



22-7078

23 May 2022

GENERAL SERVICE BULLETIN

Various Vehicles - Engine Failure Analysis

This bulletin supersedes 20-7062.

Summary

This article supersedes GSB 20-7062 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).

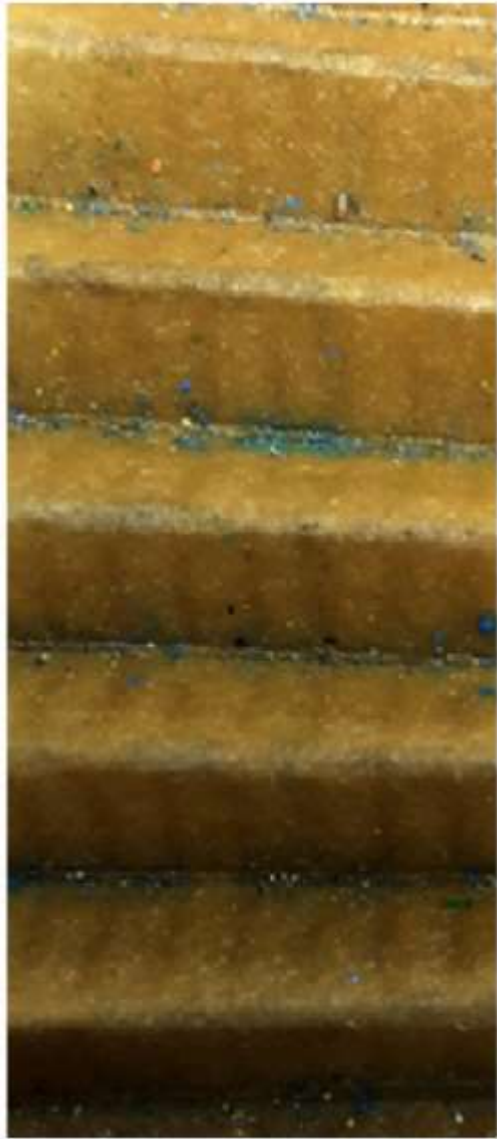
Figure 3



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



E336123

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

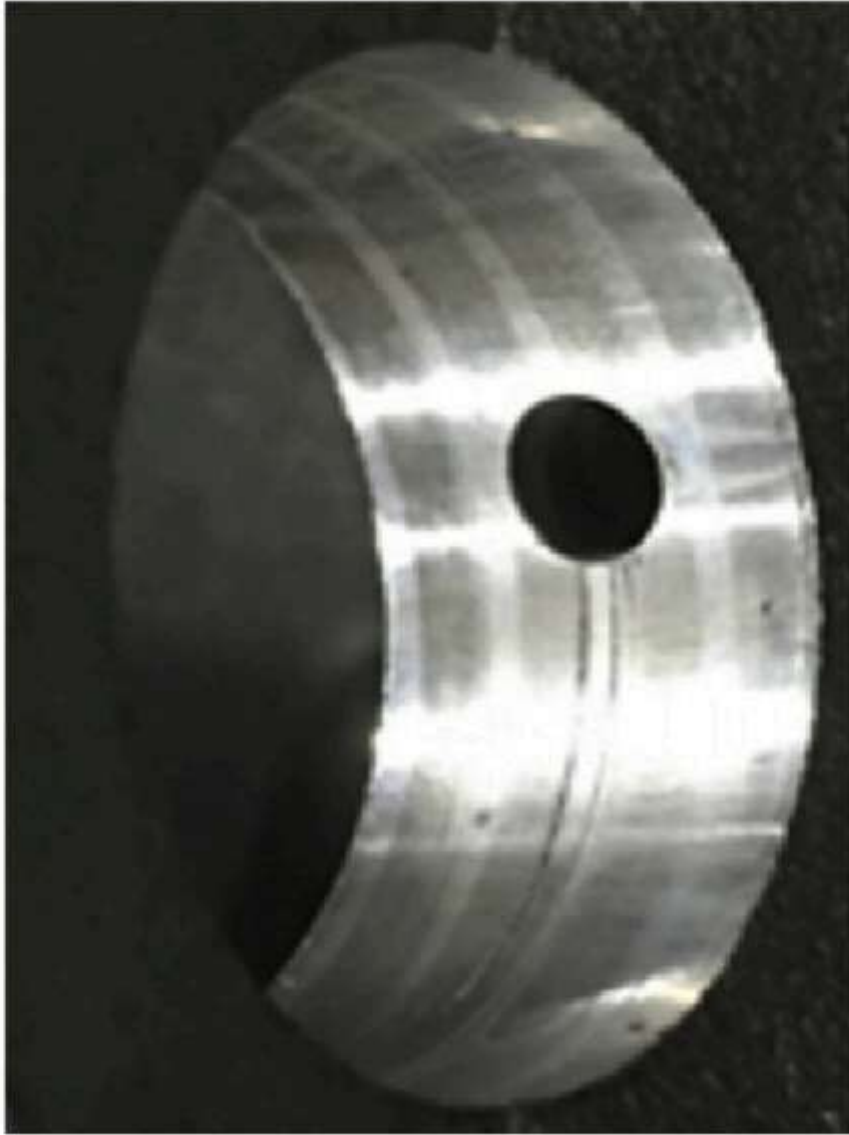
Cam Bore – Normal Wear: Polishing, discoloration, slight porosity or minor scoring (Figures 9-10).

Figure 9



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Figure 10



E336128

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

Figure 11



E336129

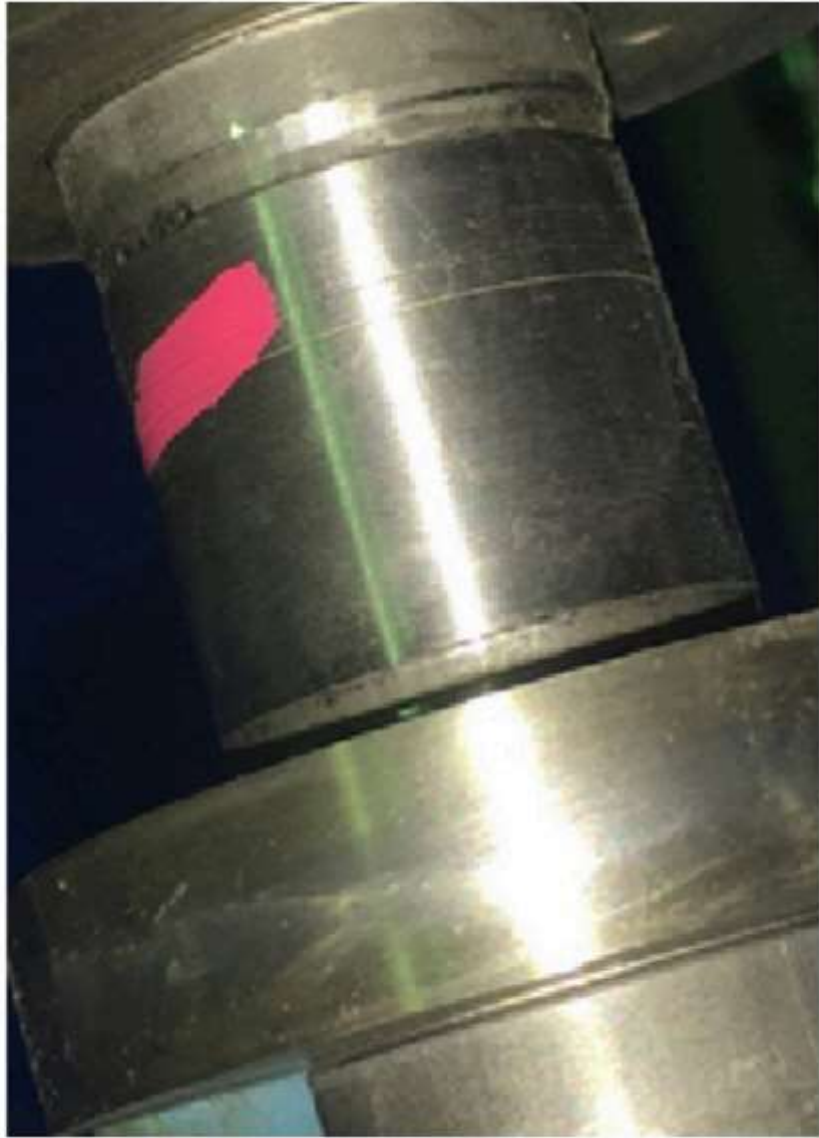
Figure 12



E336130

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

Figure 13



E336131

Figure 14



E336132

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



E336307

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

Figure 30



E336308

Figure 31



E336309

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



E336313

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

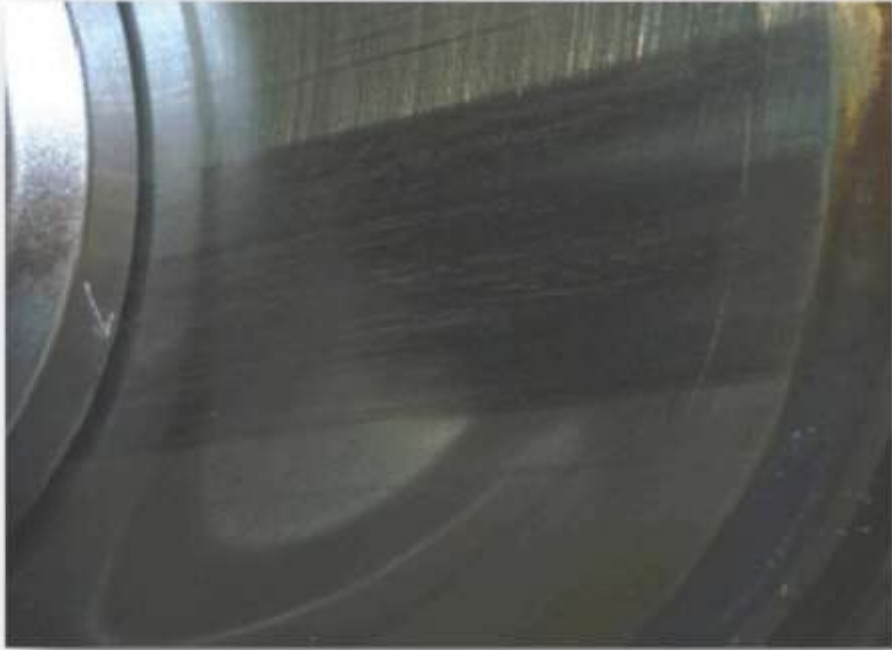
Preventing Repeat Engine Failures

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

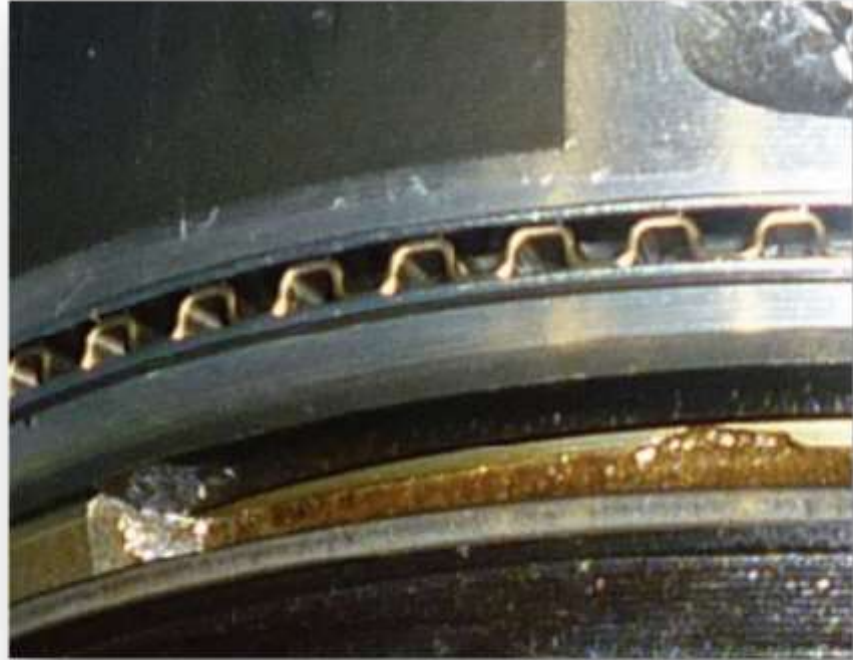
Heat generated from friction can cause cylinder walls to crack. (upper ring land damage) (Figure 51)

Figure 51



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

Figure 52



E336486

Cylinder Wall Damage (Figure 53)

Figure 53



E336487

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



E336493

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



E336640

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



E336642

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



E336643

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

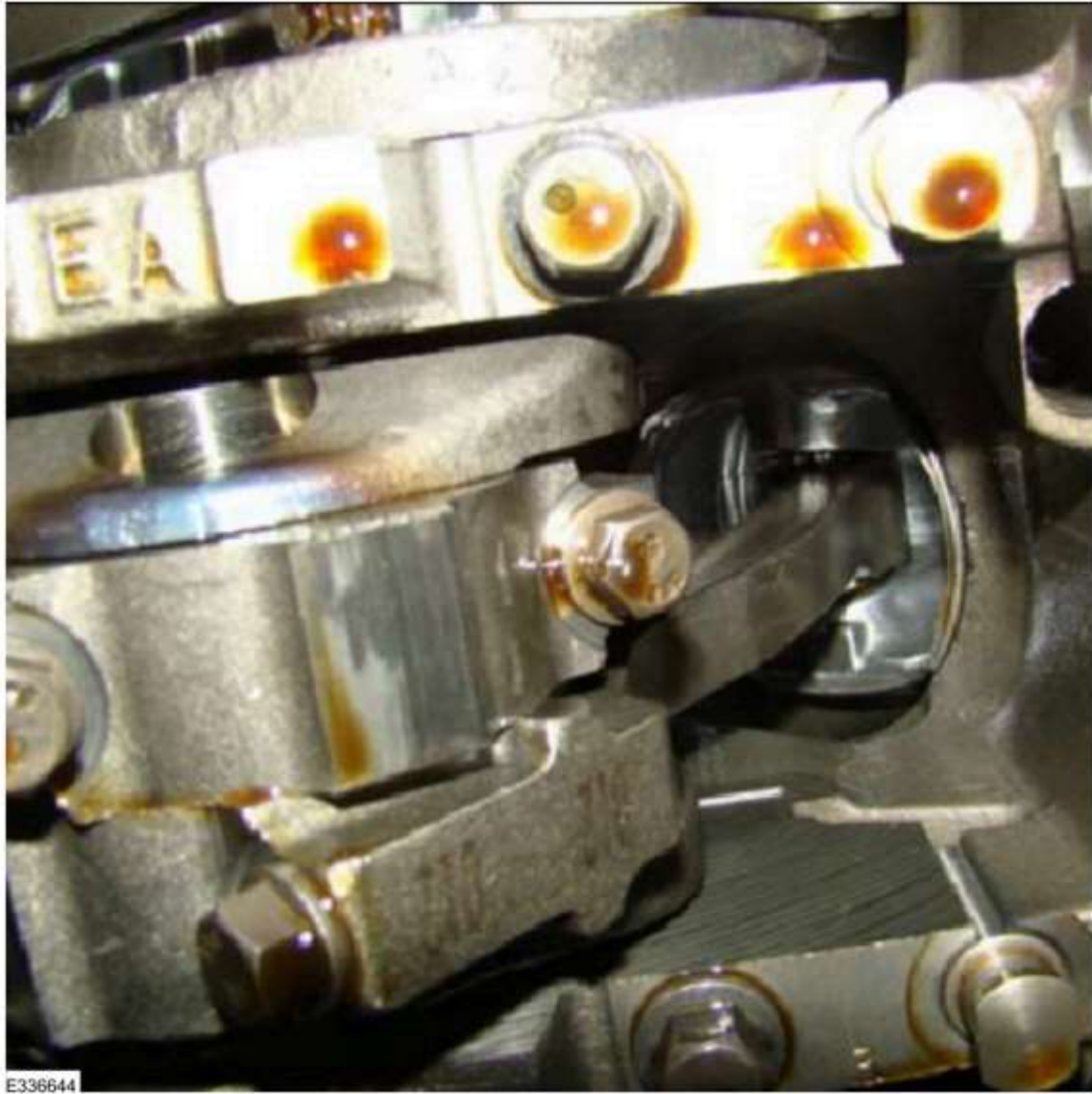
- Liquid cannot be compressed and will prevent the piston from traveling to top dead center (TDC)

Damage: Connecting rod

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

(Figures 64-65)

Figures 64



E336644

Figure 65



E336645

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