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# CURING THE FORD 6.0L POWER STROKE DIESEL

## BULLET PROOF OIL COOLER KIT

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## The Purpose for the Bullet Proof 6.0 Kit

This kit is designed to replace several components that are prone to failure or degradation on 2003 through 2007 models of the F-Series and 2003 through current E-Series models equipped with the 6.0L Navistar/Power Stroke Diesel engine. The Bullet Proof kit is designed to substantially upgrade the reliability and longevity of the engine.

The Bullet Proof Kit upgrades numerous parts on the Ford Power Stroke diesel engine. These parts perform specific functions; filtering and cooling the engine oil and cooling the exhaust gasses that are ducted into the intake manifold via the Exhaust Gas Recirculation (EGR) valve. The High-Pressure Oil Pump (HPOP) filter screen is also upgraded to a heavy-duty, stainless-steel mesh from the original nylon-mesh version.

The original equipment (OE) parts are upgraded to circumvent several critical issues. The primary issues originate within the OE engine oil cooler. The secondary issues are a direct result of the engine oil cooler plugging or failing.

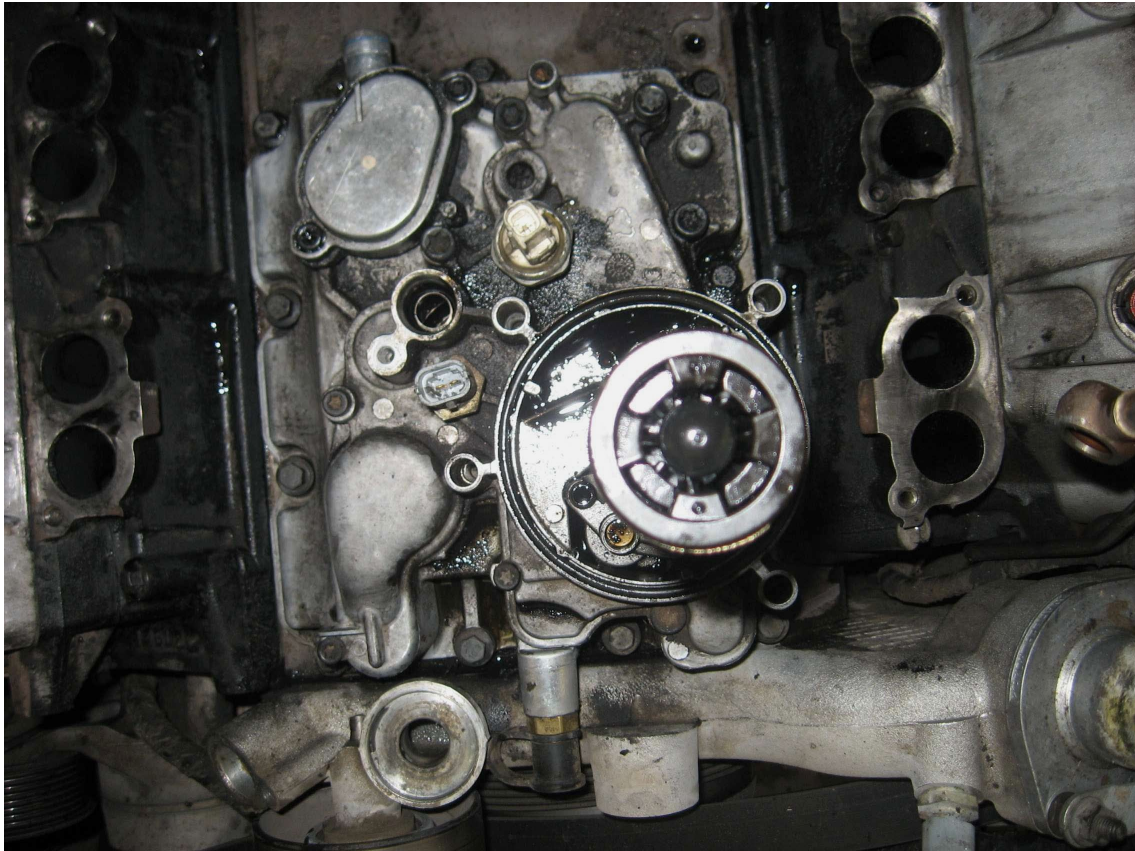
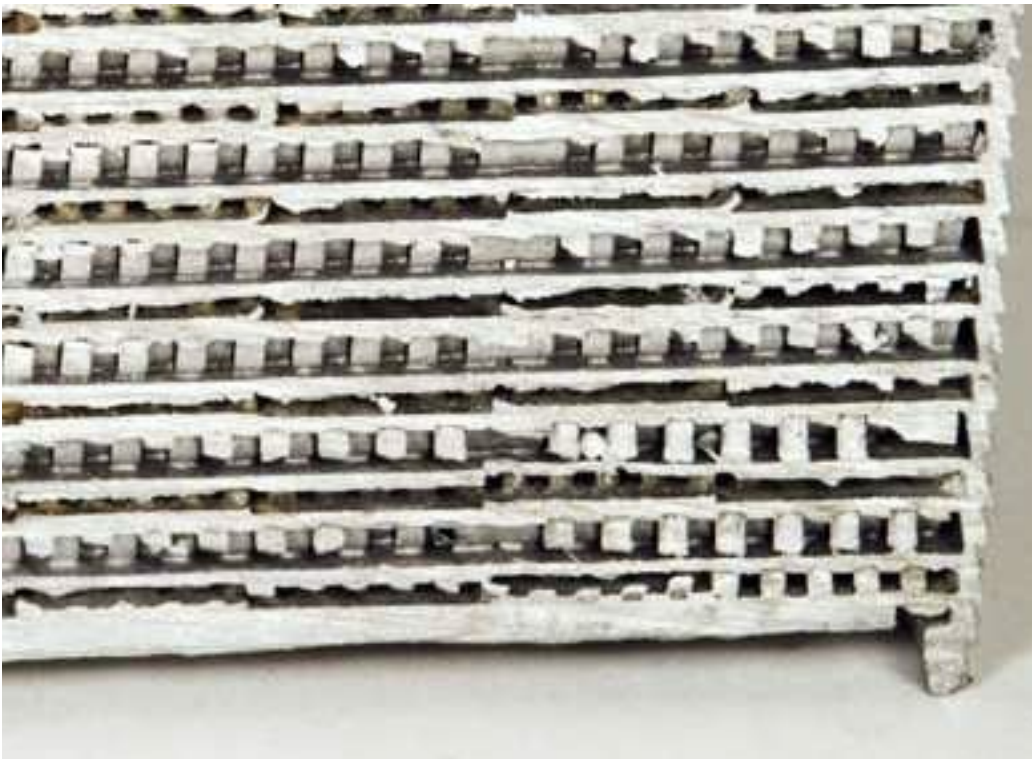


Figure 1 OE Engine Oil Cooler, Top View

## How the Original Equipment Oil Cooler Works

The OE engine oil cooler is a self-contained liquid-on-liquid stacked-plate heat exchanger. Heat from the engine oil is transferred to engine coolant by way of conduction through the fins and plates within the engine oil cooler. Oil from the oil pan is pumped by the engine oil pump to the oil cooler. The oil is confined to the taller “oil levels” within the cooler (see Figure 2). Coolant from the coolant pump (aka water pump) is pumped into the oil cooler where it is confined to the shorter coolant levels. Heat transfers from the oil to the coolant through the aluminum fins and divider plates. The engine oil and coolant are not intended to mix.



**Figure 2 Cross Section View of OE Engine Oil Cooler. Note the Fins for Increased Heat Transfer Efficiency**

After absorbing heat from the engine oil, the now heated coolant exits the engine oil cooler and flows into the EGR cooler. After exiting the EGR cooler, the coolant then flows either to the radiator or coolant pump depending on engine/thermostat temperature.

The cooled oil leaves the oil cooler and flows through the oil filter. Exiting the oil filter, the oil then travels to either the engine bearings/lubricated components or to the high-pressure oil pump. Oil in the high-pressure oil system is used to actuate the electro- hydraulic fuel injectors.

## **The Problems with the OE Engine Oil Cooler**

There are several issues that begin inside the oil cooler. The first problem has to do with the design of the oil cooler itself. A cut-away view of the oil cooler (see Figure 2) shows the close proximity of the oil and coolant levels populated by large numbers of fins, which makes for an excellent heat exchanger. It also shows just how tight and small the passages for the fluids are, making them susceptible to obstruction.

The second issue has to do with the cooling and filtration of the engine oil. The oil filter is placed AFTER (or downstream from) the oil cooler. This has the effect of making the oil cooler the primary filter, allowing it to catch and plug with debris. The debris hinders oil flow through the cooler and thus to the rest of the engine. It also decreases the efficiency of the heat transfer from the oil to the coolant.

The third issue occurs within the coolant section of the engine oil cooler. Cooling system solids and debris can deposit in the intricate passages of the coolant section, restricting the flow of coolant through the cooler. Any restrictions in either the coolant or oil sections of the engine oil cooler will result in less than optimal heat transfer.

The fourth issue is evident when the integrity of the oil/coolant barrier is compromised. When this barrier is compromised, oil and coolant will mix. Normally, the first symptom of this happening is oil in the coolant (degas) bottle.

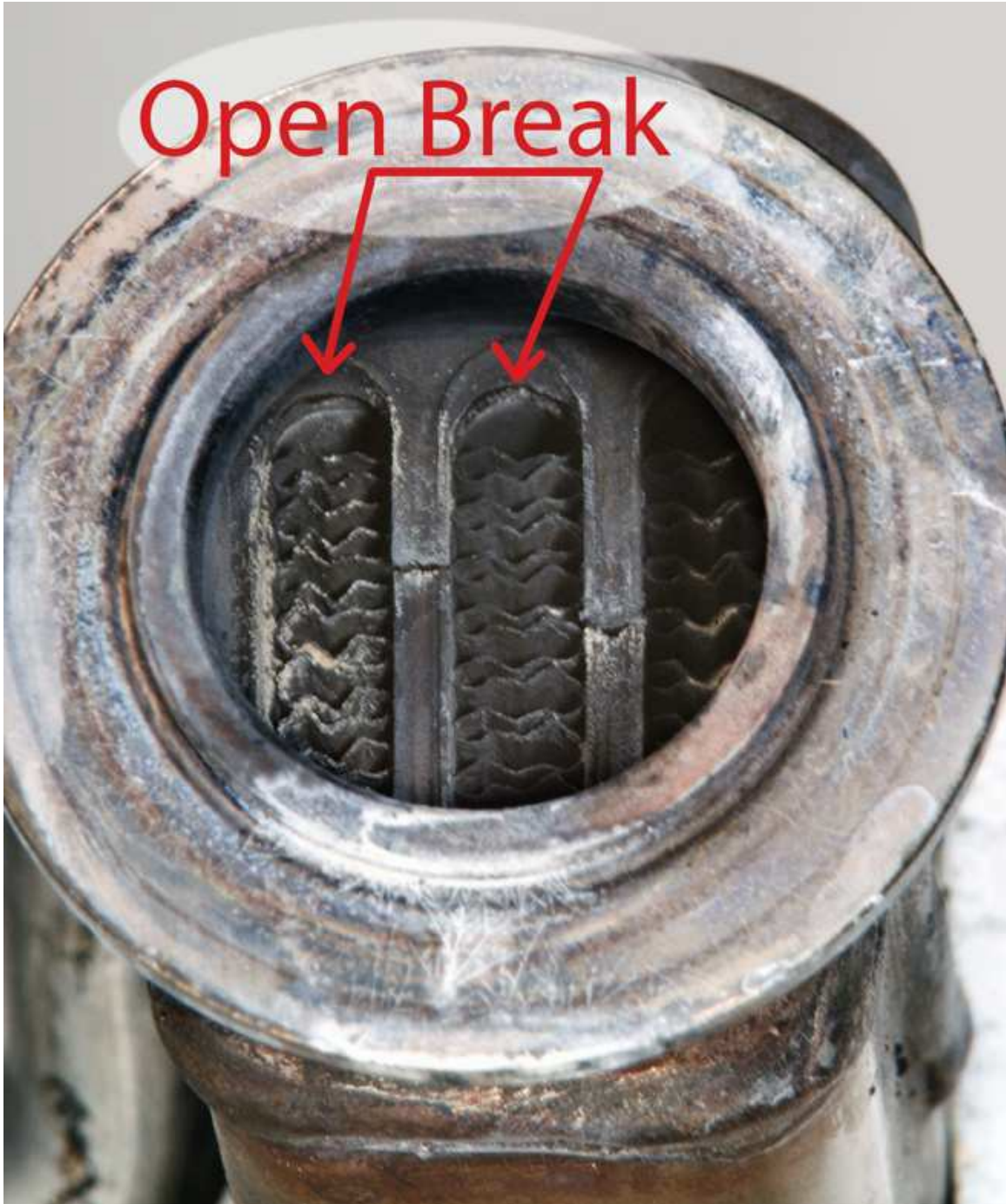
## **The Domino Effect of the OE Engine Oil Cooler**

The four engine oil cooler issues can have a domino effect on other 6.0L components. The secondary issues common on the 6.0L Power Stroke engine include:

- EGR Cooler Failure
- Premature Injector Failure
- Engine Oil break-down due to high temperatures
- Early Engine Wear due to Poorly Conditioned Engine Oil

### **EGR Cooler Failure**

The EGR cooler has several common failures. The first and most common is a rupture failure. While the EGR coolers are made from good quality stainless steel, the design of the heat exchanging core makes it prone to metal fatigue. As the EGR cooler heats and cools, is pressurized and depressurized, the heat exchanging core is constantly worked. This action generally leads to failure of the core near the hot end at the bulkhead seam.



**Figure 3 EGR Cooler with Rupture Failure**

This type of failure in Figure 3 is a catastrophic failure. This failure could lead to blown head gaskets, cracked heads and/or block, a hydro-locked engine and ultimately complete engine failure.

The second common failure is the flash boiling of the coolant within the EGR cooler. The cause of this failure can be traced back to the engine oil cooler. As the coolant side of the engine oil cooler becomes restricted, less flow is available to transfer heat from

the engine oil. This results in a higher coolant temperature and a lower volume of coolant exiting the oil cooler. This restricted, hot flow of coolant is then ducted into the EGR cooler. Once inside the EGR cooler, this overheated coolant is flash boiled by the hot exhaust gasses flowing in the adjacent channels. This failure usually results in the loss of coolant from the coolant reservoir. This condition also dramatically speeds up EGR cooler rupture failure by overheating the EGR coolers heat exchanging core.

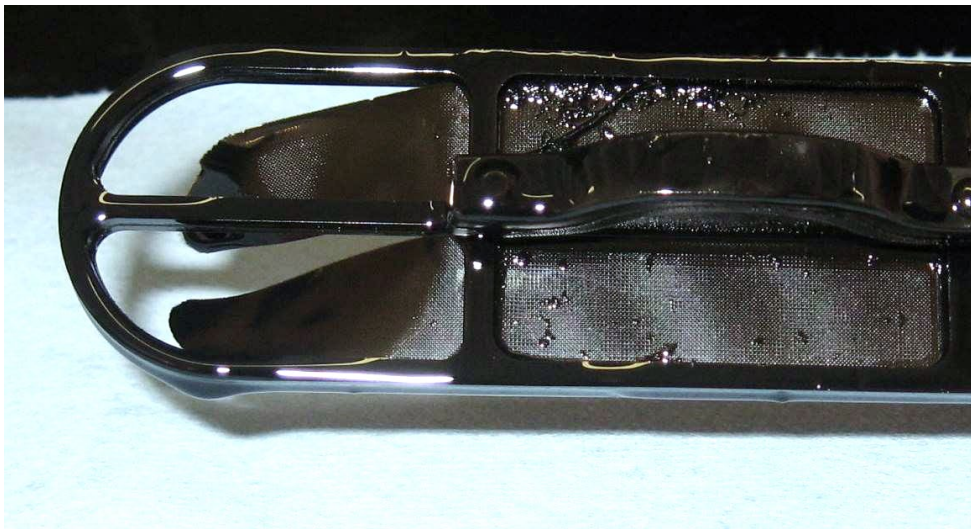
In the summer of 2009 Ford issued a service bulletin regarding EGR cooler failure under warranty. This bulletin mandated the replacement of the engine oil cooler along with the EGR cooler for a warranty claim to be honored.

### **The Engine Oil Filtration System**

The oil filter filtration system also has several problems. According to the OE oil filter marketing information, the 6.0L Power Stroke engine can demand up to 18 ½ gallons of oil a minute. The filter specifications for engine oil filter shows it flows less than half of that amount. When the volume of oil needed exceeds the filters capacity, the filter bypass valve opens. This allows unfiltered oil to join the filtered oil bound for the lubrication and injection oil circuits.

The oil filter housing also contains an oil filter housing drain valve. This valve opens a drain back to the crankcase when the oil filter element is removed. This valve may break during an engine oil filter element change. The result could be an immediate or a delayed catastrophic loss of oil pressure.

### **The High-Pressure Oil Pump Filtration Screen**



**Figure 4 HPOP failed filter screen**

The HPOP Filter Screen is an important element of the oiling system on the Ford Power Stroke 6.0L diesel engine. This engine utilizes two connected - but different - oiling systems: the low pressure and high-pressure oil systems. The low pressure is mostly concerned with 'traditional' engine oiling duties that include the main bearings, cam shaft bearings, pistons, and the like. The high-pressure system is mostly concentrated on the diesel fuel injectors. This critical pump is protected from debris within the oil by both the engine oil filter AND a secondary level of protection: the HPOP filter screen.

This screen is located directly below the stock Ford engine oil cooler. Upon inspection, most of these plastic/nylon mesh screens are torn (see Figure 4) allowing debris from the engine's oil to enter the HPOP. Replacing the nylon-mesh screen is a top priority – one that is addressed by the Bullet Proof Oil Kit with a stainless- steel mesh.

## **Review of Improvements and Features of the Bullet Proof 6.0 Kit**

In review, the main pattern failures addressed by this upgrade kit are:

1. Plugged or restricted oil side of the engine oil cooler.
2. A compromised oil/coolant barrier inside the engine oil cooler resulting in the mixing of oil and coolant.
3. High Pressure Oil Pump (HPOP) filter screen failure resulting in possible HPOP failure.
4. Restricted coolant flow to the EGR cooler caused by a plugged or restricted coolant side of the engine oil cooler.
5. Early injector failure due to overheated and poorly filtered oil.
6. Early engine wear due to overheated and poorly filtered oil.
7. Coolant reservoir (degas) venting coolant due to flash boiling of the coolant in the EGR cooler.
8. EGR cooler rupture failure.
9. Immediate or delayed catastrophic loss of oil pressure due to a faulty oil filter housing drain valve.

To address these pattern failures, the oil cooling, filtration and EGR cooling systems had to be re-engineered.

## How the Bullet Proof Oil Cooler Kit Works

The Neal Technologies Oil Transfer Block (patent pending) replaces the OE engine oil cooler. The oil transfer block mounts where the OE oil cooler mounted and it utilizes OE gaskets and hardware to retain the assembly to the engine.

Engine oil is directed through extreme duty hose, first to the oil filter assembly and then to the oil cooler. The supplied oil filter is much larger and is rated for almost twice the oil flow before bypass than the OE oil filter element. This eliminates the pattern failure of a plugged or restricted oil side of the engine oil cooler, early engine wear due to poorly filtered oil and early injector failure due to poorly filtered oil.

Since the engine oil filter is a remotely mounted “spin-on” filter, the need for an oil filter housing drain valve is eliminated. This eliminates the pattern failure of an immediate or delayed catastrophic loss of oil pressure due to a faulty oil filter housing drain valve.

To maintain or exceed OE engine oil heat removal, an effective liquid to air heat exchanger needed to be utilized. Further, this new engine oil cooler needed to have sufficient air flow to maximize heat transfer.

The supplied engine oil cooler is mounted just behind the condenser. The oil cooler is in direct air for maximum heat transfer. The radiator fan also acts to move air through the oil cooler. Even during extended idle with little to no air flow, the radiator fan moves more than enough air through the oil cooler to effect more than sufficient heat transfer. This eliminates the pattern failures of early injector failure and early engine wear due to overheated engine oil. This also cures the pattern failure of coolant and oil mixing because of a compromised oil/coolant barrier. This system also has the added benefit of liberating the engine oil temperature from the coolant temperature. This means that during cooler seasons, engine oil temperatures can run cooler than can be accomplished with the OE engine oil cooler. Another benefit of this system is the separation of the oil coolers reliance on the engine coolant for heat transfer. Since the OE oil cooler is the highest point in the cooling system, a low coolant condition could effectively render the OE oil cooler inoperative.

The oil then travels from the supplied oil cooler back to the Oil Transfer Block. The now fully filtered and cooled oil is then directed to the various oil circuits. The oil transfer block has an integrated High-Pressure Oil Pump (HPOP) filter screen. This screen is constructed from stainless steel and will last the life of the engine. This cures the pattern failure of the High-Pressure Oil Pump (HPOP) filter screen failing, resulting in the HPOP failing.

The Engine Coolant (coolant) enters the Oil Transfer Block from the same path as with the OE oil cooler, but the coolant is diverted directly to the EGR cooler. This eliminates



the pattern failure of restricted coolant flow to the EGR cooler caused by a plugged or restricted coolant side of the engine oil cooler and coolant reservoir (degas) venting coolant due to the flash boiling of the coolant in the EGR cooler. This also has the added benefit of much cooler coolant entering the EGR cooler. This in turn allows for more heat to be removed from the exhaust gas before it is blended with the air charge. The result is cleaner combustion with fewer emissions. Everybody wins.

The Neal Technologies EGR cooler has been designed to prevent rupture failure yet operate in a fashion that conforms to OE emission standards. By using a round tube design, stronger materials, and a larger volume of coolant, the strength and reliability of the EGR cooler is greatly improved. This cures the pattern failure of the EGR cooler rupture failure and coolant reservoir (degas) venting coolant due to flash boiling of the coolant in the EGR cooler.