



GENERAL SERVICE BULLETIN

Gas Engine Performance Modifications

20-7094

17 September 2020

This bulletin supersedes G0000162. Reason for update: update the vehicle model years affected

Model:

Ford
2013-2018 C-MAX Hybrid
2013-2019 E-Series
2018-2020 EcoSport
2013-2020 Edge
2013-2020 Escape
2013-2020 Expedition
2013-2020 Explorer
2013-2020 F-150
2013-2020 F-Super Duty
2013-2019 Fiesta
2013-2019 Flex
2013-2018 Focus
2015-2018 Focus RS
2013-2020 Fusion
2013-2020 Mustang
2013-2019 Police Interceptor Sedan
2013-2020 Police Interceptor Utility
2019-2020 Ranger
2013-2019 Taurus
2014-2020 Transit
2013-2020 Transit Connect
Lincoln
2020 Aviator
2017-2020 Continental
2020 Corsair
2015-2019 MKC
2013-2016 MKS
2013-2019 MKT
2013-2018 MKX
2013-2020 MKZ
2019-2020 Nautilus
2013-2020 Navigator

Summary

This article supersedes GSB G0000162 to update the vehicle model years affected.

This bulletin is intended to be used by technicians when servicing vehicles that have suspected aftermarket modifications. If an aftermarket modification can be associated with the need for a repair, that repair may not be warrantable. To make this determination, the technician should refer to the aftermarket modifications flowchart within this document.

Service Information

The following information supplement the flowchart through pictures and descriptions of common aftermarket modifications and possible associated failures. This document is not all inclusive and other aftermarket modifications may exist that are not covered here. Note that sections listed as "Universal" are applicable to all engine families. If additional repair assistance is needed, the technician should refer to PTS > Technical Assistance > Service Repair and Technical Support > Service Repair and Technical Support.

Below is the modification flowchart for a vehicle that exhibits a failure that leads to suspicion of unauthorized aftermarket modifications.

1. Determine the failure conditions. Use a borescope to inspect the piston crowns and bore walls. Examine the damaged components. Refer to the Common Failure Modes section later in this article.
2. Retrieve diagnostic trouble codes (DTCs). Do not clear the DTCs.
3. Were any DTCs retrieved?
 - (1). Yes - proceed to Step 4.
 - (2). No - proceed to Step 6.
4. Do the DTCs explain the failure?
 - (1). Yes - proceed to Step 5.
 - (2). No - proceed to Step 6.
5. Are misfire code present?
 - (1). Yes - proceed to Step 6.
 - (2). No - follow normal diagnostics and/or repair procedures. repair under warranty. Flowchart is complete.
6. Has original equipment manufacturer (OEM) calibration been modified? Refer to the Aftermarket Calibrations section later in this article.
 - (1). Yes - proceed to Step 7.
 - (2). No - proceed to Step 8.
7. Is the failure consistent with aftermarket calibration? Refer to the Aftermarket Calibrations section later in this article.
 - (1). Yes - engine repair not covered under warranty. Refer to the Warranty and Policy Manual on FMCDdealer.com. Flowchart is complete.
 - (2). No - proceed to Step 8.
8. Inspect for hardware modifications. Is there any hardware present that could cause the failure? Refer to applicable sections later in this article.
 - (1). Yes - engine repair not covered under warranty. Refer to the Warranty and Policy Manual on FMCDdealer.com.
 - (2). No - repair under warranty.

Service Guidelines

Inform owners that the current factory approved and certified calibrations adjust fuel and spark settings for maximum performance with production hardware, while protecting the engine over a wide range of operating conditions. This includes a knock sensor calibration enabling optimized performance based on fuel grade usage. See the Owner's Manual for details. Aftermarket hardware and calibrations risk damage to engine and transmission assemblies.

Unauthorized calibration modifications may or may not be detectable using standard tools such as a Ford diagnostic scan tool. Changes can be made to the calibration and flashed to the powertrain control module (PCM) through the on-board diagnostics (OBD) port. Physical modifications to the hardware may or may not be present. If aftermarket power/torque-increasing modifications are suspected, care should be taken to record and store the following items: permanent diagnostic trouble codes (DTCs), pending DTCs, freeze frame data, mode 6 and mode 9 data. The data should be printed and attached to the repair order for later reference.

The DTCs, freeze frame data, mode 6 and 9 data can be obtained by using the IDS under the tool box selection. The Powertrain tab will provide the OBD test modes tab and mode 6 and 9 data selection after the vehicle has been identified.

Attempting to increase the engine output via recalibrating the PCM may result in poor drivability, DTCs, or premature component failures.

Common DTCs associated with aftermarket mods:

- P0300-P0308 (engine misfire)
- P0605 (read only memory error)
- P0325, P130D (engine knock)
- P0420, P0430 (catalyst temperature)
- P0171, P0174 (lean air-fuel ratio)

The following aftermarket brands are covered under a separate warranty through Ford Performance:

- Ford Performance
- Ford Racing
- Mountune

If parts from any of these brands appear on the vehicle, refer to OASIS to confirm installation and for warranty information.

Common Failure Modes

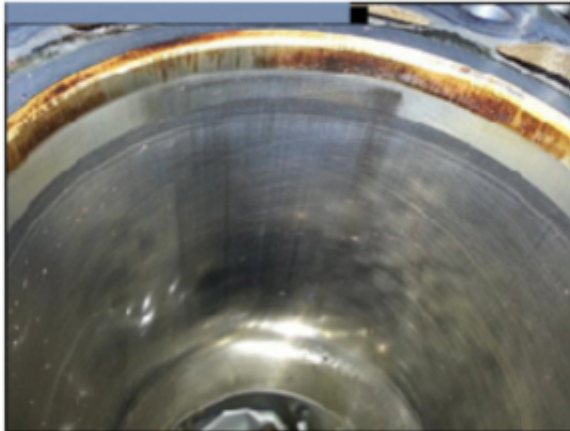
This section contains common failure conditions that are seen in vehicles with aftermarket modifications. Technicians should compare the failure modes found in the vehicle being serviced to the conditions presented in this section. The aftermarket modifications that may have contributed to these failure conditions can be found in Section C.

Universal Failure Modes - Failures found in all engine families

Piston Damage From Pre-Ignition

Scored cylinder wall. (Figure 1)

Figure 1

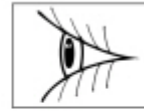
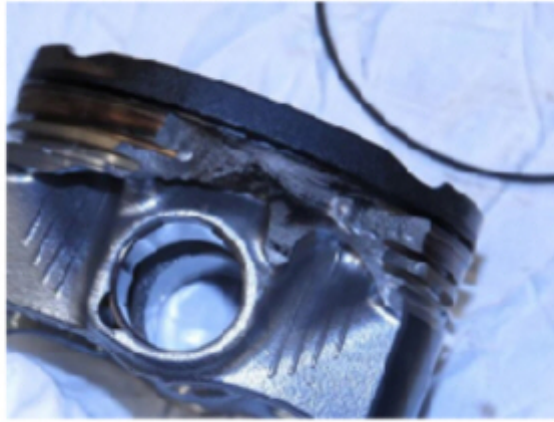


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Piston ring land damage. (Figure 2)

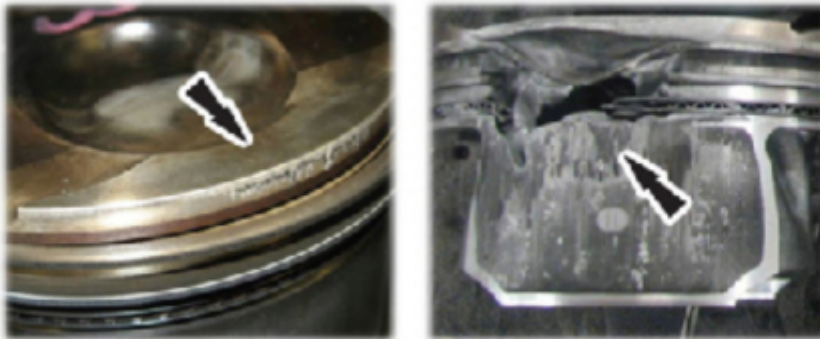
Figure 2



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Piston damage from pre-ignition. (Figure 3)

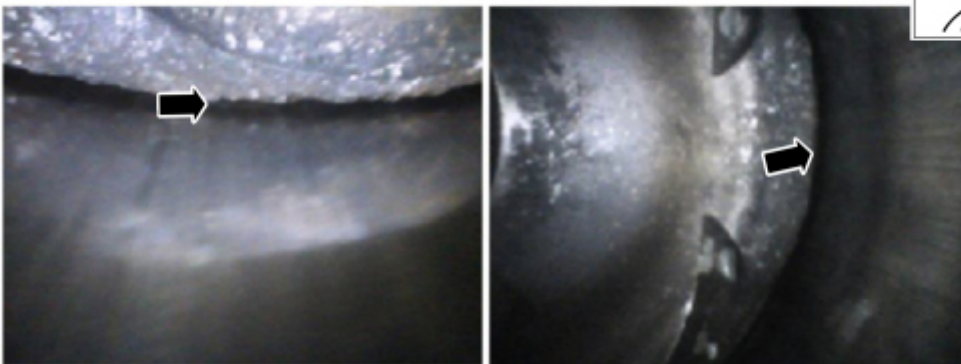
Figure 3



E344231

Borescope view of piston damage and cylinder scoring. (Figure 4)

Figure 4



E344232

Description: Damage to piston profiles can often be attributed to pre-ignition (knock) events. OEM calibrations will protect the engine from pre-ignition damage by retarding spark. Aftermarket calibrations will typically change timing schedules and allow the engine to run closer to damage limits. Pre-ignition along with extreme air-fuel ratios and excessive oil consumption may also damage catalyst material. This material can then be pulled back into the engine, scoring the cylinder bore walls.

Possible causes:

- Aftermarket calibration
- Turbo modifications
- Exhaust system modifications
- Catalyst damage
- Low quality fuel

Piston Ring And Spark Plug Damage

Piston ring damage. (Figure 5)

Figure 5



E344233

Ring land damage. (Figure 6)

Figure 6



E344234

Spark plug ground electrode damage. (Figure 7)

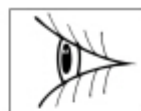
Figure 7



E344235

Spark plug damage and abnormal color. (Figure 8)

Figure 8



E344236

Description: Similar to the pre-ignition piston damage, piston rings can also be damaged from preignition (knock) events. OEM calibrations will protect the engine from pre-ignition damage by retarding spark. Aftermarket calibrations will typically change timing schedules and allow the engine to run closer to damage limits. Damage to the top piston ring may exhibit in the form of delamination, pitting or fracture.

Spark plug damage as shown in the figures above can be another indicator of an aftermarket calibration, changes to the vehicle induction system, or other revisions that can increase combustion temperatures. This is especially true when the plugs show rapid degradation in all cylinders as shown in Figure 8.

Possible causes:

- Excessive spark advance from aftermarket calibration
- Excessive spark advance from changes in induction system

Connecting Rod Damage

Bent connecting rod from hydrolock. (Figure 9)

Figure 9



E344237

Description: Hydrolock occurs when a volume of liquid greater than the smallest volume of the combustion chamber enters the cylinder and becomes incompressible as the piston reaches Top Dead Center. The result is most commonly a bent or broken connecting rod. Connecting rod damage may also be caused by excessive cylinder pressure (overboost condition) and may not be obvious via visual inspection. Connecting rod twisting can lead to bore scoring and eventual piston failure. Note that connecting rod bends or twists may not be obvious visually, but can still contribute to engine damage or failure.

Possible causes:

- Leaking fuel injectors
- Rerouted air induction systems that show evidence of water ingestion
- Turbocharger modifications
- Supercharger modifications

Torque Converter Damage

Normal converter on the left, overheated converter on the right. (Figure 10)

Figure 10



E344238

Description: Overheated torque converters will exhibit discoloration.

Possible causes:

- Any aftermarket modification that increases torque or power output may cause the torque converter to overheat.

Automatic Transmission Clutch Damage

Damaged clutch discs. (Figures 11-12)

Figure 11



E344239

Figure 12



E344240

Description: Clutch damage can present itself in many forms including discoloration, cracking, and warping of the clutch discs and separator plates.

Possible causes:

- Any aftermarket modification that increases torque or power output may cause damage to the clutch system

Driveshaft Damage

Twisted driveshaft. (Figures 13-14)

Figure 13



E344241

Figure 14



E344242

Description: Twisting of the driveshaft is commonly associated with increased torque output.

Possible causes:

- Any aftermarket modification that increases torque or power output may cause damage to the driveshaft.
- Soft compound race tires (often identified by rubber built up in the wheel well) combined with hard launches.

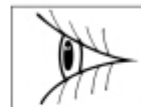
Forced Induction Failure Modes

This section contains failures specific to turbocharged engines.

Turbocharger Compressor Damage

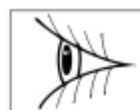
Compressor blade damage from overspeed. (Figures 15-16)

Figure 15



E344243

Figure 16



E344244

Description: Turbo compressor damage is commonly identified by broken or deformed turbine blades.

Possible causes:

- Aftermarket calibration
- Wastegate modification
- Exhaust system modification
- Air induction system modification
 - Cold air intake
 - Throttle body spacer
- Aftermarket blow off valve

Aftermarket Calibrations

This section contains information on how to verify if a aftermarket powertrain control module (PCM) calibration was potentially installed. It is recommended to conduct this step on vehicles that have aftermarket modifications installed and/or vehicles towed in with unexplained engine damage.

Description: Aftermarket calibrations are used to increase engine performance by altering calibratable parameters such as the engine RPM limiter, spark advance and air-fuel ratio. The following is a list of possible calibration-induced component failures.

Excessive cylinder pressure and temperature:

- Piston damage
- Turbocharger damage

- Catalyst damage

Knock sensor calibration changes:

- Piston and/or ring damage due to improper knock control.

Increased RPM limit/overspeed:

- Piston damage
- Connecting rod damage
- Oil pump damage
- Catalyst damage
- Clutch damage

Over-temperature/melting:

- Transmission, PTU and torque converter damage

Ignition counter

The mode 9 data stored on the IDS/FDRS includes an ignition counter that is reset when the PCM is recalibrated. Compare the ignition counter (IGNCNTR) value to the vehicle service history. If the value is abnormally low and there is no history of a recent reflash, investigate for an unauthorized reflash and/or signs of aftermarket tuner connections.

Low ignition count in conjunction with any of the failure modes, symptoms, or indicators above suggest possible aftermarket modifications to the vehicle.

Common Aftermarket Modifications

This section contains items that are frequently modified in an effort to increase the engine's torque/power output. Modifying these items may improve performance, but can also lead to drivability issues, DTCs and component failures. This section covers modifications that may occur in all engine families and modifications that are specific to forced induction engines. Universal Modifications included in this section may be present in any engine family, including forced induction engines.

Air Intake Modifications

Aftermarket intake tube. (Figure 17)

Figure 17



E344245



Aftermarket air filter assembly. (Figure 18)

Figure 18



E344246

Aftermarket intake tube and air filter assembly. (Figure 19)

Figure 19



E344247

Aftermarket air induction pump. (Figure 20)

Figure 20



E344248

Description: Modifications to the air intake system may include aftermarket air boxes, filters and low/high pressure air ducts. The system may be particularly susceptible to flexible air ducts between the air filter and the compressors. Restrictions on either side of the compressor can result in over-speeding the turbo in forced induction engines. Aftermarket air induction systems may cause lean air/fuel ratio DTCs (P0171 and P0174).

Possible failure modes:

- Turbocharger compressor damage
- Catalyst damage
- Piston damage from detonation

Positive Crankcase Ventilation (PVC) System Modifications

PVC block-off plate. (Figure 21)

Figure 21



E344322



Description: PCV systems that are modified (vented to atmosphere being the most common modification) can result in a condition where oil gets past the turbine seal even on an undamaged, fully functional turbocharger. Oil in the exhaust system alone may not be sufficient evidence to identify a failed turbo if the PCV system has been compromised. Modified PVC systems can also contribute to oil consumption and are often good indicators that other engine modifications are likely present.

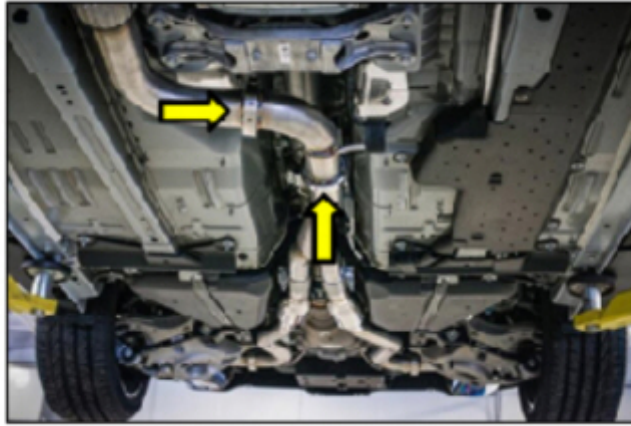
Possible failure modes:

- Unlikely to be the direct cause of base engine failure
- Emission compliance issue
- Oil in exhaust system and/or smoke from tailpipe
- Oil consumption concerns

Aftermarket Exhaust

Aftermarket exhaust examples. (Figures 22-25)

Figure 22



E344323

Figure 23



E344324

Figure 24



E344325

Figure 25



E344326

Description: Common modifications include the removal of catalysts, mufflers and resonators. In turbocharged applications modifications to the exhaust system can reduce backpressure and may result in over-speeding the turbocharger(s). In some cases a good indicator of an aftermarket exhaust is the presence of additional clamps. Visually compare the installed exhaust to the pictures of OEM exhaust, if necessary.

Possible failure modes:

- Turbocharger compressor damage
- Exhaust smoke due to change in system backpressure
- Piston damage

Overdrive Crankshaft Pulley/Damper

Aftermarket crankshaft pulley. (Figure 26)

Figure 26



E344327

Description: Overdrive pulleys are intended to spin faster than OEM pulleys. On forced induction engines they may increase boost pressure which can lead to an overboost condition and subsequent engine damage. Most aftermarket pulleys are machine finished, where OEM pulleys are painted a dull black. Examine the stock pulley bolt for signs of tampering.

Possible failure modes:

- Piston damage
- Driveshaft damage
- Clutch damage
- Oil Pump damage

Fuel Injection Devices

Description: The high pressure fuel system used for the EcoBoost engine will not support additional fuel flow beyond what the factory calibration requests. Inspect the engine for an additional aftermarket injector(s) located somewhere in the induction system to provide increased fuel flow.

Possible failure modes:

- Ruptured fuel lines
- Hydrolock induced failures if injectors are leaking:
 - Bent or broken connecting rods
 - Fractured crankshaft
 - Crankcase damage
 - Damaged bearing(s)

Nitrous Oxide Systems

Description: Nitrous oxide is often used in drag racing to increase an engine's rate of fuel consumption and thus power output. Nitrous oxide systems can most easily be identified by reservoir bottles (usually mounted in the trunk) and trigger buttons in the cockpit. There may also be holes drilled in the trunk for the bottle bracket, along with extra wiring and lines running to the engine compartment.

Possible failure modes:

- Piston damage
- Connecting rod damage
- Intake manifold damage
- Cylinder head damage
- Crankshaft damage

Aftermarket Part Badges/Decals/Handheld Dash Mounts

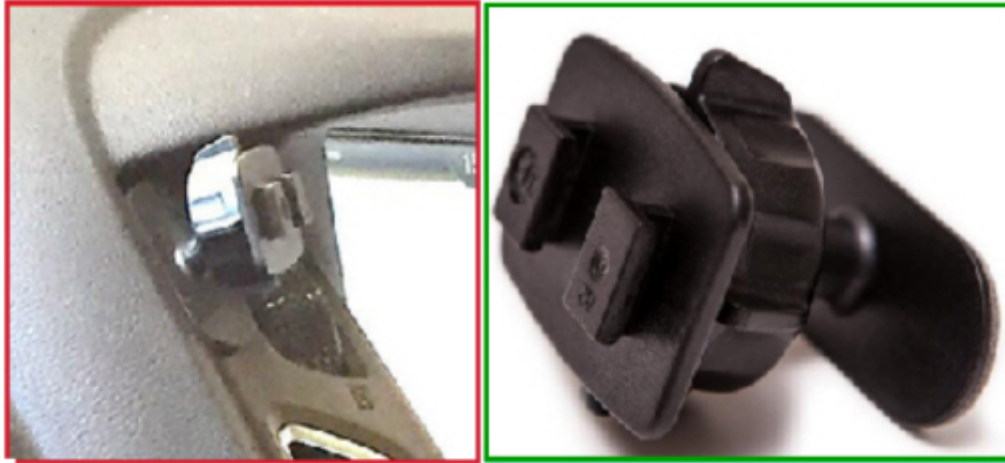
Figures 27-28

Figure 27



E344328

Figure 28



E344329

Description: Badges from aftermarket companies are indicators of possible aftermarket modifications present including calibrations. Dash and/or A-pillar mounts are also indicators of a possible aftermarket calibration. Inquire with the customer about the purpose of any badges and/or mounts and check for the existence of an aftermarket calibration.

Forced Induction Engine Modifications

Modifications presented in this section are specific to turbocharged and supercharged applications.

Wastegate Modification

Wastegate adjuster modification. (Figure 29)

Figure 29



E344330

Description: The full load output of some turbocharged engines will increase if the wastegate spring pretension is increased. This is not the case with the EcoBoost engine. Adjusting the wastegate pre-tension out of the specified range can result in DTCs. A tamper evident paint dot has been applied to the wastegate actuator adjustment mechanism to make modifications more apparent.

Possible failure modes:

- Piston damage
- Turbocharger damage

Compressor Bypass Valve (Blow-off Valve)

Figures 30-31

Figure 30



E344331



Figure 31



E344332



Description: Bypass valves relieve intake manifold pressure to prevent turbo compressor surge. When the pressure is released a distinct hissing sound can be heard. Bypass valves are often tuned for their auditory effect. In doing so, the amount of pressure relieved from the system can change leading to compressor surge.

Possible failure modes:

- Turbocharger compressor damage

Turbocharger Downpipe

Figure 32



E344333



Description: A downpipe is an unrestricted section of exhaust directly downstream of the turbo. By unrestricted the flow, the turbo may be able to spool up faster, reducing turbo lag. However, unrestricted the flow of exhaust can change the backpressure in the system which can lead to turbo overspeed.

Possible failure modes:

- Turbocharger Compressor Damage
- Piston damage
- Exhaust smoke from turbocharger seal leakage

Drive Pulley Modifications

Figure 33



E344334

Description: Customers may modify or replace supercharger drive pulleys to increase supercharger speed and associated boost pressure. Customers may reinstall the OEM drive pulley before bringing the vehicle in for repair. Figure 33 shows both untampered and tampered with pulleys. On the left side of Figure 33, note the white anti-tamper compound and smooth face of the supercharger shaft. The black plastic cover is a Christmas tree style and can be removed by unscrewing it from the blower shaft. On the right side of Figure 33, note the white anti-tamper compound is almost all removed and is misaligned (12 o'clock on shaft and 3 o'clock on pulley). Gall marks on the face of the blower shaft and scuff marks on the face of the pulley indicate use of a puller to remove the pulley and a press tool to reinstall the pulley. The most common change is a smaller diameter drive pulley to increase boost by spinning the supercharger at higher RPMs. This modification also requires an aftermarket calibration. The OEM pulley diameters are 3.0 inches for the 5.4L and 2.7 inches for the 5.8L. Aftermarket pulleys are available in various sizes smaller than these diameters and may visually appear to look exactly like OEM stock pulleys.

Possible failure modes:

- Piston damage
- Transmission clutch damage

Induction System

Aftermarket supercharger, throttle body and air induction tube. (Figures 34-35)

Figure 34



E344335

Figure 35



E344336

Description: Adding aftermarket superchargers can stress the engine beyond design limits through increased torque and power outputs and cause numerous failures. Changes in the induction system such as aftermarket throttle bodies and inlet tubes can cause changes in air-fuel ratio that leads to piston damage. These modifications should be easily visible. Most aftermarket superchargers will have a custom surface finish (polished or wrinkle black).

Possible failure modes:

- Piston damage
- Transmission clutch damage
- Driveshaft damage

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NOTE: This information is not intended to replace or supersede any warranty, parts and service policy, workshop manual (WSM) procedures or technical training or wiring diagram information.