

Daimler Surveillance Panel Meeting Minutes

December 19, 2023

10:00 AM – 11:00 AM CST

Call Participants:

Lubrizol – Robert Slocum (Chairman)

Southwest Research Institute – Jose Starling (Secretary), Robert Warden

Intertek – Josh Ward, Joe Franklin

Daimler – Suzanne Neal, Murat Bilgin

Afton – Bob Campbell, Amanda Stone

Infineum - David Brass, Elisa Santos, James Gutzwiller

TEI – Derek Grosch

Chevron Oronite – Josephine Martinez

TMC – Sean Moyer

Haltermann Solutions – N/A

ExxonMobil – N/A

Ford – N/A

Agenda Items

Proposal for bearing screening protocol (David Brass) – David Brass outlined main and rod bearing recommendations (see attached Infineum slides). Establishing a bearing oil clearance limit for the main and rod bearings going forward.

It was suggested that current conrod bearings be removed due to recent spun bearings occurring during Infineum DD13 scuffing testing at Intertek. Excessive bearing wear was also observed which was investigated to have come from minimal to negative oil-bearing clearance.

TEI has had this “current” version of bearing supply in circulation since about 2018, however the bearings are ordered in quantities as needed from dealer stock (not batched).

To avoid further issues David Brass suggested it is best to replace current bearings with the new style bearing supply already available at TEI (Tenneco Conrod Bearings and Daido Main Bearings as outlined in Infineum’s presentation).

Bob Campbell asked how long these spun bearing issues have been occurring? It was stated that this has occurred over the last 6 months.

It was asked if when rotating the crankshaft after assembly did it feel tight or difficult to rotate. Josh Ward stated that the crankshafts when assembled all would rotate normally. It was stated by Murat (Daimler Bearing Expert) that at the connecting rod torque values with an interference fit you should not be able to rotate the crankshaft or be very difficult. There is some bearing crush that occurs during the installation process, which is normal, but Murat to look at bearings and explore further.

Action Item: Josh Ward will send Murat at Daimler some sets of current batch bearings so that he can measure them and return results. These will be bearings that have been previously measured by

Intertek and found to be out of specification in oil clearance. Murat will measure these and provide results at the next panel meeting.

David Brass presented two motions to the panel (see attached Infineum Slide 10). However, these motions were not voted on during these meeting as it was expressed that additional measurements of the current and new bearings were needed to verify the issue was not present on these bearings.

It was asked if the new bearings have been measured in the same manner as the current bearings to verify that the same issue is not occurring with those. It was stated that the new bearings have not been measured yet but can be done.

Action Item: TEI to send Josh Ward a few sets of new style bearings to conduct the same measurements and results presented at the next panel meeting.

It was also asked if only one supplier for bearings would be possible, or if it was possible for the bearings to be batched so that large quantities could be acquired. When TEI orders bearings from the dealer network, the same part number is ordered but they may receive bearings from several suppliers. TEI will work with dealer network to see if they can request certain bearing supplier and if not may work with Daimler to source the appropriate bearing supply.

As a final topic it was asked if a build workshop for the DD13 test would be of interest or necessary before we head into the BOI/VGRA matrix. Group consensus was that this is a good idea, Robert Slocum stated he could possibly host this build workshop but will start looking into the details.

Walk-in Topics: None

Meeting was adjourned at 10:53 AM CST.

Next Meeting: Tentatively scheduled for January 12, 2024

DD13 Scuffing Test Bearing Analysis

David Brass

December 19, 2023

Performance you can rely on.



Recommendation Conrod Bearings



- Removal of all Conrod Bearings with Part Numbers:
 - Upper Conrod = A471 0610, Lower Conrod = A471 0611
- **Use only new conrod bearings going forward:**

Recommended Supplier: Daido

- Upper Conrod = A471 038 0910 (Dark Gray Coating)
- Lower Conrod = A471 038 0911
- Bearing Oil Clearance Limits = 0.059 / 0.132 mm

Alternative Supplier: Tenneco

- Upper Conrod = A471 038 1010 (Dark Gray Coating)
- Lower Conrod = A471 038 1011
- Bearing Oil Clearance Limits = 0.071 / 0.144 mm

Bearing suppliers should not be mixed across conrod bearings in each kit

Recommendation Main Bearings



- **Use only new main bearings going forward:**

Recommended Supplier: Daido

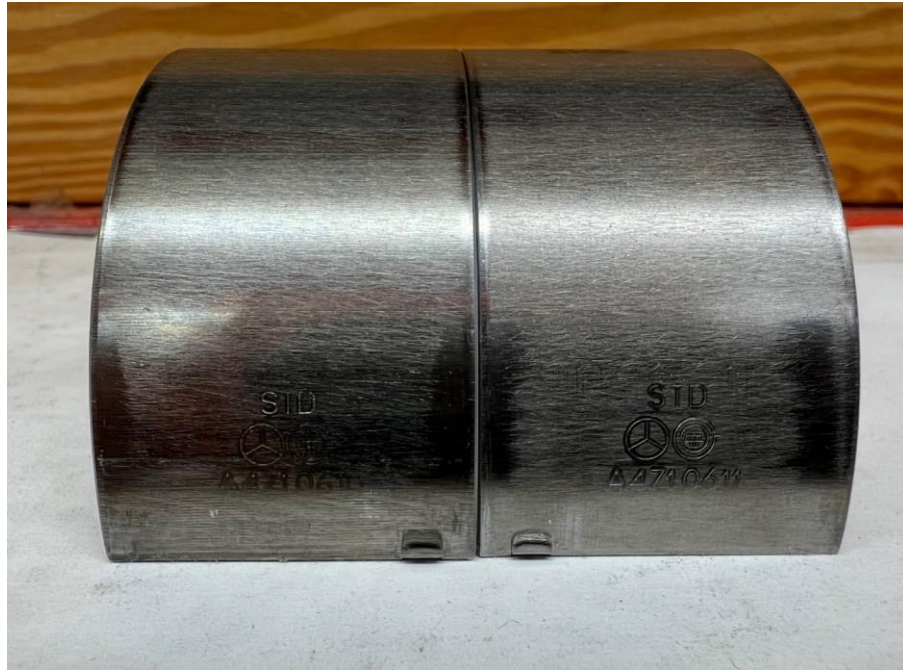
- Upper Main = A471 033 1001
- Lower Main = A471 033 1002 (Dark Gray Coating)
- Bearing Oil Clearance Limits = 0.069 / 0.138 mm

Alternative Supplier: Tenneco

- Upper Main = A471 033 0701
- Lower Main = A471 033 1502 (Dark Gray Coating)
- Bearing Oil Clearance Limits = 0.083 / 0.152 mm

Bearing suppliers should not be mixed across main bearings in each kit

Removal of Current Conrod Bearings



- Upper P/N: A471 0610, Lower P/N: A471 0611

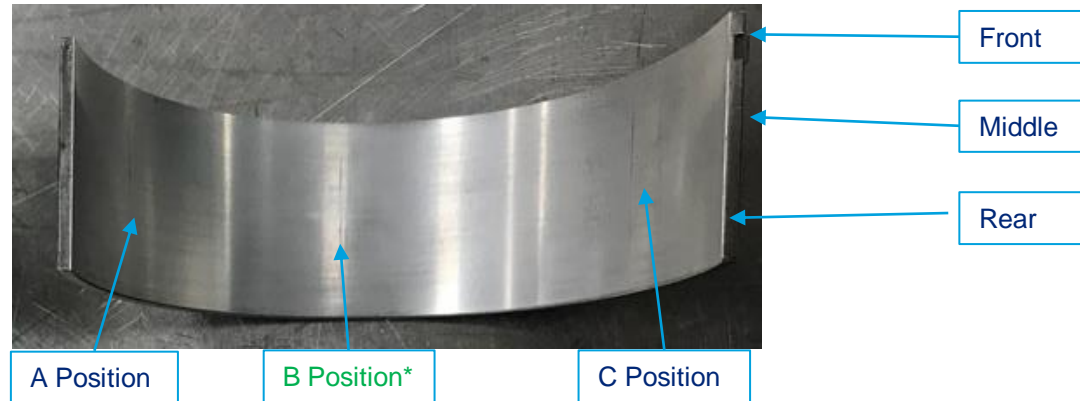
Removal of Current Conrod Bearings



- Infineum during recent tests has recorded spun bearings on known strong DD13 scuffing technologies and seen excessive bearing wear after completion of testing, regardless of viscosity grade.
- Upon further investigation, test labs have measured very low oil clearance with this current batch of conrod bearings in the DD13 engine. In many cases the bearings are self clearancing (negative clearance measurements).
- **Infineum would like to propose removal of these bearings from test kits and the institution of a minimum bearing oil clearance to be written into the screening process for all future engine builds.**
- Sound engineering judgement by test labs and parts suppliers should be taken to minimize excess bearing wear in the DD13 Scuffing Test.

DD13 Bearing Investigation Measurement Process

- Measurements were taken in a total of nine locations on installed connecting rod bearings.
- A Sunen bore gauge was used and measurements taken with the rod bolts torqued to spec using a nominal rod journal diameter of 3.740" (94.996 mm) as a baseline.
- A good clearance for Tenneco Bearings would be = 0.0028" / 0.0057" (0.071 / 0.144 mm),
Measuring = 3.7428" / 3.7457" (95.067 mm / 95.140 mm)



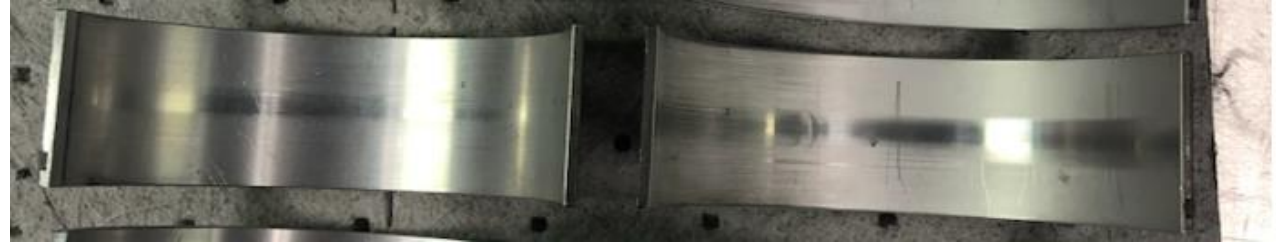
Witness lines from bore gauge measurements visible in lower bearing shell

*B Position measurements displayed in following slides

Concern with Conrod Bearing Oil Clearance

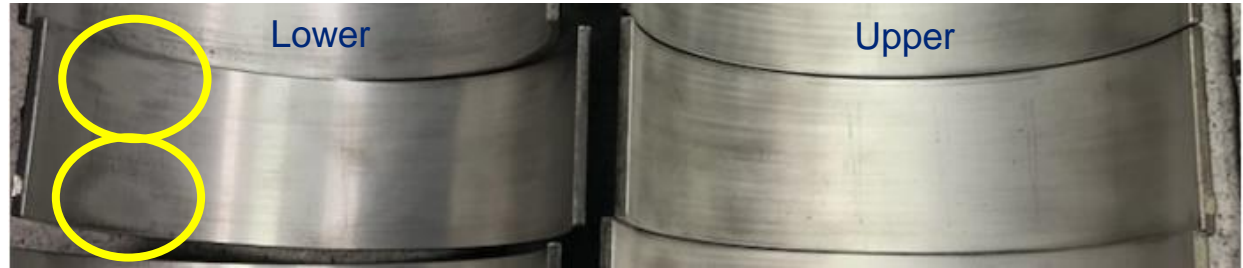
Examples of Excessively Worn Bearings

Conrod Bearings after 31 hour test



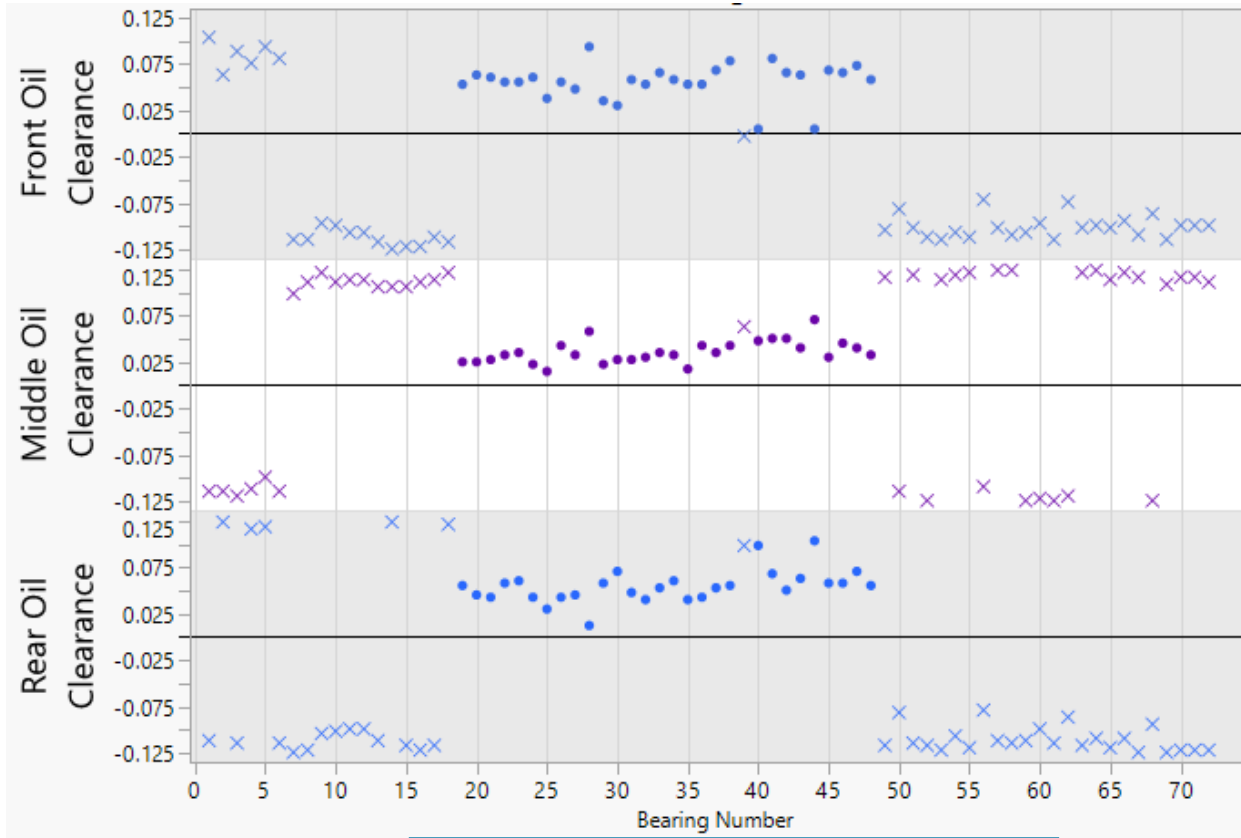
Conrod Bearing #	Outer Edge Oil Clearance (mm)	Center Oil Clearance (mm)	Outer Edge Oil Clearance (mm)
4	0.0127	0.0584	0.0940

Conrod Bearings after 25 hour test



Conrod Bearing #	Outer Edge Oil Clearance (mm)	Center Oil Clearance (mm)	Outer Edge Oil Clearance (mm)
4	-0.1118	0.1168	-0.1168

Bearing Oil Clearance Measurements



● oil clearance < 0.071 mm in at least one location
X self clearance in at least one location

Of the 72 conrod bearings that were measured from the current batch (A471 0610/0611), **none** would have passed the proposed screening process

New Bearing Supply at TEI

- Tenneco Conrod Bearings = A471 1010 & A471 1011
- Daido Main Bearings = A471 1001 & A471 1002



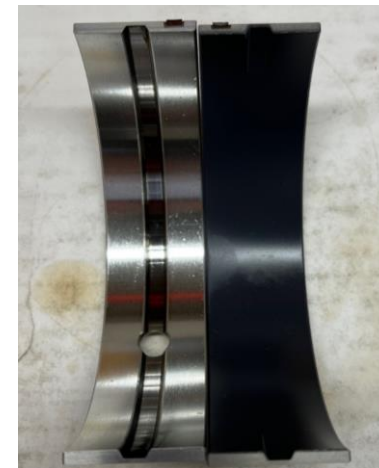
Upper Lower

Conrod Bearings



Upper Lower

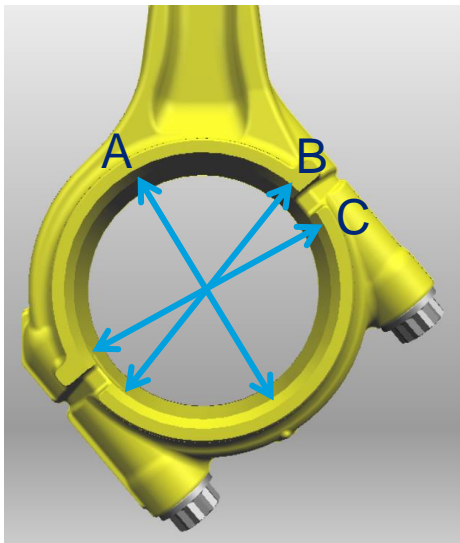
Main Bearings



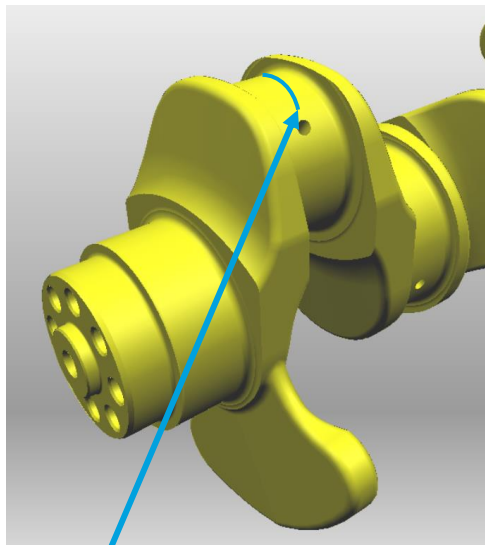
David Brass (Infineum) Motions to:

- Remove all Conrod Bearings with Part Numbers (Upper Conrod = A471 038 0610, Lower Conrod = A471 038 0611) from any kit that is not currently built into an engine. Subsequent tests should be run on either Daido Bearings (Upper Conrod = A471 038 0910, Lower Conrod = A471 038 0911) with minimum bearing oil clearance of 0.059 mm or Tenneco Bearings (Upper Conrod = A471 038 1010, Lower Conrod = A471 038 1011) with minimum bearing oil clearance of 0.071 mm across the whole bearing. Conrod Bearings that do not meet this minimum oil clearance should not be used.
- Subsequent tests should be run on either Daido Bearings (Upper Main = A471 033 1001, Lower Main = A471 033 1002) with minimum bearing oil clearance of 0.069 mm or Tenneco Bearings (Upper Conrod = A471 033 0701, Lower Conrod = A471 033 1502) with minimum bearing oil clearance of 0.083 mm across the whole bearing. Main Bearings that do not meet this minimum oil clearance should not be used.

Oil Clearance Measurement Process



Installed Conrod Bearings w/o Crankshaft - bolts torqued to specification
ID measurement on three positions (A, B & C)



Crankshaft pins journal outer diameter measurements on the middle of the journal



Bearings running clearance for oil flow

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