R&T Reliability Technologies P/L,
Laboratory, 62 Wyndham Street,
Alexandria NSW 2015

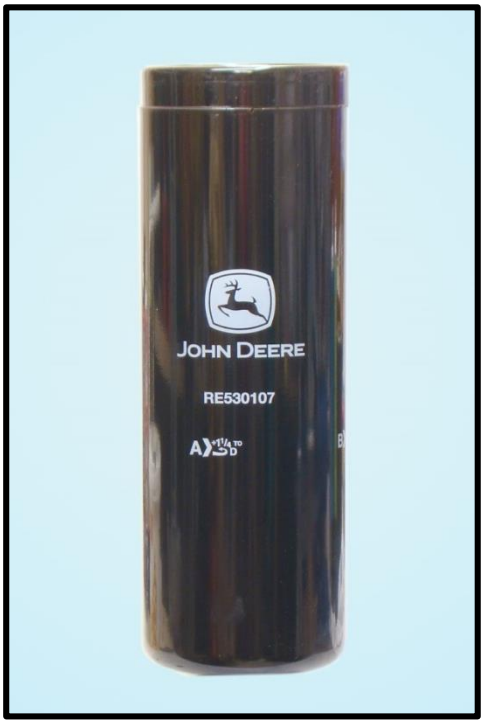
E: Lab@rttech.com.au
P: +61-2-9698-8840
M: 0411-243-150

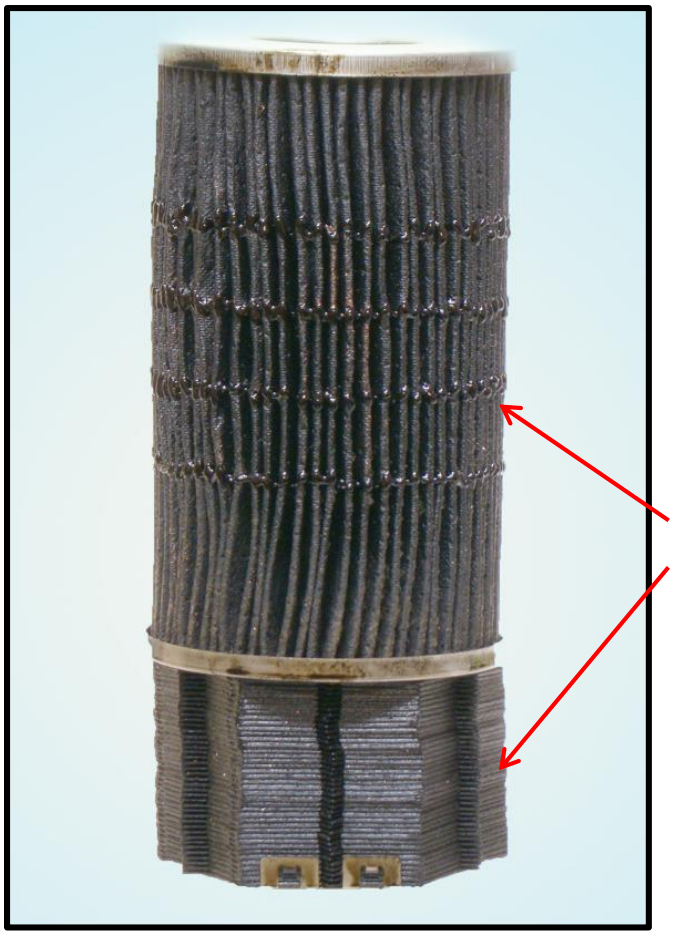
Report Printed 18 November 2015 Order # ZZZZZZ

WDA No 000 Cotton Harvester FEOFMA

Objective. Cotton Harvester Failed Engine Oil Filter Media Analysis Sample from 8/05/2014.

Method. Sample preparation in accordance with R&T's Procedure No. 28.
Oil Filter Sample was opened and media retrieved,
One sample processed of wear debris trapped in a 75 mm X 75 mm section of the oil filter element. This sample is filtered @ 0.3 µm.
The amount seen in the video pictures is not relatable to the debris concentration per mL of oil.

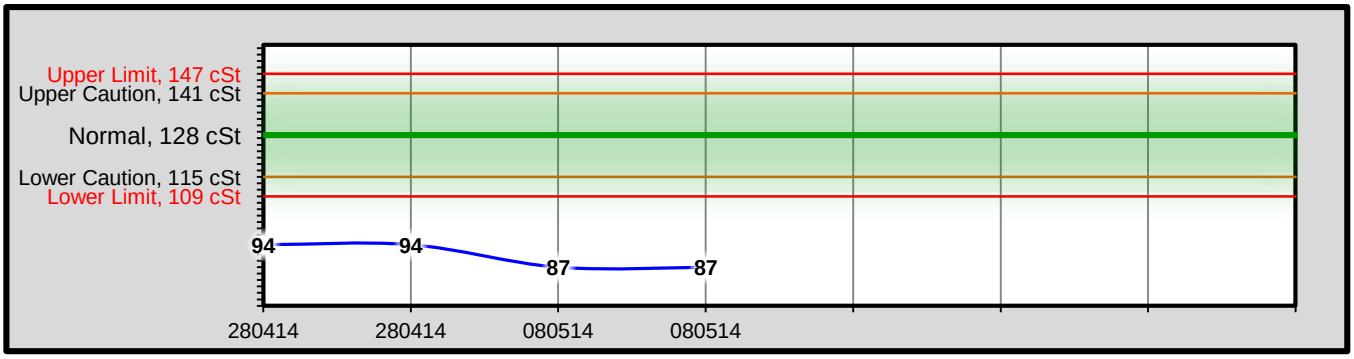




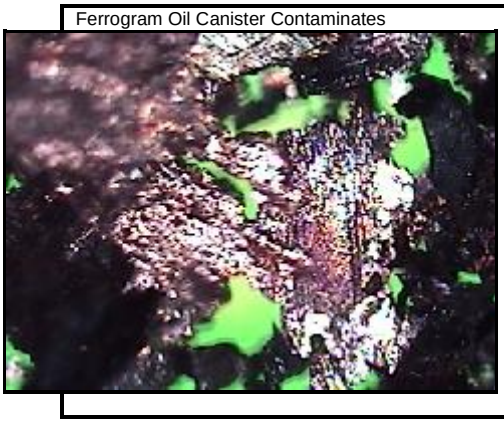
Three samples were processed,
Sample A: Oil Filter Canister contaminates
Sample B: Oil Filter Main Media Contaminates
Sample C: Oil Filter Polishing Stack contaminates

This engines lubricant was run through the lab on the 28th of April but the highly efficient oil filter was removing the wear debris as soon as it was created, note how the lubricants viscosity has reduced further since the analysis 10 days earlier.

John Deere 50 plus 15w40- Upper & Lower limits, Sample Viscosity cSt @ 40 °C



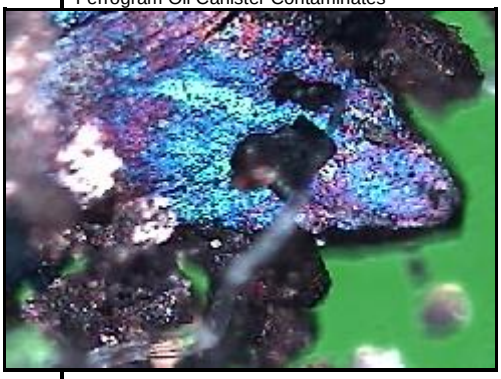
Ferrogram Oil Canister Contaminates



These images at 100X/200X indicate the average wear debris and contaminates deposited on the analysis filter from 1 CC of the sample forced through the 3-µm Membrane Analysis Filter.

The brightness of microscopes bottom green/blue light shining up through the sample can provide an indication of the level of wear debris and contaminating particles per cc

Ferrogram Oil Canister Contaminates



Heat Damaged Lubricant & Abrasive White Metal, Copper & Ferrrous Wear Debris @ 50X Sized 2-600 µm

There was a heavy amount of heat damaged metallic wear debris present in the sample.

200 µm

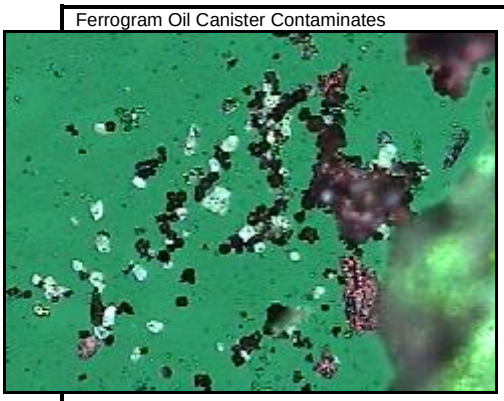
Ferrogram Oil Canister Contaminates

Melted Abrasive White Metal, & Copper Wear Spheres @ 500X Sized 2-90 µm

There was a heavy amount of heat damaged metallic wear debris present in the sample.

20 µm

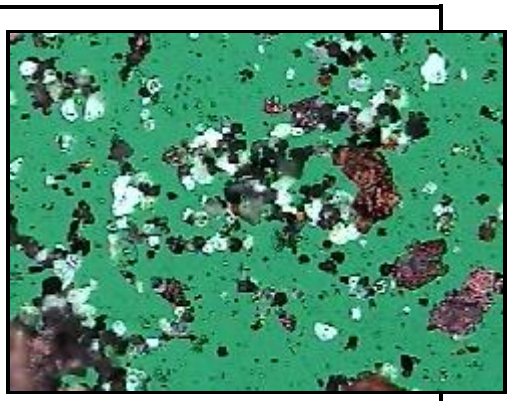
Ferrogram Oil Canister Contaminates



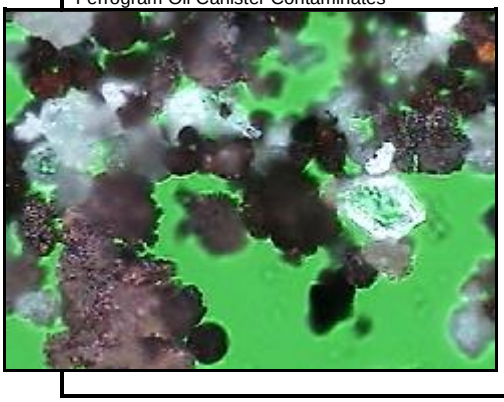
Hard Inorganic Silica Type Crystals @ 200X Sized 5-20 µm

There was a moderate to heavy amount of this hard environmental contaminate present

50 µm



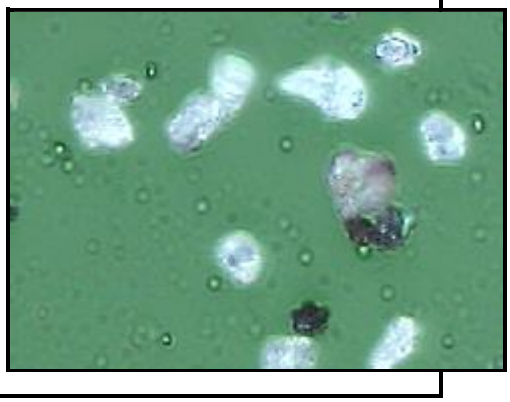
Ferrogram Oil Canister Contaminates



Hard Inorganic
Silica Type Crystals @ 500X
Sized 2-90 µm

There was a moderate to heavy amount of this hard environmental contaminate present

20 µm

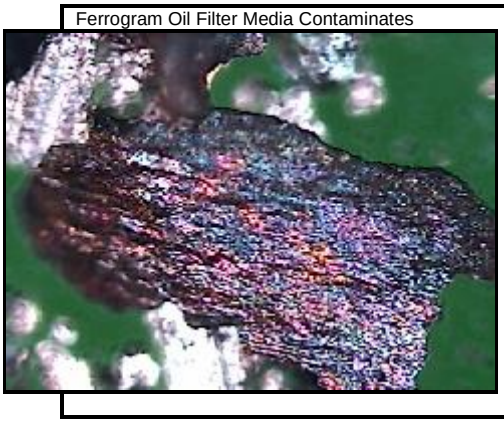


Ferrogram Oil Filter Media Contaminates

These images at 50X/200X indicate the average wear debris and contaminates deposited on the analysis filter from 1 CC of the sample forced through the 3-µm Membrane Analysis Filter.

The brightness of microscopes bottom green/blue light shining up through the sample can provide an indication of the level of wear debris and contaminating particles per cc

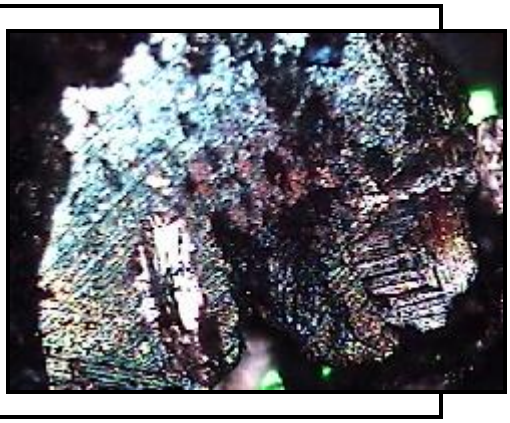
Ferrogram Oil Filter Media Contaminates



Hard Particle Damaged Heat Coloured Abrasive White Metal, & Copper Wear Debris
@ 200X Sized 2-250 µm

There was a heavy amount of heat damaged metallic wear debris present in the sample

50 µm

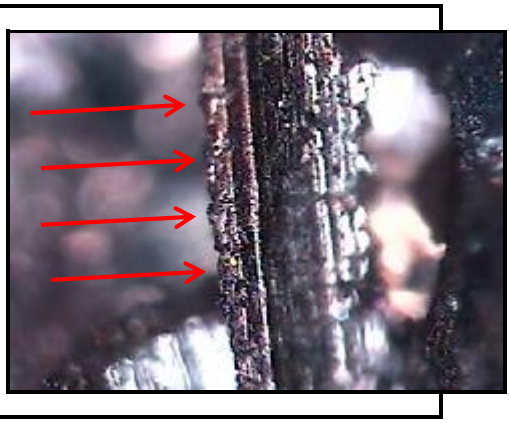


Ferrogram Oil Filter Media Contaminates

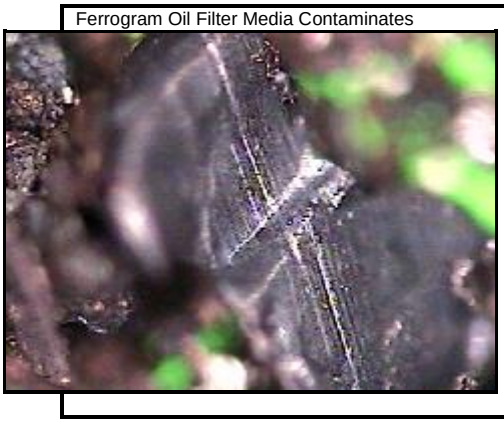
Hard Particle Damaged Heat Coloured Abrasive White Metal, & Copper Wear Debris
@ 200X Sized 2-250 µm

There was a heavy amount of heat damaged metallic wear debris present in the sample

50 µm



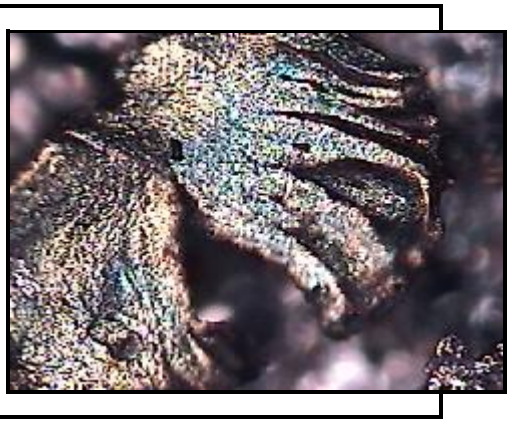
Ferrogram Oil Filter Media Contaminates



Hard Particle Damaged White Metal, & Copper Wear Particles @ 100X/200X Sized 2-500 µm

These wear particles indicate how the failure occurred. These large intact white metal particles are produced when the ingested hard particles slit the white metal embedment layer and the lubricant becomes trapped under the white metal layer.

100 µm / 50 µm



Ferrogram Oil Filter Media Contaminates

Hard Particle Damaged White Metal, & Copper Wear Particles @ 100X/200X Sized 2-500 µm

Once the white metal overlay is slit the lubricant trapped under the white metal is hydrauliced along under the bearing face with the next revolution of the crankshaft with the complete section of white metal bearing overlay then ejected out of the bearing journal on into the sump.

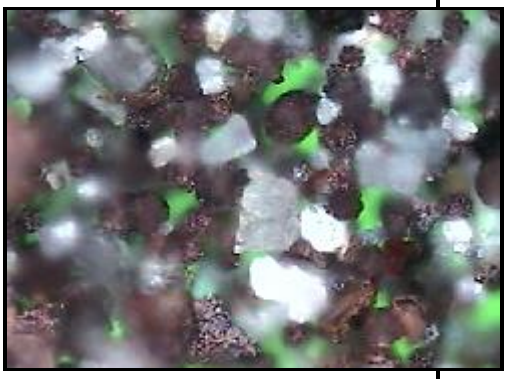
100 µm / 50 µm

Ferrogram Oil Filter Media Contaminates

Hard Particle Damaged White Metal, & Copper Wear Particles @ 200X Sized 2-55 µm

These four images indicate the hard particles that caused the failure plus the amount of melted bearing material present shows the failure most likely was rapid and without any warning noticeable for the operator.

50 µm



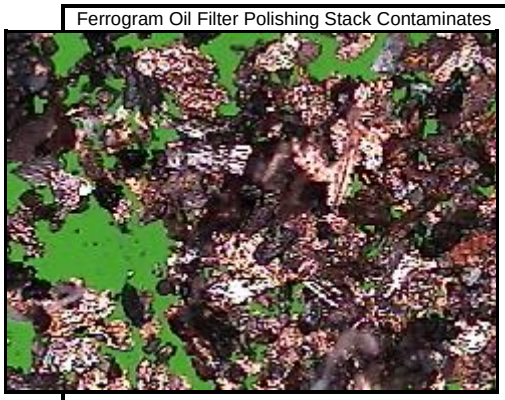
Ferrogram Oil Filter Media Contaminates

Melted White Metal. Copper Wear Spheres and Hard Silica Type Crystals @ 200X Sized 2-55 µm

There was a heavy amount of heat damaged metallic wear debris and this hard environmental contaminate present in the sample.

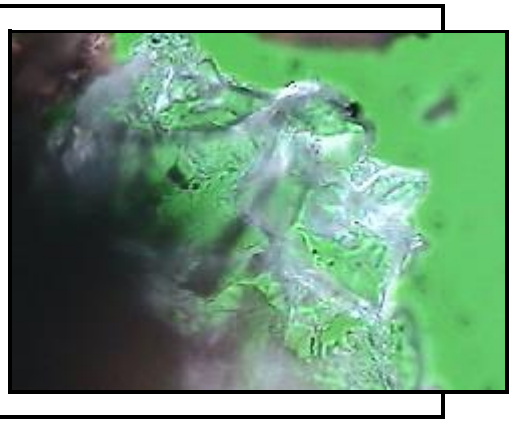
50 µm

Ferrogram Oil Filter Polishing Stack Contaminates



These images at 100X/1000X indicate the average wear debris and contaminates deposited on the analysis filter from 1 CC of the sample forced through the 3-µm Membrane Analysis Filter.

The brightness of microscopes bottom green/blue light shining up through the sample can provide an indication of the level of wear debris and contaminating particles per cc

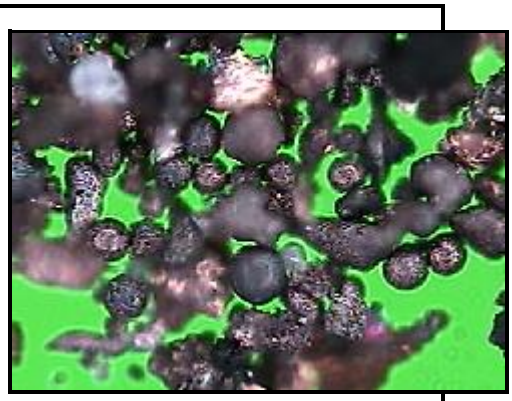


Ferrogram Oil Filter Polishing Stack Contaminates

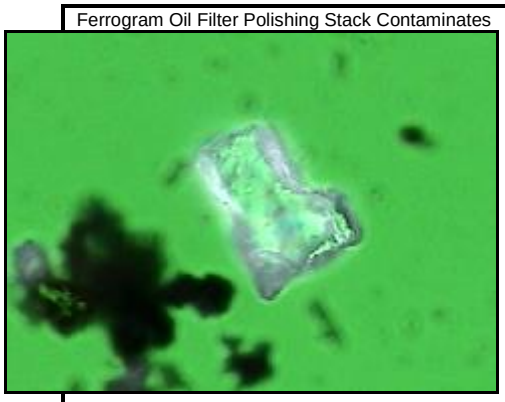
Heat Damaged Lubricant
& Metallic Wear Debris
@ 200X Sized 2-60 µm

There was a moderate amount of this wear debris present in the sample.

50 µm



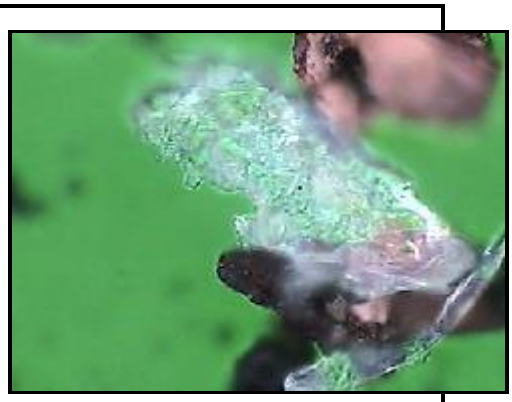
Ferrogram Oil Filter Polishing Stack Contaminates



Hard Inorganic
Silica Type Crystals
@ 500X Sized 5-90 µm

There was a light to moderate amount of this hard environmental contaminate present

20 µm

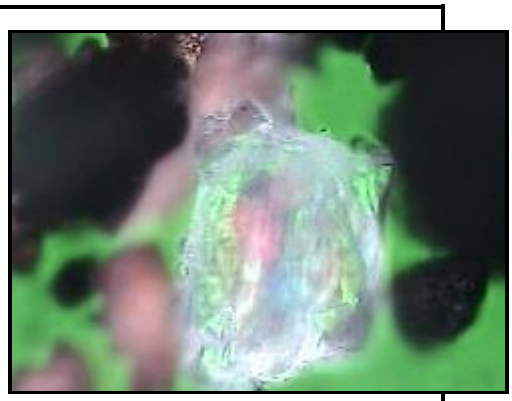


Ferrogram Oil Filter Polishing Stack Contaminates

Hard Inorganic
Silica Type Crystals
@ 500X Sized 5-90 µm

There was a light to moderate amount of this hard environmental contaminate present

20 µm

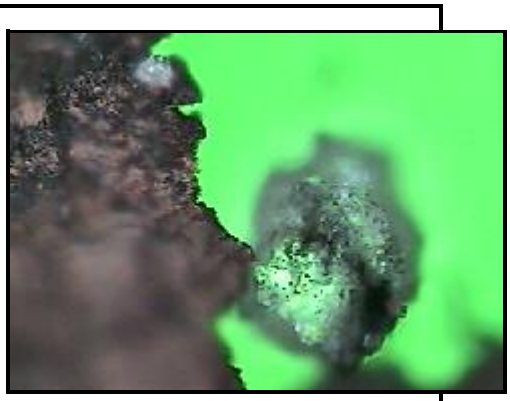


Ferrogram Oil Filter Polishing Stack Contaminates

Hard Inorganic
Silica Type Crystals
@ 500X Sized 5-55 µm

There was a light to moderate amount of this hard environmental contaminate present

20 µm

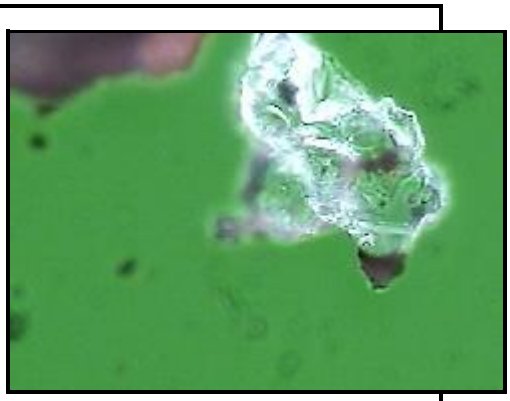


Ferrogram Oil Filter Polishing Stack Contaminates

Hard Inorganic
Silica Type Crystals
@ 500X Sized 5-55 µm

There was a light to moderate amount of this hard environmental contaminate present

20 µm



080514 Results Conclusions and Recommendations

The Cotton Harvester failed Engine Oil Filter Sample analysis indicates the engine was dusted and the elevated amount of hard silica type crystals gaining entry have abraded the bearings white metal overlay cutting through the overlay permitting high pressure lubricant to hydraulic the white metal overlay off the bearing shell surface.

Once the bearing shell had lost the white metal overlay the increase in big end bearing clearance catalysed a rapid big end failure with melted bearing metal, damaged lubricant and hard environmental silica type crystals found in the oil filter.

Looking at wear debris after the failure is always difficult to find the root cause because of the amount of melted damaged metallic wear debris and in this instance the presence of the large pieces of intact white metal overlay indicating this was the first step in the failure.

Once these large pieces of the white metal bearing overlay were hydrauliced off the bearings the increase in clearance caused a rapid failure of the bearing.

If oil starvation or over heating was the primary cause of failure we don't find these large intact white metal particles because these areas melt and no intact particles are found.

The main size range of the hard silica type crystals from the paddock environment was less than 50 µm indicating the dirt has been filtered leading to the conclusion that the existing filter was working but appeared to be grossly overloaded with air filter servicing requiring to be considerably shorter that what was occurring prior to this failure.

After the engine is back in service resample at 50 hours and 250 hours to ensure the air filters are removing contaminates as required for the contaminated environs the harvester is required to work in.

Rob Simmonds
Reliability Manager