064	117	99168-L371	20150324		0.064	61	7	8	8	9.9	10	0.055	63	7	10	9	9.9	10	
D	Non-Lubrited		3-201	Standard	2124465	2124399	117	98455-L371	20150331		0.06	61	7	6	6	9.9	10	0.083	62	7	9	7	9.9	10	
B	Non-Lubrited		370	Standard	2116453	2115440	117	96483-L371	20150506		0.051	61	9	10	9	9.9	9	0.058	62	9	10	10	10	10	Unusual wear on pinion. Possibly scored and polished out
B	Non-Lubrited		372	Standard	2116453	2115440	117	96484-L371	20150509		0.051	61	8	9	9	9.9	10	0.058	62	9	10	9	9.9	10	Unusual contact on pinion. 1 shutdown due to power outage
D	Non-Lubrited		3-205	Standard	2124465	2124399	117	99169-L371	20150428		0.06	61	7	8	8	9.9	10	0.083	62	7	10	9	9.9	10	
D	Non-Lubrited		3-206	Standard	2124465	2124399	117	99170-L371	20150429		0.06	61	7	8	7	9.9	10	0.083	62	7	10	8	9.9	10	
D	Non-Lubrited		3-207	Standard	2124465	2124399	117	99171-L371	20150501		0.06	61	7	8	7	9.9	10	0.083	62	7	9	7	9.9	10	
G	Non-Lubrited	Matrix Axle 9	27	Standard	2116453	2115440	117	96496-L37-1	20150716	LAB-G0009-01	0.051	61	9	10	9	9.9	10	0.058	62	9	10	10	9.9	10	
G	Non-Lubrited	Matrix Axle 7	28	Standard	2116453	2115440	117	108140-L371	20150717	LAB-G0010-01	0.051	61	9	10	9	9.9	10	0.058	62	9	10	10	9.9	10	
G	Non-Lubrited		35	Standard	2116454	2116458	117	108141-L371	20150925	LAB-G0004-01	0.052	61	8	9	9	9.9	10	0.053	63	9	10	9	9.9	10	Built 0.010 into mesh (into the root)
G	Non-Lubrited		36	Standard	2116454	2116458	117	108142-L371	20151001	LAB-G0002-03	0.052	61	7	9	10	9.9	10	0.053	63	8	10	10	9.9	10	Built 0.010 out of mesh (out of the root)
A	Non-Lubrited	Matrix Axle 6	42	Standard	2116453	2115440	155-1	106972-L371	20150723	LAB-A0027-01	0.051	61	7	8	7	9.9	10	0.058	62	7	10	10	10	10	Chipping on one tooth
A	Non-Lubrited		43	Standard	2115435	2116457	155-1	106973-L371	20150225	LAB-A0022-02	0.05	62	8	9	10	9.9	10	0.06	63	8	10	10	9.9	10	
D	Non-Lubrited	Matrix Axle 1		Standard			155-1		20150213		#N/A	#N/A	7	9	9	9.9	10	#N/A	#N/A	8	10	10	9.9	10	
D	Non-Lubrited		3-198	Standard	2124465	2124399	155-1	106960-L371	20150325		0.06	61	7	10	10	9.9	10	0.083	62	7	10	10	10	10	
B	Non-Lubrited	Matrix Axle 2	366	Standard	2116453	2115440	155-1	106968-L371	20150430		0.051	61	8	10	10	9.9	10	0.058	62	9	10	10	10	10	
B	Non-Lubrited		368	Standard	2135702	2135619	155-1	106969-L371	20150502		0.055	62	9	10	10	9.9	10	0.056	62	9	10	10	9.9	10	Chipping on Pinion Teeth
G	Non-Lubrited		30	Standard	2116454	2116458	155-1	106984-L371	20150724	LAB-G0002-01	0.052	61	8	10	9	9.9	10	0.053	63	9	10	10	9.9	10	
G	Non-Lubrited		31	Standard	2116454	2116458	155-1	106965-L371	20150724	LAB-G0003-01	0.052	61	8	9	9	9.9	10	0.053	63	9	10	10	9.9	10	
B	Lubrited		395	Standard	2116441	2116444	155-1	106970-L371	20150624		0.052	63	9	10	10	9.9	10	0.054	63	9	10	10	9.9	10	
A	Non-Lubrited		47	Standard	2116453	2115440	152-2	107271-L371	20150305	LAB-A0025-01	0.051	61	7	7	10	9.9	10	0.058	62	8	10	10	9.9	10	1 Shut down due to dyno output 100%
A	Non-Lubrited		50	Standard	2116453	2115440	152-2	107272-L371	20150312	LAB-A0028-01	0.051	61	7	6	9	9.9	10	0.058	62	8	10	10	9.9	10	
D	Non-Lubrited		3-195	Standard	2153061	2153064	152-2	99162-L371	20150319		0.064	61	7	10	9	9.9	10	0.055	63	7	10	10	10	10	
D	Non-Lubrited		3-196	Standard	2153064	2153061	152-2	99163-L371	20150321		0.064	61	7	10	10	9.9	10	0.055	63	7	10	10	9.9	10	
B	Non-Lubrited		369	Standard	2135702	2135619	152-2	99172-L371	20150503		0.055	62	9	10	10	9.9	10	0.056	62	9	10	10	9.9	10	
B	Non-Lubrited		371	Standard	2135702	2135619	152-2	99173-L371	20150507		0.055	62	8	10	10	9.9	10	0.056	62	9	10	10	10	10	Chipping on 2 pinion teeth
G	Non-Lubrited		32	Standard	2116454	2116458	152-2	107194-L371	20150805	LAB-G0003-02	0.052	61	8	8	9	9.9	10	0.053	63	9	9	9	9.9	10	
G	Non-Lubrited		33	Standard	2116454	2116458	152-2	107195-L371	20150808	LAB-G0002-02	0.052	61	8	8	10	9	9.9	10	0.053	63	9	10	9	9.9	10	
B	Non-Lubrited		380	Standard	2135702	2135619	IND 1				0.055	62	7	6	8	9.9	10	0.056	62	7	10	9	10	10	
B	Non-Lubrited		407	Standard	2135702	2135619	IND 1				0.055	62	7	5	6	9.9	10	0.056	62	7	10	8	9.9	10	
B	Non-Lubrited		410	Standard	2135701	2135618	IND 1				0.064	62	7	7	9	9.9	10	0.056	63	8	10	9	9.9	10	10% reduction in dyno load
independe	Non-Lubrited			Standard	2116453	2115440	IND 1				0.051	61	6	5	7	9.9	10	0.058	62	7	9	7	9.9	10	
D	Non-Lubrited		3-262	Standard	2116457	2116457	IND 1	120259-L371	20160908		0.050	62	7	6	7	9.9	10	0.060	63	7	7	8	9.9	10	2359 N-m
D	Non-Lubrited		3-263	Standard	2116457	2116457	IND 1	120258-L371	20160910		0.050	62	7	7	9	9.9	10	0.060	63	7	10	9	9.9	10	2359 N-m
D	Non-Lubrited		3-264	Standard	2115435	2116457	IND 1	120257-L371	20160915		0.050	62	7	8	8	9.9	10	0.060	63	7	10	10	9.9	10	2359 N-m
B	Non-Lubrited		462	Standard	2135703	2135700	IND 1		20161006		0.054	62	8	8	9	9.9	10	0.052	61	9	10	9	9.8	10	
B	Non-Lubrited		463	Canadian	2135703	2135700	IND 1		20161008		0.054	62	9	10	10	9.9	10	0.052	61	9	10	10	9.9	10	
B	Non-Lubrited		465	Standard	2153061	2153064	IND 1		20161013		0.064	63	7	9	8	9.9	10	0.05	63	9	10	9	9.9	10	
B	Non-Lubrited		466	Standard	2124466	2124462	IND 1		20161014		0.058	62	7	9	8	9.9	10	0.06	63	9	10	9	9.9	10	
1645 N-m Test Load																									
B	Non-Lubrited		422	Standard	2124465	2124399	IND 1				0.06	61	8	10	10	9.9	10	0.083	62	9	10	10	10	10	1645 N-m
B	Non-Lubrited		425	Standard	2116453	2115440	IND 1				0.051	61	8	10	10	9.8	10	0.058	62	9	10	10	9.9	10	1645 N-m
B	Non-Lubrited		429	Canadian	2135702	2135619	IND 1				0.055	62	8	10	10	9.9	10	0.056	62	9	10	10	10	10	1645 N-m
D	Non-Lubrited		3-227	Standard	2135703	2135700	117	108589-L371	20150924		0.054	62	7	10	10	9.9	10	0.052	61	8	10	10	10	10	1645 N-m
B	Non-Lubrited		433	Standard	2124466	2124462	152-2	108835-L371	20151028		0.058	62	8	10	10	9.9	10	0.06	63	9	10	10	9.9	10	1645 N-m
B	Non-Lubrited		434	Standard	2124466	2124462	155-1	106971-L371	20151030		0.058	62	9	10	10	9.9	10	0.06	63	9	10	10	9.9	10	1645 N-m
A	Non-Lubrited		05-0057	Standard	2116453	2115440	155-1	106974-L371	20151029	LAB-A0036-01	0.051	61	7	7	9	9.8	10	0.058	62	8	10	10	9.9	10	1645 N-m - High vibration during test phase
A	Non-Lubrited		05-0058	Standard	2116453	2115440	152-2	107302-L371	20151103	LAB-A0037-01	0.051	61	7	7	9	9.9	10	0.058	62	8	10	10	9.9	10	1645 N-m
A	Non-Lubrited			Standard	2116453	2115440	155-1	106975-L371	20151119		0.051	61	7	8	7	9.9	10	0.058	62	8	10	10	9.9	10	1645 N-m
A	Non-Lubrited			Standard	2116453	2115440	155-1	107305-L371	20151203		0.051	61	7	7	10	9.9	10	0.058	62	8	10	10	9.9	10	1645 N-m
A	Non-Lubrited			Standard	2124465	2124399	155-1	107306-L371	20151219		0.06	61	7	10	10	9.9	10	0.083	62	7	9	9	9.9	10	1645 N-m - LZ built axle
A	Non-Lubrited			Standard	2124464	2124398	155-1	114309-L371	20160108		0.052	62	7	8	10	9.9	10	0.06	63	8	10	10	9.9	10	1645 N-m
A	Non-Lubrited			Standard	2124464	2124398	155-1	114310-L371	20160109		0.052	62	7	8	10	9.9	10	0.06	63	8	10	10	9.9	10	1645 N-m
A	Non-Lubrited			Standard	2124464	2124398	155-1	114311-L371	20160128		0.052	62	7	7	9	9.9	10	0.06	63	8	10	10	9.9	10	1645 N-m
D	Non-Lubrited		3-240	Standard	2153061	2153064	155-1	106961-L371	20160106		0.064	61	7	9	10	9.9	10	0.055	63	8	10	10	10	10	1645 N-m
D	Non-Lubrited		3-241	Standard	2115435	2116457	152-2	99166-L371	20160108		0.05	62	7	10	9	9.9	10	0.06	63	8	10	10	10	10	1645 N-m
G	Non-Lubrited		46	Standard	2116454	2116458	155-1	106986-L371	20160123	LAB-G0021-01	0.052	61	7	9	10	9.9	10	0.053	63	8	10	10	9.9	10	1645 N-m
G	Non-Lubrited		47	Standard	2116454	2116458	152-2	101842-L371	20160126	LAB-G0022-01	0.052	61	8	9	9	9.9	10	0.053	63	9	10	9	9.9	10	1645 N-m
D	Non-Lubrited		3-226	Standard	2135703	2135700	134	99161-L371	20150922		0.054	62	7	8	5	9.9	10	0.052	61	7	9	5	9.9	10	1645 N-m
D	Non-Lubrited		3-229	Standard	2153061	2153064	134	108544-L371	20150929		0.064	61	7	7	4	9.9	10	0.055	63	7	10	5	9.9	10	1645 N-m
B	Non-Lubrited		427	Standard	2135702	2135619	134	108833-L371	20150929		0.055	62	6	7	4	9.5	10	0.056	62	6	10	6	9.9	10	1645 N-m
B	Non-Lubrited		432	Standard	2124466	2124462	134	108834-L371	20151024		0.058	62	5	7	4	6	10	0.06	63	6	10	6	10	10	1645 N-m
G	Non-Lubrited		38	Standard	2116454	2116458	134	107191-L371	20151014	LAB-G0004-02	0.052	61	6	9	5	9.9	10	0.053	63	8	10	6	9.7	10	1645 N-m
G	Non-Lubrited		40	Standard	2116454	2116458	134	107192-L371	20151028	LAB-G0004-03	0.052	61	7	6	5	9.7	10	0.053	63	7	8	6	9.9	10	1645 N-m
A	Non-Lubrited		56	Standard	2116453	2115440	134	106148-L371	20151026	LAB-A0035-01	0.051	61	5	7	4	8.0	10	0.058	62	5	9	4	9.9	10	1645 N-m
A	Non-Lubrited		55	Standard	2116453	2115440	134	106147-L371	20151024	LAB-A0034-01	0.051	61	6	6	5	9.7	10	0.058	62	6	9	5	9.8	10	1645 N-m
G	Non-Lubrited		41	Canadian	2135703	2135700	152-2	107169-L371	20151104	LAB-G0012-01	0.054	62	7	8	9	9.9	10	0.052	61	8	9	9	9.9	10	1645 N-m
G	Non-Lubrited		42	Canadian	2135703	2135700	152-2	107197-L371	20151105	LAB-G0013-01	0.054	62	7	8	9	9.9	10	0.052	61	7	8	9	9.9	10	1645 N-m
ALTERNATIVE HARDWARE																									
D	Non-Lubrited		3-230	Standard	V1L528	P4T883A	134	112515-L371	20151001		#N/A	#N/A	5	8	5	9	10	#N/A	#N/A	6	9	5	9.9	10	full load 2359 N-m. Dana hardware
ALTERNATIVE BREAKIN LOADS																									
D	Non-Lubrited		3-234	Standard	2135703	2135700	117	108590-L371	20151020		0.054	62	7	8	7	9.9	10	0.052	61	7	10	8	9.9	10	1.5 times (800 N-m) breakin, full load test
D	Non-Lubrited		3-231	Standard	2135703	2135700	134	112516-L371	20151003		0.054	62	5	8	4	9	10	0.052	61	6	9	5	9.9	10	1.5 times (800 N-m) breakin, full load test; chipping/spalling on pinion
CANADIAN																									
A	Non-Lubrited		51	Canadian	2116453	2115440	152-2	107273-L371	20150313	LAB-A0029-01	0.051	61	8	6	9	9.9	10	0.058	62	8	10	9	9.9	10	
A	Non-Lubrited		53	Canadian	2116453	2115440	152-2	107301-L371	20150318		0.051	61	8	10	8	9.9	10	0.058	62	8	10	9	9.9	10	
D	Non-Lubrited		3-199	Canadian	2124465	2124399	152-2	99164-L371	20150327		0.06	61	7	9	8	9.9	10	0.083	62	7	10	10	9.9	10	
D	Non-Lubrited		3-200	Canadian	2124465	2124399	152-2	99165-L371	20150328		0.06	61	7	10	8	9.9	10	0.083	62	7	10	8	9.9	10	
B	Non-Lubrited		374	Canadian	2116453	2115440	152-2	99174-L371	20150522		0.051	61	7	10	10	9.9	10	0.058	62	9	10	10	10	10	Non-Typical look on Pinion. Similar to scoring that has been polished out
B	Non-Lubrited		375	Canadian	2135702	2135619	152-2	99175-L371	20150523		0.055	62	7	10	10	9.9	10	0.056	62	9	10	10	10	10	Non-Typical look on Pinion. Similar to scoring that has been polished out

				Pinion					Ring				
				Wear	Ripple	Ridge	Spitt	Score	Wear	Ripple	Ridge	Spitt	Score
STD	134	Dana	erence Data	N= 28	5.82	8.21	5.92	4.94	10	6.57	9.21	6.96	9.81	10
STD		Gleason	Data		4.83	7.83	3.83	7.75	10	6.17	9.33	4.50	9.82	10
STD		Gleason	Data	1650 N-m	6.13	7.13	4.50	9.00	10.00	6.50	9.38	5.38	9.88	10.00
STD	152 (-1-2)	Dana	erence Data	N= 94	7.53	9.1	9.1	9.54	10	7.9	9.63	9.97	9.91	10
STD		Gleason	Data		7.75	8.875	9.25	9.9	10	8.25	9.875	9.75	9.925	10
STD	155 (-1)	Dana	erence Data	N= 67	7.16	9.16	9.03	9.4	10	7.86	9.54	9.93	9.75	10
STD		Gleason	Data		7.9	9.6	9.6	9.9	10.0	8.4	10.0	10.0	9.9	10.0
CAN	152 (-1-2)	Dana	erence Data	N= 26	7.5	8	8.9	9.68	10	7.57	9.38	9.69	9.78	10
CAN		Gleason	Data		7.3	9.2	8.8	9.9	10.0	8.0	10.0	9.3	9.9	10.0

Next Steps

New Business?

Thanks!



SUCCESS TOGETHER

Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.

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Meeting Date: 11/2/16

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