THIS TSB HAS BEEN SUPERSEDED OR DEACTIVATED

GENERAL SERVICE BULLETIN
Engine Failure Analysis

20-7062
23 June 2020

This bulletin supersedes G0000184. Reason for update: Update the vehicle model years affected

Model:

Ford 2013-2018 C-MAX
2008-2012 Crown Victoria
2008-2019 E-Series
2012-2020 EcoSport
2008-2020 Edge
2008-2020 Escape
2008-2020 Expedition
2008-2020 Explorer
2008-2011 Explorer Sport Trac
2008-2020 F-150
2008-2020 F-Super Duty
2008-2013 F-650/750
2015-2019 F-650/750
2008-2009 F-53 Motorhome Chassis / F-59 Commercial Stripped Chassis
2011-2020 F-53 Motorhome Chassis / F-59 Commercial Stripped Chassis
2011-2019 Fiesta
2008-2009 Five Hundred
2009-2019 Flex
2008-2018 Focus
2013-2020 Fusion
2008-2020 Mustang

2010-2019 Police Interceptor Sedan
2011-2020 Police Interceptor Utility
2019-2020 Ranger
2010-2019 Taurus
2008-2009 Taurus X
2014-2020 Transit
2008-2020 Transit Connect
Lincoln 2020 Aviator
2017-2020 Continental
2020 Corsair
2008 Mark LT
2015-2019 MKC
2009-2016 MKS
2010-2019 MKT
2008-2018 MKX
2008-2020 MKZ
2019-2020 Nautilus
2008-2020 Navigator
2008-2011 Town Car
Mercury 2008-2011 Grand Marquis / Marauder
2008-2011 Mariner
2008-2011 Milan
2008-2010 Mountaineer

Summary

This article supersedes GSB G0000184 to update the vehicle model years affected.

This bulletin is a guide to engine failure analysis and preventing repeat engine failure.

Service Information

Determining Root Cause

Understanding normal engine wear vs. actual engine damage can increase the accuracy of determining the root cause. If the true root cause of the engine failure is not identified with visual confirmation, an over repair or incomplete repair leading to repeat engine failure may result. Root cause determination and the extent of engine damage is necessary during engine assessment. Inspection areas include:

- Oil filter
- Oil pan
- Cylinder head and deck surfaces
- Camshaft bores, journals and lobes
- Crankshaft journals
- Cylinder walls and piston skirts
- Rod and main bearings

Engine Analysis

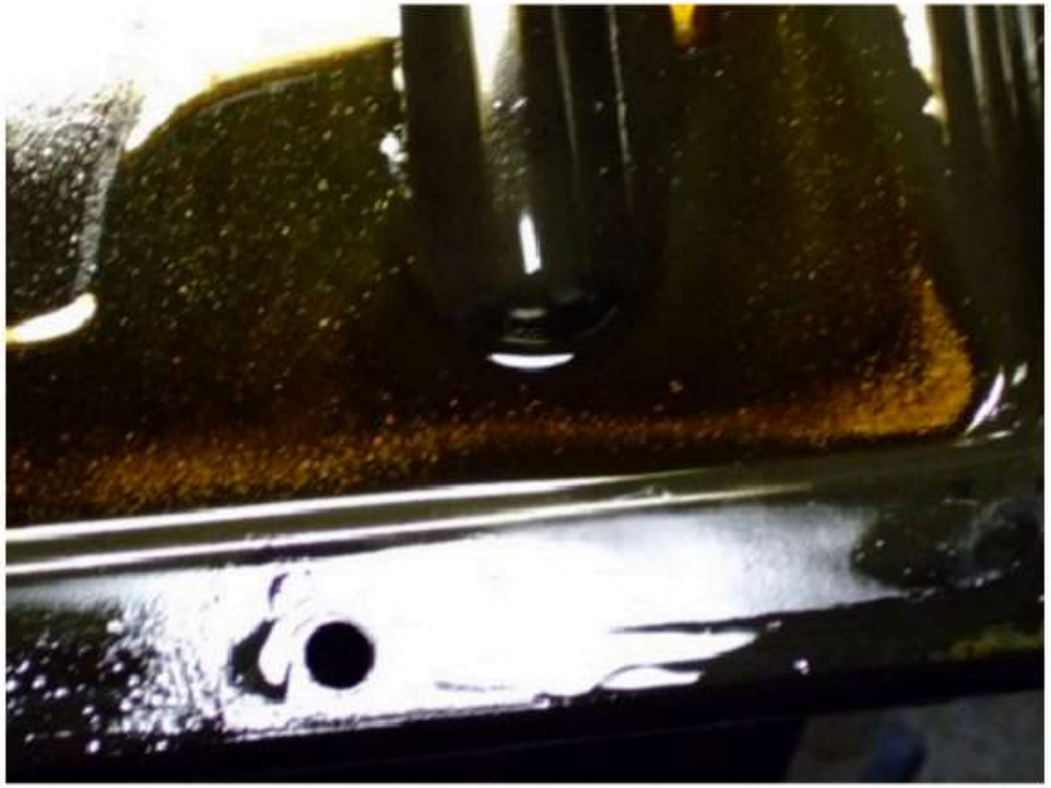
Metal in the Oil Pan, Filter and/or Screens – Acceptable Conditions

Some metal in the oil pan and filter is expected and considered normal (Figures 1-2).

Figure 1

E336119

Figure 2



E336120

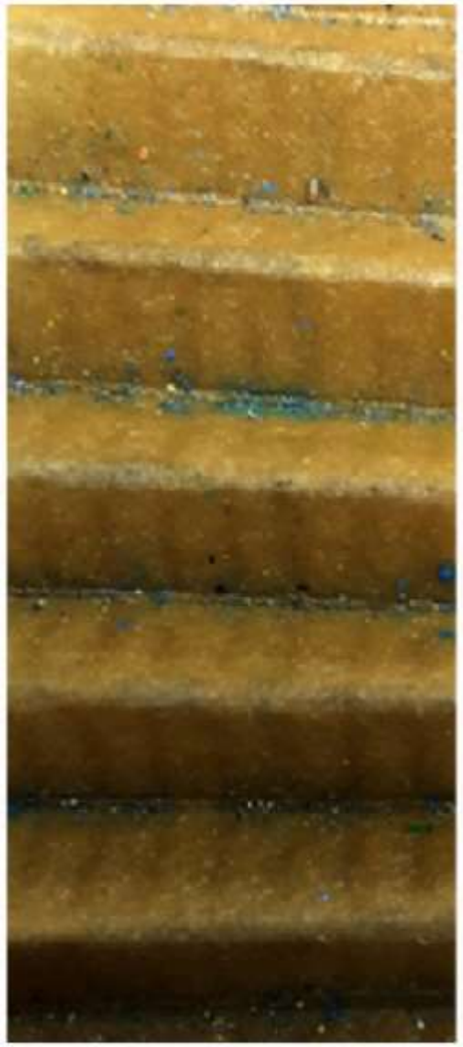
Some metal shavings in the oil filter are not a concern (Figure 3).

Figure 3

E336121

Small specs of metal in the filter media is normal (Figure 4).

Figure 4



E336122

Assembly paint is not a concern. Do not confuse with bearing material.

Metal in the Oil Pan, Filter and/or Screens – Unacceptable Conditions

Large chunks of metal in the pan and/or filter merit further root cause investigation (Figures 5-6).

Figure 5

Figure 6

E336124

Excessive amounts of metal in the oil filter and/or screens require further root cause investigation (Figures 7-8).

Figure 7

E336125

Figure 8

E336126

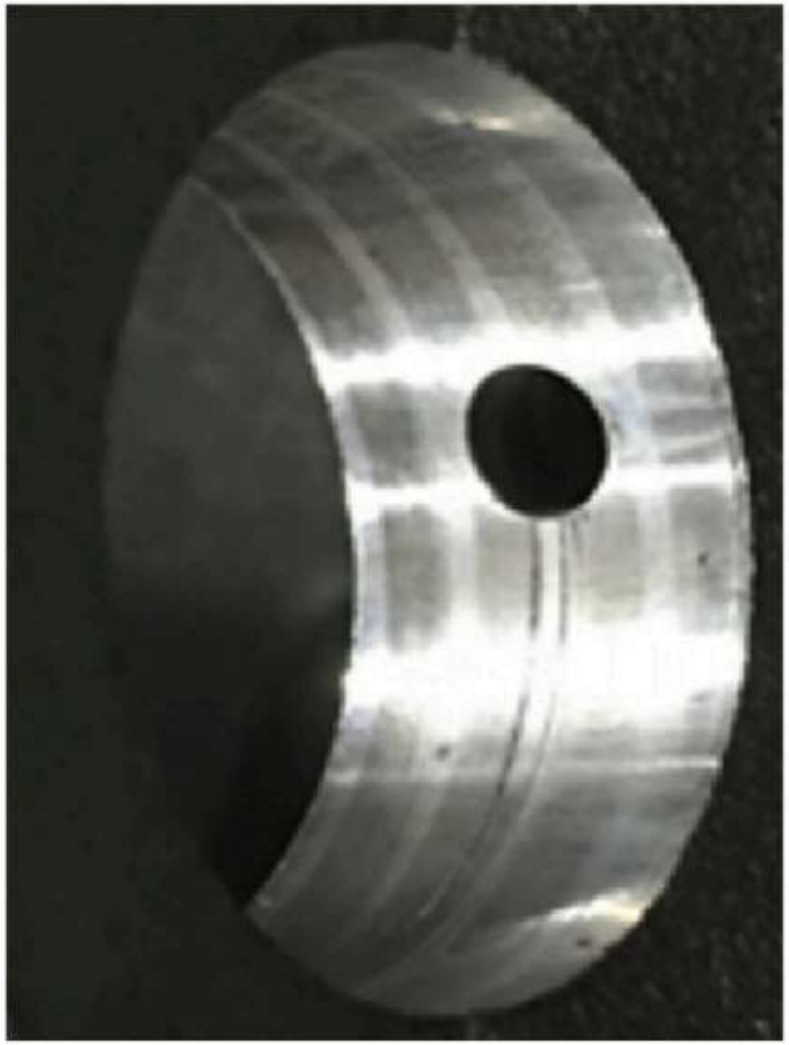
Camshaft Bore, Journal and Lobe Inspection

Cam Bore – Normal Wear: Polishing, discoloration, slight porosity or minor scoring (Figures 9-10).

Figure 9

E336127

Figure 10



E336128

Cam Bore – Damage: Material loss, deep scoring and severe porosity (Figures 11-12).

Figure 11

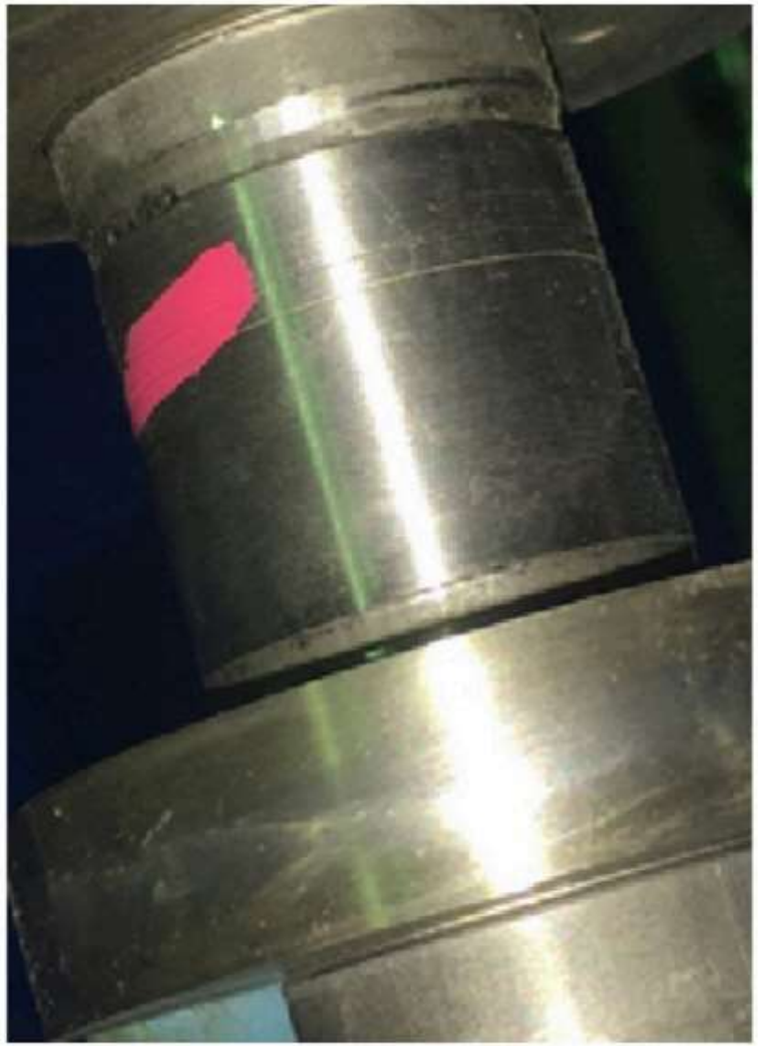
E336129

Figure 12

E336130

Camshaft Journals and Lobes - Normal Wear: Polishing, discoloration, minor uniform scoring felt with a fingernail (Figures 13-15).

Figure 13



E336131

Figure 14

Figure 15

E336133

Camshaft Journals and Lobes – Damage: Material loss/transfer, deep scoring or bluing of the metal are all signs of damage (Figures 16-18).

Figure 16

E336134

Figure 17

E336135

Figure 18

E336136

Crankshaft and Bearing Inspection

Bearings – Normal Wear: Polishing, discoloration, light scoring, light contact with red coating (Figures 19-22).

Figure 19

E336137

Figure 20

E336138

Figure 21

E336299

Figure 22

E336300

NOTE: Bearings are designed to manage some debris; therefore, some light scoring found on the bearing surface is not necessarily an indication of engine failure or root cause determination.

Bearings – Damage: Metal transfer, erosion, material loss, coolant contamination, deep scoring, cracking, spun bearing (Figures 23-27).

Figure 23

E336301

Figure 24

E336302

Figure 25

E336303

Figure 26

E336304

Figure 27

E336305

Crankshaft – Normal Wear: Discoloration, polishing, light scratches (Figures 28-29).

Figure 28

E336306

Figure 29

Crankshaft – Damage: Material loss, deep scoring, material transfer (Figures 30-32).

Figure 30

E336308

Figure 31

Figure 32

E336310

Head and Block Surface Inspection

Head and Block Surface – Normal Wear: Porosity outside sealing surfaces, gasket surface discoloration, light scratches (Figures 33-34).

Figure 33

E336311

Figure 34

E336312

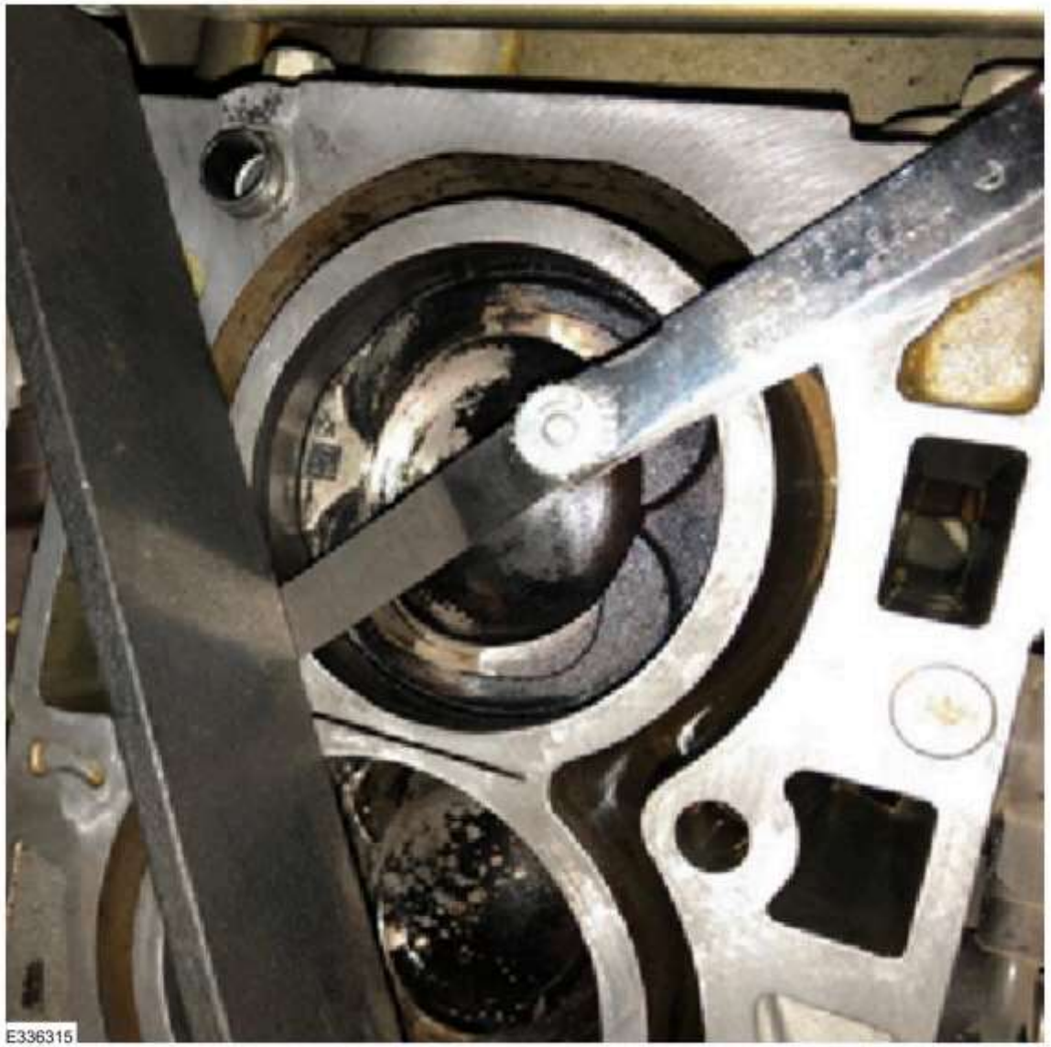
Head and Block Surface – Damage: Porosity on sealing surfaces, deep gouges, material transfer, warpage (Figures 35-37).

Figure 35

Figure 36

E336314

Figure 37



Cylinder Wall and Piston Skirt Inspection

Cylinder Wall – Normal Wear: Slight polishing and/or discoloration, vertical streaking, slight scoring, cross hatch present, light staining (Figures 38-40).

Figure 38

E336316

Figure 39

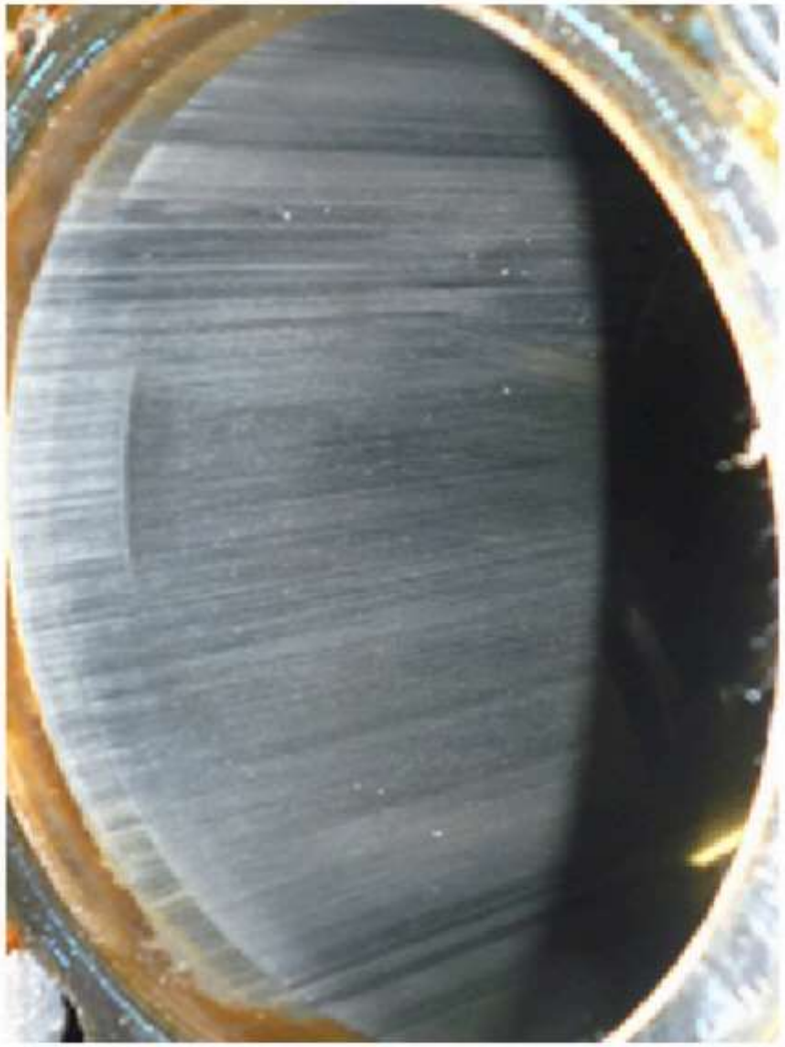
E336317

Figure 40

E336318

Cylinder Wall – Damage: Deep gouging, impact marks, loss of crosshatch, cracks (Figures 41-43).

Figure 41



E336475

Figure 42

E336476

Figure 43

E336477

Piston Skirt – Normal Wear: Light wear of the coating (Figures 44-45).

Figure 44

E336478

Figure 45

E336479

Piston Skirt – Damage: Deep scoring, severe coating wear (Figure 46-47).

Figure 46

E336480

Figure 47

E336481

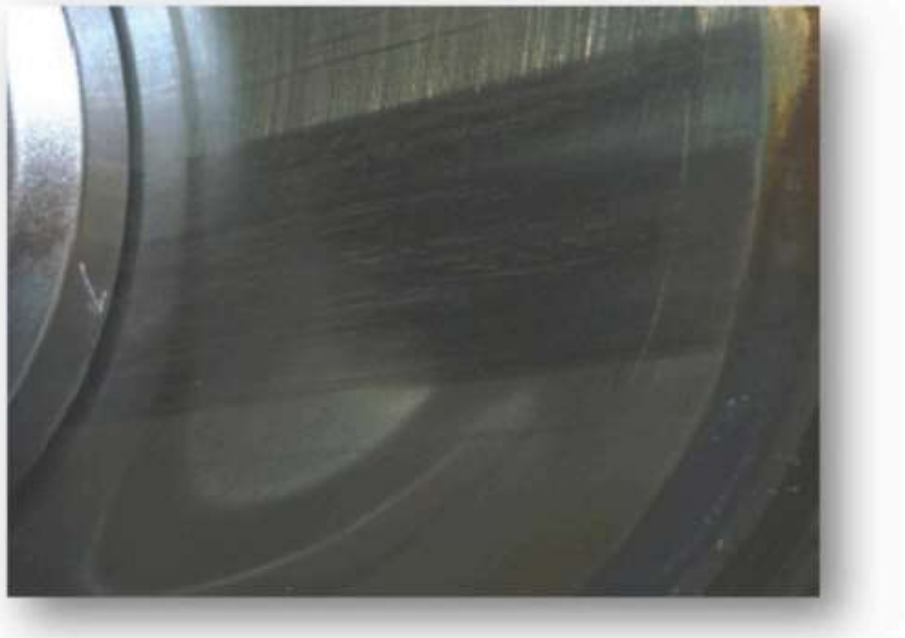
Preventing Repeat Engine Failures

Identifying certain failure modes such as detonation, running lean, oil consumption and/or hydro-locking will help determine if further inspection of components is required to prevent repeat failures.

Piston and Cylinder Wall Damage

Root Cause: Lean conditions or modifications (Figures 48-49)

Figure 48



E336482

Figure 49

E336483

- Modifications (timing, CNG, incorrect spark plugs)
  - Overboost (supercharger/turbocharger)
  - PCM performance chip/programmer
- Lean conditions
  - Mass air flow (MAF) sensor failure
  - Damaged air intake

Effect: High cylinder pressure or spark knock

- Excessive combustion temperatures
- Excessive cylinder pressure
- Pre-ignition
- Excessive levels of detonation (low octane/poor fuel quality)

Damage: Piston and cylinder wall

- Spark plug electrode damage
- Hole in piston (pre-ignition)
- Piston ring land damage (detonation)

- Pitted piston face
- Cylinder wall scoring

Spark plug damage (porcelain fracture or melted electrode) is an indication of excess detonation (Figure 50)

Figure 50

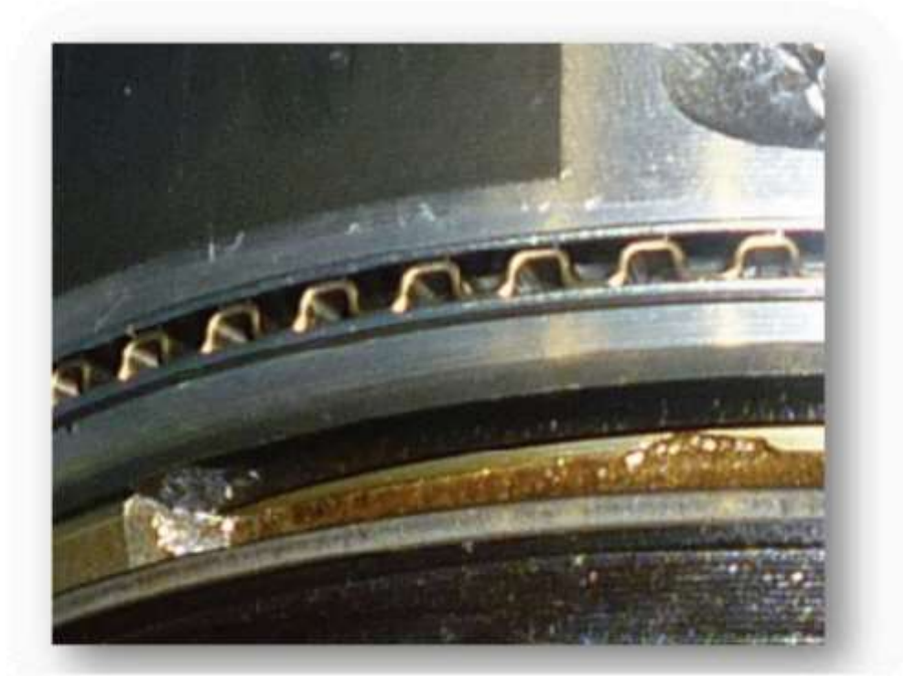
E336484

Heat generated from friction can cause cylinder walls to crack. (upper ring land damage) (Figure 51)

Figure 51

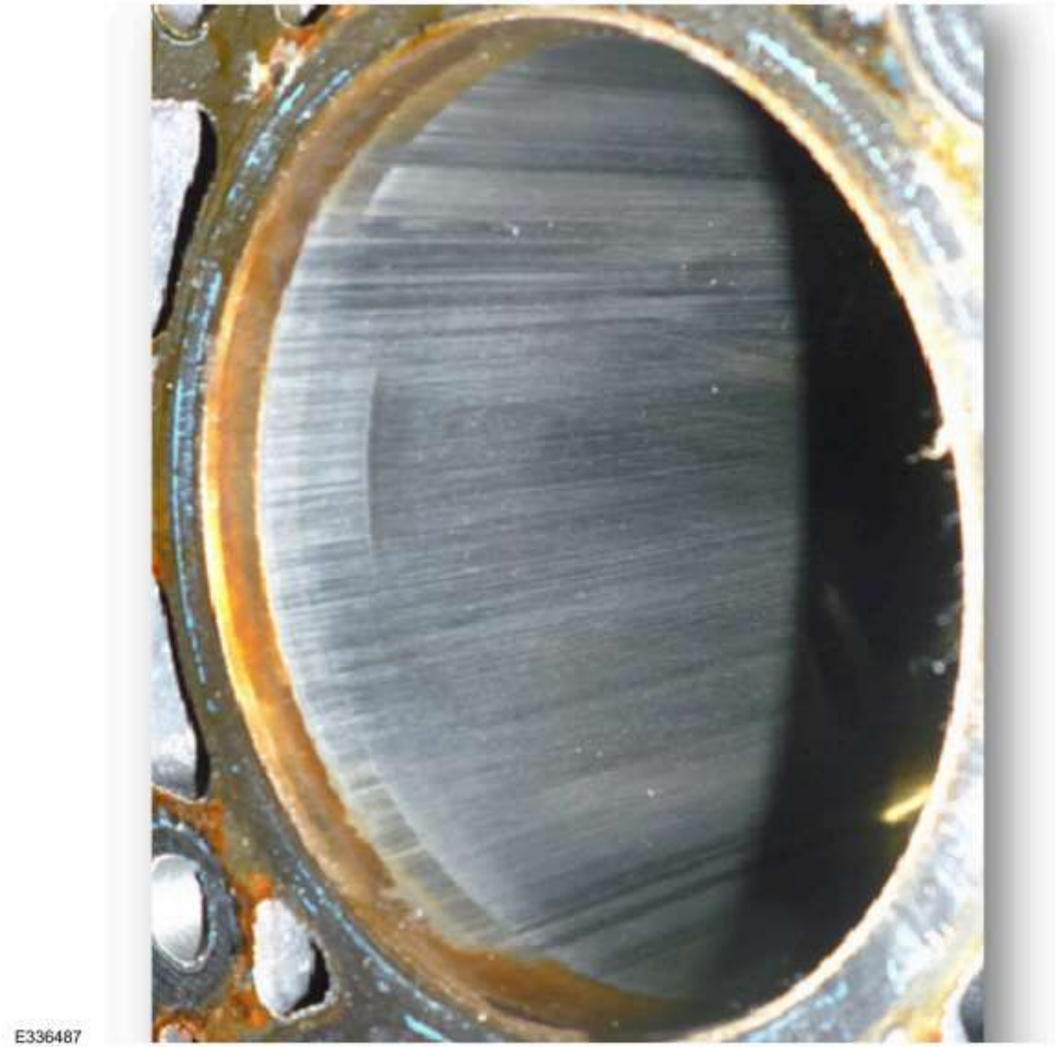
Excess detonation causes excess cylinder pressure spikes leading to piston ring land fractures (second ring land is damaged). (Figure 52)

Figure 52



Cylinder Wall Damage (Figure 53)

Figure 53



Root Cause: Fuel/air mixture concerns

- Excess oil consumption
- Lean/rich conditions
- Cylinder misfire

Effect: Catalyst damage

- Catalyst material begins to deteriorate (turns to dust/sand)

- Catalyst material is pulled into the engine

Damage: Cylinder wall

- Cross hatch is polished away
- Vertical scoring
- Bearing damage may be present if catalyst material made it to the engine oil.

Check for catalyst debris by shaking out the converter onto a clean surface (Figure 54)

Figure 54

Catalyst material can collect on the sides of the piston damaging cylinder wall surfaces (Figure 55)

Figure 55

E336489

Valve Damage (Figures 56-57)

Figure 56

E336490

Figure 57

E336491

Root Cause: Lean condition

- Modification or damage to the air induction system

- MAF sensor damage/failure
- Lack of fuel to the cylinder

Effect: Excessive combustion chamber temperatures

- Misfire, lacks power
- Catalyst damage
- Running lean = hot cylinder

Damage: Valve and valve seat

- Valve tuliping
- Valve seat recession

(Figure 58)

Figure 58

E336492

If cylinder leakage is present past the valves:

- Check for valves held open by other valvetrain components
- Check for the valve stem sticking in the guide
- Inspect for debris between the valve and seat that could hold the valve open

Excessive lean conditions can cause valves to overheat and soften. Over time, the valve can stretch and deform against the seat causing the valve to “tulip” creating leakage and a misfire. Comparing total valve height of the suspect valve to a known good valve can help identify issues. A height difference in the suspect valve is an indication of valve tuliping. Valve tuliping is the effect, not the root cause of the concern.

Foreign Object Debris (Figure 59)

Figure 59

Root Cause: Combustion chamber damage

- Broken piston/rings
- Broken valves
- Dropped valve seats

Effect: Debris transfer

- Original intake manifold transferred to the new engine
- Intake manifolds cannot be cleaned in these instances and require replacement

Damage: Repeat engine failure

- Engine vacuum dislodges debris left in the manifold
- Debris will enter the combustion chamber and cause piston/cylinder damage

(Figure 60)

Figure 60

- Foreign object debris can cause metal transfer from the piston to the cylinder head
- This metal debris can also make it to the intake manifold
- The intake manifold must be replaced in these instances to prevent repeat damage

Bearing Damage (Figure 61)

Figure 61

Root Cause: PCV system concerns

- PCV system damaged
- Open breather tube in place of PCV valve
- Lack of oil maintenance

Effect: Oil consumption

- Oil is pulled through the engine and burned off

Damage: Bearing damage

- Bearing and journal damage from lack of lubrication
- An open breather tube fitting mistaken for a PCV valve could be transferred to the new engine leading to repeat bearing failure (Figure 62). During engine replacement, verify the PCV valve is operational and correct for the application.

Figure 62

NOTE: Remanufactured Modular 2V V8 and V10 engines do not come with a PCV valve installed. If there appears to be a valve/tube in place on a new Remanufactured 2V V8 or V10 engine, replace it.

Bent Connecting Rod (Figure 63)

Figure 63

Root Cause: Hydrolocking from liquid ingestion

- Leaking or stuck open fuel injector
- Water ingestion through the air inlet (wet, warped or damaged air filter)

Effect: Hydrolocking

- Liquid cannot be compressed and will prevent the piston from traveling to top dead center (TDC)

Damage: Connecting rod

- Connecting rod will bend or break
- May occur on more than one cylinder

(Figures 64-65)

Figures 64

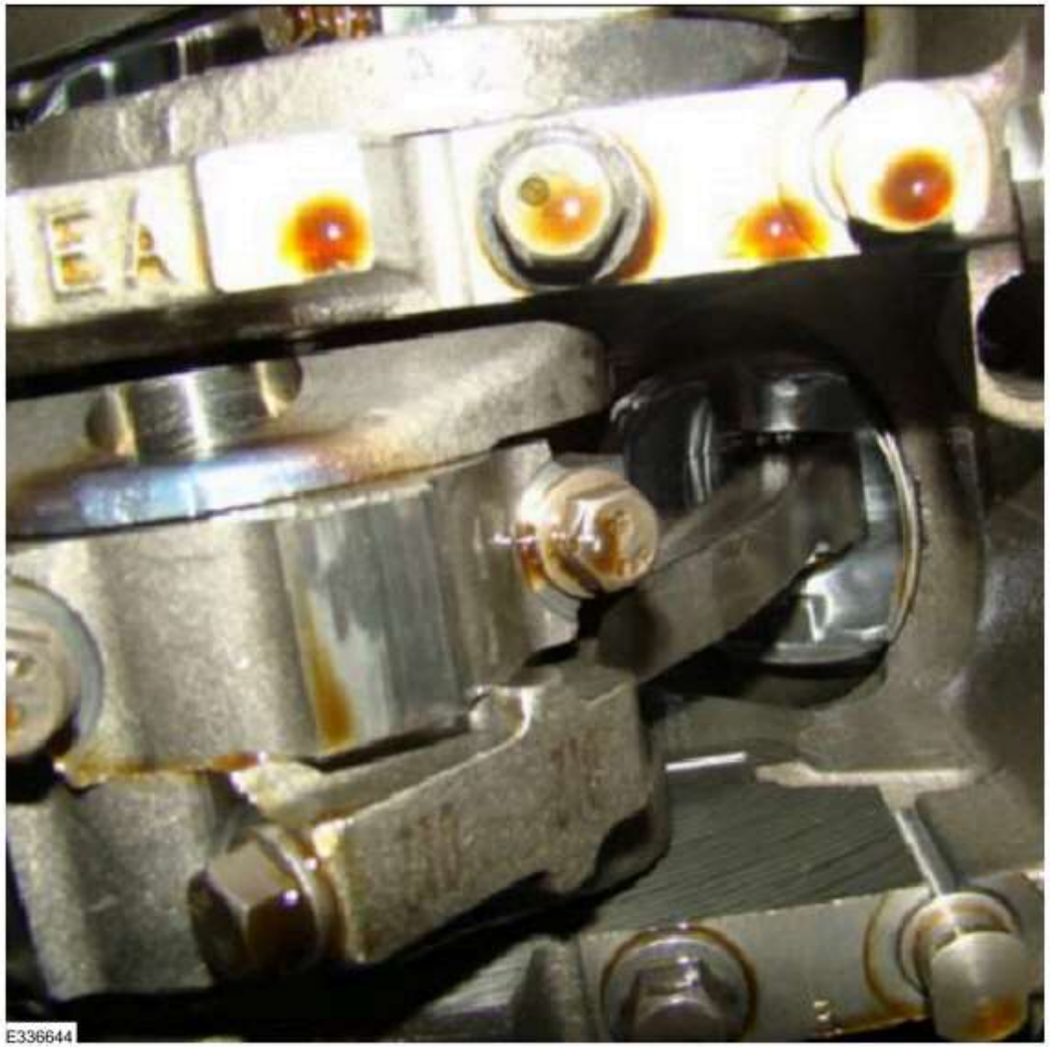


Figure 65

- Since fluids cannot be compressed, the connecting rod typically suffers from a hydrolock event.