Pepper Hamilton LLP
Attorneys at Law

3000 Two Logan Square
Eighteenth and Arch Streets
Philadelphia, PA 19103-2799
215.981.4000
Fax 215.981.4750

215-981-4412
richmand@pepperlaw.com

January 31, 2003

HAND DELIVER

RECEIVED
2003 JAN 31 P 3:49

Richard Boyd, Chief
Medium & Heavy Duty Truck Division
Office of Defects Investigation
Safety Assurance
National Highway Traffic Safety
Administration
400 Seventh Street, SW
Washington, DC 20590

Re: Information Request to SKF USA Inc.
PE02-088

Dear Mr. Boyd:

This letter is submitted in response to your Information Request dated December 16, 2002, addressed to Richard W. Frett, attorney for SKF USA Inc. ("SKF"). SKF has engaged our firm to assist the company in responding to the Request. By electronic mail of January 24, 2003, directed to Nate Seymour, I requested a 30-day extension of time to respond to certain paragraphs of the Request. As I have not been advised to the contrary, I assume the requested extension has been allowed. SKF appreciates your courtesy.

We are producing with this letter documents responsive to Paragraphs 1, 2, 4, 5, 7, and 8 of the Information Request. With the exception of the two tables of warranty claims being produced in response to Request No. 4, the documents have been Bates-numbered sequentially. For ease of reference, we are enclosing a Document Index which correlates each document, by Bates-number reference, to the paragraph or paragraphs of the Request which call for the document. All of the documents identified on the Document Index are being produced in hard copy and in electronic format on CD Rom as requested save for the table of sales data (SKF001187-88) produced in response to Request No. 1, which is produced in hard copy only.

Because of their bulk, the tables of warranty claims are being produced today exclusively on disk in Microsoft Excel spreadsheet format. The tables, which were furnished to SKF by ArvinMeritor on December 16, 2002, have not been Bates-numbered. If you decide that you want us to produce the tables in hard copy as well, please let me know and we will accommodate your request.

Our supplemental response to be made within thirty days will include internal and external electronic communications, which are now being gathered. Much of the communication between SKF and ArvinMeritor concerning the alleged defect has occurred electronically.

Confidentiality

A number of the documents being produced have been designated "confidential" and are so identified on the Document Index. We respectfully request a thirty-day extension of time within which to submit the information required by 49 CFR Part 512 in support of the assertion of privilege. Time has not allowed us to do more than collect responsive documents and determine as a preliminary matter which of the documents are apparently confidential within the meaning of the applicable regulations.

Information Requests and SKF's Responses

1. By month and year, state the total number of subject component assemblies sold to ArvinMeritor for use in the FF-981 Front Hub Assembly. Separately, in the same format, state the total number of subject component assemblies sold to any other source. Identify the source.

Response: The requested information is set forth in the Table, which is enclosed at Appendix 1. All of the subject components were sold to ArvinMeritor. The hub unit models designated as BTF-0031, BTF-0032, BTF-0048, and BTF-0049 were all manufactured at an SKF plant in Germany. None of those models is associated with the alleged defect, which is linked to production at SKF's Aiken, South Carolina plant beginning in August 1998 with hub unit model designated BTF-0052.

2. State the number and provide copies of all the following, from all sources, of which SFK is aware and which relate, or could relate to the alleged defect in the subject component:

a. owner/fleet complaints;

b. field reports;

c. crash/incident claims;

d. subrogation claims;

e. lawsuits; and

f. third-party arbitration proceedings (where SKF is a party to the arbitration)

Please list and collate your response for each category ("a" through "f") by date of claim. Please provide for each item in this response the bearing sequence number (include an explanation of the sequence number), the incident date, mileage of the vehicle at time of incident (if known), build date of bearing assembly, and description of claim. For items "a" through "d," please provide all related information and reports whether or not SKF has verified each one. For items "e" and "f," summaries are acceptable. Please identify in the summary the caption, court, docket number, and filing date of each lawsuit if a copy of the complaint initiating the lawsuit is not provided. Please provide the requested information in Microsoft excel 2000. Provide a separate spreadsheet for each category "a" through "e." Arrange the records on the spreadsheet in chronological order, by incident date. For each responsive record, provide the information requested in separate columns with a single row.

Response: A copy of the requested documents in categories "a" through "c" is enclosed. SKF is not aware of any subrogation claims, lawsuits, or third-party arbitration proceedings involving SKF as a party relating to the alleged defect and therefore has no documents in categories "d" through "f.".

SKF will supplement this Response with a spreadsheet summarizing the information contained in Appendix 2 relating to categories "a" through "c."

3. If SKF has issued any service bulletins, technical bulletins, advisories, or any other communications to final stage manufacturers, axle manufacturers, dealers, zone offices or field offices pertaining to the alleged defect provide a copy of each such document. If no documents have been issues, so state.

Response: SKF has not issued any service bulletins, technical bulletins, or advisories relating to the alleged defect to anyone. SKF did consult to ArvinMeritor on service bulletins issued by ArvinMeritor relating to the alleged defect. Insofar as Request No. 3 calls for communications between SKF, ArvinMeritor, and OEMs concerning the alleged defect, apart from service bulletins, technical bulletins, or advisories, such communications are being produced pursuant to Paragraphs 2, 5, and 8.

4. State the number of warranty claims, including extended warranty claims, and requests for "good will," field, or zone adjustments received by SKF from any source(s) that relate to the alleged defect in the subject component. Provide a table summarizing the claims, including the following information: build date, bearing sequence number, claim date, and claim

code. Each problem claim code must be identified. Please provide the requested information in Microsoft Excel 2000.

Response: As the manufacturer of a sub-assembly of an axle, SKF does not receive warranty claims from end users or OEMs. ArvinMeritor has provided to SKF on request a tabular summary of warranty claims, which it received, allegedly pertaining to the subject component. The most recent and therefore most complete version of such summary was received from ArvinMeritor on December 16, 2002, and is enclosed in hard copy and on disk in Microsoft Excel spreadsheet format, as requested. As SKF is not the author of the summary and does not, with few exceptions, possess documentation of the claims underlying the summary, SKF is unable to vouch for the meaning, reliability, or significance of the data contained in the summary.

5. Identify and provide copies of all documents reflecting any study, survey, and investigation pertaining to the alleged defect, that is known to SKF. Include all pertinent documents, regardless of whether they are in interim, draft, or final form.

Response: A copy of documents responsive to Request No. 5 is enclosed. SKF anticipates supplementing this response when electronic communications have been compiled.

6. Identify and describe all significant modifications or changes made by or on behalf of SKF in the manufacture, design, or material composition of the subject components that relate, or could relate to the alleged defect. The following information must be included for each such modification or change, if none exist, then so state.

a. the date, or approximate date on which the modification or change was incorporate into production.

b. a description of the modification or change;

c. the reason for the modification or change;

d. SKF's opinion of the change or modification's effectiveness;

e. the part number of he modified part;

f. whether the original unmodified component was withdrawn from sale, and if so, when; and;

g. whether the modified or changed components can be interchanged with earlier production components.

Response: SKF has twice changed the supplier of the seals incorporated into the subject component. In April 2000 SKF switched from an oil seal made by Freudenberg in Germany to a grease seal made at SKF's Bethlehem, Pa. plant. The purpose of the change was to upgrade seal performance. Freudenberg seals were not withdrawn from sale, and the change in supplier did not bring about a change in the part number assigned to the subject component. In SKF's opinion, the grease seal constitutes an effective design.

In June 2000 SKF switched its source of seal supply from its Bethlehem plant to its Elgin, Ill. plant due partly to a planned closure of the Bethlehem facility. The switch to Elgin was hastened; however, by the finding that certain of the Bethlehem seals had manufacturing flaws in the form of "knit lines," which could constitute leak paths. The change to Elgin as a source of supply eliminated the incidence of knit lines. Bethlehem seals still in SKF's inventory or already installed in hubs awaiting assembly by ArvinMeritor were returned to SKF and have not been resold

All of the seals mentioned above are interchangeable.

7. Provide a copy of any maintenance recommendations and or requirements provided to ArvinMeritor by SKF concerning the subject component. For each communication provided, state the date of the communication

Response: A copy of the requested documents is enclosed. SKF anticipates supplementing this response when electronic communications have been compiled.

8. Furnish copies of all communications between SKF, ArvinMeritor and OEMs pertaining to the design, manufacture, field performance, durability , quality and testing of the subject components and the alleged defect. If any communications on this subject were oral or were conducted electronically, provide a written transcript or summary of tech such communication, and include the statement that identifies the participants and the date of the communication.

Response: SKF is in the process of gathering the requested information, which will be produced within thirty days of the date hereof.

9. State whether SKF ever considered substituting alternative design or components in the subject components for reasons that relate in any way to the alleged defect. If so, identify and describe each such alternative design or component, state the date it was first proposed and the disposition of that proposal (i.e., approved, disapproved, or still being evaluated), and the reasons for that action.

Response: The only change in design or components that relates in any way to the alleged defect was the change in seal supply source from SKF's Bethlehem plant to its Elgin plant discussed in Response No. 6.

10. Furnish SKF's detailed opinion of the alleged defect in the subject components. Please include an assessment of the following:

a. the causal or contributory factors which may result in the alleged defect;

b. the failure mode;

c. the risk to motor vehicle safety that it poses;

d. d. what warning(s), if any, would the operator of a subject vehicle have.

Response: SKF is in the process of formulating its detailed opinion of the alleged defect, which will be furnished within thirty days of the date hereof.

11. On what date(s) did SKF cease collecting information for use in responding to this Information Request? If more than one date applies, please provide the date for each information type (e.g., production quantity, owner reports, warranty claims, etc.).

Response: SKF has not stopped collecting information for use in responding to this Information Request; hence the information and documents produced herewith are believed to be current.

Sincerely,

David Richman

Information Request to SKF USA Inc.
NHTSA PE02-088
Document Index

Bates-Number(s)	Request Number	Confidentiality
SKF 000001	None (File Label)	
SKF 000002	2(b)	
SKF 000003	None (File Label)	
SKF 000004	2(b)	
SKF 000005- SKF 000014	2(b)	
SKF 000015- SKF 000033	2(b)	
SKF 000034- SKF 000036	2(b)	
SKF 000037	2(b), 7	
SKF 000038- SKF 000046	2(b)	Confidential
SKF 000047- SKF 000060	2(b)	Confidential
SKF 000061- SKF 000071	2(b)	Confidential
SKF 000072- SKF 000077	2(b), 4	Confidential
SKF 000078- SKF 000083	2(b), 4	Confidential
SKF 000085- SKF 000153	8	Confidential
SKF 000154- SKF 000163	2(b)	Confidential
SKF 000164- SKF 000181	2(b)	
SKF 000182	2(b)	
SKF 000183	7	
SKF 000184	5, 8	
SKF 000185	5	
SKF 000186- SKF 000236	2(b), 7, 8	Confidential
SKF 000237- SKF 000345	2(b), 5, 8	Confidential

Information Request to SKF USA Inc.
NHTSA PE02-088
Index to Responsive Document Index

Bates-Number(s)	Request Number	Confidentiality
SKF 000346- SKF 000378	5, 8	Confidential
SKF 000379- SKF 000384	2b	Confidential
SKF 000385- SKF 000386	5	Confidential
SKF 000387	2(b)	
SKF 000388	8	Confidential
SKF 000389- SKF 000391	5	Confidential
SKF 000392- SKF 000397	2(b)	
SKF 000398- SKF 000403	2(b)	Confidential
SKF 000404- SKF 000413	5	Confidential
SKF 000414- SKF 000418	8	Confidential
SKF 000419	8	Confidential
SKF 000420- SKF 000435	8	Confidential
SKF 000436- SKF 000445	8	Confidential
SKF 000446	5	Confidential
SKF 000447- SKF 000484	2(b)	Confidential
SKF 000485	None (File Label)	
SKF 000486- SKF 000521	5	Confidential
SKF 000522	5, 8	
SKF 000523- SKF 000610	5	Confidential
SKF 000611- SKF 000637	5	Confidential
SKF 000638- SKF 000663	5	Confidential
SKF 000664- SKF 000665	5, 8	

Information Request to SKF USA Inc.
NHTSA PE02-088
Index to Responsive Document Index

Bates-Number(s)	Request Number	Confidentiality
SKF 000666- SKF 000698	5	Confidential
SKF 000699	5, 8	Confidential
SKF 000700- SKF 000787	5	Confidential
SKF 000788	5, 8	Confidential
SKF 000789- SKF 000855	5, 8	Confidential
SKF 000856- SKF 000859	7	
SKF 000861- SKF 000894	2(b), 5, 8	Confidential
SKF 000895- SKF 001086	2(b)	Confidential
SKF 001087- SKF 001096	5	Confidential
SKF 001097- SKF 001103	5	Confidential
SKF 001104- SKF 001113	2(b), 5	Confidential
SKF 001114	5	Confidential
SKF 001115- SKF 001119	8	Confidential
SKF 001120- SKF 001126	2(b)	Confidential
SKF 001127- SKF 001135	2b	Confidential
SKF 001136- SKF 001153	2(b), 8	Confidential
SKF 001154	2(b)	Confidential
SKF 001155- SKF 001156	2(b), 8	Confidential
SKF 001157	2(b), 5, 8	Confidential
SKF 001158	5	Confidential
SKF 001159- SKF 001161	5	Confidential
SKF 001162- SKF 001175	5	Confidential

Information Request to SKF USA Inc.
NHTSA PE02-088
Index to Responsive Document Index

Bates-Number(s)	Request Number	Confidentiality
SKF 001176- SKF 001178	2(b)	Confidential
SKF 001179- SKF 001186	5	Confidential
SKF 001187- SKF 001186	1	Confidential

[redacted] TRUCKING FAILURE

SKF 000001

August 25, 2000

Plymouth, MI
USA

David Dassecker
Manager Worldwide Procurement
ArvinMeritor Heavy Vehicle Systems
2135 West Maple Road,
Troy, MI, 48084-7186

Dear David:

Please find enclosed a check for $68,403.00 to cover the [redacted] on fire. After reviewing the results of your metallurgical study, we revisited our own analysis and agree that your conclusions are correct. The raceway was not hardened properly resulting in pre-mature eroding of the raceway. We have corrected this issue at our Aiken plant and have forwarded [redacted] a copy of the corrective action.

We believe that the operators must be made aware of the consequences of driving a vehicle that has brake drag with these hubs. Instead of a wheel off condition, the hub will remain with the vehicle and generate heat. Though this is a safer mode, you can't continue to operate the vehicle when this condition occurs. At a meeting with Brad Arnold last week, we agreed that a technical bulletin will be issued to advise drivers to shut the vehicle down instead of trying to "limp" home. We also agreed to develop a system to jointly process claims of this kind with the intention of responding quickly to the customer and ensuring that we are making the correct decision.

Irrespective of the failure mode of any wheel end, they have to be prevented. We have the capability to develop wheel sensors that can provide feedback on temperature or an entire matrix of wheel end conditions. Since you are the industry leader with axles and wheel ends, we feel that we should jointly embrace this challenge to make our highways safer, and improve our profitability.

If you have any further questions, please don't hesitate to contact me.

Best Regards,

Robert J. Bondy

Robert J. Bondy
Senior National Account Manager

cc. B. Arnold, K. Belling, S. Brown, M. Lewis

[illegible]
Telephone (734) [illegible] Fax (734) [illegible]
An SKF Company

REMITTANCE STATEMENT

NO. 253378

VENDOR NO.	VENDOR INVOICE NO.	YOUR INV. NO.	DATE	DATE YEAR	P.O. NUMBER	GROSS AMOUNT	DISCOUNT	AMOUNT OF PAYMENT
69062	AUGUS	08	08	2000		68,483.00		68,483.00
		ATTN:		ARVIN	MERITON			
						68,483.00		68,483.00

DETACH BEFORE DEPOSITING

NO. 253378

SKF USA Inc.

PAY TO THE ORDER OF

[redacted]

DATE 08 24 2000

EXACTLY****68,483DOLLARS 00CENTS

V2

First Union Bank of Delaware
Wilmington, DE 19809

AUTHORIZED SIGNATURE

[redacted]

SKF 000002

BOB
BONDY

INTERNAL LETTER

MERITOR

Date June 2, 2000 No. 00[illegible]072

To: D. Dessecker From: S. E. Ketcham
Product Analysis
Troy / SE-005
5-1643

Subject: [redacted]

Meritor paid [redacted] g sixty eight thousand four hundred three dollars ($68,403.00) as compensation for the damage to their Freightliner tractor, VIN 1FUYDSEB7YP940386, and the loss of the driver's personal property. This amount was determined based on the following:

Vehicle Purchase Price	$74,903
Driver's Personal Property	1,500
Sub-Total	$76,403
Estimated Salvage Value	($8,000)
Total	$68,403

A copy of the vehicle purchase order and the executed Property Damage Release are enclosed.

Assuming that no unresolved issues remain following Meritor's meeting with SKF on June 12, please convey this information with your request for reimbursement.

Sincerely

Enclosure

cc: P. Donnelly (f/encl.) – 5-128

ARVIN MERITOR
ENGINEERING EXPENSE

$ 6,860
68,403
$ 75,263 TOTAL REQUESTED

CC Lewis
Weeks
Brown

MA-4904-A-270

** TOTAL PAGE.01 **

MERITOR

REQUEST NUMBER: 20105-1
PROJECT NUMBER: AV-MS-0217
DATE: June 8, 2000

MATERIALS ENGINEERING

METALLURGICAL ANALYSIS OF SKF HUB INVOLVED IN A FREIGHTLINER FF-661 FRONT AXLE FIELD RETURN

PART NUMBERS:

Serial #: 0101547 | Mfg Date Code: 06499 | STF-0062-A

MODELS: FF-661 | Vehicle S/N: 1FUYDBEB7YP940398

PLANTS/SUPPLIERS:

SKF

CUSTOMERS:

Freightliner | [redacted]

REFERENCE REPORTS:

SKF Report No.: AT99A164 | SKF Report No.: AT99C313

ABSTRACT:

One passenger side (right) SKF THU hub for an FF-661 front axle assembly was submitted to Meritor Materials Engineering for metallurgical analysis. The front axle assembly was installed in a 1999 Freightliner vehicle that caught fire in service after 17,030 miles. The vehicle was operated by Dick Simon Trucking of Salt Lake City, Utah. The analysis concluded that the root cause of the vehicle fire was the non-induction hardened Inboard Row Outer Ring Bearing Raceway. It is suspected that as the tapered rollers eroded material from the non-induction hardened inboard row outer ring raceway, dimensional changes occurred which caused excessive movement in the assembly, resulting in brake component misalignment. With this misalignment, it is possible that the brake components could have then generated some excessive heat that contributed to the subsequent damage and fire. There have been other instances of bearing seizure/burn-up on FF-661 THU hubs due to missed induction hardening of the outer ring raceways.

KEY WORDS:

Field Return | Legal | Steel - Carbon

Harden-Induction | Process | Wear

REQUESTED BY: Bruce Ketcham

TOTAL COST: $ 6,000

PREPARED BY: Nathan Clark

APPROVED BY: Steven M. Foster

DISTRIBUTION:

D. Dowagan
S. Foster
N. Clark
B. Ketcham
D. Bell
J. Meleklan
D. Deseecker
J. McKenzie - AV
J.P. Pan - AV
M. Berlie - AV

INTRODUCTION

One passenger side (right) SKF Truck Axle Hub Unit (THU) for an FF-991 front axle assembly was submitted to Materials Engineering for metallurgical analysis. The front axle assembly was installed in a 1999 Freightliner vehicle, which caught fire in service after 17,030 miles. The driver reportedly pulled over to the side of the road after experiencing what appeared to be brake drag on the right front axle. After allowing the wheel end to cool, the driver reportedly adjusted the brakes to release the drag and continued driving the vehicle until the right front tire burst into flames. The vehicle was operated by Dick Simon Trucking of Salt Lake City, Utah. Identification markings of the THU are shown in Figure 1.

A metallurgical analysis of the THU was performed by SKF (SKF Report No.: AT99A184) prior to being delivered to Meritor, and therefore a section of the hub was missing upon arrival. The SKF report contained details on many metallurgical aspects of the hub, however data was missing from some key areas, particularly from the inboard and outboard outer raceways, which were reported to be induction hardened. A section of the hub adjacent to the SKF section was removed to evaluate these areas (Figure 2).

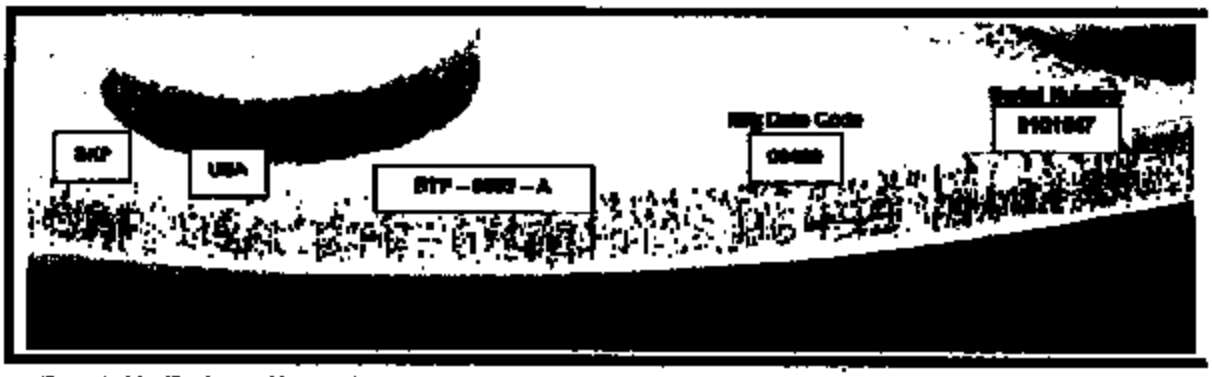


Figure 1. Identification markings on the flange outside diameter of the passenger side (right) SKF Truck Axle Hub Unit. Test bores are shown above each section for identification.

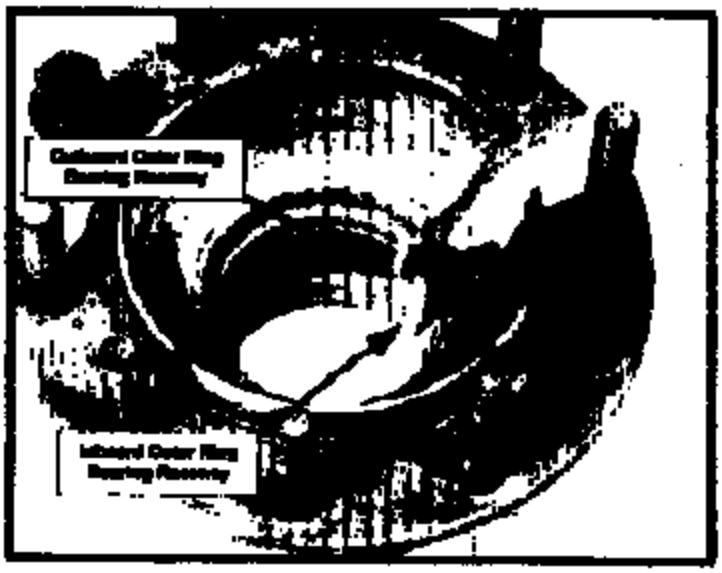


Figure 2. Photograph showing the area of the hub removed for analysis. The arrows point to the Inboard and Outboard Outer Ring Bearing Raceways. These raceways are required to be induction hardened.

CONCLUSIONS

- A cross-section of the SKF THU hub was etched to reveal the induction hardened pattern at the outboard outer ring raceway. The inboard outer ring raceway did not exhibit an induction hardened pattern (Figures 3 & 4).

- Microhardness gradients were taken at the induction hardened outboard outer ring raceway and ranged from HRC 40-43 (Figure 5). This hardness range indicates that the raceway was exposed to an estimated temperature of 700-900°F which tempered back the hardness approximately 20 HRC points from its induction hardened state (Figure 6). The microstructure of the outboard outer ring raceway consisted of tempered martensite (Figure 8).

  The hardness values at the inboard outer ring raceway were significantly lower than the outboard outer ring raceway, and ranged from HRC 22-29. Microstructural analysis of the inboard outer ring raceway revealed a mixture of ferrite and pearlite, indicating that this raceway was not induction hardened (Figures 9 & 10).

- It is theorized in the SKF metallurgical report that, "*an initial condition of excessive heat caused the right THU bearing to lose its lubricant and fail. The source of heat, which appears to have affected the hardness levels of the right THU bearing components, may have been a result of the brake pads dragging against the brake drum during operation. This is believed to have caused the seals on the ring to burn and the bearing lubricant to be lost. Thus, the unlubricated condition of the bearing caused its imminent failure.*"

  It is Meritor Materials Engineering's opinion that the root cause of the vehicle fire was the non-induction hardened Inboard Row Outer Ring Bearing Raceway. It is suspected that as the tapered rollers eroded material from the non-induction hardened inboard row outer ring raceway, dimensional changes occurred which caused excessive movement in the assembly, resulting in brake component misalignment. With this misalignment, it is possible that the brake components could have then generated some excessive heat that contributed to the subsequent damage and fire.

- There have been other instances of bearing seizure/burn-up on FF-881 THU hubs due to missed induction hardening of the outer ring raceways.

EXPERIMENTAL RESULTS

Figure 3 shows the cross-section etched to reveal the induction hardened patterns of the outer ring raceways. No induction hardened pattern was revealed at the inboard outer raceway.

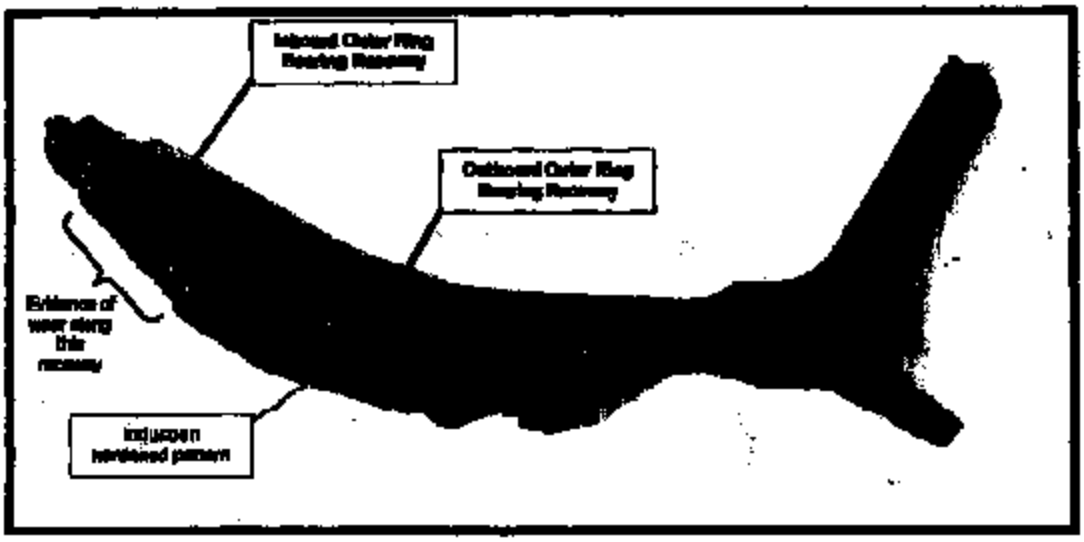


Figure 3. Etched cross-section through the bearing raceways. The red arrow points to the induction hardened pattern of the outboard outer ring raceway. No induction hardened pattern was revealed at the inboard outer ring raceway. Evidence of wear was observed at the inboard outer ring raceway.

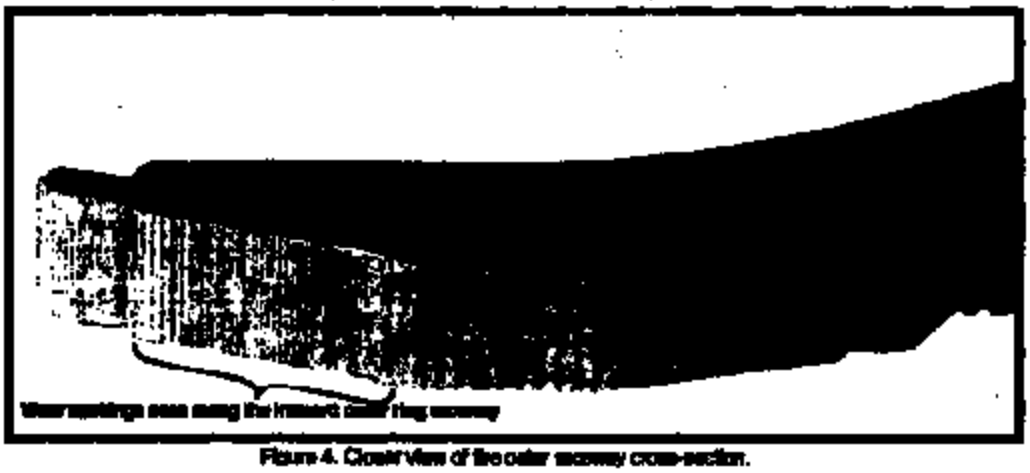


Figure 4. Closer view of the outer raceway cross-section.

Microhardness

Knoop 500g microhardness gradients were generated at the inboard and outboard outer bearing raceways and are illustrated in Figure 5. Figure 6 shows the estimated temperature exposure of the induction hardened outboard row outer ring raceway, which can be estimated from the tempered hardness values and the carbon content of the steel (taken from SKF report AT99C313).

Figure 5. Microhardness of Outer Raceways

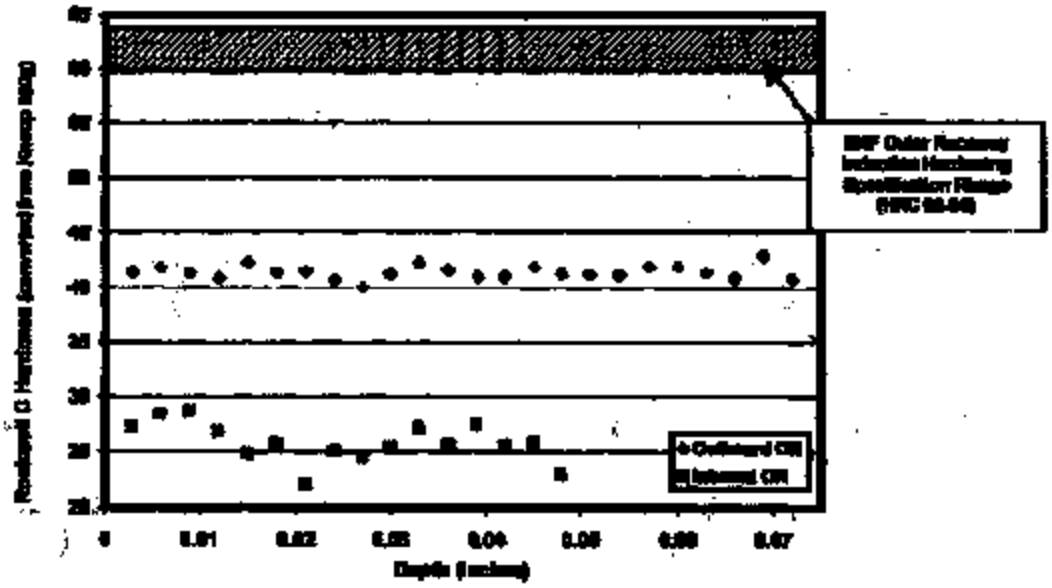
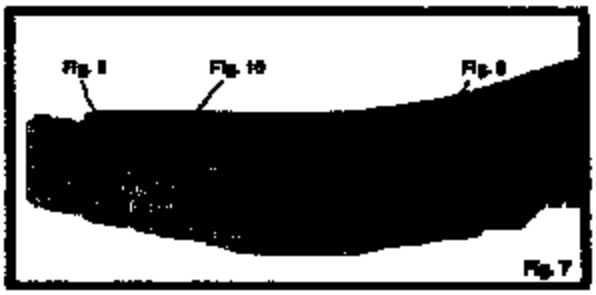


Figure 6. Estimated Temperature Exposure of the Induction Hardened Outboard Outer Ring Raceway

Outboard Outer Ring	40-43	700 – 800

Microstructure
Figure 7 shows the locations of the microstructures pictured in Figures 8-11.



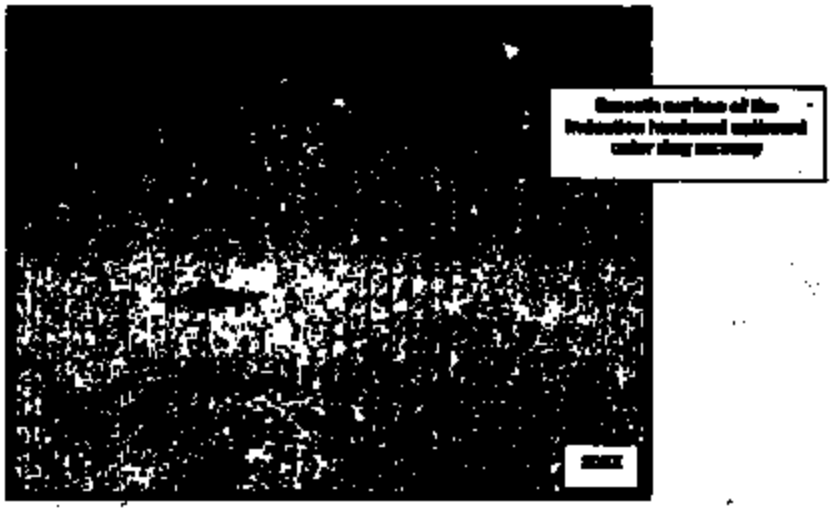


Figure 8. Microstructure of the outboard outer ring bearing raceway consists of tempered martensite. Microhardness indentations are shown at 0.003" intervals.

Figure 9. Microstructure at the end of the inboard outer ring bearing raceway consisted of pearlite and ferrite. The "step" in the surface is a result of the tapered roller bearing wear, and was found to be approximately 0.0078" deep. A "swirling" grain flow is seen from the elevated temperature smearing of the non-induction hardened raceway surface.

Figure 10. Microstructure near the middle of the inboard outer ring leaving raceway consisted of pearlite and ferrite. As in Fig. 9, the "melting" grain flow is seen from the elevated temperature smearing of the non-induction hardened raceway surface. The depth of the smearing grain flow was found to be approximately 0.010".

Technical Error Report (TER)

[illegible] Pre-Information of Complaint [illegible]

Mandatory fields are marked with: *
X1 Section

Gen[illegible]

Reference Number	LA-20000329-42128	Local Reference No.:	
Creation Date	03/29/2000	Received Date: *	02/29/2000
Reason why the report creation was delayed: *	Field failure, returned for Warranty		

Reporting Unit Information

Complaint Reporting Person (X1): *	Bruce Weeks/AMER/SKF	Reporting Operational Unit: *	A115 ABU USA
Business Area:	A115 ABU USA	Segment:	A162 AD North America
Division:	Automotive		

[illegible]

Customer Name: *	Meritor		
Customer No.: *	Not Available	Customer Invoice No.: *	Not Available

If Customer Number is not available press here. [redacted]
If Customer Invoice Number is not available press here. [redacted]

[illegible]

Seriousness Code: * [redacted]
Serious Complaint i.e. Corrective Action, Repeating Complaints.

Preliminary Technical Error Type: * [redacted]

Product Designation: *	THU		
Preliminary Type Of Error: *	1.28 Missing operation	Error Detected: *	Field in warranty

Additional Complaint Information: In board Outter Ring raceway has not been hardened, due to a missing operation at the factory.

Is there going to be a sample sent ? * [redacted]

Sample Sent Date: * 03/27/2000

Number of Samples to be sent: 2

Packaging Date:	2/24/99 & 3/16/99	Bearing Serial Number:	99995, 100832
Manufacturing Date:	2/24/99 & 3/16/99		
Product Line: *	THU 2.1		
Factory: *	Alten- Truck - THU	Factory Unit Rep. (X2):	Willem H Heelsen/AKN/SKF
Business Area co-ordinator (X3):	Juergen Schulheis/SCH/SKF	Sample Sending Address (X2):	SKF Automotive Division Alten Factory 1064 International Place Greenville, SC 29609 USA
Business Area:	AD TRUCK	Division:	AUTOMOTIVE

Additional Packaging Information:
Attachments:

[redacted]

Actions Requested by Customer:	*	TBD
Agreement with Customer:	*	TBD
Application: *		Steer Axel FF-351
Consequence:		TBD
Persons automatically informed by X1:		Willem H Heelsen/AKN/SKF
Additional Persons involved in the Process:		Volker Mueller/AKN/SKF

Corrective Action Report

[redacted]

Person responsible for the CAR if not X2:

Other persons involved in CAR, internally: Mario G Winkler/AKN/SKF, George F Wineman/AMER/SKF, Kevin Cannon/AKN/SKF, Bruce Weeks/AMER/SKF

Sample Received Date or Investigation starts: 04/09/2000

Complaint Confirmed: * [redacted]

Does this complaint involve Interim Actions: [redacted]

Interim Actions: * Present situation at the induction heatreatment machine EFD is that overflow and rejects are coming out on the same conveyor. Operators are informed about the occurance off the problem and advised to clearly physically separate rejects from good parts.

EFD will be contacted to implement program changes to avoid that non conforming parts are transferred to the machine exit but removed at the faulting station.

All conforming parts are automatically marked with a sequencial number. Non conforming parts have no number. This system has been implemented in middle March.

Interim Actions Answer Date: 04/10/2000

Factory QA:	Willem H Hacken/AKN/SKF	Channel Rep. in Factory:	Mario G Winkler/AKN/SKF
Channel Designation: *	2.1	[redacted]	

If Channel Designation is not available please have: [redacted]

Further Investigation and Conclusions: The reason why scrit parts made it thru the channel is caused by a weakness in the heat treatment sequence program and clearly by human error.

Determined Technical Error Type: * [redacted]

Determined Error Type: 04.0 Material Defects on OR

Actual Problem Description: Missed operation 1.29 in heat treatment

Root Cause: * Present situation at the induction heatreatment machine EFD is that overflow and rejects are coming out on the same conveyor. Operators are informed about the occurance off the problem.

How many Corrective Actions are needed ? * [redacted]

You need to enter all information for the number of corrective actions chosen. If persons to be assigned for Corrective Actions does not have notes use the comments field below.

#	Corrective Action	Assigned Person	Target Date	Close Date	
1	Inform all personnel about the problem	Mario G Winkler/AKN/SKF	04/07/2000		[redacted]
2	Contact EDF to change the program.	George F Wheeler/AMER/SKF	04/10/2000		[redacted]

3	All conforming parts are marked with a sequencial number.	George F Wireman/AMEF/BKF	08/15/2000		[redacted]
4	Investigate feasability to install eddy current measuring device after final washing station.	Mado G Winkler/AGM/BKF	04/19/2000		[redacted]

When the last Corrective Action is performed and the last Done button are pressed, the complaint is
considered closed.

Corrective Action Plan Comments:

The induction heat treatment machine has been reprogrammed to stop at the hardening station 2 and tempering station 4 when a defects occurs. At these two stations the operator has to physically remove the defective part from the HT machine and place it in a designated area in it is rework. Scrap is immediately discarded in a scrap container. All accepted parts are marked with a serial number. Final inspection personnel has also been instructed to check for this number and mark with green paint. If for any reason a bearing is found without a number (e.g malfunctioning of the marker) the bearing is disassembled and checked. The soft chute will be changed to have a better control over overflow parts coming of the line.

Corrective Action Plan sent to X1 Date: 05/16/2000

Corrective Action Approved by X1: * [redacted]

Corrective Action Plan Approved Date:

Customer Notification Date: * 05/19/2000

Attachments: NONE

Closed at Customer Date:

CAR Close Date:

Number of Days to approve CA Plan:
(CA Approved - CA Sent)
Total Complaint Lead-Time (TCL): 58
(Customer Notified - Receive Date)
Factory Complaint Lead-Time (FCL): 31
(Sample Received - CA Sent)

Sales Complaint Lead-Time 1 20 (SCL1):
(Received Date - Creation Date)
Sales Complaint Lead-Time 2 (SCL2):
(Customer Notified - Closed at Customer)

History Rev.	Editor	SCR Date
11	Bruce Weeks	[illegible] 04:54:11 PM
10	William H Hackon	[illegible] 12:50:23 PM
9	Lonie A Mathis	[illegible] 12:42:09 PM
8	William H Hackon	[illegible] 10:02:27 AM
7	William H Hackon	[illegible] 08:44:58 AM
6	William H Hackon	[illegible] 10:18:21 AM
5	William H Hackon	[illegible] 11:24:32 AM
4	William H Hackon	[illegible] 08:28:44 AM
3	William H Hackon	[illegible] 08:27:58 AM
2	William H Hackon	[illegible] 08:12:48 AM
1	Lonie A Mathis	[illegible] 10:18:47 PM

Created By: Lonie A Mathis/DET/SKF
Date Created: 03/28/2000

SKF

January 11, 2000

Meritor Heavy Vehicle Systems, LLC
Attn: Mr. Bruce Ketchum
2135 West Maple Road
Troy, MI 48084-7186

Re: Final Report - Steer Truck Hub Unit Analysis
Dick Simon Trucking VIN 1FUYDSEB7YP940398
Truck Hub Units: Right Serial #0101547 Mfg date code 06499
Left Serial #0101604 Mfg date code 06499

Dear Bruce,

Attached please find two copies of the final report detailing our observations and test results on subject hubs. After a painstaking review of all the data and test results and based on the evidence found in the left hand hub unit, it is believed that the most probable cause of the vehicle fire was a brake system malfunction resulting in extreme heat to the hub unit.

The driver's testimony (attached) states that he experienced a brake drag in the right front. He stopped to allow the drum to cool and then readjusted the brake to release the drag. A few miles later the tire caught fire. Most likely the brake drag heated the truck hub unit from the outside, burning the seals and deteriorating the grease which caused the subsequent hub unit failure. This in turn caused even more brake heating from the misaligned brake shoes and drum which resulted in the fire.

This conclusion is supported by the wear on the brake linings. The right side linings are worn significantly more than the left side linings around their entire circumference which would be consistent with a brake drag situation. The left side is then worn even more on the bottom which is consistent with the brake drum supporting the vehicle after the bearing failure. If the bearing failure had occurred first, there would be excessive wear on the bottom of the linings only. The circumferential wear pattern indicates that the brake drag is the most probable cause of the bearing failure and subsequent fire.

Microstructural analysis of the remaining bearing components show that a great amount of heat was applied from a source external to the hub unit (the brake), while little heat came from the bearing failure itself. Also the failed right side hub unit did not display the typical spalling of the raceways that would indicate that the bearing failure came first. This hub unit failed very quickly, probably within a few minutes. Only dents and smears were found on the upper portion of the inner rings from the rollers being out of alignment after the polymer cage had melted. Had the bearing failed first, spalls would have been located on the raceways. The noted fracture of the inner raceways also occurred in the last few minutes of operation due to metal to metal contact between the inner and outer rings after the rollers were gone.

While it cannot be said with 100% certainty that brake drag initiated the fire, there is no evidence to support other possible failure modes. The left and right side hub units are very close in serial number (547 on the right, 604 on the left, both manufactured on the same day). The Aiken manufacturing processes are very stable and consistent from bearing to bearing and no defects of any kind were found in the unfailed left side truck hub unit. The right side unit in question appears to have been made to SKF specifications for materials and heat treatment. The advanced nature of the damage from the failure and subsequent fire prevents dimensional analysis.

A lubrication failure is also unlikely as a main cause of the failure because there is no spalling of the raceways, as mentioned above. Grease samples from the left hub unit were found to be normal (report attached). Grease specifications allow 0.2% water in new grease and water content of the left side THU grease is only 0.1%. The "dirt" content noted in the report is simply the run-in particles from the bearing itself. These soft hydrated iron oxides do not affect bearing life. Due to the failure and subsequent fire, there was no grease available in the right side truck hub unit for analysis.

The design of the truck hub unit, and its application on the Easy Steer axle does not result in the same failure mode as earlier, adjustable single row taper roller bearing units. The large washer under the clamp nut effectively prevents the loss of the wheel/tire/drum/hub assembly from the vehicle as would have happened with single row taper designs. The subsequent misalignment of the brake drum with the shoes coupled with continued operation of the vehicle then results in tremendous heating, and can lead to a fire as we believe happened in this case. Drivers need to take more care in analyzing brake failures and determining if continued safe operation of the vehicle is possible.

SKF will retain this material on site at its North American Technical Center in Plymouth for 60 days where it will be available for review. Or it may be shipped according to Meritor's directions. If we receive no further directions as to the disposition of them, after the 60 days we will dispose of these materials.

Sincerely,

J. Bruce Weeks
Project Manager
SKF Automotive Division

cc: SKF
Mr. Steve Brown
Mr. Mike Lewis
Mr. Robert Bondy

Meritor
Mr. Dave Deesecker

Attachments:

Materials Laboratory Final Report number AT99A184 dated 12/14/99
Chemistry Laboratory Final Report number AT99C313 dated 11-18-99

AUG 26 '99 09:38 FR MERITOR ENG TECH CTR 248 435 8882 TO 917344148858-239 P.02/02

MERITOR 08/14/99 02:27 PM
George B Walrath

To: Gilbert T [illegible]@Auto
cc: John E [illegible]@Auto
Subject: SKF Hub / FF661

Tom

Enclosed you will find pictures of one 1999 Freightliner belonging to [redacted] of S.L.C. Utah.
SN 1FUYD[illegible]
17,000 miles
Copies of all service records are also enclosed.
The truck burned to the ground and was towed to Laramie, WY, on 8/02/99 and from Laramie to S.L.C. on
8/04/99.
The driver pulled over to the side of the road with a brake drag on the right front axle, he sat on the side of the
road until the drum cooled. He then backed of the brakes and continued on down the road until the right front
tire burst into flames at which time he passed over and was unable put out the fire. The damage is clearly shown
in the attached pictures.
The hub was still on the spindle when arriving in Dick Simon's yard. I arrived 10 minutes after the hub was removed
with two light raps with a chisel. Only the inner race of each bearing remained on the spindle, held by both lock nuts
and washers. One bearing roller was inside the Drum and five rollers lay on the lower Brake Shoe, all other Rollers
were missing. The lower right Brake Shoe and Drum are severely worn as the weight of the vehicle was supported at
that point and it appears a Brake fire may have started as a result.

Contact at [redacted] Vandermeuse Director of Maintenance [redacted]
West Valley City, Utah 84126-6297 (Salt Lake City)

I was contacted to inspect the vehicle, as was Freightliner, no comments were made and no contact with the front after
inspection. The front axle can be removed and shipped to Troy if needed. Please contact me on Phone Mail at 1313
or call Phone [redacted] if further action is needed.

George Walrath

Results:

Introduction

A fire damaged truck front axle assembly was received for analysis of the truck hub units (THUs). In its "as received" condition, the right (passenger) side THU exhibited high temperature damage. This THU had been disassembled prior to being received at the NATC. Figure 1 shows the truck axle in its "as received" condition. The left (driver) side THU bearings appeared to be in relatively good condition. Figure 2 shows the left hubs and THU assembly. Figure 3 shows the right (damaged) THU outer ring and inner rings. The truck was put into service in May 20, 1999 and had approximately 17,000 miles.

The right THU was severely damaged by high temperature, metal to metal contact and water damage. The rollers were missing and the (inner and outer) ring raceways contained dents, scattered metal, were dark blue in color and were rusted. The outboard inner ring contained cracks and was fractured. No grease samples could be extracted from of the right THU. Figure 4 shows photos of the damaged inner rings. The rings contained roller dent marks, fractures and dark blue color from exposure to heat. The rust is believed to have occurred as a result of water use during the fire extinguishing.

The left THU contained the hubcap, both seals and grease. No damage or abnormalities in these bearing components were observed upon disassembly and inspection. The grease from the bearings was found to be in good condition. Moisture and particulate content in the grease were within specification. Refer to Chemistry Lab report AT99C315 (attached). Table 1 provides additional background information gathered during disassembly of the truck axle THUs.

Table 1

Dick Simon Truck Axle Disassembly Comments

	Left THU	Right THU
Hubcaps	good condition	not available
End Play	0.00mm	not available
Outer Jam Nut Removal	approx. 250 ft-lbs	not available
Inner Nut Removal	351 to 401 ft-lbs.	not available
Mfg. Date	April 6, 1999	April 6, 1999
Serial Number	0101404	0101947
Grease wt.	59.02 grams	not available

Hardness

The right THU bearing components contained obvious signs of having been exposed to elevated temperatures (well above 200C). Figure 4 shows the dark blue color of the right THU inner rings. The hardness values of the bearing components were reduced from their original levels by the exposure to heat. The inner rings, which were manufactured through hardened, lost between 6 and 10 Rockwell C hardness points. The outer ring, on the other hand, appeared to have lost 20 to 25 Rockwell C hardness points from its induction hardened raceways. This indicates that the outer ring reached higher temperatures than the inner rings. The microstructure of the outer ring base material (non-heat-treated sections) is composed of primarily pearlite. As expected, this microstructure did not change in hardness or appearance.

The left THU bearing components did not appear to have been heated above 150C. The hardness values of all the left THU bearing components were within SKF requirements. Table 2 gives the hardness values of the various THU bearing components and the estimated temperature exposure levels.

Table 2

Hardness and Estimated Temperature Exposures of Left and Right THUs

THU	Component	Hardness	Specification	Est. Temp. Exposure °F (C)
Left	Outer Ring Raceway	63 HRC	60-64 HRC	<300 (<150C)
	Inboard Inner Ring	63 HRC	60-64 HRC	<300 (<150C)
	Outboard Inner Ring	na	60-64 HRC	---
	Outboard Roller	case 61 HRC	59-63 HRC	<300 (<150C)
	Inboard Roller	na	59-63 HRC	---
Right	Outer Ring Raceway	55 HRC	60-64 HRC	800 to 1000 (425C to 540C)
	Inboard Inner Ring	51 HRC	60-64 HRC	500 to 600 (260C to 315C)
	Outboard Inner Ring	55 HRC	60-64 HRC	450 to 550 (230C to 290C)

na = not applicable. Hardness of samples from these components were not obtained. The components were considered in good condition. Measurements on the other components from the same THU were obtained for comparative purposes.

Microstructures

Analysis of the microstructures on the available bearing components (all rings and driver side THU rollers) indicated that the parts were heat treated in accordance with SKF specifications. Both the left and right THU outer ring raceways (inboard and outboard) were induction hardened. The inner rings (both left and both right THUs) were through hardened. The left THU rollers were case carburized. The hardened rings and rollers (induction hardened outer ring raceways, through hardened inner rings and case carburized rollers) consisted of tempered martensite. The through hardened inner rings contained carbides which were evenly distributed throughout the steel matrix. The outer ring base microstructures (material away from the induction hardened raceways) consisted of fine pearlite. This microstructure is consistent with SKF requirements.

The right THU components exhibited signs of high temperature tempering, attributed to post heat treatment high temperature exposure. This is believed to have occurred during service as a result of a dragging brake. The microstructures are described in Table 3. Figures 5 through 7 show the microstructures of the right THU bearing components. The martensitic microstructures indicate that the components had been hardened as required.

Table 3

Microstructures and Heat Treatments of the Left and Right THU Bearing Components

THU	Component	Microstructure	Specification	Heat Treatment
Left[a]	Outer Ring Raceway	AFT3	AFT2 - AFTT4	Induction Hardened
	Outer Ring Core	Pearlite & Ferrite	Pearlite & Ferrite	As Forged
	Inboard Inner Ring	MT2; TG1; TN1	≤MT4; ≤TG3; ≤TN3	Through Hardened
	Roller case	SH2	≤SH4	Carburized 8620H
	Roller core	CS5	CS4 to CS6	Carburized 8620H
Right[b]	Outer Ring Raceway	AFT3 (OB side)	AFT2 - AFTT4	Induction Hardened
	Outer Ring Core	Pearlite & Ferrite	Pearlite & Ferrite	As Forged
	Inboard Inner Ring	MT2; TG1; TN1	≤MT4; ≤TG3; ≤TN3	Through Hardened
	Outboard Inner Ring	MT2; TG1; TN1	≤MT4; ≤TG3; ≤TN3	Through Hardened

a = OB inner ring was not examined. The left THU was undamaged and the IB inner ring microstructure was obtained primarily for comparison.
b = Damage from overheating was observed on all components. The microstructures were derived from the best samples obtained.

Roller Case Depths

The THU roller case depth was found to be within specification. The value, obtained from an outboard roller, was determine to be 0.043" (1.1mm). The minimum case depth requirement is 0.039". Case depths are the depth to 50 HRC hardness.

Chemical Composition

The chemical composition of the THU bearing components were within specification. Table 4 gives the chemical composition of the left and right THU bearing components. The composition of the rollers were not obtained. However, based on the microstructures, the left THU rollers appeared to be carburized 8620H steel.

Table 4

Chemical Composition (wt%) of the Left and Right THU Bearing Components [a]

THU	Component	Grade	C	Mn	P	S	Si	Cr	Mo	Ni	Al	Ti
Left	Outer Ring	55	0.60	0.78	0.013	0.017	0.18	0.10	0.01	0.06	0.02	0.001[b]
	I/B Inner Ring	3	0.99	0.32	0.018	0.012	0.29	1.38	0.04	0.16	0.04	0.001[b]
Right	Outer Ring	55	0.60	0.78	0.015	0.024	0.21	0.08	0.02	0.06	0.02	0.001[b]
	I/B Inner Ring	3	0.93[c]	0.43	0.013	0.003[c]	0.21	1.44	0.05	0.21	0.01	0.001[b]
	O/B Inner Ring	3	0.96	0.45	0.015	0.003[c]	0.23	1.45	0.05	0.21	0.01	0.001[b]
Specifications		55	0.55 to 0.60	0.60 to 0.90	0.030 max	0.018 to 0.030	0.10 to 0.30	0.20 max	0.10 max	0.20 max	0.01 to 0.05	0.003 max
		3	0.95 to 1.10	0.25 to 0.45	0.025 max	0.015 max	0.15 to 0.35	1.35 to 1.65	0.10 max	0.25 max	0.01 to 0.05	0.003 max

a = Elemental analysis performed by an independent AZLA certified Laboratory (AZLA certification # 0388-01/02).
b = Data obtained at NATC. The independent lab equipment accuracy for readings of these elements was limited to a minimum value of 0.005.
c = Carbon content considered to be in the low end of the specification range.
d = Chemical analysis performed by NATC.

Fractured Inner Rings

As discussed above, the right side THU was severely damaged by high temperature, metal to metal contact and water damage. The rollers were missing and the (inner and outer) ring raceways contained dents (see figure 4), smeared metal, were dark blue in color and were rusted. The carburized inner ring contained cracks and was fractured circumferentially (see figure 4). The fractures and cracks are believed to have occurred as a result of the bearing operating without lubricant after the seals were burnt. No spalls were observed on the raceways. Typically, inner or outer rings that crack during service also spall as a result of the stresses imposed by the rolling elements. The fractures and cracks are likely to have occurred within the last few minutes of operation.

Root Cause of Failure

It is theorized that an initial condition of excessive heat caused the right THU bearing to lose its lubricant and fail. The source of heat, which appears to have affected the hardness levels of the right THU bearing components, may have been a result of the brake pads dragging against the brake drum during operation. This is believed to have caused the seals on the ring to burn and the bearing lubricant to be lost. Thus, the unlubricated condition of the bearing caused its imminent failure.

The right THU outer ring appears to have reached higher temperatures than the inner rings. This indicates that the source of the heat source was outside of the right THU, namely the brake components. Reportedly, the driver of the truck noticed that the right brake drum had overheated and stopped the vehicle to allow the brake drum to cool. During this stop, the brakes were adjusted to restore wheel rotation. Continued operation of the truck resulted in the right wheel to burst into flames.

The right brake drum and brake pads appear to have been worn disproportionately compared to the left brake drum and brake pads. All the brake pad surfaces (including surfaces on the top brake pad) of the right side brake exhibited heavy wear and discoloration compared to the brake pads on the left side brake. The wear seen on the bottom brake pad surface of the right side brake is likely to have occurred after the bearing was damaged. This is believed to have occurred as a result of the loss of support that the bearing is designed to provide. The wear seen on the top surface of the right side brake, however, is believed to have occurred as a result of the brake pads dragging prior to the bearing becoming damaged. A faulty brake mechanism could have caused the brake pad to be in contact with the brake drum continuously during operation of the truck causing the brake components to heat and the brake pads to wear. Figure 8 shows the right brake drum and pads. Figure 9 shows the left THU brake drum and pads for comparison.

Conclusions

1. The microstructures and chemical compositions of the THU bearing components from both the right and left sides of the truck axle were within SKF specifications. The components are believed to have been heat treated in accordance to SKF requirements.
2. The hardness values of the right THU bearing components were reduced due to exposure to elevated temperatures. The source of heat is believed to be primarily from a faulty (dragging) brake. The hardness values of the left THU bearing components were within specifications. These components were not affected by heat.
3. The root cause of failure could not be determined with a high degree of confidence due to the extent of damage to the bearing components. It is theorized that high temperature exposure to the right THU caused the bearing seals to burn and the lubricant to leak out. This would have caused the bearing to operate unlubricated and fail prematurely.
4. The inner ring fractures, cracks and chars are likely to have occurred during the last few minutes of operation as the bearing was operating without lubricant and metal to metal contact between the ring and rollers occurred.

Figures

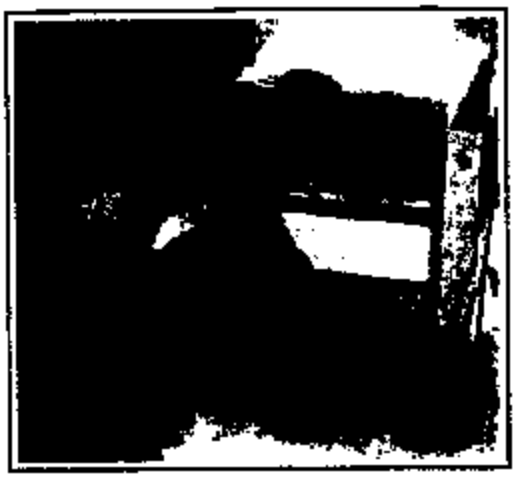


Figure 1a. Driver (left) side brake and THU assembly of a truck axle in its "as received" condition. The axle was burnt in a fire.

Figure 1b Passenger (right) side brake assembly of the truck axle in fig. 1a. The right THU was severely damaged by metal to metal contact and heat. The brake pad rivets appeared to have contacted the brake drum.

Figure 2 Close up view of the driver (left) side THU and brake assembly of a truck axle after a fire. The hubcap, which is made of aluminum, was in good condition.

Figure 3a Right side THU outer ring from a burnt truck front axle. The component was severely damaged by heat, metal to metal contact and rust.

Figure 3b Right side THU inner rings from the truck axle shown in figure 3a. The rings were severely damaged by heat, metal to metal contact and rust.

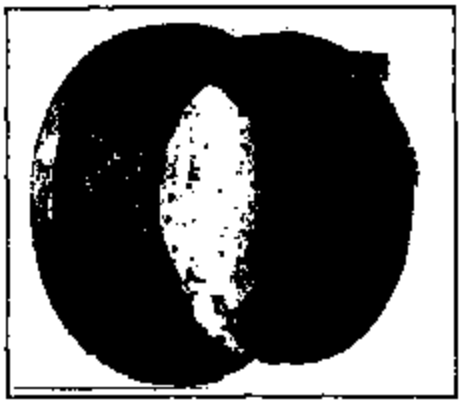


Figure 4a Inboard inner ring from the passenger side THU of a damaged truck axle. The ring was fractured circumferentially.

Figure 4b Inboard inner ring raceway. Dents appear to have been caused by the rotating rollers. The blue color indicates exposure to high temperatures.

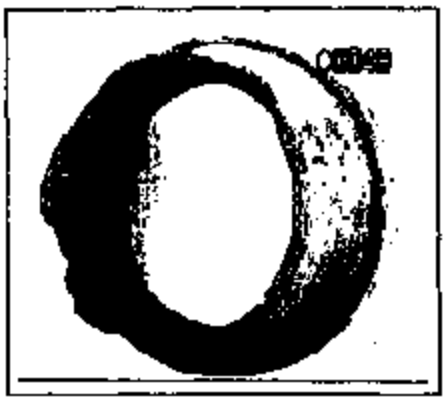


Figure 4c Outboard inner ring from the passenger side THU of a damaged truck axle.

Figure 4d Outboard inner ring from the passenger side of a damaged truck axle. The unlubricated operation of the bearing is believed to have caused the ring to heat, crack and fracture.

Figure 5a Martensitic microstructure of the driver (left) side THU inboard IR. Mag 1,000x

Figure 5b Martensitic microstructure of the driver (left) side THU induction hardened OR raceway. Mag. 1,000x

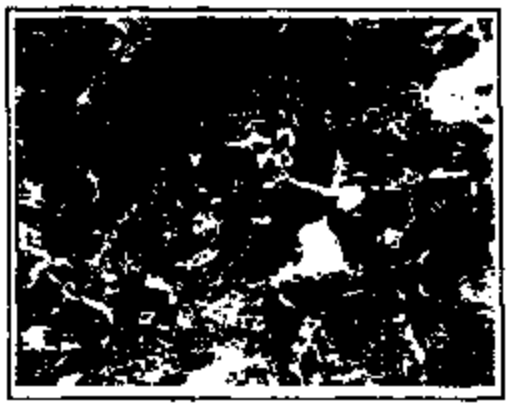


Figure 5c Fine pearlite and grain boundary ferrite microstructure of the driver (left) side THU OR base material. Mag. 1,000x.

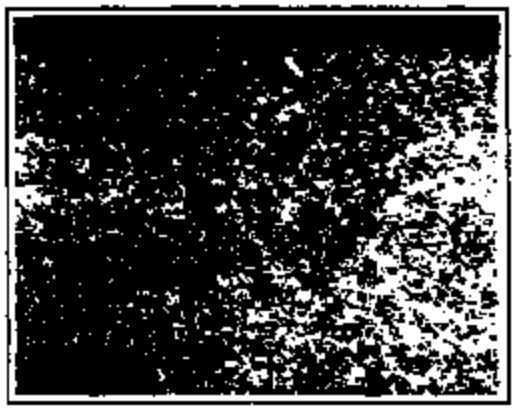


Figure 6a Martensitic microstructure of the passenger (right) side THU inboard IR. Mag. 1,000x. The carbides indicate that the ring was hardened as required.

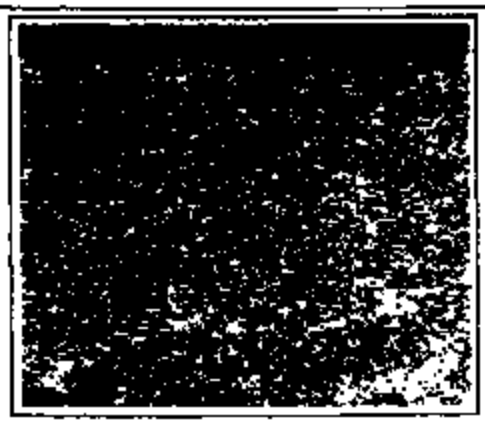


Figure 6b Martensitic microstructure of the passenger (right) side THU inboard IR. Mag 1,000x. Heat damage is apparent.

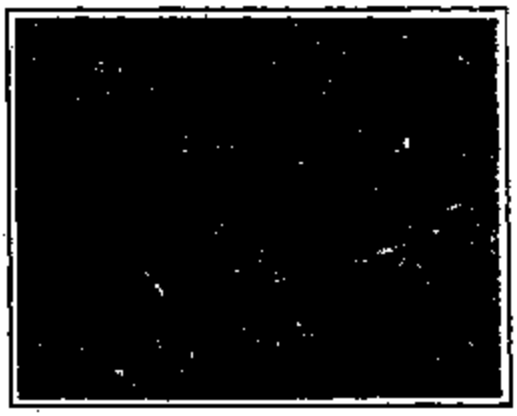


Figure 6c Fine pearlite and grain boundary ferrite microstructure of the passenger (right) side THU OR (near the inboard raceway) base material. Mag. 1,000x. Heat damage is apparent.

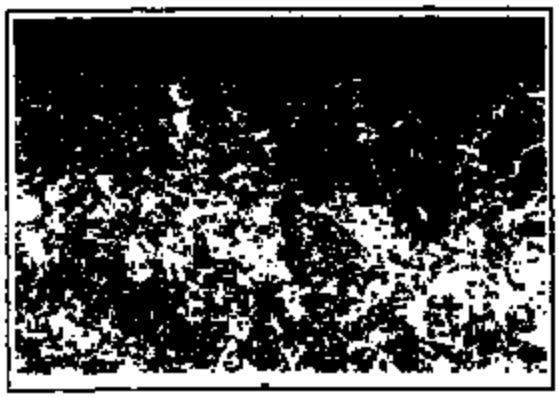


Figure 7a Martensitic microstructure of the passenger (right) side THU outboard IR. Mag. 1,000x. The emblem indicate that the ring was hardened as required.

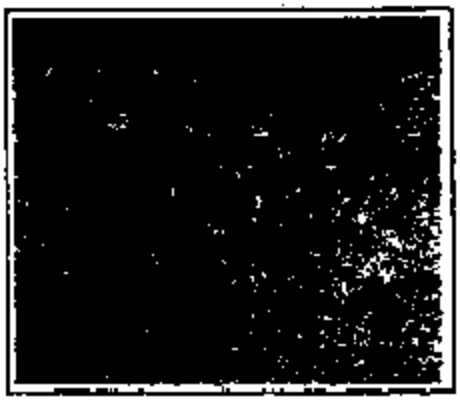


Figure 7b Martensitic microstructure of the passenger (right) side THU outboard IR. Mag 1,000x.

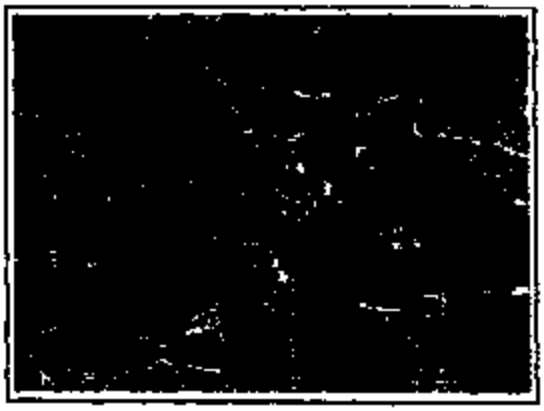


Figure 7c Fine pearlite and grain boundary ferrite microstructure of the passenger (right) side THU OR (near the outboard raceway) base material. Mag. 1,000x.

Figure 5a. Close up view of the bottom brake pads of the right side truck axle THU. The pads were significantly worn.

Figure 5b. Brake drum of the truck axle THU in figure 5a: significant wear of the braking surface (BD) was observed.

Figure 5c. Close up view of the top brake pads of the right side truck axle THU. The pads were worn and discoloured.

Figure 5d. Close up view of the top brake pads of the right side truck axle THU. The pads were worn and discoloured.

Figure 9a. Close up view of the bottom brake pads of the left side track axle THU. The pads appeared relatively new.

Figure 9b. Close up view of the top brake pads of the left side track axle THU. The pads appeared relatively new.

Figure 9c. Close up view of the top brake pads of the left side track axle THU. The pads appeared relatively new.

SKF

SKF Trade Auxiliary Technical Center

CHEMISTRY LABORATORY FINAL REPORT

Report No.:	AT99C313	To:	N. Bacigalupo, S. Weaks
Project Code:	G-AD 711	From:	D. Pallister
Registration No.:		Copies:	J. Rosales
Reference:	RLS 100216		Laboratory
Date Received:	11-10-99	Date:	11-18-99

© 1999 SKF USA Inc.

CONFIDENTIAL
This report contains proprietary information of SKF USA Inc. Recipients are expected to treat the information contained in this report as confidential and not to provide it to parties outside the SKF Group. Where [illegible] the prior written consent of SKF Technical Application Manager.

Title: THU failure investigation, evaluation of lubricant from operational THU from failed truck axel.

Background:

Application:	THU	No. of Samples:	2
Customer:	Dick Simon Trucking Co.	Service Life:	17000 miles
Product No.:		Service Load(s):	
Manufacturing Facility:	Alton	Operating Temperature:	
Alloy/Material:		Speed:	
Lubricant:	Cellulo EP 2	Environment:	

Data Requested: Dirt Analysis, FTIR Analysis, Water Content

Identification:

Chem Lab #	Sample Identification
99C313A	Outboard Sample
99C313B	Inboard Sample

Results:

Chem Lab#	Dirt Content	Water Content	Microscopic Filtrate Evaluation
99C313A	0.23 %	1225 PPM	Debris filed consists of mostly red and black iron oxide particles.
99C313B	0.14 %	1537 PPM	Debris filed consists of mostly red and black iron oxide particles.

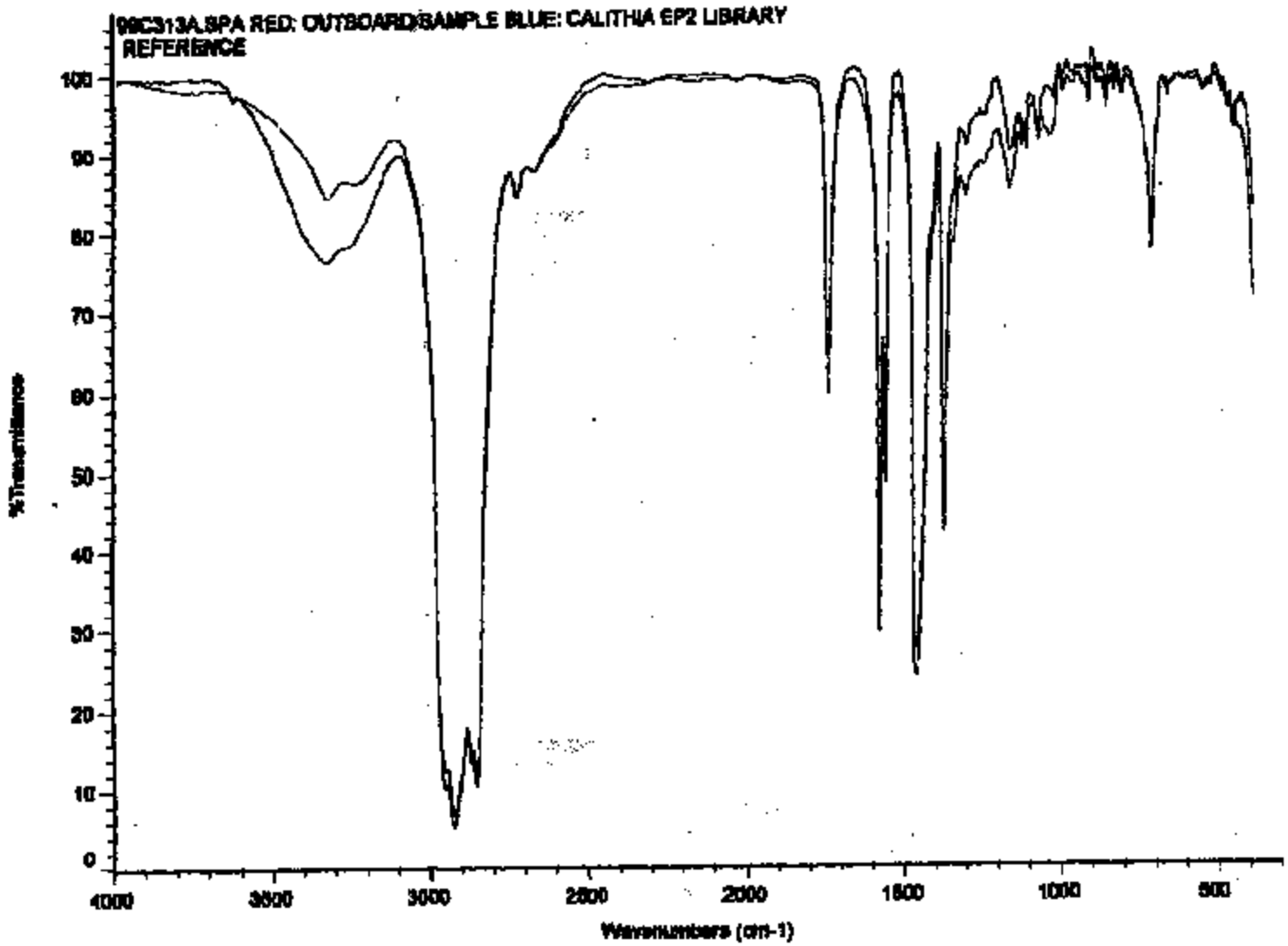
Chem Lab#	FTIR File	FTIR Spectrum Evaluation
99C313A	99C313A.SPA	FTIR spectrum appear normal
99C313B	99C313B.SPA	FTIR spectrum appear normal

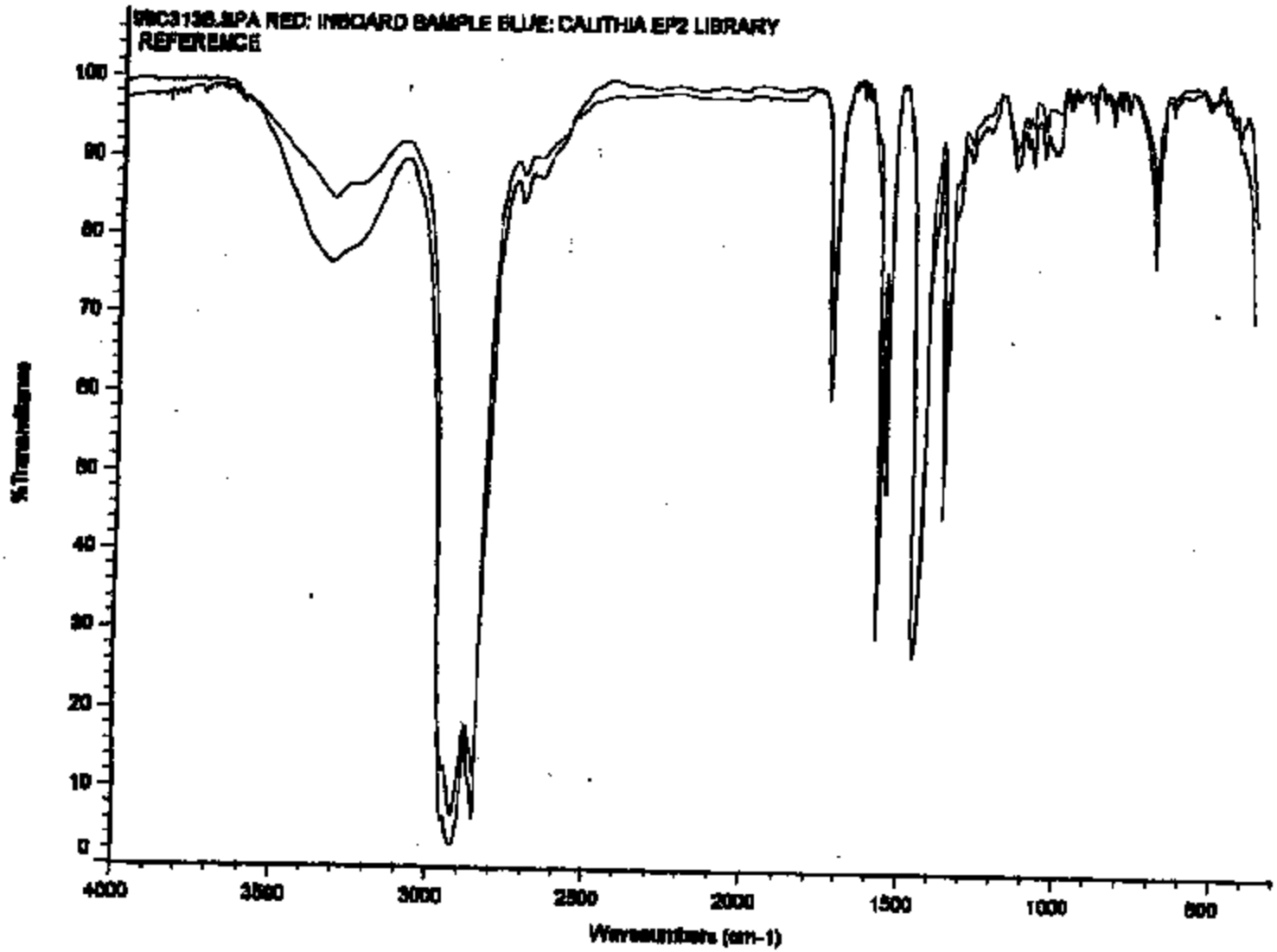
Conclusion:

The dirt and water contamination content of the grease appears normal for the service life of the lubricant sample. Microscopic examination of the grease contamination did not produce any evidence for deleterious particles in the contamination filtrate.

Author

Reviewed and Understood by


99C313A.SPA RED: OUTBOARD/SAMPLE BLUE: CALITHIA EP2 LIBRARY REFERENCE
%Transmittance
100
90
80
70
60
50
40
30
20
10
0
4000
3500
3000
2500
2000
1500
1000
500
Wavenumbers (cm-1)


RED: INBOARD SAMPLE BLUE: CALITHIA EP2 LIBRARY
REFERENCE
100
90
80
70
60
50
40
30
20
10
0
4000
3500
3000
2500
2000
1500
1000
500

cc: S. Brown
M. Lewis
B. Brown
R. Bugden

FACSIMILE

To:	B. Weeks M. Lewis	From:	B. E. Ketchum
Company:	SKF Plymouth, MI	Company:	Mentor Automotive Troy, MI
Fax:	734-414-6850	Fax:	
Talk:	734-414-6823	Talk:	248-435-1643
Pages:	2 (including cover)	Date:	August 28, 1999
Subject:	Hub Unit		

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

---

Begin message here

Bob Boody requested that I forward the attached to your attention. The Freightliner tractor was destroyed by the fire. Please call as we can discuss.

Regards,

Bruce

The information contained in this facsimile message is confidential, may be privileged, and is intended for the use of the individual or entity named above. If you, the reader of this message, are not the intended recipient, the agent, or employee responsible for delivering this transmission the intended recipient, you are expressly prohibited from copying, disseminating, distributing, or in any other way using any of the information contained in this facsimile.

AUG 28 '99 09:39 AM MERITOR END TECH CTR 248 435 8682 TO 917344146850-239 P.01/02

MERITOR. 09/14/99 03:27 PM
George B Walsh

To: Gilbert T Bowman/Amer/Auto@Auto
cc: John E Hirsch/Amer/Auto@Auto
Subject: SKF Hub / FF001

Tom

Enclosed you will find pictures of one 1999 Freightliner belonging to Dick Simon Trucking of S.L.C. Utah.
SN 1FUYDSEBTYP[illegible]
17,[illegible] miles
Copies of all service records are also enclosed.
The truck turned to the ground and was towed to Laramie, WY. on [illegible] and from Laramie to S.L.C. on
[illegible].
The driver pulled over to the side of the road with a brake drag on the right front axle, he sat on the side of the
road until the drum cooled. He then backed of the brakes and continued on down the road until the right front
the burst into flames at which time he pulled over and was unable put out the fire. The damage is clearly shown
in the attached pictures.
The hub was still on the spindle when arriving in Dick Simon's yard. I arrived 10 minutes after the hub was removed
with two light raps with a chisel. Only the inner race of each bearing remained on the spindle, held by both lock nuts
and washers. One bearing roller was inside the Drum and five rollers lay on the lower Brake Shoe, all other Rollers
were missing. The lower right Brake Shoe and Drum are severely worn as the weight of the vehicle was supported at
that point and it appears a Brake fire may have started as a result.

Contact at Dick Simon Trucking: Hans Vandermarwe Director of Maintenance 801-924-7000
5175 west 2100 South
West Valley City, Utah 84120-6297 (Salt Lake City)

I was contacted to inspect the vehicle, as was Freightliner, no comments were made and no contact with the fleet after
inspection. The front axle can be removed and shipped to Troy if needed. Please contact me on Phone Mail at 7315
or call Phone 206-987-3101 if further action is needed.

George Walsh

AUG 26 '99 09:39 PM MERITOR ENG TECH CTR 248 405 6652 TO 917344146959-239 P.02/02

STEER WARRANTY REG

SKF 000036

Automotive Division

July 13, 2000

Kevin Belling
Director, Worldwide Procurement
Arvinmeritor Inc
2135 West Maple Road,
Troy, MI, 48084-7186

Plymouth, MI
USA

Dear Mr. Belling:

As a follow-up to your letter of June 16, 2000 and our meeting of July 5, 2000 regarding the Dick [redacted] fire, we agreed that another meeting is required to address this entire issue of compensating fleets. You discussed setting up a meeting with Brad Arnold.

Here's what I believe must be addressed:

- We cannot continue to pay for the end user's decision to "continue to drive" after experiencing brake drag. This is a dangerous precedent that consolidates the fleet and driver responsibilities to safely and responsibly operate a vehicle. How do we stop this now?

- The FF981 axle provides a much safer failure mode than a conventional wheel end. Driving under these conditions on a conventional configuration will result in a wheel off while the FF981 configuration prohibits a wheel off. If the driver continues to drive FF-981 axles on a deteriorating hub, there may be a fire. How do we communicate this to the market?

- It puts SKF in a difficult position when unilateral decisions are made to pay fleets and the resulting expectation is that SKF support the cost. How can we jointly come to an agreement within a reasonable time in situations of this type?

We cannot accept total responsibility for the events that led to the [redacted] fire. In the hub analysis, it is clear that the recovery was not hardened which resulted in an early mortality. However, per G. Weinstit's report (14 August 2000) " the driver pulled over to the side of the road, let the drum cool, adjusted the brake, and then continued down the road until the right front tire burst into flames" which clearly illustrates driver negligence. Had the driver exercised this practice with a conventional wheel end, there would have been a wheel off situation. With this spindle-hub-lockrut configuration the wheel stayed on the truck, which is a much safer mode. The driver should have stopped the vehicle at the first sign of trouble. For him to continue to drive demonstrates a clear lack of customer understanding of the product.

If the market dictates that we compensate customers for collateral damages, regardless of responsibility, we need to look at different ways to support the cost of reimbursement. In the past we have always worked together to do what is best for both of us. I'm confident that we can find a mutually viable solution.

Sincerely,

Steven F. Brown
Director, North American Truck Business Unit

AB&F Fort Street, Plymouth, MI 48170
Telephone (734) 414-[redacted] Fax: (734) 414-[redacted]
An SKF Company

SKF AUTOMOTIVE DIVISION

SKF

Sales Office

Plymouth, MI
USA

SKF Automotive Division

Failure Investigation

for

MONSON TRUCKING

Duluth, MN

Final Report

Date: 12/19/2001
By: Michael Lewis

Distribution: Bruce Weeks – NATC
Steve Brown – NATC
Arno Stubenrauch – Schweinfurt
Achim Mueller – Schweinfurt
J. P. Pan – ArvinMeritor
Jack McKenzie – ArvinMeritor
Robert Bondy - NATC
Chris Jones – Aiken
Bill Farrell – Elgin

46811 Port Street
Plymouth, MI 48170

Telephone: (734) 414-6000
Fax: (734) 414-6050

Introduction/Background

[redacted] of Duluth, Minnesota, experienced 4 wheel end issues in 2001. These issues occurred with SKF manufactured Truck Hub Units (THUs) used on ArvinMeritor FF-981 axles and International Trucks. These trucks were all produced in 1997.

The original failures (prior to June 5th, 2001) and their assigned root causes were:

–Unit 324R - parts were unavailable for analysis
–Unit 310L – Outboard row/hubcap thread corrosion – suspect lost hubcap
–Unit 345R - Low clamp load (IRs show severe creep) evident
–Unit 326R – Inboard seal leak

SKF, ArvinMeritor [redacted] and [redacted] began their investigation into this issue in June, 2001 with a visit to the [redacted] maintenance facility. During removal of some of these hubs, it was noted that there was an orange residue on the spindle. Several hub units were returned to SKF for more detailed analysis. Some of these units were also noted to have had low nut torque on the inner retaining nut (nuts which hold the unit on the spindle).

The major findings of the analysis of the parts removed in June were:

•Spindle residue is grease base oil, water, rust, and brake dust.
•No significant water was inside the units
•Although not ideal, the lower torques had not created water ingress in the hub unit and do not appear to have created any performance problem. Long term, the presence of water will increase rust and potentially cause problems with removal of hubs from spindles. This issue has been addressed with the addition of an o-ring seal at the spindle to hub interface.
•Some of the inboard seals are wearing at a rate greater than expected.

In late July 2001, SKF recommended that all of the 1997 units be returned to broaden the field of data regarding the seal wear and the condition of the bearings. The remainder of the hubs from the 50 trucks (1997) was replaced and the hubs returned to SKF. Thus, all 50 original 1997 units have been exchanged for new units.

This report will cover the findings to date of the units investigated.

General Information

The units returned were all of 1997 make (SKF Part Number BTF-0032). The trucks ranged in mileages from 450,000 miles to 550,000 miles. [redacted] hauls general freight, mostly in the mid-west USA and southern middle Canada. Trucks average 100,000 to 120,000 miles per year general linehaul service.

Conclusions

Seals from the [redacted] show higher wear rates than previously seen or documented during development or with other fleets.

Although some seals showed a higher than expected wear, all seals investigated were still functional. All bearings were in good condition with no signs of distress. The grease was also in good condition with no indication of contamination present.

Measuring wear widths with vernier calipers gives an indication of wear, but does not equate well with results from sectioned seals measured with an optical comparator (as done by the seal manufacturer). In general, the vernier caliper measurements yielded larger wear widths than the optical comparator method. This is important because the baseline wear (from 1996 units) was all measured by optical comparator while much of the Monson data is from vernier calipers.

At this point in time, the higher wear rate cannot be explained by any material or process change by either seal or bearing manufacturer. No process changes occurred in the 1996 to 1997 time frame. One potential variation between [redacted] and other fleets is the geographic location in which they operate. Northern climates often use salt mixed with sand to treat roads in the winter snows. The sand may contribute to the increased wear rate.

In mid-2000, SKF changed the seal used in the steer hub units. The new seal (R-Safe seal) has many enhancements and has performed better than the 1997 seal in laboratory testing, yielding 2 to 3 times better life in contaminated environments (mud and salt slurry).

Recommendations

1. Mid-2000 and later units should be monitored to ensure that the seal design changes have eliminated the high wear rate in this environment. SKF would like to evaluate some units equipped with the new seal (R-safe) at 500,000 mile and 750,000 mile intervals.
2. [redacted]n should continue their diligent monitoring and inspection program. Although some of the seals have high wear, analysis of the bearings and grease show these seals to be functional and, therefore, should remain in service

Results

Out of the 85 additional units returned to SKF, all units were disassembled and the seal wear measured with a vernier caliper and the general condition of the bearings and grease examined. Although not as accurate as sectioning and measuring with an optical

comparator, this measurement gives some indication of the relative wear of the seals. If the seal wear at the main lip is characterized as low (less than 1 mm), moderate (between 1 and 2 mm) and high (2.0 mm and greater), then the seal wear is fairly evenly distributed through these ranges.

All seals examined had some degree of contamination between the inboard seal lip and dirt excluder lip. In some cases the contamination was light, in others heavy – this seemed to be directly related to the amount of seal wear. As more contamination passed the dirt excluder lip to the main lip, the main lip wear increased.

Figure 1 shows the Monson and 1996 units measured using all optical comparator data. Figure 2 shows the Monson data using vernier caliper measurements (1996 data from optical comparitor method).

The above diagram shows what is measured as "wear". It is the length of the wear flat under the main lip (the lip under the spring). This starts as a point contact and increases as the seal wears.

Figure 3 shows the new data (from the additional 1997 parts) added to Figure 2.

Photos 1 and 2 show the actual seals, the lip wear and the contamination between the seal lips.

Table 1 shows the inspection data from the additional 85 parts by [redacted]n unit number.

In addition, several units were cleaned as well as possible, and then disassembled with care to try to prevent external debris from entering the bearing. Six samples were then selected based on varying degrees of seal wear (light to heavy). Grease samples were then taken from the inboard seal/bearing area to be analyzed for contamination. The analysis is included as Attachment 1(AT01C225). This analysis concluded that all samples were in basically the same condition (including the control sample of new grease). Although all samples were close to each other regarding contamination content, the unit with the highest amount of contamination was the one with the least seal wear. Also, all the bearings were in good condition with no denting or scratching which would occur from operating in contaminated conditions. From this information, we can conclude that all the seals are still functional.

Seal Design Details

The sketch above is the seal used from 1996 through mid-2000. The seal is basically an garter spring oil type seal with a dirt excluder lip. This seal has been used in Europe in a high volume steer hub unit since 1986 with no problems. The seal rides directly on the bearing flange outer diameter. As an oil seal, the seal has an inward pumping action which helps to keep oil in the system.

The above seal is an SKF "R-Safe" design. It incorporates a stainless steel flinger/counterface, a labyrinth, and two seal contact areas. The stainless steel counterface prevents corrosion under the seal contact areas, thereby extending life. The R-Safe seal was designed to operate in grease – The seal has an outward pumping action, which pushes contamination away from the seal and bearing. The labyrinth and flinger provide a first line protection from contamination and protection from large particles. The seal lips contact in two areas. First, an axial lip provides protection as well as the main, spring loaded lip. This seal design has been used since 1992 with no field or testing problems.

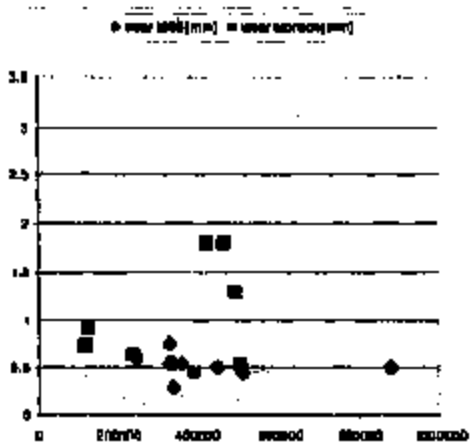


Figure 1. Optical Comparator Data

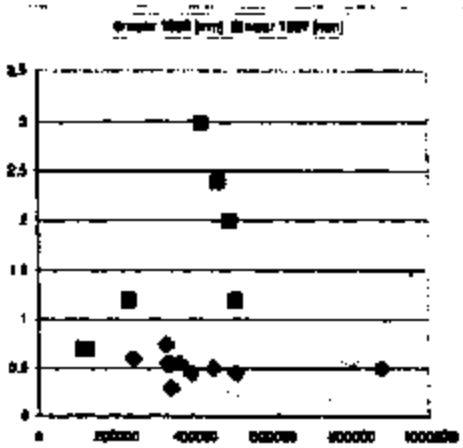


Figure 2. Vernier Caliper data

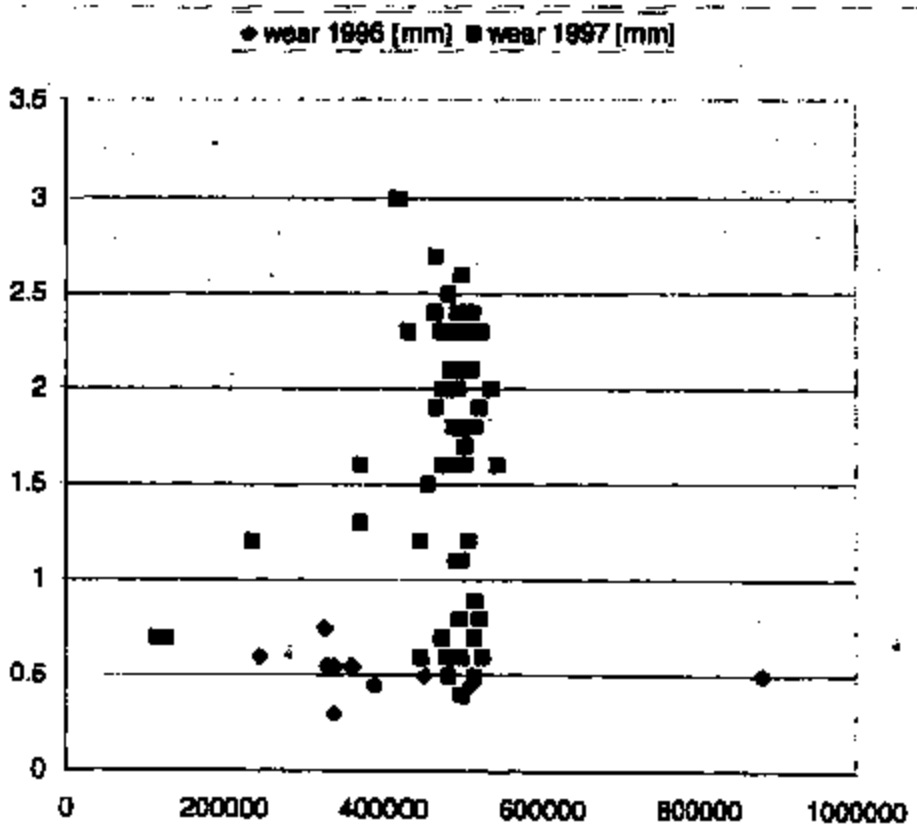


Figure 3: Vernier Caliper all MONSON Data (with 1996 units)

Photo 1: Unit 311 inboard seal - shows wear of dust lip (longer arrow) and main lip (short arrow)

Photo 2: Unit 311 inboard seal - Contamination between dust and main lips indicating that the dust lip has passed material

TABLE 1: Data from units returned August 2001 - 1997 units

Unit Number	Side	Mileage	Wear Width (mm)	Contamination between lips of seal	Dust lip Cond	Comments
301	R	473,299	2	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
302	R	498,761	2	Yes, Heavy	Grooves gone	Brg/Grease Good Cond
302	L	498,761	2.4	Yes, Moderate	Grooves gone	Brg/Grease Good Cond
304*	L	477,097	0.6	Light	Grooves mostly gone	Brg/Grease Good Cond
305*	R	513,359	2.3	Yes, Heavy		Brg/Grease Good Cond
305*	L	513,359	0.6	Light	Grooves mostly gone	Brg/Grease Good Cond
309	R	488,117	1.8	Yes, Moderate	Grooves still visible	Brg/Grease Good Cond
313	R	542,638	1.6	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
315	R	472,187	2.3	yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
315	L	472,187	0.7	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
316	R	480,467	1.6	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
316	L	480,467	0.5	Light	Grooves mostly gone	Brg/Grease Good Cond
321	L	491,425	2.9	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
325*	L	514,002	1.8	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
327*	R	501,461	1.6	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
329*	R	474,463	1.6	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
329*	L	474,463	0.7	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
330	R	486,298	2.7	Yes, Heavy	Grooves gone	Brg/Grease Good Cond
330	L	486,298	1.9	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
331	L	444,948	0.6	No	Grooves still visible	Brg/Grease Good Cond
331	R	444,948	1.2	Yes, Moderate		Brg/Grease Good Cond
332	R	512,954	0.7	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
332	L	512,954	2.4	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
333	L	503,003	1.7	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
335	R	495,166	2.3	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
335	L	495,166	0.8	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
336	R	496,249	1.9	Yes, heavy	Grooves still visible	Brg/Grease Good Cond
336	L	496,249	0.6	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
337	R	493,663	2.8	Yes, heavy	Grooves mostly gone	Brg/Grease Good Cond
337	L	493,663	2.1	Yes, heavy	Grooves mostly gone	Brg/Grease Good Cond

TABLE 1: Data from units returned August 2001 - 1997 units (cont.)

Unit Number	Side	Mileage	Wear Width (mm)	Contamination between lips of seal	Dust lip Cond	Comments
338*	L	534,445	2	Yes, heavy	Grooves gone	Brg/Grease Good Cond
339	R	497,626	1.1	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
339	L	497,626	0.4	Yes, light	Grooves still visible	Brg/Grease Good Cond
341	L	491,269	2	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
341	R	491,269	1.1	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
342	R	486840	2.1	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
346	R	520,660	1.9	Yes, Heavy	Grooves mostly gone	Brg/Grease Good Cond
346	L	520,660	0.8	Yes, light	Grooves still visible	Brg/Grease Good Cond
348	R	372,473	1.6	Yes, heavy	Grooves mostly gone	Brg/Grease Good Cond
348	L	372,473	1.3	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
349*	R	523,497	2.9	Yes, Moderate	Grooves mostly gone	Brg/Grease Good Cond
349*	L	523,497	0.8	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
350*	R	498388	2.6	Yes, light	Grooves gone	Brg/Grease Good Cond
Unknown			0.6	Yes, light	Grooves mostly gone	Brg/Grease Good Cond
303	L	455967	1.6	Yes, Light	Grooves still visible	Grease sampled
307*	R	491923	2.6	Yes, Heavy	Grooves gone	Grease sampled
318	R	477233	2.3	Yes, Heavy	Grooves gone	Grease sampled
320	R	511211	2.1	Yes, Moderate	Grooves mostly gone	Grease sampled
326*	R	514,002	0.9	Yes, Light	Grooves still visible	Grease sampled
350	L	498388	2.3	Yes, Heavy	Grooves gone	Grease sampled

*Indicates mileage from July file data.

SKF

SKF North American Technical Center

Investigation Report

Date: June 15, 2001

Customer: Mike Lewis
SKF NATC
Plymouth, MI

Reference: g-AD-711

SKF Report Number: AT01C123 RLS 100253

Investigation: Evaluation of Meritor THU Warranty Returns
Revision Number: 0

Reported by: David M. Pallister, Ph.D.

Reviewed by: John Hickling

Copies to: John Runnietz, Bruce Weeks, Bob Bondy , Chemistry Laboratory

46815 Port Street
Plymouth, MI 48170

Telephone: (734) 414-6800
Fax: (734) 414-6854

SKF

Identification:

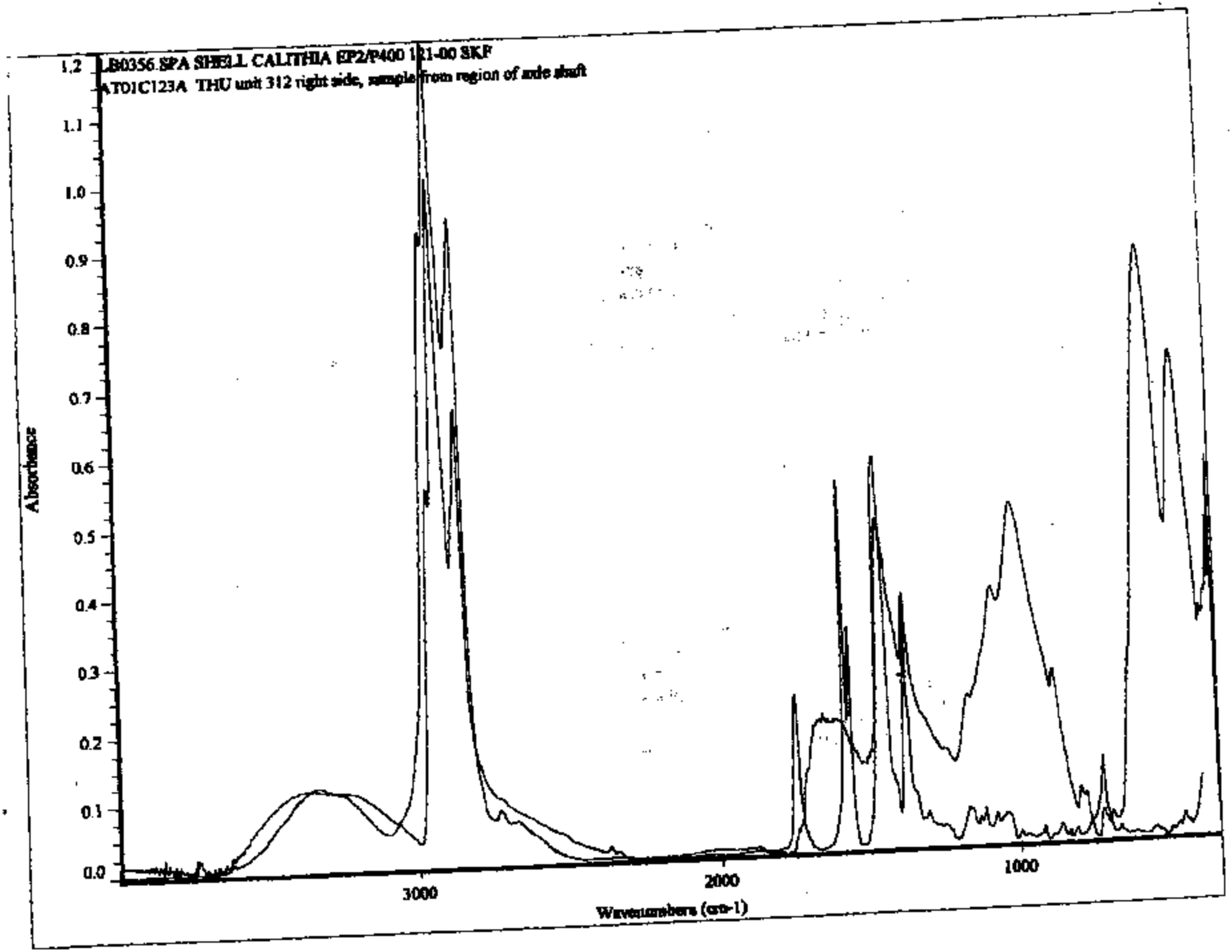
Chem Lab #	Sample Identification	FTIR File
AT01C123A	Meritor Unit 312 right side	AT01C123A.SPA
AT01C123B	Meritor Unit 312 left side	AT01C123B.SPA
AT01C123C	Meritor Unit 313 left side	AT01C123C.SPA
AT01C123D	Meritor Unit 324 left side	AT01C123D.SPA
AT01C123E	Meritor Unit 328 left side	AT01C123E.SPA
AT01C123F	Meritor Unit 378 left side	AT01C123F.SPA
AT01C123G	Meritor Unit 414 left side	AT01C123G.SPA
AT01C123H	Meritor Unit 428 left side	AT01C123H.SPA
AT01C123I	Meritor Unit 311	AT01C123I.SPA

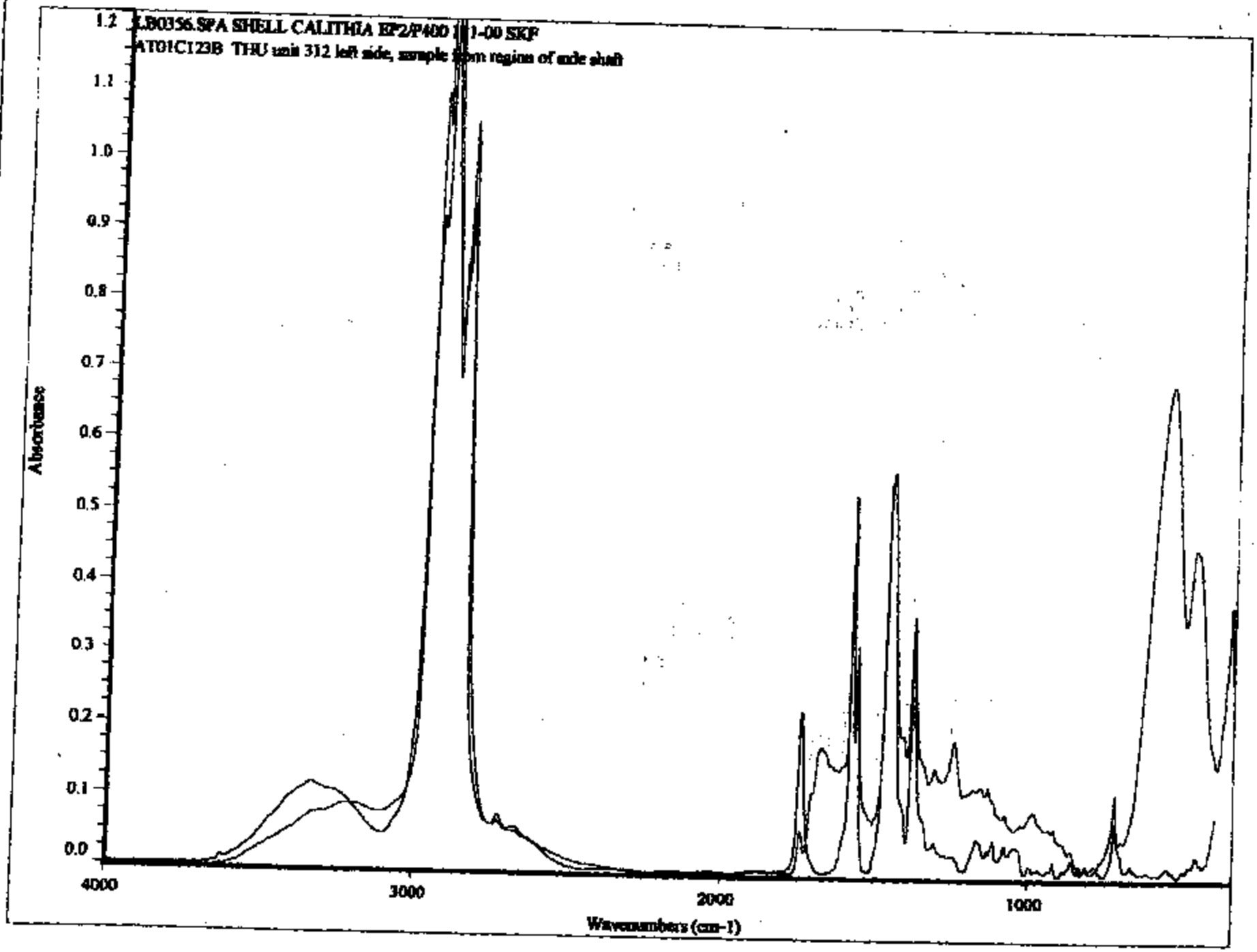
Results:

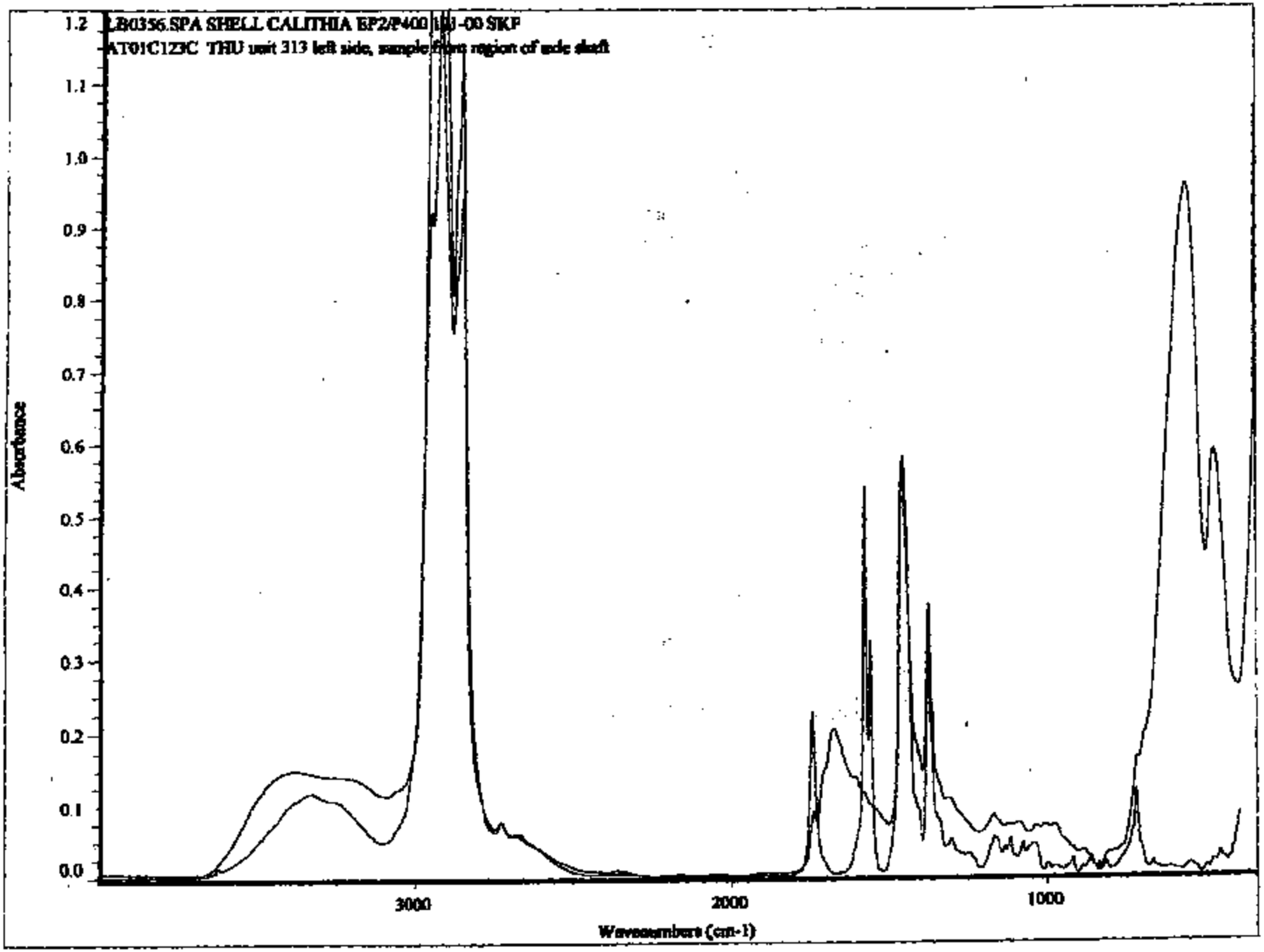
Sample Description	*Chemistry No*	*Water Content Inboard Seal*	*Water Content Bearing Center*	*Water Content Outboard Seal*	*Water Content Outboard Seal*	*Water Content Inboard Side*	*FTIR Analysis Spindle Residue*
Cullinin EP 2 control	*LB0356*	*2000 PPM Max.*	*NA*	*NA*	*NA*	*NA*	*FTIR control*
Meritor Unit 312 Right	*AT01C123A*	*5501 PPM*	*1977 PPM*	*NA*	*NA*	*NA*	*Spindle residue is mostly oil contaminated with high levels of rust, water acidic organic material and brake dust.*
Meritor Unit 312 Left	*AT01C123B*	*8520 PPM*	*4674 PPM*	*NA*	*NA*	*NA*	*Spindle residue is mostly oil contaminated with high levels of rust, water and acidic organic material. Low levels of brake dust contamination*
Meritor Unit 313 Left	*AT01C123C*	*3858 PPM*	*1624 PPM*	*NA*	*32719 PPM (3.27 %)*	*25882 PPM (2.59 %)*	*Spindle residue is mostly oil contaminated with high levels of rust, water and acidic organic material. Low levels of brake dust contamination*
Meritor Unit 324 Left	*AT01C123D*	*4170 PPM*	*3005 PPM*	*NA*	*16481 PPM (1.65)*	*39042 PPM (3.90 %)*	*Spindle residue is mostly oil contaminated with high levels of rust, water and acidic organic material. Low levels of brake dust contamination*
Meritor Unit 328 Left	*AT01C123E*	*6934 PPM*	*2380 PPM*	*NA*	*NA*	*NA*	*Spindle residue is mostly oil contaminated with high levels of rust, water and acidic organic material. Low levels of brake dust contamination*
Meritor Unit 378 Left	*AT01C123F*	*4617 PPM*	*458 PPM*	*NA*	*NA*	*NA*	*Spindle residue is mostly oil contaminated with high levels of rust, water, acidic organic material and brake dust.*
Meritor Unit 414 Left	*AT01C123G*	*2829 PPM*	*1208 PPM*	*3257 PPM*	*18270 PPM (1.83 %)*	*NA*	*Spindle residue is mostly grease contaminated with low levels of rust, water acidic organic material and brake dust.*
Meritor Unit 428 Left	*AT01C123H*	*2119 PPM*	*2946 PPM*	*NA*	*NA*	*NA*	*NA*
Meritor Unit 311	*AT01C123I*	*7130 PPM*	*2148 PPM*	*NA*	*NA*	*NA*	*NA*

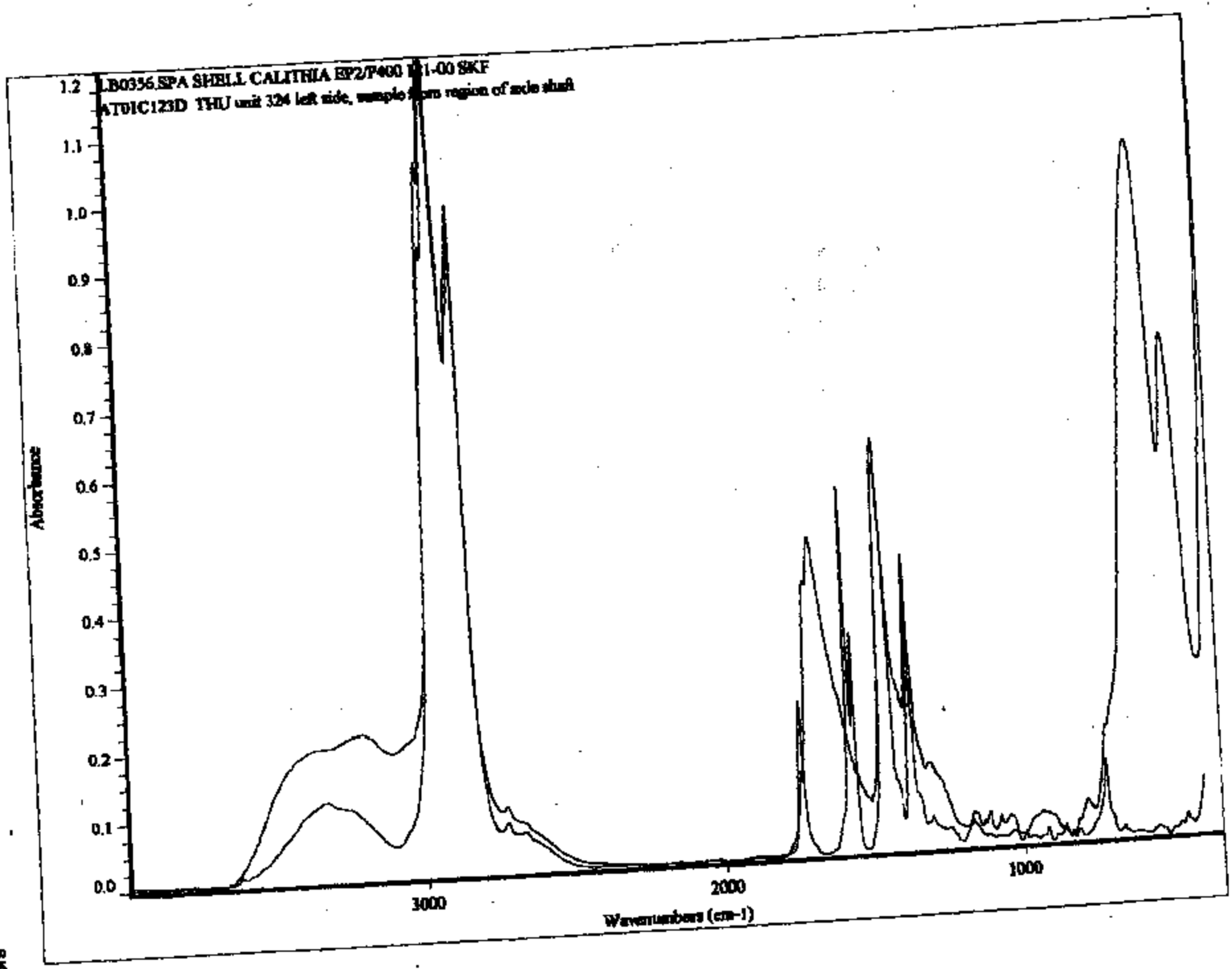
Conclusion:

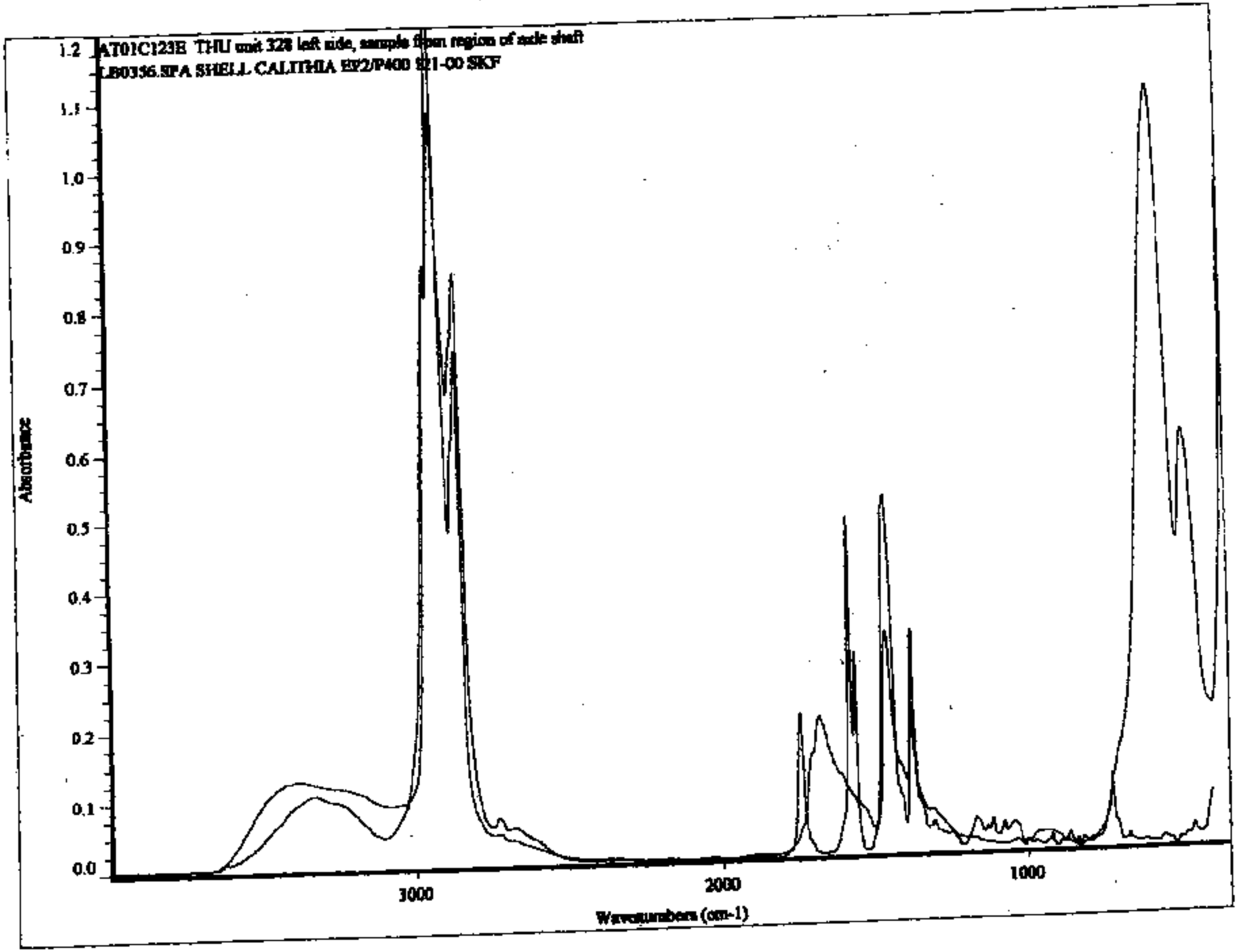
Water ingress into THU appears to occur from the spindle-bearing interface on the inboard side.

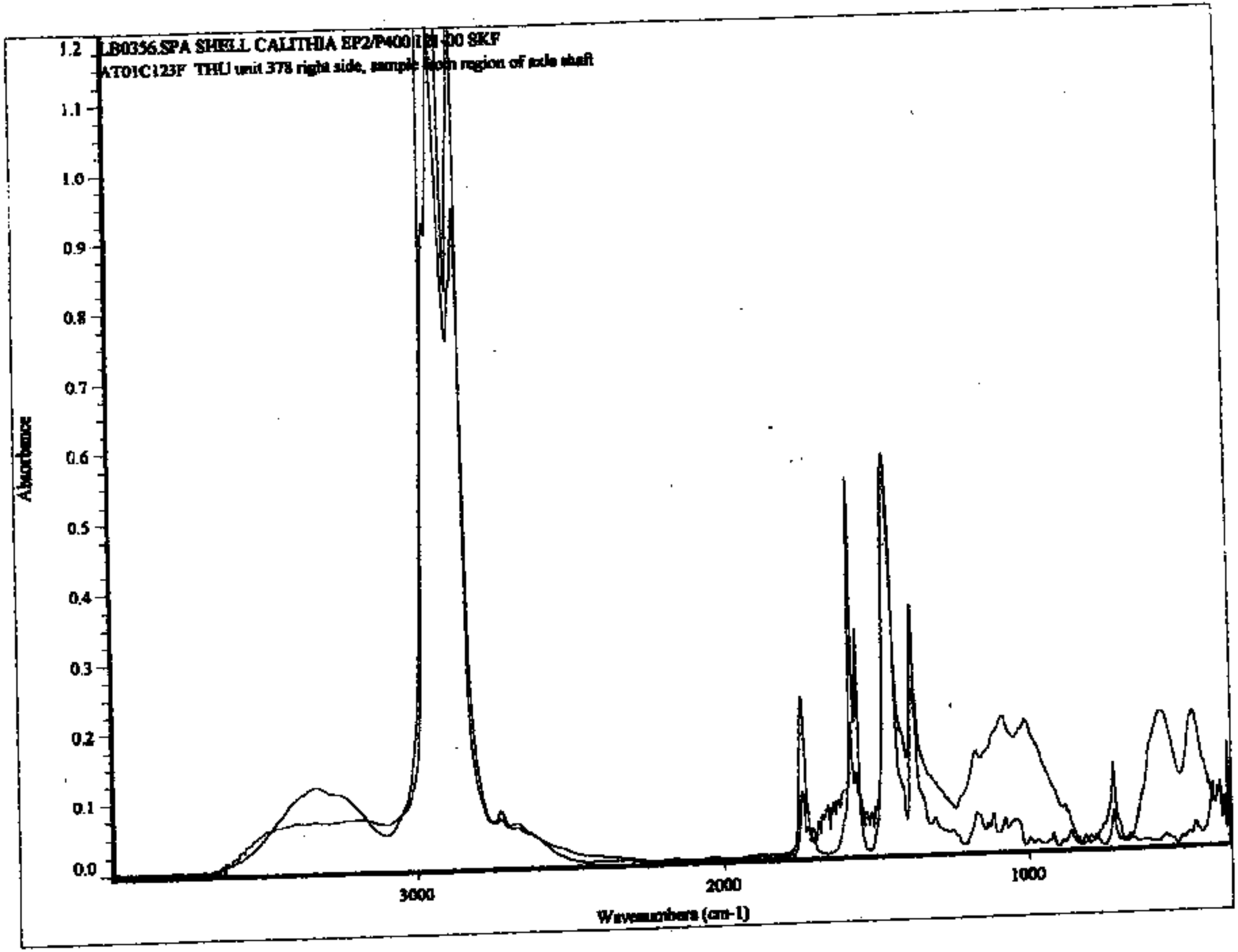

LB0356 SPA SHELL CALITHIA EP2/P400 121-00 SKF
ATO1C123A THU unit 312 right side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)

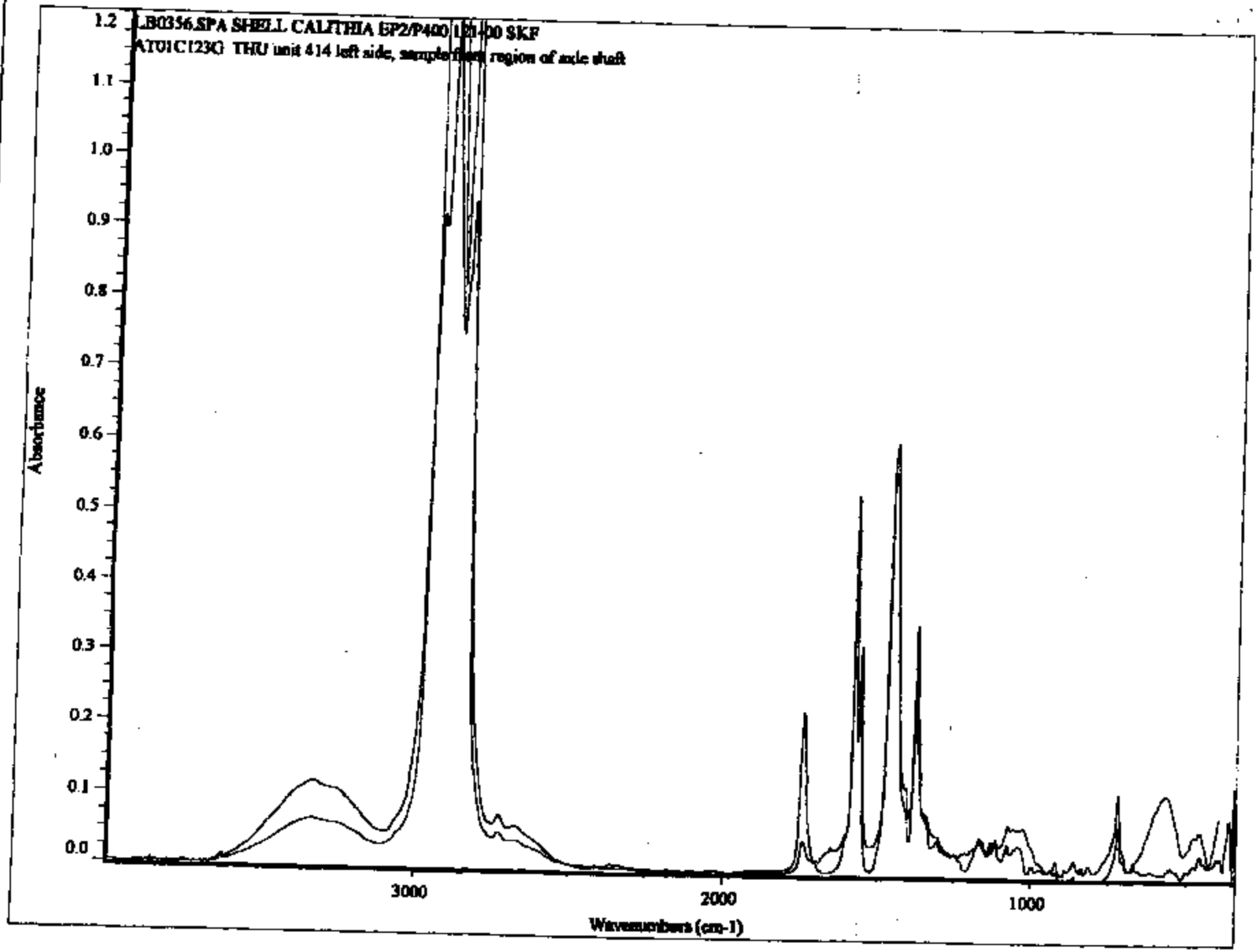

1.B0356.SPA SHELL CALITHIA EP2/P400 1-00 SKF
AT01C123B THU unit 312 left side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
4000
3000
2000
1000
Wavenumbers (cm-1)


LB0356.SPA SHELL CALITHIA EP2/P400 1[illegible]-00 SKF
AT01C123C THU unit 313 left side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)


LB0356.SPA SHELL CALITHIA EP2/P400 1-00 SKF
AT01C123D THU unit 324 left side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)


AT01C123E THU unit 328 left side, sample from region of axle shaft
LB0356.SPA SHELL CALITHIA EP2/P400 S21-00 SKF
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)


LB0356.SPA SHELL CALITHIA EP2/P400
AT01C123F THU unit 378 right side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)


LB0356.SPA SHELL CALITHIA EP2/P400 121-00 SKF
ATO1C123G THU unit 414 left side, sample from region of axle shaft
Absorbance
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3000
2000
1000
Wavenumbers (cm-1)

Review of Units Returned from Monson Trucking

June/July 2001

M. Lewis
B. Weeks
S. Brown

SKF

UNIT NO.	MILEAGE	HUBODOMETER
305	743904	

MONSON TRUCKING, INC.

DATE	ORDER NO.
10-28-02	17445

MECHANICAL REWORK? YES ☐ NO

PARTS

QTY.	PART NO.	DESCRIPTION	COST
1	HFFU 00TS 34	Steer Hub	608 91
or	2500572 C9		

TOTAL PARTS

TYPE	QTY.	GREASE & OIL	COST

TOTAL GREASE & OIL

ANTIFREEZE AND MISC.

QTY.	DESCRIPTION	COST

TOTAL ANTIFREEZE & MISC.

JOB DESCRIPTION

1. Right steering hub making grinding noise. 1.5
2. VIN: 2HSFMAKR4VC034765
   D.I.S. 3-31-97
3.
4. Hub [redacted]eriously replaced.
   Date: 08 Aug 01
5. Mileage: 526,254
6. Note: End play not measured. Can feel grinding by rotating bearing by hand.
7.

OFFICE USE ONLY

COST SUMMARY

01	LABOR	55
02	PARTS	608
03	OIL & GREASE	
04	ANTIFREEZE & MISC.	
	SUBTOTAL	
05	SHOP SUPPLIES – 2%	
06	SALES TAX	
07	TOTAL	664

MONSON TRUCK DUL.

☎ 002/002

☎ 218 526 7310

11/28/02 16:16

SKF 000183

Unit 313

Background

Side:	Left
Mileage:	523,912 miles
Inner nut on torque:	375 ft. lbs (as measured by Monson prior to June 5th)
End Play:	Customer measured 0.0025"
	SKF/ARM measured 0.000" at 600 ft. lbs.

Observations:
Came off easily.

Unit 324

Background

Side:	Left
Mileage:	464,000 miles
Inner nut on torque:	450 ft. lbs (as measured by Monson prior to June 5th)
End Play:	Customer measured 0.000"
	SKF/ARM measured 0.000" at 600 ft. lbs.

Observations:

Unit came off easily. Right side was original wheel off in 2000. Left side returned for examination.

✓Unit 414

Background

Side:	Left
Mileage:	126,536 miles
Inner nut on torque:	600 ft. lbs (as measured by Monson prior to June 5th)
End Play:	Customer measured 0.004"
	SKF/ARM measured 0.003" at 600 ft. lbs.
	NATC measured 0.003" at 700 ft. lbs.

Observations:
Unit had plastic hubcap (inappropriate for truck production date). Original aluminum hubcap was lost at 88k miles for an estimated 150 miles. Unit came off easily.

June 7, 2001
[redacted]
FF981 Hub Issue

Summary of activities to date

- Approximately 15 months ago the right front wheel end came off Unit # 324. Repairs were made at Northwest IHC and vehicle put back into service. Parts not available for analysis
- Monson experienced 2 additional wheel end separations. The left wheel end separated on unit # 310, and the right side of unit 345.
- Parts for unit 310 and 345 were returned to ArvinMeritor for analysis by ARM (ArvinMeritor) and SKF. Additionally the right hub from unit 326 was returned at the same time due to end play findings of .004"
- Analysis of the hub from unit 310 exhibited corrosion in the outer bearing, caused by water ingression.
- Hub from unit 345 exhibited advance deterioration of the bearings. Root cause was not determined due to damage.
- Analysis of the hub from unit 326 exhibited water ingression in both bearing rows.

May 30, 2001

Mac Whittemore and Greg Anderson from ArvinMeritor held a meeting at Monson's headquarters to discuss the above findings. Present at that meeting were:

Mark Monson	Monson Truck Lines
Gene Scholz	ITE
Pat Galvin	Northwest International (via conference call)

Conclusion of the discussions were to do 1 or the other of the following:

- Replace all hubs on remaining 48 units
- Provide written document stating it is OK to operate remaining 48 units after the completion of fleet program to re-torque all wheel ends to 600 Lb Ft and measuring/ recording of end play.

May 31,2001

Mac Whittemore / Greg Anderson contacted ARM engineering for guidance. Jack McKenzie, Chief Engineer ARM axles, suggested formation of an investigation team to consist of ARM, SKF, and ITE personnel. Investigation to begin on or about June 4, 2001 Contacts made, team assembled including the following people:

From ARM:

J.P.Pan	Steer Axle engineer Asheville Plant
Mac Whittemore	Regional Service Manager
Greg Anderson	District Service Manager

From SKF

Mike Lewis	Manager Truck Applications Engineering

From IHC

Gene Scholz	Field Service Engineer

BTF-0005 Query 03 Apr 2002 [illegible]

Wednesday, April 03, 2002

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Frtlnr	03212174	10/17/00	Ryder	D1104490	10/19/01	02/28/01		108318	Rec'd disarm, pulled and fastened clip ring noses, IB IR RW shallow spalls - shiny	IB SEAL LEAK - INGRESS
Navistar	0326003	01/05/01	WalMart	9382098A	01/14/02	06/22/01	Worn - Left	57613	Endplay 0.000", smooth quiet rotation, IB row corrosion	IB SEAL LEAK - INGRESS
Frtlnr		01/12/01	Star Transp	NFFD0001F062		03/18/01	Found bearings dry		OB seepage nil, IB dry, endplay 0.000", noisy, OB row VG, IB IR RW line spalls, grease no water or debris.	INNER RING SPALL
Frtlnr	0332652	02/27/01	Mike Holsington	E1750131	01/14/02	07/26/01	Noise	60934	Endplay 0.000", noisy, OB row G, IB row corrosion	IB SEAL LEAK - INGRESS
Frtlnr	0334602	03/01/01	Prime	E1762589	01/15/02	06/28/01	Noise	91572	Endplay 0.000", noisy, OB row G, IB row shallow spalls IR RW shiny	IB SEAL LEAK - INGRESS
Frtlnr	0334556	03/09/01		E1869300	07/28/01	06/29/01	Loose	2325	Cage melted, seal lip burned away, grease has low water content	LOW GREASE WEIGHT
Navistar	0321467	11/21/01	Ruan leasing	44368A	12/28/01	02/23/01	Worn - left	69353	Endplay 0.000", noisy, IB IR RW shallow spalls - shiny	IB SEAL LEAK - INGRESS

SKF 000387

Printed for: MICHAEL LEWIS
04/15/2002, 01:28:46 PM, 1

Bruce Weeks 04/11/2002 10:30 AM

To: dale.bell@arvinmeritor.com
cc: Michael D Lewis/DET/SKF@SKF, Robert J Sondy/DET/SKF@SKF
Subject: INFO: Mileages on R-Safe Failure Analysis Parts

Dear Dale,

On Wednesday 10 Apr, you requested mileages on the R-Safe returned parts that SKF has reviewed. I have added them below to a copy of the original information.

1. R-safe failure analysis
   6 units returned to date

Ser No.	Manf Date	Seal Lot.	Mileage
0312174	10/17/00	3	109,318
0328003	01/05/01.	3,4	57,013
0332852	02/27/01.	4,5	60,994
0334602	03/09/01.	5,6	91,572
0321467	11/13/00.	3	69,353
0348940	07/24/01	??	21,093

Also attached below is the electronic copy of the Pareto I gave you in hard copy on Wednesday as well.

1Q2002 Interim Report 09 APr 2002

Regards,

Bruce

SKF SERIAL #	YEARLY PROGRESSIVE INCIDENTS	VIN #	CLAIM #	FLEET	IN SERVICE DATE	FAILURE DATE	CLAIM DATE	MILES	R/L OR BOTH	END PLAY	SKF / FB LAB COMMENTS	ABT PD
1606 B M122079	Yes		51299						2 of 27		Complete failure; worn spindle under IR; groove worn in slip ring; low clamp load	
20000-0126412	Yes	1HSCAAHNRYJ068085	68008	Dakota Cottage	10/04/99			265,000			Pass hub bag zone burn up; low clamp load	
13400-0126102	Yes	1FUPCZYB0YDN97519	797519	KLLM	05/14/99			341,549			Cannot accurately determine failure origin; IB IR seized; OB; Hub burn up	
	Yes	2HSFTAMR6YC085149	0026991A	Kool Lease	05/30/99	11/07/01		281,2985			Hub burnt up; IB rollers returned; IB inner cone fractured into 6 pieces; D washer deformed; tone ring fractured into several pieces; OB inner cone not fractured - shows very little damage from rollers	
20000 0166711	Yes		0041497A	Mentor Warranty Repairing							Unauthorized repairer	
	Yes		0087460A					91,309	1 of 27		IB dust wheel bearing fell apart; unauthorized repairer	
M017664	Yes	2HSFMAXR1YC084769	0034769 / CK201534	Monson Unit 310	05/17/97	04/11/01		499,547			Hub "fell off" when vehicle was jacked up, hub was washed in Tray characteristic for circular scratches on inner race and there (indicating no relative motion between the races); stains in the hub cap threads & outer seal bore - this stains was sampled by SKF - results of analysis not available at this time, corrosion in outer bearing in there at outer spacing; Hub off as truck was jacked up	
10000-0146053	Yes	3HSCNAGR7YL049117	1018034A	Westmoor Freight	10/18/99	08/05/01		178,052			Hub was returned with OB bag cone in place & IB seal in place; IB bag cone A slip ring missing; tone ring broken off, OB cage starting to melt; all grease dry & salt; can only imagine what IB bag looks like	
07300 0264208	Yes		1189558A					59,824			Wheelhubs; unauthorized repairer; IB Rear bolted; entire hub opened; melted shear; knuckle @ AP end	
14000 0127601	Yes		0094400								Unauthorized repairer	
06300 0348606	Yes		66601								Wheels burnt; bearings were hot; unauthorized repairer	
20000 0165879	Yes		82658A					21,209			Smashing hub; hub cap ok	
00400-0071594	Yes	1FUYDCYB4GPW6888	0073544			10/13/01		380,730	B		Pass hub burned up; inconclusive	
	Yes	2HSFMAXR4YC084779	CA89740	Monson Unit 334	05/17/97	03/23/00		337,133			Hub off	
unknown	Yes	2HSFMAXR9AC034774	C0074089	Monson Unit 345	05/2007	03/08/01		400,000			Hub separation from vehicle, failed hub assembly, spindle worn under inner races, groove worn in slip ring (indication of relative motion between inner races); Hub off	

22/117

(2)

	SKF SERIAL #	NEALY PROBLEM/ INCIDENTS	VIN #	CLAIM #	FLEET	IN SERVICE DATE	FAILURE DATE	CLAIM DATE	MILES	R / L OR BOTH	END PLAY	SKF / FS LAB COMMENTS	ANT PO
A		Yes	2HSCAAMN21C013885	KFA03341	Mako International Trucks	08/14/99	01/14/02		120,710			Oil saw rusty without corrosion in OR RW; IB saw worn; chips in Fits @ clip ring house, bitmell lines across both IR RW; spindle head sheared off & pulled out of knuckle; corrosion in bearing appears to be post-failure (no shorting); repeat load	
?	No info	Yes		No info								Hub'd disassembled, no rollers or cages, all cup failed test	
A		Yes		RO 28188 15399 0180511	Wal-Mart				as off?			Locked up; unscheduled recovery IB	
A/P	05788 0087088	Yes		TNFD8000A 719	Prime Inc							Bearing locked up; Fits fractured; IB IR cracked	
		Yes		Unit 1631	Interstate		10/14/01					Fits	
L	SN149788-03 1/01	Yes	1FUYDDYB6NLBZ2988	Unit 302502	Ryder Truck Rental; Oklahoma City, Ok	12/10/97	12/15/01		491,164			16 rollers from OR; 16 flat rollers from IR returned; both inner cones backed off spindle; not all pieces of IB inner cone ring returned; cannot determine if inner cones were cracked causing loss of clamp load; ob inner cone did not crack; burn up	
A	0123372	Yes		Unit 3039	Fleet Pride							Hub'd disassembled, badly damaged, no rollers-cages-grease or seals, cannot determine origin of failure due to lack of components	$2,151.16
A		Yes	1FUYDDYB7YPA88347	Unit 3188	Interstate	08/2000	11/28/01					Fits	
P	36788 B024014	Yes		Unit 379	Interstate							Almost wheel off	
L	004817 M0-01100	Yes	WO46455	WO46455	Rancho Trucking							RETURNED KNUCKLE RIGHT SIDE; BOTH CONES & CLIP RING, NO ROLLERS RETURNED; CIRCULAR WITNESS MARKS ON CONE FACES; GROOVES ON SPINDLE FROM CONES ROTATING; LOW CLAMP LOAD	
A		Yes	1FUYDDYB6YPA88747		Mono	04/1999	02/1/02		165,488			Hub off	
A		Yes	1FUWNNDAZYLP88513		CF	09/1999	02/1/02		374,845			Hub off	
A	25388 0184418	Yes	1M1AA07Y1W601743		CF	10/1999	10/2/01		278,729			Almost wheel off	
A	08200 0110749	Yes			Prime Inc							No rollers, seals or grease; smashed Fits; name kick on SPEED; broken lone ring retainer rivets; Fits fractured; low clamp load; grease in oil fill	
A		Yes			Ryder							Unscheduled repair, no data, pb only	
A		Yes			Dale Simon							Fits / Bruce Gingham	
?		Yes	1FUYDDYB[illegible]PA88348		Interstate		01/8/02		555,279			Fits	
A	12488 0123838	Yes	1FUYDZYB7YLZ87491		KLLM		01/10/02		280,273			Almost wheel off	
X		Yes	1FUYDDYB[illegible]		Blue Ridge							Hub burn up	
X		Yes	1FUYDDYB[illegible]		Worldwide Express							Hub off	
X		Yes	1FUYDDYB[illegible]		Interstate							Great West Casualty Company; Fits	
A	00480 0227802	Yes	no remark									No data; sent to SKF	
A	Too rusty After	Yes	1FUYDDYB01LZ72731						234,346			Inner cone still attached to knuckle; both fractured; scan	

SKF SERIAL #	HIGHLY PROGRESSIVE INCIDENTS	VIN #	CLAIM #	FLEET	SI SERVICE DATE	FAILURE DATE	CLAIM DATE	MILES	R/L OR BOTH	END PLAY	SKF / PO LAB COMMENTS	AMT PD
	Yes	1FUY[illegible]	E170[illegible]17		07/2000	10/1/01		191,[illegible]			Rear hub burned up; inconclusive	
01700 0039954	Yes	1FUY2W[illegible]X1A[illegible]243	E171[illegible]5		[illegible]	10/15/01		[illegible]	B		Rear hub & half bearing burned up; inconclusive	
19200 0142720	Yes	1FUY[illegible]XP[illegible]01	E171[illegible]09	CR England	03/24/00	11/03/01		387,[illegible]			Almost wheel off	
20000 0[illegible]	Yes	1FUY[illegible]YP[illegible]738	E171[illegible]18	Wilgoyne Pepsi	09/00/00	11/03/01		[illegible]			Almost wheel off	
20000 0070[illegible]	Yes	1FUPC[illegible]XP[illegible]743	E171[illegible]	Prime	04/15/00	10/1/01		[illegible]			Almost wheel off	
	Yes	1FUY[illegible]71L[illegible]177	E172[illegible]	Prime	09/1/00	11/[illegible]01		[illegible]				
Too rusty - Allen	Yes	1FUPC[illegible]L[illegible]189	E172[illegible]	Tagan Logistics	12/3/01	12/[illegible]01		[illegible]			No rotate returned, all mounting hardware & inner cones returned; sent to SKF	
	Yes	1FUY[illegible]	E172[illegible]	New Trucking		10/3/01		[illegible],172			Fire	
14000 0120944	Yes	1FUY[illegible]YFF[illegible]783	E172[illegible]71	New Prime	08/15/00	11/1/01		[illegible],405			Rear hub & both bearing cones; rotate and rear one burned up; almost wheel off	
12000 0120[illegible]2	Yes	1FUY[illegible]YP[illegible]672	E173[illegible]	Mult Service	06/1/00	12/1/01		[illegible],145			Almost wheel off	
28100 0[illegible]	Yes	1FUY[illegible]21L[illegible]171	E173[illegible]74		06/01/00	11/1/01		[illegible],182			Rear hub only; no logs; hub mark are burned up	
13000 0[illegible]147	Yes	1FUN[illegible]41P[illegible]471	E173[illegible]37	Intermodal	08/28/00	10/1/01		126,[illegible]			Almost wheel off	
	Yes	1FUY[illegible]YF[illegible]	E173[illegible]01	New Trucking	[illegible]	11/3/01		387,[illegible]			Almost wheel off	
24000 0017[illegible]	Yes	1FU[illegible]CC[illegible]1P[illegible]	E174[illegible]24	CR England	04/08/01	09/11/01		63,[illegible]			HUB & ROLLERS RETURNED; NO INNER CONES; SENT TO SKF	
16000 0131247	Yes	1FUY[illegible]2N[illegible]054[illegible]	E174[illegible]53	New Prime	06/17/00	07/30/01		370,[illegible]			Rear hub, bearing cones & rollers; all & CR cups hubs spun; others show lack of lub, burn up	
25000 0034037	Yes	1FUY[illegible]1X[illegible]A[illegible]74	E174[illegible]71	Thompson Arnstrong	11/1/00	12/3/01		394,[illegible]			Hub returned; still on brackets; a few rollers were returned; both inner cones fractured	
22000 0023[illegible]74	Yes	1FUY[illegible]2[illegible]A01[illegible]24	E174[illegible]63	New Prime	11/[illegible]	01/17/02		501,[illegible]			Rear hub only; no bearings; bearing cones burned up; burn up - L side	
15000 0140[illegible]4	Yes	1FUPC[illegible]1QF[illegible]	E174[illegible]20		09/17/00	12/1/01		453,[illegible]			Rear hub, drum; no bearings, hub burnt up; inconclusive; burn up, rear off	
11100 0123[illegible]46	Yes	1FUY[illegible]1X[illegible]J[illegible]78	E174[illegible]29	Ryder	07/01/00	01/10/02		[illegible],[illegible]			BOTH INNER CONES RETURNED UNCRACKED & HUB, KNUCKLE, TONERING; SENT TO SKF	
Too rusty - Allen	Yes	1FUMANDA[illegible]YLF[illegible]760	E175[illegible]28	Consolidated	08/28/00	01/05/01		410,001			Sent to SKF	
01001 0120[illegible]30	Yes	1FUY[illegible]2K[illegible]LA[illegible]47	E175[illegible]34	New Prime	03/[illegible]	01/07/02		739,019			Knuckle returned with hub still on. Both inner cones fractured; put in box	
28200 0187400	Yes	1FUY[illegible]EK[illegible]YL[illegible]513	E175[illegible]74		01/03/00	01/1/02		169,217			INNER CONES MISSING, TONE RING GONE, HUB CAP STILL INSTALLED BUT BROKEN OUT; SENT TO SKF	
12400 0120[illegible]40	Yes	1FUY[illegible]2[illegible]YL[illegible]032	E176[illegible]43	Zagan Parts	09/1/00	12/3/01		340,[illegible]			Sent to SKF	
0200110 Allen	Yes	1FUY[illegible]EKXYF[illegible]435	E175[illegible]35	Swanson	01/03/00	01/09/02		124,[illegible]			Sent to SKF	
12200 0120[illegible]28	Yes		GKFD01A38 BT	Knuckle 321107							Inner cones not returned; only 20 rollers returned; half were flat; D washer shows extremely loose fault; both hubs & lock washer returned; not an unreasonable company - fire extinguisher used on hub; hub cap threads show no sign of rust; suspect hubcap was on at time of failure; burn up	
[illegible] 0[illegible]	Yes	1FUY[illegible]2[illegible]L[illegible]491			09/1/00	09/01/01		640,[illegible]			1999 FTL Cardinal; Hub off right side	

SKF 000384

(3)

SKF SERIAL #	HIGHLY PROGRESSIVE INCIDENTS	VIN #	CLAIM #	FLEET	SERVICE DATE	FAILURE DATE	CLAIM DATE	MILES	IB/L OR BOTH	BRG PLAT	SKF / PS LAB COMMENTS	AMT PD
Not legible	YES	1FUYDWDB0YLB17892	E167289	Midwest Transit	08/20/99	04/03/01	07/09/01	686,312	1 of 27		Was burnt up; had to cut inner cones off trunnion; inner cones were not cracked at time of return; inner cones cracked during removal; clip ring grooved from rotation; circular marks on inner cone faces	2,339.10
15000-0147231	YES	1FUYDWDB0YLB17892	E167289	Midwest Transit	08/20/99	08/23/01	07/09/01	686,312	2 of 27		Was burnt up; inner cones cracked; clip ring grooved; inner IB outer bag have wear damage & heat indicators	2,339.10
	YES	1FUYDWDB0YP667443	E167289	Bauer	11/1/99	08/16/01		686,408			Hub burn up	
	YES	1FUYKDTB0YLB17890	E167339		04/01/99	08/16/01	07/11/01	262,709			Shipped to SKF for further inspection / Received disassembled, no internal components, OB row badly worked, unfoundered	1,859.88
	YES	1FUYNMZB0YLB43249	E167311	Trans	08/27/00	08/21/01	07/11/01	173,343			Received disassembled, IB row badly damaged, pass unfoundered row	727.29
	YES	1FUYNDDB0YP668422	E167339	Pass Transits	01/04/99	04/14/01		482,398			Hub off	
	YES	1FUPDCYB0XLA14617	E167127		01/08/99	05/04/01		420,874K			IB & OB CONE BURNED; NO OTHER BRG PART WERE RECEIVED; INCOMPLUSIVE	
	YES	1FUYTCCA20YB60489	E168219		11/24/99	06/20/01					Almost wheel off	
34100-0014700	YES	1FUYTCCA20YB60489	E168219	OF	11/24/99	07/27/01		143,093			Almost wheel off	
	YES	1FUYDCYB4YDF49179	E168213					288,000			Was hub burnt up; had to cut inner cones off; inner cones not cracked when returned; outer cone cracked during removal; outer cone spun on spindle; excessive galling on spindle; clip ring grooved	
36000-N168137	YES	1FUPDDB4YP70884	E168230		04/21/99	07/23/01		391,164	B		Front wheel come; truck jewed to stop	
	YES	1FUPDB2B0YB09121	E168267		02/24/99	08/13/01		426,015			Was disassembled; could not find cause of failure	
	YES	1FUYBDYB1XP665272	E169499	Interstate	07/31/99	07/11/01	08/20/01	480,701			Received disassembled, OR OR IR grease seals ribbon bagas missing, OB spindle and heat damage, suspect OB row failure, IB row CI constituting damage, cannot determine origin of failure due to lack of components	1,956.27
	YES	1FUYDMDB4YLB03499	E169122		05/15/99	12/28/00		286,538			Was, hub burned up; etc. IB and OB cones; clip ring - both cones were cut with cutting tools; inconclusive	
010000-0087128	YES	1FUPDBDB0YP668673	E169391		03/25/99	08/27/01		765,199K	B		Was hub burned up; has one bearing cone; do not know if it is IB or OB; inconclusive	
13200-0131000	YES	1FUPDB2B1YLF88730	E169549		05/01/99	08/03/01	08/17/01	387,091			Was burnt up; cones cracked; clip ring grooved; station wagon cones on cone faces; cannot determine if low clamp load caused failure due to cones being cracked; both bags burned in outer dust seal	$1,287.49
10F704-N779000	YES	1FUYDKYB1YP646899	E169429	Wings Foods	10/21/99	08/04/01	09/24/01	328,433			Was hub IB & OB cones, clip ring & cones rollers; all items were burned up; lack of lubricant	$449.60
15000-0144403	YES	1FUYBBDBXYLA66396	E170284		08/08/99	10/22/01		355,284			Rec. disassembled; IB & OB cone heavy galling; OB cone heavy; inconclusive	
23000-0010530	YES	1FUYDDB2XP668703	E170492		10/04/99	08/19/01		416,199			Was hub burned up; inconclusive	
31400-[illegible]	YES	1FUPDB2B1YP668014	E170518		09/08/99	10/01/01		308,852			Was hub only no IB; OB bag clip ring; IB hub has heavy damage due to big failure; what caused the failure is unknown at this time because of lack of information; unknown	

SKF SERIAL #	TRULY PROGRESSIVE INCIDENTS	VIN #	CLAIM #	FLEET	IN SERVICE DATE	FAILURE DATE	CLAIM DATE	[illegible]	R/L OR BOTH	[illegible]	SKF / PS LAB COMMENTS	ABIT PO
000001-W770337 R	Yes	1FDSD[illegible]	CNA[illegible]		07/21/97	10/11/01		439,397			Rear hub only; no bearings; bearing areas are all rusty; burn up - R side	
12300-0120000	Yes	1FUY[illegible]	CNA[illegible]		[illegible]	12/3/2001		550,678			Returned hub, drum, drum, knuckle, ABS sensor, king pin	
Too rusty - Alan	Yes	4V4ND1UFTYN[illegible]	CNA[illegible]		06/11/99	12/31/01		344,200			Hub returned still connect on knuckle; scrap	
	Yes	1FUY[illegible]	CNA[illegible]	[illegible]	[illegible]	01/15/02		507,449			Almost wheel off	
	Yes	1FUY[illegible]	CNA[illegible]	Road Express Inc. Silver Star Trucking, Readford, OH	01/20/97	12/26/01		642,473			Almost wheel off	
28400 0023491	Yes	1FUY[illegible]X[illegible]	CNA[illegible]		03/01/99	01/16/02		[illegible]			Hub off	
07500-0109530	Yes	1M1A[illegible]Y[illegible]W001143	CNA[illegible]		08/14/99	11/20/01		677,000K			Knuckle returned with all inner cone still attached; hub was returned; bring	
12300-0120[illegible]	Yes	3HS[illegible]	CNA10141		07/14/99	01/14/02		387,000			Rear hub; spindle, bearings rollers & cones burnt up; cone spinning on spindle; Oil cone saw more heat than 5th cone; rollers are distorted & burnt up; Oil cone has signs of high heat; clip ring crooked; lack of lube	
02000 0107771	Yes	1FUY[illegible]	E1[illegible]		05/1/99	03/07/00	05/03/00	[illegible]			Loose; unfastened revenue; bearing burn up. Hubs, front bearing unadjusted; L front hub smoking; repaired L front fire hub & drum; wheel bearing dry on passed & hot spot	
001530 M170[illegible]	Yes	1FUY[illegible]	E1[illegible]		01/2000	05/01/00	05/01/00	304,315			One too much play; 2 gears locked; [illegible] failed; complete least - unfastened assembly? Driver steer wheel bearing has too much play; both F hubs leaking, tend to cause brake off adjuster	
	Yes	1FUY[illegible]	E1[illegible]		04/23/99	09/22/01	09/13/01	386,482	R		Rear disassembled, OB IR seal missing, cover rust in hydrolic fluids	9.80
	Yes	1FUY[illegible]	E1[illegible]	Midwest Transit	05/[illegible]	03/07/01		606,700			Hub off	
	Yes	1FUY[illegible]	E1[illegible]		11/24/98	03/21/01	04/16/01	386,908			IB rear spined, OB heat damaged-rusted cage & bland, IB roller ends mapped, IB in RW spall is fine	999.99
	Yes	1FUY[illegible]	E1[illegible]	K.L.M.	08/06/97	03/22/01	05/07/01	461,460			Received disassembled, IB IR out & spall, spun on spindle, badly damaged, root cause not determinable	1,136.89
	Yes	1FUY[illegible]	E1[illegible]		06/07/99	04/09/01	05/14/01	223,499			Received disassembled, IB OR RW badly deformed, metallurgy confirms over heat heated up	1,545.17
	Yes	1FUY[illegible]	E1[illegible]	Port Noth Transport	10/23/98	08/16/01	09/11/01	447,000			Received disassembled, IB rear broken-cage cracked, and lips burned away, OB rear debris dented	1,109.89
	Yes	1FUY[illegible]	E1[illegible]		05/07/99	05/30/01	06/2/01	41,412			IR OB RW ground badly	673.34
	Yes	1FUY[illegible]	E1[illegible]		10/15/98	09/19/01	07/03/01	230,545			Shipped to SKF for further inspection / received disassembled, rollers, cages, seals & grease goes, OB RWs badly damaged, root cause not determinable; Hub burn up; Fire	1,802.00
	Yes	1FUY[illegible]	E1[illegible]		07/08/97	09/28/01	07/03/01	762,014			Received disassembled, badly damaged, IB or ball-mounted, no rollers, cages, seals or grease, very rusty, cannot determine origin of failure due to lack of seals and dirt/rust	1,148.01

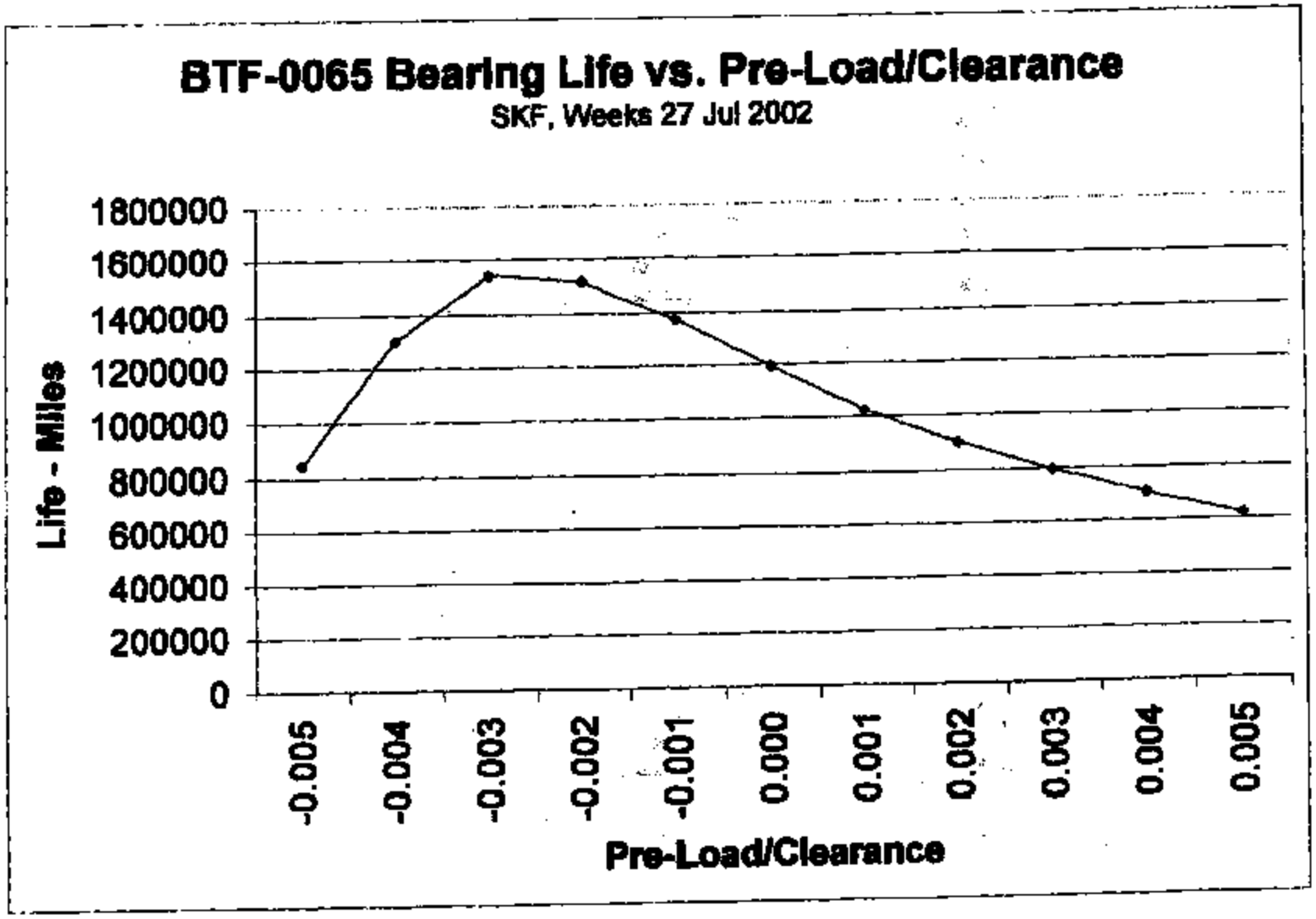
(7)

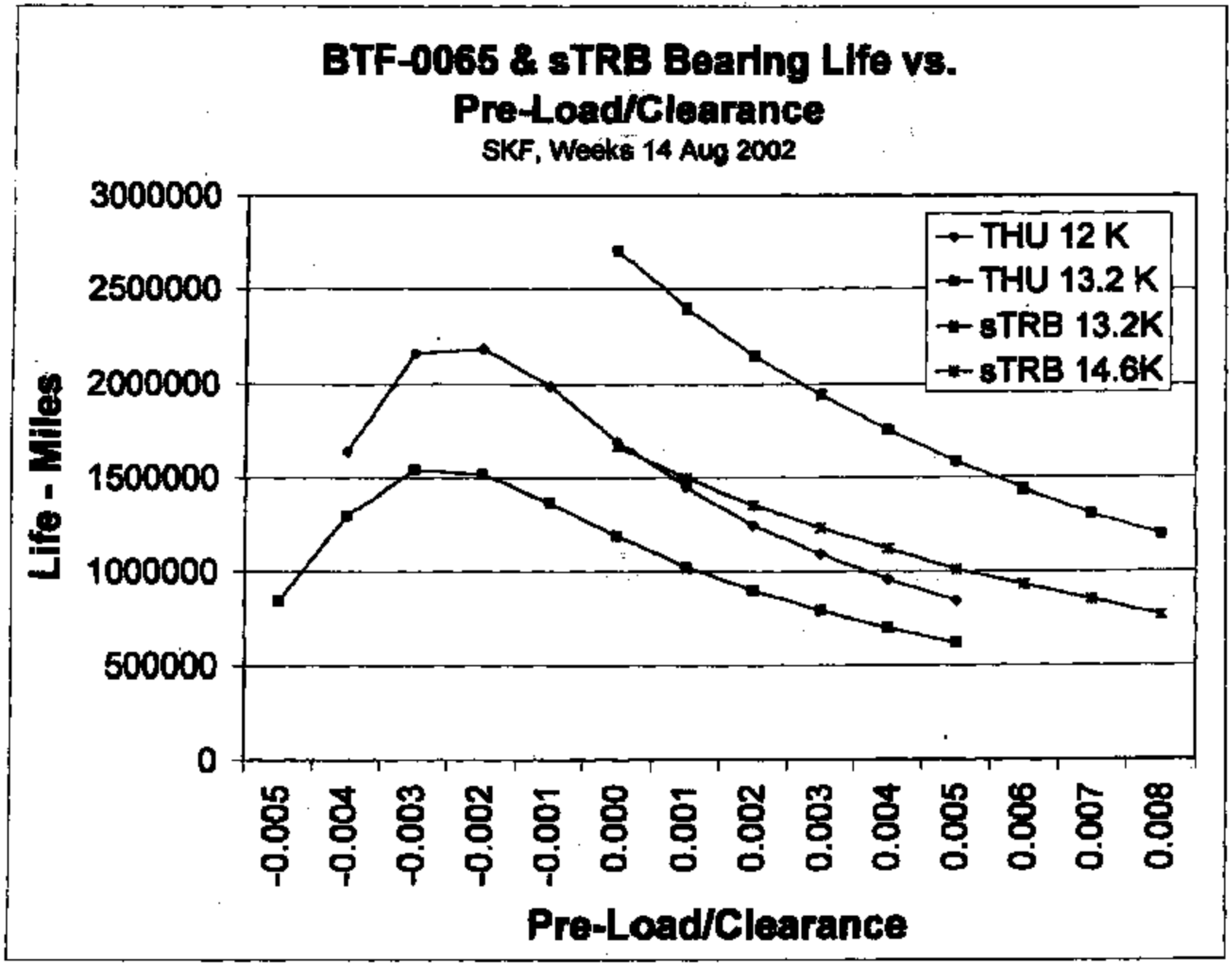
SKF SERIAL #	NEWLY PROCESSING INCIDENTS	VIN #	CLAIM #	FLEET	IN SERVICE DATE	FAILURE DATE	CLAIM DATE	MILES	S/L OR BOTH	2ND PLAY	SKF / P4 LAB COMMENTS	AMT PD
14400 0385228	YES		CS000473		10/02/00	10/18/00	10/24/00	888			Wheel separated; inner leg over edge fractured; clip ring 2 inches away w/ light contact scratches; OB IR shaker scratches on side; small amount oil small liner; brake shoe fastened one piece (wear tab off); IB seal was F-NOK; grease was GAMS; one is wrong. Outer nut was missing from the assembly, and inner nut backed off allowing hub, drum, and wheel to depart from the vehicle; spindle threads were slightly damaged on end, but not under the area where the nut is torqued; very little damage to bearings and the unit showed no signs of heat.	
001484 S	YES	2HSFNHR9XC050102	CS/100084		08/15/97	05/26/00	06/13/00	284,808			Burnt up; wheel casing came apart; toasted. Bearing failure damaging drum and brakes, truck pulled to the right, had to replace lst side brakes also bearing failure	
	YES	1FUYDSEB7YLA57756	CS/00/98	EPES	09/1999	09/1/00		285,183			File	
	YES	1FUY[illegible]	CS/K0400	Pilot Inc	02/24/00	09/10/01	09/17/01	421,484			100000; Rec disassembled; bags destroyed; only 10 rollers from OB & from IB inner cones cracked. ?; Right wheel caught fire from wheel bearing failure; also impacted left front wheel – clc; parts shipped to Troy via Yellow Freight to Rosendhal; rotor is for wheel rim due to damage from fire.	
	YES	4V4NC9RH11N392277	CC/00348	Independent Trucking	08/01/00	10/05/00		43,671			Fig; Hub brun up	
	YES	1FUY3MEB0XLA61780	CF/02803	Penske (Plymouth Trans)	01/1999	11/08/01		914,888K			Bearing burn up	
	YES	1FUY6DYB49PB99377	CN/A01121	Interstate Dist. Co. Tacoma, WA	11/2499	04/12/01	04/24/01	423,265			Rec'd disassembled, OB only, appears all roll bind free, cannot assign rect cones	$82.15
	YES	1FUY6DZB7XLA01440	CN/A02731	New Prime	01/2000	09/03/01		492,229			Hub burn up	
	YES	1FUPDSZB7XLA94174	CN/A02797		01/01/99	07/09/01	07/12/01	799,797K	B		New hub burnt up; inconclusive; L side front wheel cracking (bend in); bearing failure on L front wheel damaging spindle & s-cam	
	YES	1FUPDSZB7XLA94174	CN/A02797		01/01/99	10/29/01	11/01/01	999,236K	B		R front steer side wheel bearing failure; progressive damage to hub, brake, steering knuckle, tie rod cross tube; ABS sensor & hub cap sheet bearing failed causing R hub to wobble violently damaging additional parts.	
	YES	2HSFBMER7WC087126	CN/A02873					899,236K			Rec disassembled; IB inner cone cracked; smudges of rollers trp & clip ring; IB inner cone spalled; not all roller spinning; seal /burnt on IB cone smashed; IB seal bad; nut lip groove completely worn out; bearings have signs of water ingress; IB seal leaks	
21199 0010100	YES	2HSFRNHR4XC070295	CN/A04659		10/14/99	09/19/01		155,379			IB inner cone spalled on bottom 1.87"; sent to SKF	
20168 0020811	YES	1FUYSLDB0LA01933	CN/A05892		11/16/99	10/30/01		639,168			King pin REP 160K miles previous; cannot accurately assess root cause; regular wear. Rip bearing	
088017-3770000	YES	1FUYDSYB8YLA94429	CN/A0870		07/1787	10/31/01		1,089,722K			Clip ring grooved; one hub burned up; IB & OB cone show signs of spinning rollers have heavy wear on strait end; inconclusive	

A
L
P
A
P
A
P
A
P
A
P
A
P
A
P
A
P
A
L

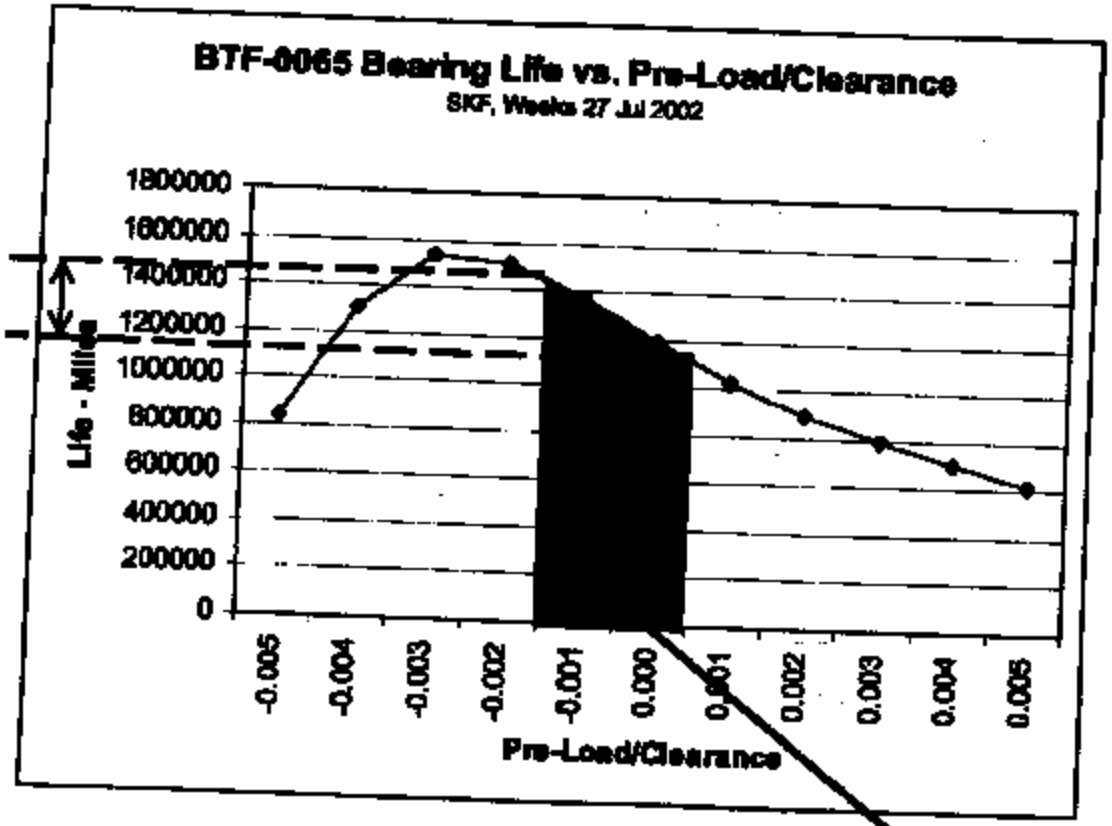
Steel PWU L2 Calculation

SKF 000485


BTF-0065 Bearing Life vs. Pre-Load/Clearance
SKF, Weeks 27 Jul 2002
Life - Miles
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
-0.005
-0.004
-0.003
-0.002
-0.001
0.000
0.001
0.002
0.003
0.004
0.005
Pre-Load/Clearance


BTF-0065 & sTRB Bearing Life vs.
Pre-Load/Clearance
SKF, Weeks 14 Aug 2002
Life - Miles
3000000
2500000
2000000
1500000
1000000
500000
0
THU 12 K
THU 13.2 K
sTRB 13.2K
sTRB 14.6K
-0.005
-0.004
-0.003
-0.002
-0.001
0.000
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
Pre-Load/Clearance

ArvinMeritor



Life Range B-10

Factory Settings

The above is for 13,200 lb axle
For 12,000 lb axle life increases by approx 1.5

MEST printout for:	Msgname:	Ref:	Received/Sent:
MAASSEN, ERIK C.	H1600141	*DISOSS*	95-06-08 21:29

From:	Company, Country:	Addr:
	ADDR: IBMX400.51940	HSNADS
To:		
MAASSEN, ERIK C.	SKF USA, DETROIT (AUTOM.), US	UDETECM

Subject:	Date:
SKF THUII Meeting	95-06-09

A meeting was held in Asheville on June 8 to discuss the THUII project. Attendees were:
Jerry Krug
Jack McKenzie
JP Pan
Ken Chalfin
Mike Barnett
Erik Maassen-SKF
Peter Lindholm-SKF
Steve Brown-SKF
Uwe Brockmuller-SKF Germany
Hans-Jurgen Dau-SKF Germany
The following items were discussed:
SKF has completed the validation testing for the hub. Hub testing was suspended when a 15-20mm crack was detected. The hub cycles are

530,000
670,000
810,000
837,000
970,000

SKF had misunderstood Rockwell's TP-926 test procedure and was under the impression that the one hub that had to run to 1,000,000 could not have a crack. J. Grant clarified the procedure to say that one hub must run one million cycles without a thru crack. SKF will place the hub that ran 970,000 cycles back on their test rig and run until 1 million cycles. Test was run at 13.2K rating.
Asheville will send two wheel nuts to J. Jennings so that Troy can run TP-926 on two SKF hubs. J. Krug to follow up.
SKF was asked to supply a free body diagram of their test procedure and compare it to the TP-926 loading.
SKF has proposed eliminating the undercut at the base of the drum pilot. This would increase the section size at their primary failure mode. RI must verify drum ID chamfers. Trailer Product's hub has no undercut and has a 2.3 mm radius. SKF will supply J. Krug the tolerance of the radius.

2.5 +0.5 mm

Pages: 0 1 2 Msgname: H1600141

SKF has agreed to provide a chanfer on the OD of the hub flange to accommodate the reduce envelope brake drum. RI must supply the maximum diameter that can be allowed.

SKF has asked if the long stud can be used for steel wheel vocations (short stud vocations). RI will address issue with Freightliner.

SKF must have a decision on what seal design to use for production. Currently a Freudenburg design is being used. SKF has converted RVI to a CR design back in August of 1994. SKF is proposing the use of the CR design on RI product. RI has requested a design review meeting be held in Troy on July 6 at 1:00 pm to discuss this issue. Dale Bell and Bruce Murden have been asked to provide technical support. LAE will have a representative present. SKF has asked for RI to create a list of questions in advance of the meeting. B. Murden will be asked to help with formulating a list.

The decision has been made to introduce the screw in hub cap for production. Modifications to the hub design will be required. SKF is in the process of changing forging sources and moving to a larger capacity press. A new forging die is required and will contain the modifications to allow the screw in design. The changes will add approximately .5 kg of weight per hub and cost approximately 2.80 more. Regular production validation testing will be run on this design version. Ri is requesting that the new die be expidited due to the small quantity of hubs currently available from the last forging run. 150 hubs remain in Germany but approximately 25% of them contain forging laps. RI has requested SKF to hold non-conforming hubs for emergency use.

SKF has proposed changing the stud boss design to a continuous surface. This would make the forging axi-symatrical and result in a cost savings. This design change would be implemented after production has begun. Approximate timing is April of 96. Full validation testing would be run at that time. There is a potential for a weight increase of approximately 3 grams worst case.

SKF has requested an increase in the tolerance from the inner bearing seat to the drum/hub integrate. Current tolerance is +.2 mm. RI feels that +/- .4 mm would be acceptable. RI will verify this number with trailer products.

3009

Pages: 3 4 Magname: H1600141

SKF is concerned about the lead in chamfer on the spindle. RI to review. SKF to provide proposal of chamfer angle and dimensions.

Hub identification information will be stamped on the OD of the flange. SKF is requesting information on Rockwell's requirement (julian date, logo, part number, etc). SKF has indicated that they can not put the Rockwell logo on the hub. SKF has indicated that they will provide a julian date plus several other serial numbers that will have to be tracked. Total numbers to be logged in will be 7 or 8.

If their are any corrections or additions to the meeting minutes please contact me ASAP. Thanks to all the people who were involved for their time, especially Uwe and Hans-Jurgen who travel from Europe to be here.

Jerry Krug Jr.

Extra X400 information begins:

```
      Originator
            Domain: US/TELEMAIL/ROCKWELL
   Domain Attrib: ID:AONA.GMKRUG
     Node.Userid: IBMX400.51940

  Message Id: CRSSW 950608194422677171
  Importance: Normal
     Sent by
         Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.GMKRUG
   Node.Userid: IBMX400.51940
     Subject: SKF THCII Meeting
  Recipients
         Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.SSHANEY
Free Fmt Name: AONA     -SSHANEY  *SSHANEY

         Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.KHCHALFI
   Node.Userid: IBMX400.64895
Free Fmt Name: AONA     -KHCHALFI *KHCHALFI

         Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.JPPAN
Free Fmt Name: AONA     -JPPAN    *JPPAN
```

Pages: 5 6 Magname: H1600141

```
       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.JRMCKENZ
  Node.Userid: IBMX400.63094
Free Fmt Name: AONA     -JRMCKENZ *JRMCKENZ

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.MSBARNET
  Node.Userid: IBMX400.63490
Free Fmt Name: AONA     -MSBARNET *MSBARNET

         Name: ERIC MAASSEN
       Domain: SE/IBMX400/IBMMAIL
  Node.Userid: DSVGOT.UDETECM
Free Fmt Name: CRX400   EMAASSEN
       Copy
       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.DJBURLEY
  Node.Userid: IBMX400.66908
Free Fmt Name: AONA     -DJBURLEY *DJBURLEY

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.JKJENNIN
  Node.Userid: IBMX400.67396
Free Fmt Name: AONA     -JKJENNIN *JKJENNIN

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.RJEDDING
Free Fmt Name: AONA     -RJEDDING *RJEDDING

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.WSHAGER
Free Fmt Name: AONA     -WSHAGER  *WSHAGER

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.GWBARNET
Free Fmt Name: AONA     -GWBARNET *GWBARNET

       Domain: US/TELEMAIL/ROCKWELL
Domain Attrib: ID:AONA.JWGRANT
Free Fmt Name: AONA     -JWGRANT  *JWGRANT
```

STEEL WARRANTY REVIEW 22-23 May 02

SKF 000660