



### TECHNICAL REPORT – ACCIDENT DAMAGE

<b>VEHICLE MAKE:</b>	Volvo	<b>REPORT DATE:</b>	29 <sup>th</sup> JuNE 2014
<b>VEHICLE REG:</b>	XXXXXXXXXX	<b>TRAILER:</b>	XXXXXXXXXX
<b>INSURED:</b>	XXXXXXXXXX	<b>LOCATION:</b>	XXXXXXXXXX
<b>INSURER:</b>	XXXXXXXXXX	<b>CONTACT:</b>	XXXXXXXXXX
<b>CLAIM / POL No:</b>	XXXXXXXXXX	<b>DATE OF APP:</b>	XXXXXXXXXX

#### SCOPE

To inspect the above mentioned three vehicle combination and to offer expert opinion on the condition of the vehicles, in particular, the components of the brake system and any influence they had in the overall roadworthiness in terms of complying to SANS 10047 – “The testing of motor vehicles for roadworthiness” of the individual vehicles as well as my views as to vehicle braking and handling dynamics immediately prior to and during the incident in which they were damaged.

#### PRELIMINARY REPORT

This is a preliminary report, based on the inspection of the vehicles and the available components only. In the event of a dispute arising in this matter, and it is required to proceed with further investigation, there are more detailed forensic measures we can take to reinforce my opinions on some of the components inspected and opinions offered and overall conclusion of the report.

#### COMBINATION OF VEHICLES - LAYOUT

Through my report, references will be made to the wheel position of certain components, below I have included a sketch “Fig 1” of the layout of the combination of vehicles in order to ensure no confusion exists as to which ones I am referring to. The colours are representative of my opinions regarding the braking ability of each wheel, green being adequate, yellow being impaired braking and red being totally unacceptable in terms of roadworthiness and safety.

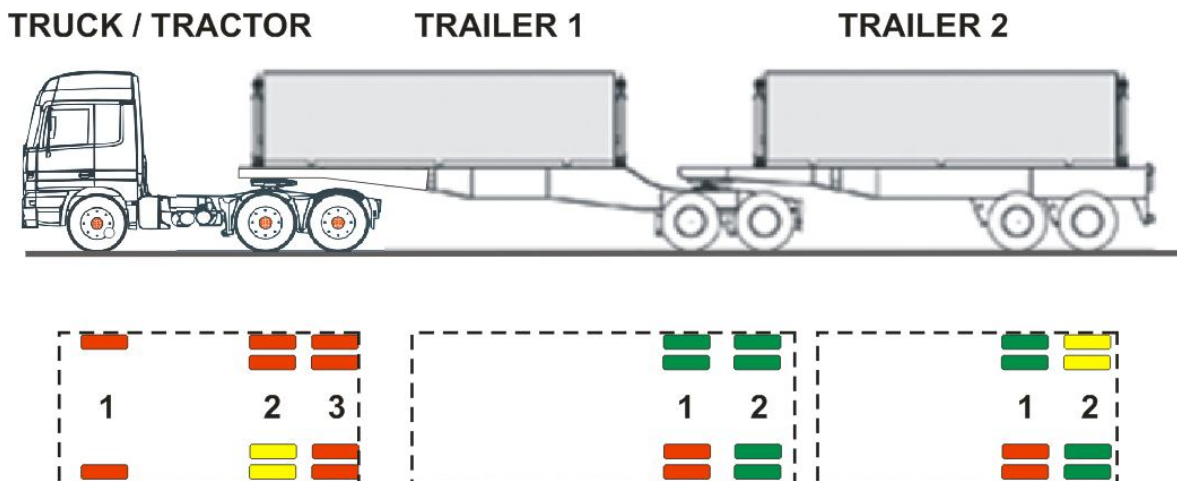


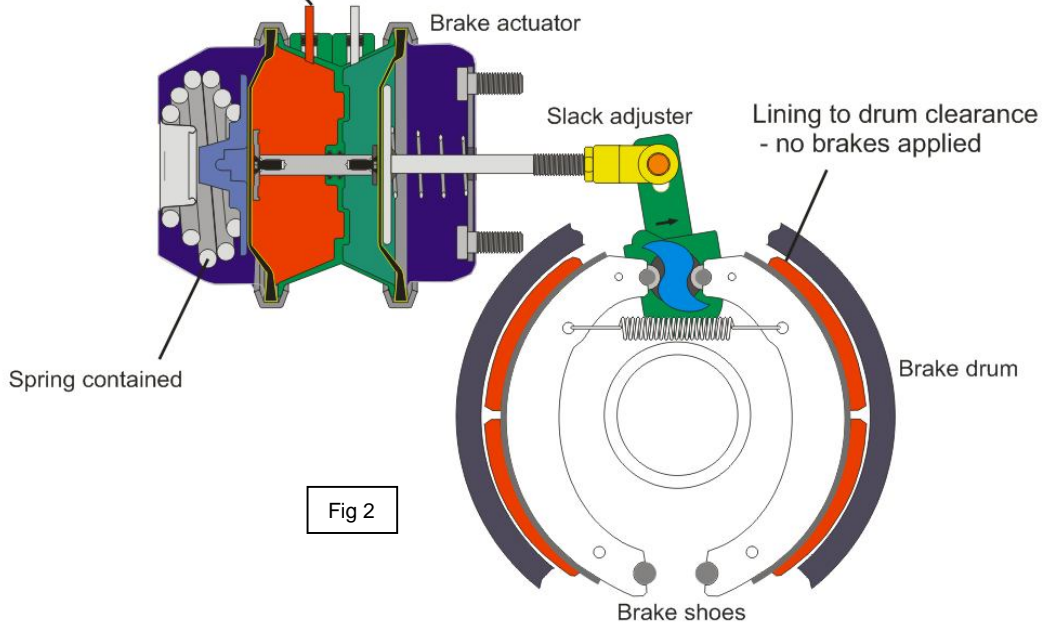
Fig 1

## FOUNDATON BRAKE OPERATION

As this report may be made available to persons of not such a technical nature, I will briefly explain the operation of the foundation brakes on the vehicles, as the main focus of this inspection is on these parts. Foundation brake is the term used for the brake components situated on the axles generating the brake force, i.e. brake drums, shoes, operating camshafts, etc, as opposed to control components such as compressors, valves and actuators.

# Driving condition

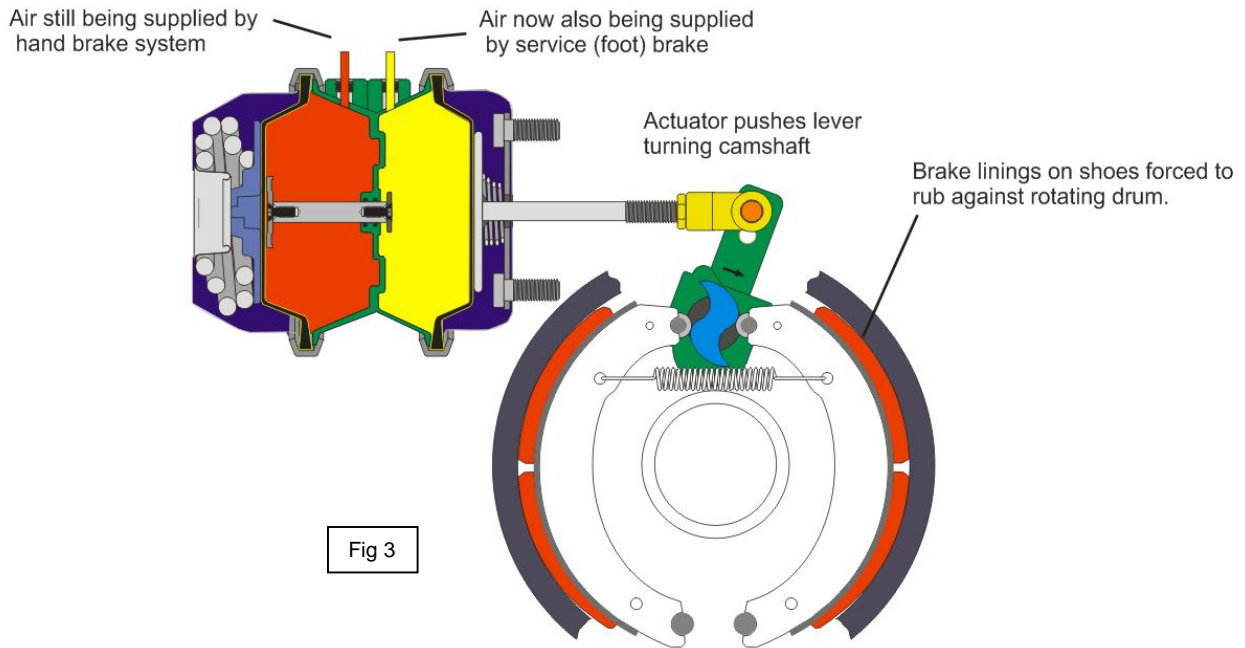
Air applied from hand brake valve to release spring pressure, turn "S" cam and put vehicle into driving condition



The brake effort on all three of the vehicles in question is generated by slowing the wheels by means of generating friction between the friction material on the brake shoes and the brake drums attached to the road wheels. Compressed air actuators act on levers which in turn cause the "S" camshafts to turn, opening the shoes against the drums. In the diagram above, the blue camshaft is released and therefore no brake is applied.

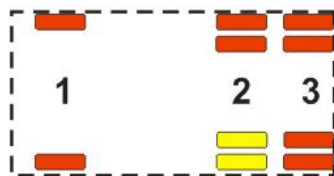
All of the brake actuators on all three vehicles with the exception of the front axle of the truck tractor are springbrake units as shown in the sketches and provide a combination of air operated force for service, secondary braking and normal park brake operation and spring applied force for emergency and uncoupled parking, also should the air drain completely.

# Brake applied



Above the brake is applied, the camshaft has been turned by the action of the actuator on the slack adjuster, forcing the linings on the brake shoes against the brake drum. This action causes a great deal of friction and with that comes heat, the friction surfaces of the foundation brakes can easily reach operating temperatures of more than 400 degrees Celsius.

**TRUCK TRACTOR  
IH9800i XXXXXX**



The truck tractor has been reduced to not much more than the chassis and axles. However, there remains condemning evidence of very poor maintenance on this vehicle in the condition of the brake shoes, front drums, linings and rear differential oil leaks onto the brakes. First the front brake shoes.



From the photos preceding of the left and right shoes of the front (No 1) axle of the truck tractor, one can clearly see the marks on the lining retaining rivets where they have been rubbing on the brake drum.

In many cases where the brake system of a commercial vehicle or combination of this nature is involved in a technical investigation due to an accident, the argument is put forward that the brakes would still work with linings that are worn below the maximum limit as directed by the manufacturers, using technicalities and bad science to totally disregard the first general instruction regarding brake systems that is issued to vehicle examiners in SANS 10047:2009 – The testing of motor vehicles for roadworthiness, on page number 36,

*Section 5.52 Braking system – General:*

*Reject if:*

- A) *Any part of the brake system is missing, or is cracked, fractured, damaged, distorted, loose or **excessively worn**, or .....*

*Note:*

- *The wear is more than that specified by the manufacturer, or*
- *The efficiency of force transmission or displacement has been reduced, or*
- *There is free play where it should not be present, or*

The brake linings on all three vehicles in question have maximum use wear indicators, a notch or step machined out of the lining at a depth where when reached, the linings must be changed. The insistence of manufacturers and the vehicle inspectorate on this point is not only related to actual brake force generated, the failure to do so will result in poor braking performance for other reasons equally as critical to the safety of the vehicle, the driver and other road users.

With worn linings the ability for the lining to handle the heat being generated during severe braking actions is greatly reduced due to its lack of mass and the problem is exacerbated in such cases by the metal to metal contact of the retaining rivet on the brake drum which increases the heat generated and prevents the lining from working as it was designed. Technically, the reduced lining to drum pressure under high heat and surface speed restricts the tiny particles of the lining material from breaking away from the lining (this is what causes normal brake lining wear) replenishing the surface with fresh, abrasive particles, maintain the coefficient of friction, this results in what is commonly known in the automotive industry as glazing of the lining and drum. This is clearly visible as the shiny area on the lining in Photo No.2.

Once the lining reaches this glazed condition, heat continues to be generated, but the coefficient of friction drops as the surfaces polish, generating more heat until the heat the temperature is high enough to break down the bonding compound of the lining and it disintegrates, as has happened to the lining from the other wheel in Photo No.1.

This phenomenon plays an enormous part poor brake performance in actual operating conditions, and explains a lot of circumstances where the driver is surprised by the brake system not reacting the way he has been used with the relatively cooler brakes prior to an incident where he claims his brakes failed.

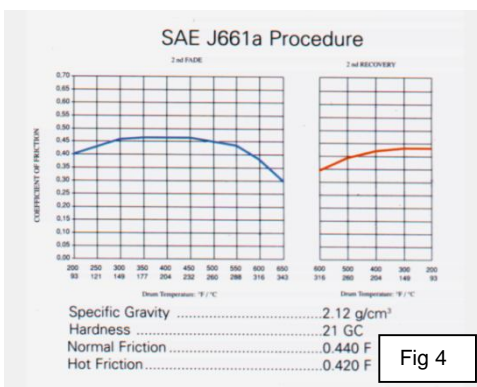
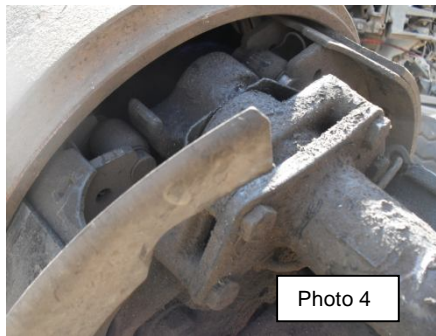


Fig 4

The graph in Fig. 5 shows the degradation of brake friction as temperature rises, taken from the American Society of Automotive Engineers (SAE) J661a – the relevant specification applicable to the truck manufacturer. The limits of acceptable wear to the linings and maximum diameters of brake drums are not there primarily to ensure these components remain structurally intact, but to give the driver of the vehicle that best possible chance of stopping the vehicle in an emergency situation, regardless of where the cause of the emergency lies.

At this point I should mention that this type of disintegration of the linings on axle No.1 is typical of overheating while braking, not damage caused by the fire.



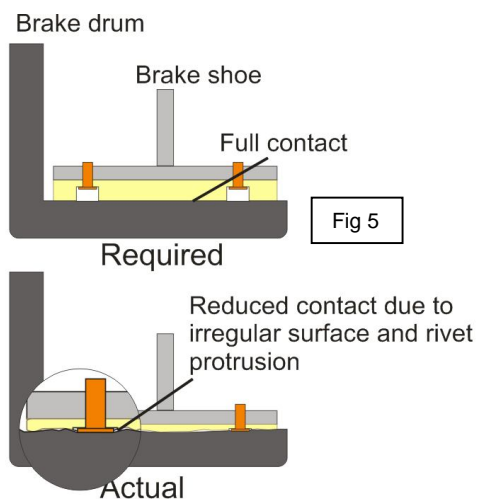
Compounding the afore mentioned problems, rivet contact with the drum removes particles of both drum and rivet, which, as the drum revolves, tear lines in the brake linings path, generating the type of uneven surface see in photo No.3.

Arvin Meritor, the axle manufacturer issue many technical publications that are available to all on their website, their publication “S CAM BRAKES AND AUTOMATIC SLACK ADJUSTERS” covers the references made in SANS 10047:2009 to manufacturers specifications relating to linings by stating:

#### *Reline the Brakes*

*Reline the brakes when the lining thickness is 0.25-inch (6.3 mm) at the thinnest point. The rivets or bolts **must not touch the drum**. Damage to components will result. Meritor recommends that you replace the springs, rollers, camshaft bushings and anchor pins at each reline. Replace shoe retainer springs, check the drum, and perform a major inspection when you reline the brakes.*

For reference purposes, on the right is a typical lining inspection hole on a sample vehicle to indicate the ease of carrying out a basic check on lining thickness without any special tools or skills.



To provide the required brake force, the lining and drum must make good surface contact. The graphical representation of what was actually taking place on both truck tractor brake drums on axle No.1. is shown in Fig.5.

The unevenness of the drums and linings contributes to the rapid buildup of heat in the brakes due to the localization of the heat on the high spots of the linings and drums.

Many of the linings on these three vehicles such as the axle No 1 left show signs of extreme heat. The layman may speculate that if there was heat, the brake must have been working properly, this is a common statement from some faced with brake issues and in many instances is incorrect.

The roadworthiness of a vehicle when dealing with the braking system of a vehicle is not only about measuring one stop or the cold performance of the brakes on a brake roller tester.

In addition to greatly increasing the chances of overheating in normal use and emergency situations that the driver would be expected to encounter, brake linings and drums in this poor condition seriously affect the brake performance of the vehicle and in fact the combination in several other ways. SANS 10047: 2009 – the testing of motor vehicles for roadworthiness, addresses several other points that are often not given the attention deserving in cases of forensic investigation into lack of brake performance on commercial vehicles.

Many of the linings on each of the vehicles such as the axle No 1 left show signs of extreme heat. Many may speculate that if there was heat, the brake must have been working properly, this is a common statement from some faced with brake failure issues. It is not always so, especially when there has been too much heat.

- Brake balance and ovality.

The dynamic road handling characteristics of the combination would most definitely be adversely affected by the unevenness of braking effort across the axle No. 1. The heat “patches” on the drum, in photo No.6 indicate that the brake was grabbing at those points and would have registered a considerable cyclical deviation in brake effort when tested.

To reduce the effect of brake units like these on the directional stability of the vehicle and any it is towing, which also plays a huge role in determining the roadworthiness of the vehicle, SANS 10047:2009 – The testing of motor vehicles for roadworthiness, on page number 39, section 5.56.1.1.1 – General Braking Performance states:

*When tested according to 5.56.1.2.1 (on a brake roller tester) Reject if:*

- b) Excessive drum ovality or disc distortion is shown by the cyclical variation of braking force, or*
- c) The measured braking force of any individual brake is different than that on any other brake on the same axle by more than 30%*



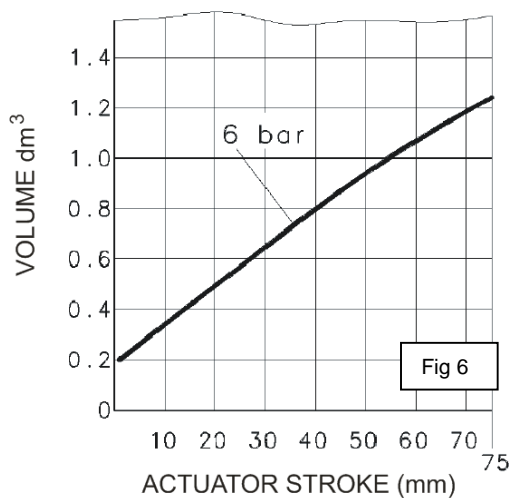
Indications that there are serious issues with the brake components are highlighted in the same Meritor brake publication:

**Important Information**

Meritor automatic slack adjusters (ASAs) should not need to be manually adjusted in service. ASAs should not have to be adjusted to correct excessive push rod stroke. The excessive stroke may be an indication that a problem exists with the foundation brake, ASA, brake actuator or other system components.

Meritor recommends troubleshooting the problem, replacing suspect components and then confirming proper brake operation prior to returning the vehicle into service.

In the event that a manual adjustment must be made (although not a common practice), a service appointment and full foundation brake, ASA, and other system component inspection should be conducted as soon as possible to ensure integrity of the overall brake system.



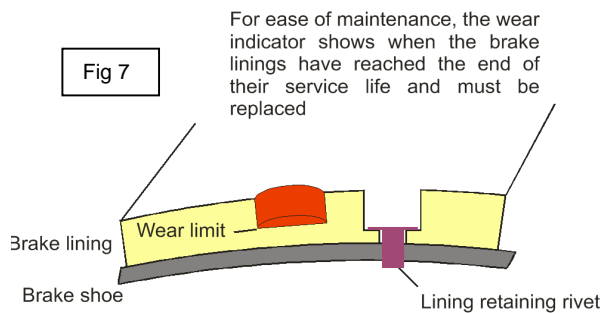
- **Increased air consumption**

Although not usually inspected by vehicle examiners due to the technical nature of the specifications, the increase of air consumption on a vehicle with badly worn or badly adjusted brakes can be a major problem.

Reduced pressure means reduced braking effort and the increased possibility of glazing and overheating. Fig 6 is a graph typical of the air consumption of a type 20 actuator as is fitted to axle No.1, the other two axles have larger diameter type 24 actuators, where air consumption is even greater.

Fig.6 shows how actuators' air consumption increases from approx .6 dm<sup>3</sup> at a well adjusted stroke of 30mm to over double that at a stroke of 75mm, where both front boosters will reach when linings are in such an appalling state as was the case with axle No. 1 of the truck tractor.

The design specification for this type of vehicle requires the truck to be able to apply the brakes fully nine times before reaching the air in reserve reaches the low pressure limit where the brakes would provide only minimal emergency braking effort. This is not a lot of brake applications when faced with an emergency situation and therefore all efforts should be made by the operator to ensure air consumption by the brakes and any other air consuming equipment be kept to a minimum.



The inspection and assessment of brake lining wear, as can be seen from Fig.7 is a simple but critical task and requires very little time and has either not been done or the reaching of wear limits has been ignored.

The sketch in Fig.7 shows one method that the lining and vehicle manufacturers use to indicate to the operator that the linings need to be replaced the other common method is a step machined at the wear limit height which serves the same purpose.

The wear limit indicator is approximately 1mm above the head of the rivet so as to avoid contact between rivet and drum when the lining needs to be replaced.

It is the operators' obligation to do his utmost to ensure that his vehicle is capable of safely completing any trip that his driver and vehicle are about to embark on. Even without taking the various motor vehicle regulations into consideration, such requirements are stipulated in certain aspects of the Occupational Health and Safety Act dealing with the drivers' rights to a safe working environment.

I can say with confidence from experience in my many years commercial brake system design, inspection, testing and repair, the poor condition, namely the excessive wear on the brake drums and linings due to lack of proper maintenance of the brakes axle No.1 alone would have been enough for the truck tractor to have been condemned as unroadworthy.

Axle No.2.



Although there are signs of slight oil contamination on the right wheel of axle No.2 on the truck tractor, it is the only wheel on the vehicle that has the physical characteristics and patent indications that it has been working extremely hard without failing.

Photo No.7 shows good contact between lining and drum and that the brake has generated extreme heat through braking actions, (the white powdery surface and a blue grey main colour), and that the lining has remained intact.



Photo No 8, shows the drum from the same right wheel of axle No.2. It is still in reasonably good condition, showing signs of extreme operation in the form of brake path discoloration and small surface heat cracks appearing.

This brake on the right of axle No.2 must surely raise the question that as all the brakes on this vehicle were exposed to the same driving situation, give or take some load movement variations; shouldn't all the brakes appear to be in a similar condition?

The brake on the left of axle No.2 was totally contaminated with oil and would have registered very little brake force if tested, this would have rendered the vehicle unroadworthy in terms of SANS 10047: 2009 due to the lack of brake force and the imbalance across the axle that would have been far in excess of the limit prescribed of 30%.

The left front wheel of axle No.2 and both left and right wheels of axle No. 3 have been contributing very little to the braking effort of this vehicle for some time. There is evidence of prolonged exposure to oil and grease. Contamination of this nature, in my experience renders the brake almost useless. I have tested many brake assemblies contaminated in such a manner and would expect them to operate at most, around twenty per cent of their designed capability.



Photo No. 9



Photo No.10



Photo No.11

The contamination of these three brake units would most definitely have been sufficient reason for a vehicle examiner to declare the vehicle unroadworthy as it would have been rejected in accordance with the instruction to the examiner in *SANS 10047: 2009, page 37,*

*Item 5.53 Brake system – Specific Items*

*Reject if any of the following are found:*

*d) Linings or pads contaminated with oil.*



## Synopsis of truck tractor

While this vehicle has been severely damaged during a collision and ensuing fire, the very purpose of the foundation brakes being that of taking the kinetic energy of the vehicle and its' imposed loads, turning that energy into heat and then dissipating this heat, means that even in a severe fire such as the one experienced by this vehicle, most of the components being designed to operate in extreme temperatures, remain relatively unscathed, leaving clear forensic evidence of their condition prior to the event.

Many would question that if the vehicle was so bad, how come the driver did not notice the fact that the trucks brakes were so bad? It must be explained that the difference in static mass of the truck tractor when unhitched from a trailer is only around 25 per cent of the static mass imposed when hitched to a laden trailer, so normal driving of the vehicle unladen would give little or no indication of the impending braking difficulties. Once hitched, the driver is dealing with a combination of vehicles.

Once called upon to deliver the brake retardation required by SANS 10047: 2009, serviceable brake shoes, linings and drums are quickly overheated by trying to make up for the loss of braking of the badly maintained components, preventing them from delivering their maximum effort.

It is my opinion, based on my experience in this field that due to the condition of the foundation brakes, that this vehicle was a safety hazard and unroadworthy in terms of the rejection criteria prescribed in SANS 10047: 2009, in as much that prior to the accident, the brake performance was totally inadequate and would have been unable to stop the vehicle within stipulated stopping distances, that the brake linings were non-complying to the relevant sections as previously mentioned in terms of oil contamination and excessive wear and that due to this, the vehicle would not have been able to meet the design performance stipulated in SANS 20013 regarding residual brake performance following multiple stops when laden due to the overheating of serviceable brake parts .

I have no doubt whatsoever that a visual inspection of the brake shoes and drums of this vehicle prior to it's' departure would have revealed sufficient reason to anyone with any mechanical ability for them to be concerned enough to have prevented it being driven on the road for the safety of the driver and other road users.

Should you require any clarification of any of the points contained herein, please do not hesitate to call me.

Yours sincerely,



Peter Banbury  
073 8000 115

P.S.

I have included a page from the Manufacturers sales brochure, detailing the dimensions and mass of the truck tractor for reference.

## PLATING DATA

Manuf's front	GA 7500kg
Manuf's rear	GAU 21000kg
Manuf's	GVM 28500kg
Manuf's	GCM 71000kg
Permiss.front A	7500kg
Permiss.rear AU	18000kg
Permiss. vehicle V	25500kg
Permiss. com. D/T	71000kg
Power P/D	355kW

## ENGINE

Make and Model	Cummins ISX Engine plus Electronic road speed governor with cruise control and Interbrake
Type	4-cycle, in-line, Turbo-intercooled
No. of Cylinders	Six
Bore/Stroke	137mm/169mm
Displacement	14,946 Litres
Power (SAE)	355 kW at 2000 r/min
Max. torque	2237 Nm at 1100 to 1500 r/min
Radiator area	6322 sq cm
Intercooler area	4515 sq cm
Air filter	Dry-type, radial seal element + gauge

## CLUTCH

Make and Model	Eaton-Fuller HD-Solo 1552
Type	Ceramic, Driven twin plates, 7 spring
Diameter	394mm
Action	Mechanical pull type, self adjusting Air Assisted Clutch

## TRANSMISSION

Make and Model	Eaton-Fuller RTLO-18913A + cooler
No. forward gears	13
Type	Constant-mesh
Ratios Low/top	12,31/0,73:1
Option	Eaton-Fuller Auto shift Transmission RTLO-1891BAS 3

## DRIVELINE

Type	Two segment Spicer SPL250/170
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## FRONT AXLE

Make and Model	Meritor MFS-16-122A
Type	Reverse Elliot I Beam
Capacity	7500kg

## REAR AXLE

Make and Model	Meritor RT-46-160P
Type	Single reduction Hypoid with Full driver controlled diff locks
Capacity	21000kg
Ratio	4,56:1 or option 4,89

## SUSPENSION

Type:	FRONT- Parabolic-Elliptic with shock absorbers REAR- Hendrickson HAS -460 Full air
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Tare weight includes:  
2 Fuel Tanks, 5th Wheel

## BRAKES

Service	Dual Circuit, Air, type 20 front 24-30 rear with ABS braking system
Brake size	Front: 420X152mm Rear: 420X178mm
Total brake area	13406sq cm (swept area)
Parking brake	Spring-brake actuators on rear axle

## STEERING

Make and Model	Ross TAS-65 with additional gear on left hand side and tilting telescopic steering column
Ratio	20,4:1

## CHASSIS

Type	Pressed steel channel 110 000psi
Dimensions	257x89x7,9 / 241x83x6,4mm
Full inner "C" channel reinforcement	
Cross members	Pressed steel/bolted

## CAB

Type	Latest generation aluminium Pro Sleeper
Windscreen	Two-piece curved glass tinted
Seats	Gre-Mag air suspension driver and passenger seats with integral seatbelts
Trim	Deluxe High Level Grey
Suspension	Cab Mate Air
Air Conditioning	International Blend-air
Option	Midroof cab with dual sleeper bunks

## ELECTRICAL SYSTEM

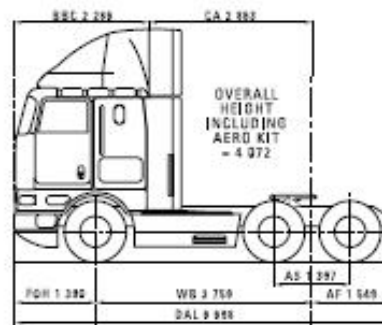
System voltage	12 Volts
Batteries	4x95 Ah 2250 CCA capacity
Starter	Delco-Remy 42MT
Alternator	Delco-Remy 34-SI 110 amp
Protection	Circuit breakers except instruments
Hooters	Air plus electric
Headlights	Rectangular H-4 Halogen

## FUEL TANKS

Type	Aluminium - Dual side mounted
Capacity	Total 870 litres

## WHEELS/TYRES

Rims	22,5x9,00 DC steel painted 10 stud
Tyres	12R22,5 or 315/80 tubeless radial



Navistar International Trucks Southern Africa

A NAVISTAR COMPANY

399 Sasolburg Street, Apex Industrial Site Benoni  
Tel +27 11 421 2129 | Web: [www.navistarinternational.co.za](http://www.navistarinternational.co.za)

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McEwan Advertising OE/RW 020

**TRAILER 1 – FRONT LINK**  
**SA Truck Bodies side tipping front link**  
**Reg No. XXXXXXXX**



Axle No.1 had come apart from the vehicle during the accident and was strapped to the chassis of the trailer. Removal of the drum on the right of this axle revealed a brake assembly in very good condition. The removal of the drum on the left side however, revealed that the brake assembly had been damaged in a prior incident. The brake spider, which is the bracket that holds the brake shoes on to the axle and the “S” camshaft, had been bent making the brake shoes rub at a peculiar angle, so they had been intentionally removed. That action alone renders this vehicle and the combination in total as totally unsafe and unroadworthy, one cannot say negligently, as the action was a deliberate decision by the mechanic to remove the brake components and then return the vehicle to operational service.



Photo NO.1



Photo No.2



Photo no.3

Photo No.1 highlights the piece worn out, not damaged, of the “S” camshaft on the outer edge which correlates with how the rollers would be sitting at an angle due to the bend in the brake spider that can be seen in Photo No.2. Also all four edges of the spider where the brake pins should have been are worn in the same manner (Photo No.3) where the brakes shoes would normally be sitting perpendicular to the pins and have plenty of clearance from the spider bracket.

This constitutes automatic rejection as unroadworthy under SANS 10047:2009 – The testing of motor vehicles for roadworthiness, on page number 36, section 5.52 – Brake system – General, which states:

Reject if:

- a) Any part of the brake system is missing, or is cracked, fractured, damaged, distorted, loose or excessively worn.

For the record, should this axle have been tested prior to the commencement of it’s last trip as described in the Standard, the maximum tolerance in the difference between brake forces generated on opposite sides of an axle of 30% would definitely have read 100% resulting in rejection as per page 39 where:

*When tested according to 5.56.1.2.1 (on a brake roller tester) Reject if:*

- b) Excessive drum ovality or disc distortion is shown by the cyclical variation of braking force, or*
- c) The measured braking force of any individual brake is different than that on any other brake on the same axle by more than 30%.*



Photo No.4



Photo No.5

While my speculation on the age of the rust and debris evident in Photo No.4, measurable in what appears to me to be close to one millimeter on the brake drum as opposed to what one would expect to measure in microns (thousandths of a millimeter) is based on my experience in dealing with many such cases, should this finding be disputed, my theory can easily be confirmed by having these components subjected to a more scientific metallurgical examination.

Such an examination, while being relatively fast, is quite expensive, but would be able to accurately determine the time period that the worn areas of the spider and also the brake drum have been exposed to the elements compared to that of the same surface areas of other similar components from the opposite side of the same axle. I really do not believe this to be necessary as the difference between the drums mentioned can be assessed visually in Photo No.5 by even an untrained eye.

## **SYNOPSIS**

The deliberate act of the removal of the brake shoes from the left side of axle No. 1, shows a blatant disregard for the safety of the driver of the combination of vehicles and any other road users he was to encounter while towing this vehicle.

Due to the nature of their high center of gravity design of this type of vehicle, it is common industry knowledge that their brakes systems operate under close to maximum capability when loaded and therefore, while the foundation brakes on this particular trailer may have produced enough brake force to satisfy a cold roller brake tester performance test, zero effort from the added stress placed upon the rest of the brakes of this vehicle and the incompatibility of the braking effort of this trailer in relation to the truck tractor and the trailer that is was itself towing, and the contribution toward the combination's directional stability, it would represent a serious threat to the ability of the combination to be operated safely on the road.

I have no doubt whatsoever that immediately prior to the accident which saw the vehicle damaged in this way, it could not have been in a road worthy condition.

I have no doubt whatsoever that a visual inspection of the brake shoes and drums of this vehicle prior to it's' departure would have also as in the case of the truck tractor, revealed an unroadworthy, unsafe vehicle.

Should you require any clarification of any of the points contained herein, please do not hesitate to call me.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Peter Banbury', with a stylized flourish extending from the end.

Peter Banbury

**TRAILER 2 – REAR LINK**  
**SA Truck Bodies side tipping rear link**  
**Reg No. XXXXXXXX**



The first thing that caught my eye on this vehicle was that despite the severe damage from the fire, there was clearly a piece of electrical wire tied around the lever of the vehicles' load sensing valve.

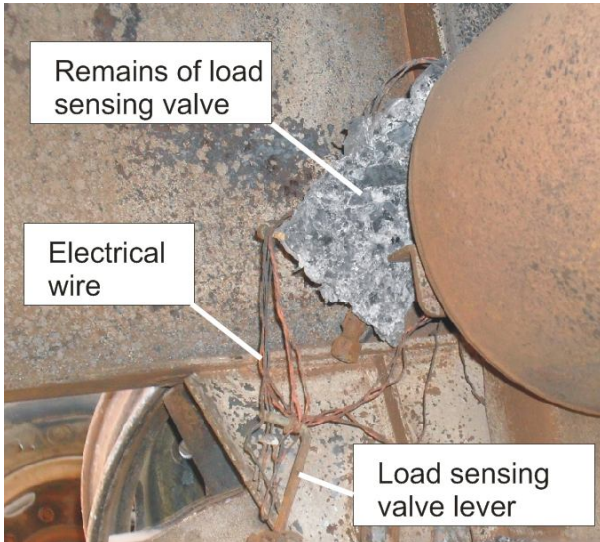


Photo No.1

As can be seen Photo No.1, the load sensing valve has been totally destroyed in the resultant fire, but the thin strands of copper wire are clearly still there, still holding the lever of the valve to the mounting screw.

This unfortunately is a common, very dangerous practice carried out by many operators due to the tricky methods of setting this valve and also the unreliability of the valves' operating linkages that are attached to the axle.

As its' name suggests, the load sensing valve dynamically modifies the air pressure delivered to the brake actuators depending on the load. It determines this by reacting to suspension deflection measured by the lever.

Regardless of in what position the lever had been fixed, had the vehicle been subjected to a roadworthy test with the load sensing valve in this condition, it would most definitely have been declared by the examiner as unroadworthy, being rejected for among other reasons, in accordance with the instruction to the examiner in SANS 10047: 2009, page 37,

*Item 5.53 Brake system – Specific Items*  
*Reject if any of the following are found:*

*n) an incorrectly adjusted load sensing valve.....*

Examination of the left side of axle No. 1 had a problem in that the top brake shoe had bent and had worn the brake lining in a taper. This bent shoe was forcing the lining against the drum unevenly, which created difficulty for the "S" camshaft in applying the brake effectively.

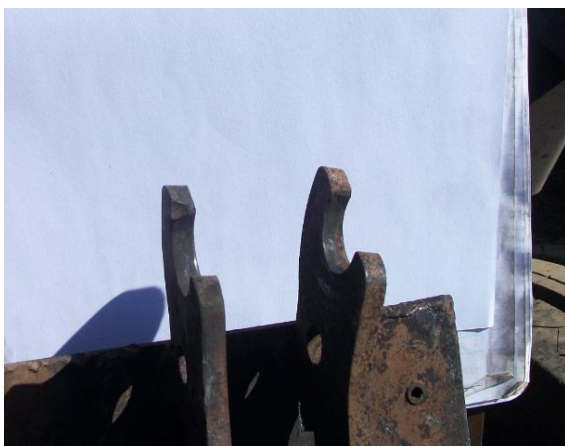


Photo No.2



Photo No.3

In Photo No. 2, the web on the right of the shoe is bent outward quite a bit, resulting in the shoe being forced against the drum at an angle. The effect of this can be seen in Photo No.3.

The lining has worn badly on the right hand side which you can see if you compare the depth of the rivets on either side. On the right, the rivet has almost made contact with the drum.

The white line on the right of the brake lining is where the uneven pressure has caused localized overheating of the lining. This shoe, without any doubt, would hinder the braking efficiency of this wheel and cause rejection by a vehicle examiner in relation to SANS 10047: 2009 under instruction to the examiner on page 39 where:

*When tested according to 5.56.1.2.1 (on a brake roller tester) Reject if:*

*c) The measured braking force of any individual brake is different than that on any other brake on the same axle by more than 30%.*



Photo No.4

The brake of the right wheel on the first axle shows signs of operating efficiently until reaching its design capabilities, being close to the point of disintegration, Photo No.4 shows the fragments of the lining having broken off from the corners of the leading shoe.

All the brake shoes on the vehicle should appear more or less in this condition having been subjected to the same event and are designed to contribute evenly to the brake effort of the trailer.

Finally, on to axle No. 2, the last axle on the combination of vehicles. The brake linings of the right wheel of axle No.2 on this trailer have been neglected in the same manner as many of the other wheels on this combination of vehicles.



Photo no.5

Photo No.5 shows the extent to which the maintenance of this trailer has been neglected with respect to the safety critical task of the inspection and replacement of worn brake linings, the highest wearing part of the vehicle.

The reduction of brake effort caused by the rivets having worn down due to make contact with the brake drum, along with the glazed appearance of the shiny surface area of the lining and the partial disintegration of the lining have all been dealt with earlier in this report.



Photo No.6

As can be seen by the alternative language spelling of axle in this photo, I was not the first person to examine these vehicles.

Photo No.6 of one of the brake shoes of the right wheel of axle No.2 shows the brake having operated efficiently until reaching its design capabilities as the right wheel on axle No.1.

As previously mentioned, any item that adversely affects the brake performance of a commercial trailer needs to be attended to immediately by the maintenance personnel responsible.

This trailer would have lost a large amount of its braking ability due to the bent brake shoe and linings that were severely worn. While the fixing of the load sensing valve probably had no direct influence on the cause of the accident, the fact that it had been done, shows a disregard for the laws governing vehicle safety and the proper maintenance recommended by the vehicle manufacturers required to keep a vehicle in a safe and roadworthy condition and could not possibly have passed a roadworthiness examination in accordance with SANS 10047: 2009, the testing of motor vehicles for roadworthiness.

I have no doubt whatsoever that a visual inspection of the brake shoes and drums of this vehicle during regular servicing or prior to its' departure would have also as in the case of the truck tractor and front link trailer, revealed an unroadworthy, unsafe vehicle that needed urgent attention.

Should you require any clarification of any of the points contained herein, please do not hesitate to call me.

Yours sincerely,

Peter Banbury

# ADDENDUM TO TECHNICAL REPORT

No.127/9/10

Due to the extreme nature of this vehicle combination's damages and possible repercussions, it was requested that I commission further metallurgical examinations of some of the components of the vehicle to reinforce the statements made regarding the poor condition of the brakes.

As these examinations are relatively expensive, I elected to have one series of tests done on what I consider to be the worst of all of the individual foundation brakes. I therefore selected as an glaring indication as to the extent of neglect of this combination with regards to the brake maintenance, the front left wheel, where the brake shoes had been completely removed some time prior to the combination embarking on its final trip.

**TRAILER 1 – FRONT LINK**  
**SA Truck Bodies side tipping front link**  
**Reg No. XXXXXXXXX**

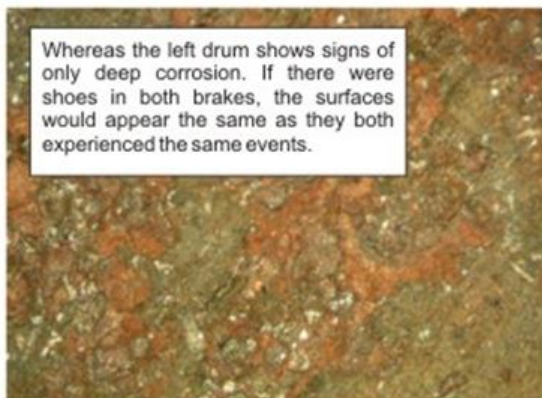


I commissioned Mr. Eric Vrugde of Metserve International, a Professional Metallurgist with some thirty years experience in mechanical failure analysis to conduct the tests as described in Annexure 1 to this addendum.

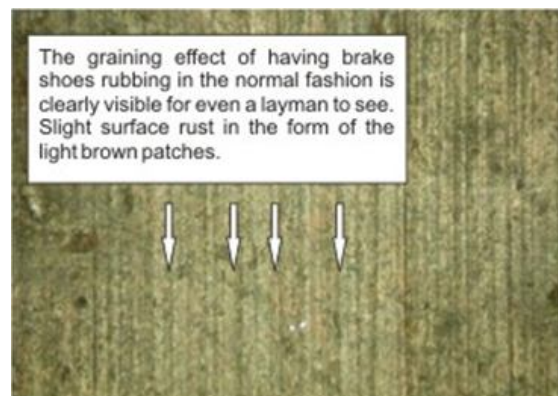
There are three major factors to consider when looking at the brakes of the wheel highlighted in red above.

It needed to be proved that brake shoes were not present during the accident, which in itself would remove 25% of the initial braking capacity of the vehicle and overloading the brakes of the other three wheels as well as contribute greatly to vehicle instability during emergency braking maneuvers.

Following are two photos extracted from Page 6616-6 of Metserve's report. The surface of the right drum brake path (on the right) where brake shoes were present and working can easily be distinguished from the left brake drum (on the left) from the same axle where there were no shoes present.



The surface of the left drum magnified



The surface of the right drum magnified

The report from Metserve is easy to understand. It shows that the huge difference between surfaces of the brake paths on the two brake drums tested are the result of one of them (the right drum) is clearly abraded by the contact with a brake shoe, whereas the left one shows no sign of such abrasion.

Secondly, on the same wheel, I am confident that the bent brake spider as mentioned on the first page of the leading trailer Report No. 128/9/10 was caused in a previous accident.

To show this, I have included illustration Fig. 1 and Photo 3 from the front link trailer report that show that the damage to the hole on the brake spider could not be caused while a brake anchor pin and brakes shoes are present, which would be necessary for the brake to be operating.





The brake shoe anchor pins are mounted in the center of the brake shoes, which obviously run in the centre of the brake path of the drum.

As confirmed in Metserve's report, the drum is made of a cast iron which properties would not allow it to deflect and cause the damage to the spider without breaking itself. There was no damage or internal marks on the brake drum of the front left axle.



The holes are badly worn as can be seen here, note the flats on the right of the lower hole. This could not have happened in an impact with a brake drum present without severely damaging the drum also.

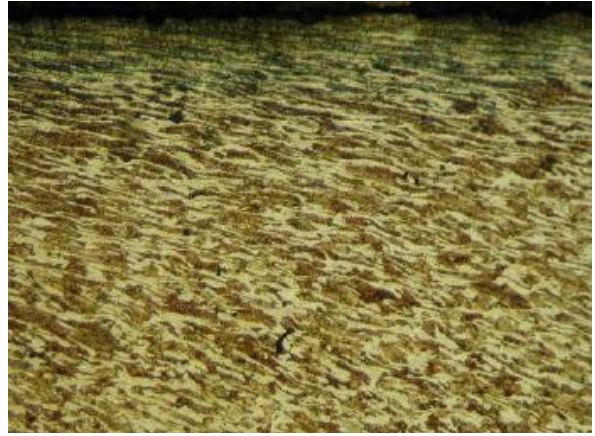
The wear marks on the side are consistent with what you would expect when considering the bend in the brake spider and abnormally worn "S" camshaft.

**Photo no.3**

Finally, I needed to prove that the abnormal shapes of the parts within the brake of the left front axle in discussion are actually wear marks and not accident related impact damage. To do this, I instructed Metserve as per the ANNEXURE 1 to help me in this regard.

Full explanation of the tests that confirm my opinion is attached in their report number 6614. I will also explain here, the outcome of the report in layman's terms.

The picture on the left is of the normal molecular structure near the edge of the "S" of the camshaft. The molecules on the outer edge can be seen to be undisturbed and consistent with the molecules further in the centre of the sample.



The deformation of the molecules of the outer edge of the picture on the right is evident. The report clearly states that this is due to mechanical wear.

In summary these further tests have reaffirmed my original conclusions regarding the poor state of repair and roadworthiness of the combination of vehicles prior to the accident that saw them destroyed.

Should anyone require any further clarity or assistance in understanding the contents of this addendum or the original report, please do not hesitate to call me.

Kind regards,

A handwritten signature in black ink, appearing to be 'Peter Banbury', written in a cursive style.

Peter Banbury

**ANNEXURE 1**  
**PRIVATE AND CONFIDENTIAL**

**TO: METSERVE INTERNATIONAL**

**Testing requirements on xxxxxxx components:**

**Test 1.**

**Components:**

Leading trailer front axle left brake drum and leading trailer front axle right brake drum.

**Aim:**

To prove that there were no brake shoes present on this wheel at the time of the accident.

**Tests required:**

Corrosion testing of the brake path surfaces.

**Reasoning:**

There is corrosion evident on the brake path of both brake drums. If there were brake shoes present on both wheels, it is reasonable to expect similar corrosion of each drum on the brake paths where the contacting brake shoes would touch.

**Expected result:**

It is clear that there were no brake shoes in one of the wheels and that there is much more and more onset corrosion on the wheel where the shoes were missing.

I require clarity of the extent and type of corrosion on the worst drum and if possible how long this would have taken to accumulate and the difference between that and the drum where there were clearly shoes working.



**TEST 2**

**Components:**

Leading trailer "S" camshaft and brake spider from the front left wheel.

**Aim:**

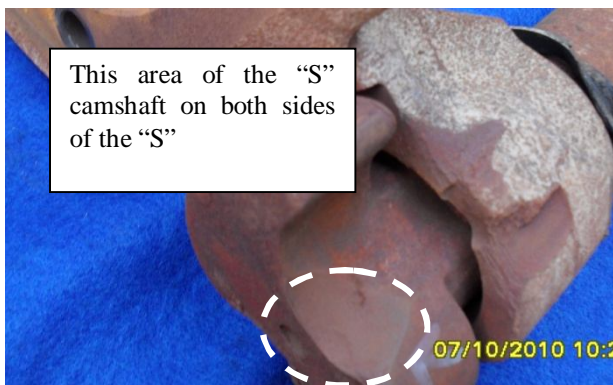
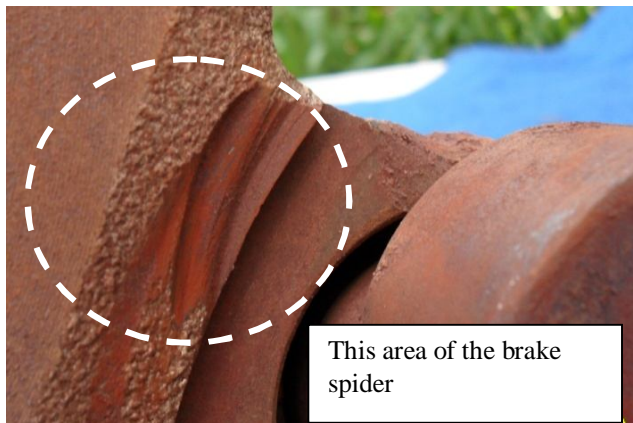
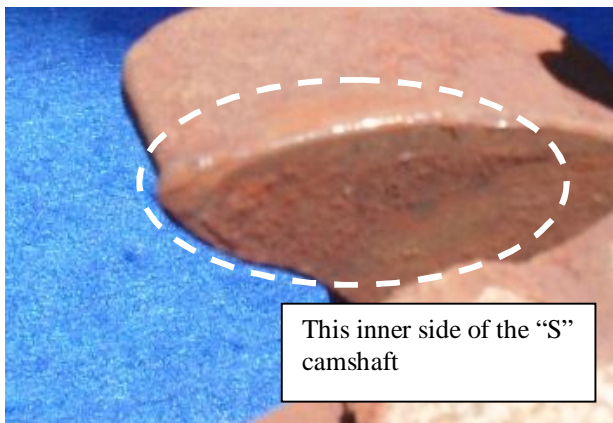
To prove that the wear on the spider and camshaft was caused prior to the accident and are due to the bend in the brake spider which could not have been caused in the incident in question due to the drum being undamaged and the wear that has taken place over some time on both the "S" camshaft and the brake spider.

**Test required:**

Assessment of the areas indicated in order to ascertain if the missing or distorted material is due to impact damage or abnormal wear due to incorrect operation of the components.

**Expected result:**

That the areas are in fact worn and not damaged from any impact during this accident.



## Accident Assessors & Auditors



## Confidential Metallurgical Report



Reference 6616

Issued by:  
**METSERVE INTERNATIONAL**  
Metallurgical Consultancy  
P.O.Box 1172  
Jubilee Park 2153  
South Africa

TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)

[WWW.METSERVE.CO.ZA](http://WWW.METSERVE.CO.ZA)

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**Author: Mr. E. R. Vreugle ASM**

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[WWW.METSERVE.CO.ZA](http://WWW.METSERVE.CO.ZA)

TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)



P.O. Box 1172  
 Jubbekel Park 2153  
 South Africa

Fax: 27-11-4622386  
 Telephone: 27-11-7041010  
 E-mail: [metserve@pixie.co.za](mailto:metserve@pixie.co.za)

Attention: Mr. P. Banbury

Reference: 6616

Subject: **METALLURGICAL EVALUATION OF BRAKE DRUM**

**INTRODUCTION**

Sections of a brake drum from a Tipper Trailer were submitted for metallurgical examination. The information supplied by the client is presented below.

**BACKGROUND DATA**

Date of failure:	Year 2010
Tag No.	N/A
Date commissioned:	Unknown
Component description:	Brake Drum
Component Type:	International 98001 .
Vehicle Combination:	WJY454GP- WJY801GP- WJY804GP

Material specification:	Not Supplied.
Original Dimensions:	Not Supplied.
Operating Temperature: C	Not Applicable
Operating Pressure: MPa	Not Applicable
Unit:	Not Applicable.

Description of failure:	
Events leading to failure, unusual or upset conditions:	It was reported that the submitted parts are part of a tipper trailer.

- Attached photos illustrate the sample in the condition received.

**BACKGROUND INFORMATION**

Sections of brake drum removed from the Tipper Trailer have been submitted for metallurgical examination  
It was requested that a comparison assessment of the submitted sections be undertaken.

**SECTIONS REMOVED**

The submitted section were removed from a brake drum (by the client) as illustrated by arrow in the photo macrographs below.



Illustrate the section removed from the brake drum hereafter named sample 6616B

The hand written identification of the drum "R/AXE"

Illustrate the section removed from the brake drum hereafter named sample 6616G

The hand written identification of the drum = "Axel one left"





**STEREOSCOPIC EXAMINATION**

Both sections were examined with the aid of a stereo microscope in the as received condition the following features were observed.



Sample 66 16G brake surface revealed a gray relative smooth surface with some evidence of abrasive wear illustrated by the "grooves"



Sample 66 16B brake surface revealed evidence of corrosion as illustrated in the photomicrograph

No "smooth surface" could be observed on the sample examined.



*Additional photo macrographs are attached to this report*

**HARDNESS TESTING**

Transverse microscopic sections were cut from the submitted samples and suitably prepared for a Vickers Hardness Testing.

The ranges of recorded values are presented in Table I.

**TABLE I HARDNESS PROPERTY DATA**

<b>Designation</b>	<b>Hardness (HV0,5)</b>
<i>Submitted Sections</i>	
<b>6616 C Core Section</b>	<i>165-170-174</i>
<b>6616 B Core Section</b>	<i>169-184-173</i>

**Machine Manufacture Leitz**  
Method Vickers  
Load 500 P  
Calibration No MI 15202B

Note :

Unlike carbon steel and certain other metals, cast iron, because of microstructural variations, does not exhibit a consistent correlation between hardness and tensile strength; thus, a simple hardness test is not sufficient to estimate the strength of the material. Instead, the strength of the material depends in a complex manner on both its hardness and microstructural composition.

**METALLOGRAPHY**

Transverse microscopic sections were cut from the submitted section and suitably prepared for a microscopic examination, the following salient features were observed.



*The microstructure of the core section of sample 6616G exhibited a characteristic pearlitic graphite flake cast iron structure.*

Core structure At 150X Mag 2% Nital

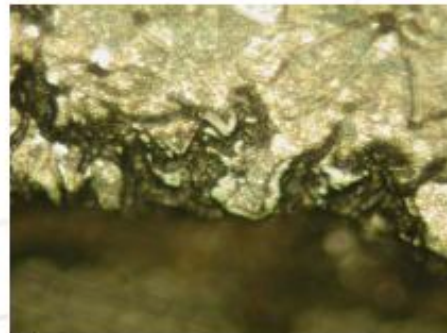
*Microscopic examination of the break surface did not reveal any abnormalities on the sample examined.*



Brake surface sample 6616G at 250x mag  
2% Nital Etch



*The microstructure of the core section of sample 6616B exhibited a characteristic pearlitic graphite flake cast iron structure similar to sample 6616G. Examination of the brake surface did reveal evidence of pitting corrosion refer RHS photomicrograph.*



Brake surface sample 6616b at 250x mag  
2% Nital Etch

**Graphite Form = Type One**  
**Graphite SA = A**  
**Graphite Size = 3**

EN ISO 945 - 1994 Cast Iron Designation of Microstructure of Graphite.

**CONCLUSIONS**

- Both drums appear to have been made from a pearlitic gray cast iron and no difference in manufacturing or heattreatment could be observed.
- The main deference between the submitted sections is that sample 6616B appears to have been corroded and no corrosion could be observed on sample 6616G suggesting that the brake drum was not working at the time of the accident.
- No material or manufacturing defects could be observed on both the submitted samples.

*We hope this information meets with your requirements and should you require any further information or assistance please contact me.  
Yours sincerely*

**Mr.E.R.Vreugle**

WWW.METSERVE.CO.ZA

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TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: METSERVE@PIXIE.CO.ZA

#### **CASTIRON RELATED DOCUMENTATION**

The standard used here follows EN ISO 945 - 1994 Cast Iron Designation of Microstructure of Graphite. This standard is based on and comparable with the standard ISO 945 Cast

#### **PROCEDURES**

- As Received
- Component Identification as received.
- Visual examination for general condition assessment.
- Photomicrograph of component as received.
- Procedure=ASTM E 1188 - Standard Practice for Collection and Preservation of Information and Physical Items by a technical Investigator.
  
- Specimen Preparation
- Specimen Preparation is to provide a sample for metallurgical examination.
- Machining equipment used includes drill presses, circular diamond saws, surface grinders, sanders, band saws, table saws and others to obtain representative sample for investigation.
- All sample preparation per ASTM procedures.
  
- Metallography
- Procedure=ASTM E 3 - Standard Guide for Preparation of Metallographic Specimens.
- Metallurgical preparation of selected cross sections for microstructural characteristics.
- Metallography=Abrasive Wet Cutting of Section
- Metallography=Cold Castable Resin Mounting of Sample.
- Metallography=Grinding of Sample- 60-120-320-600-1000 Grit.
- Metallography=Polishing Sample 6 and 1 micron diamond.
  
- Fractography
- Fractography=Ultrasonic Cleaning Fracture Surface.
- Fractography=Stereoscopic Examination of fracture.
- Fractography=Documentation and Optical Photomicrograph of fracture surface.
  
- Laboratory
- Laboratory=Ultrasonic Cleaning of Microscopic Mounted Sample.
- Laboratory=Etching of Microscopic Section.
- Laboratory Procedure= ASTM E407 Methods for Microetching Metals and Alloys.
- Laboratory=Optical microstructural examination of sample.
- Laboratory=Interpretation Including Microstructure Identification.
- Laboratory=Identification of crack morphology.
- Laboratory=Optical Photomicrography of sample.
- Laboratory Procedure= ASTM E883 Standard Guide for Reflected-Light Photomicrography.
  
- Mechanical
- Laboratory=Micro Vickers hardness testing.
- Procedure = ASTM E 384 - Standard Test Method for Micro indentation Hardness of Materials.
- Laboratory=Verify any loss of wall thickness or other dimensions.

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TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)

- Professional Service
  - Professional Service=Literature survey related to the investigation.
  - Professional Service=Metallurgical analysis and data compilation and verification.
  - Procedure =ASTME 678 - Standard Practice for Evaluation of Technical Data
  - Procedure =ASTME 620-97 - Standard Practice for Reporting Opinions of Technical Experts.
  - Professional Service=Analyzing the evidence, formulating conclusions.
  - Professional Service=Metallurgical technical report writing and express an opinion.
- 
- Reports are submitted to clients on a confidential basis.
  - No reference to the work or test results in any manner will be discussed or made public without written authorisation from the client.
  - All work is considered proprietary property of the client and is maintained by Metserve as such.

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TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: METSERVE@PIXIE.CO.ZA

## Accident Assessors & Auditors



## Confidential Metallurgical Report



Reference 6614

Issued by:  
**METSERVE INTERNATIONAL**  
Metallurgical Consultancy  
P. O.Box 1172  
JulshaiPark 2153  
South Africa

[WWW.METSERVE.CO.ZA](http://WWW.METSERVE.CO.ZA)

TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)

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**Author: Mr.E.R.Vreugde ASM**

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[WWW.METSERVE.CO.ZA](http://WWW.METSERVE.CO.ZA)

TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)





P.O. Box 1172  
Jubilee Park 2153  
South Africa

Fax: 27-11-4622386  
Telephone: 27-11-7041010  
E-mail: [metserve@pixie.co.za](mailto:metserve@pixie.co.za)

Attention: Mr. P. Barbary

Reference: 6614

Subject: **METALLURGICAL EVALUATION OF "S" CAMSHAFT  
& BRAKE SPIDER**

#### INTRODUCTION

A section of a "S" camshaft and break spider from a Tipper Trailer was submitted for metallurgical examination. The information supplied by the client is presented below.

#### BACKGROUND DATA

Date of failure:	Year 2010
Tag No.	N/A
Date commissioned:	Unknown
Component description:	Tipper Trailer.
Component Type:	International 198001.
Vehicle Combination:	WJY454GP- WJY801GP- WJY804GP

Material specification:	Not Supplied.
Original Dimensions:	Not Supplied.
Operating Temperature: C	Not Applicable
Operating Pressure: MPa	Not Applicable
Unit:	Not Applicable.

Description of failure:	
Events leading to failure, unusual or upset conditions:	It was reported that the submitted parts are part of a tipper trailer.

- Attached photos illustrate the sample in the condition received.

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FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)

**BACKGROUND INFORMATION**

A section of an "5" camshaft and break spider removed from the Tipper Trailer has been submitted for metallurgical examination. It was requested that an assessment of the submitted sections be undertaken.

It was reported that personal injuries were involved as result of the reported accident.

**VISUAL EXAMINATION**

The submitted components were examined both with unaided eye and at low magnification.



Illustrate sample in the "5 cam" in the condition received



After rust removal the "5 camshaft" revealed several smooth worn regions as indicated by the enclosed photomicrographs.

**APPEARANCE OR MORPHOLOGY OF DAMAGE DETECTED ON THE BRAKE SPIDER**



Examinations of the damage area's with the aid of a low power stereoscopic microscope revealed no extensive plastic deformation refer the photo macrograph.



Examination of the spider surface indicated that the damage region coincided with the tip of the "S Cam" resulting in severe wear of the spider as indicated at photo-macrographs.

**HARDNESS TESTING**

Transverse microscopic sections were cut from the submitted “S cam” and suitably prepared for a Vickers Hardness Testing.

The ranges of recorded values are presented in Table 1.

**TABLE 1 HARDNESS PROPERTY DATA**

<b>Designation</b>	<b>Hardness (HV0,5)</b>
<i>Tube Section</i>	
<b>S-Cam Core Section</b>	<b>207-226-220*</b>
<b>At worn edge Section</b>	<b>258-234-230</b>

**Machine Manufacture Leith**

Method Vickers  
 Load 500 P  
 Calibration No MI 15202B

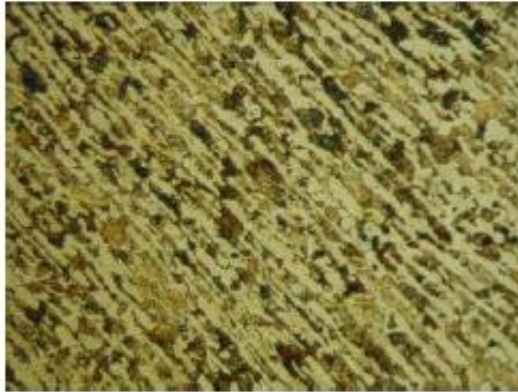
\*The mean hardness values of the material correspond to an approximately tensile strength of 726 MPa, which is acceptable for carbon steel material.

Note : The values presented are only indications of the approximate tensile strength of the examined component at room temperature and should not be used for calculations

TEL: +27 +11 704 1010  
 FAX: +27 +11 462 2386  
 E-MAIL: METSERVE@PIXIE.CO.ZA

**METALLOGRAPHY**

Transverse microscopic sections were cut from the submitted section and suitably prepared for a microscopic examination, the following salient features were observed.



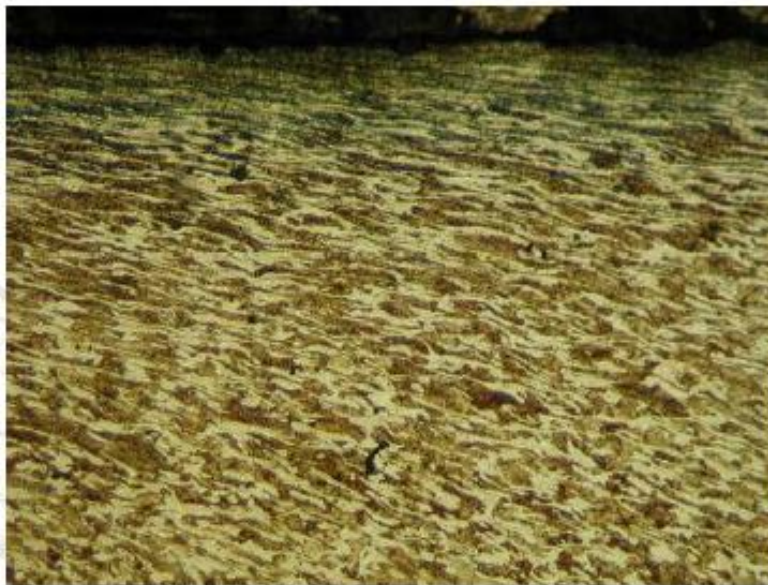
*The microstructure of the core section of the "S Camshaft" exhibited a characteristic ferrite - pearlite structure typical for low carbon steel in the as normalized condition.*

*Core structure At 150X Mag 2%Nital*

*No extensive plastic deformation or un-tempered martensite (Frictional heat) was detected on the worn surface.*

*Microscopic examination suggests that the observed damage region is the result of mechanical wear.*

*No metallurgical abnormalities or material defects could be observed .*



*Section of at the worn part of the " S Camshaft" surface  
Mag 225x 2%Nital. The grain deformation was approximately 40 micron in depth.*

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TEL: +27 +11 704 1010  
FAX: +27 +11 462 2386  
E-MAIL: METSERVE@PIXIE.CO.ZA

**CONCLUSIONS**

- It is the writer's opinion that the damage observed on the break spider and "5 camshaft" is the result of mechanical wear.
- No metallurgical abnormalities could be detected on the "5 Camshaft"
- No material or manufacturing defects could be observed on the submitted "5 Camshaft" sample.

*We hope this information meets with your requirements and should you require any further information or assistance please contact me.  
Yours sincerely*

**Mr.E.R.Vreugle**

#### WEAR RELATED DOCUMENTATION

- *Wear Failures*, Metals Handbook, 9th Edition, Vol. 11: Failure Analysis and Prevention, ASM International, 1986, pp. 145-162 [17] J.R. Davis (editor), ASM Materials Engineering Dictionary, ASM International, 1992
- J.A. Collins and S.R. Daniewicz, *Failure Modes: Performance and Service Requirements for Metals*, M. Kutz (editor), Handbook of Materials Selection, John Wiley and Sons, 2002, pp. 705-773
- P. Niskanen, A. Manesh, and R. Morgan, *Reducing Wear With Superfinish Technology*, AMPTIAC Quarterly, Vol. 7, No. 1, AMPTIAC, 2003, pp.3-9,

#### PROCEDURES

- As Received
- Component Identification as received.
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FAX: +27 +11 462 2386  
E-MAIL: [METSERVE@PIXIE.CO.ZA](mailto:METSERVE@PIXIE.CO.ZA)

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- Procedure =ASTM E 620-97 - Standard Practice for Reporting Opinions of Technical Experts.
- Professional Service=Analyzing the evidence, formulating conclusions.
- Professional Service=Metallurgical technical report writing and express an opinion.
  
- Reports are submitted to clients on a confidential basis.
- No reference to the work or test results in any manner will be discussed or made public without written authorisation from the client.
- All work is considered proprietary property of the client and is maintained by Metserve as such.