

# POWER STROKE BULLETPROOFING TACTICS

## Part 1: What it takes to make a 6.0L reliable

By Robin Stover *Photography: Robin Stover*

**M**ore than one million 6.0L Ford Power Stroke vehicles are on the road today. Despite an exceptional torque curve, an impressive power-to-weight ratio, and a surprisingly compact package size, the 365ci Navistar International-built V-8 suffered from a series of reliability and warranty issues during its short lifespan. In response, Navistar redesigned, tooled up and built the improved 6.4L version of the Power Stroke for '08-'10 Ford HD trucks. As a result, pre-owned 6.0L Ford pickups are in abundant supply, and are often a few thousand dollars less than a similarly equipped diesel pickup of the same vintage from Dodge or GM. For those of us diesel enthusiasts with mechanical aptitude, the 6.0L Power Stroke is possibly the best late-model pre-owned truck value going today.

Upgrades and troubleshooting strategies for this truck are numerous. One company that specializes in all things Power Stroke is Bulletproof Diesel of Mesa, Arizona. The company's owners, brothers Ken and Gene Neal, have invested a ton of time and money into resolving problems associated with the 6.0L. As the name implies, Bulletproof Diesel products circumvent expensive repairs and costly downtime while providing the reliability that Super Duty owners expect from their trucks. We put their upgrades to the test recently on a friend's '04 F-350 dually. Check out what we discovered.

► Inside Bulletproof Diesel's Mesa facility: Each week, three to five 6.0L-powered Super Duty pickups cycle through the shop receiving a plethora of upgrades that ensure long engine life and improved power and efficiency. In virtually every case, Bulletproof's technicians must remove the cab from the chassis to gain access to the critical areas of the engine compartment. While this may seem like a lot of work initially, remember that it took Bulletproof less than one hour to complete this procedure on our donor truck.

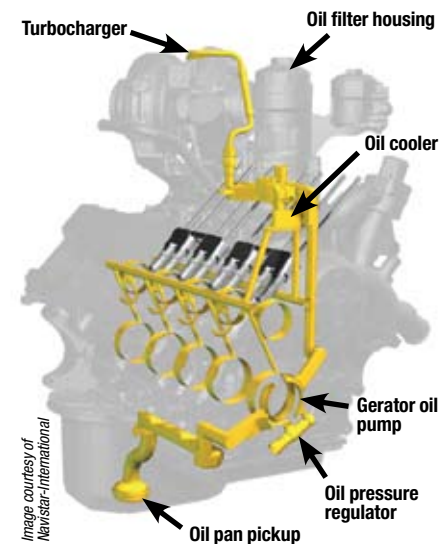


### Diagnosing the Patient

In almost every case, 6.0L engine failures can be attributed to shortcomings in the oil cooling system. In this section, we will cover the how and why of these failures and showcase a proven solution.

► This diagram shows how engine oil moves within the 6.0L Power Stroke engine. Notice the absence of an external cooling device.

1 The 6.0L Power Stroke engine has a unique oil temperature regulation system that relies on engine coolant to raise or lower oil temperature within a given operational range. The system utilizes a compact aluminum heat exchanger that is located in the front of the engine, just under the oil filter assembly. The 6.0L engine block features a void that allows the cooler to mount inside the "V" of the engine. The self-contained stacked-plate heat exchanger is highly effective when the engine is new. However, over time the narrow interior passageways can become restricted by corrosion, debris in the coolant, and casting sand left over from the manufacturing process. This picture shows a cooler that Bulletproof Diesel cut in half with a bandsaw. Despite having roughly 45,000 miles on it, this unit was compromised. Notice the discolored areas in the passageways between the fins; this is the material that creates the restriction. When this happens, coolant flow is significantly impacted. If left unchecked, this lack of coolant flow creates a domino effect that eventually leads to catastrophic engine failure.

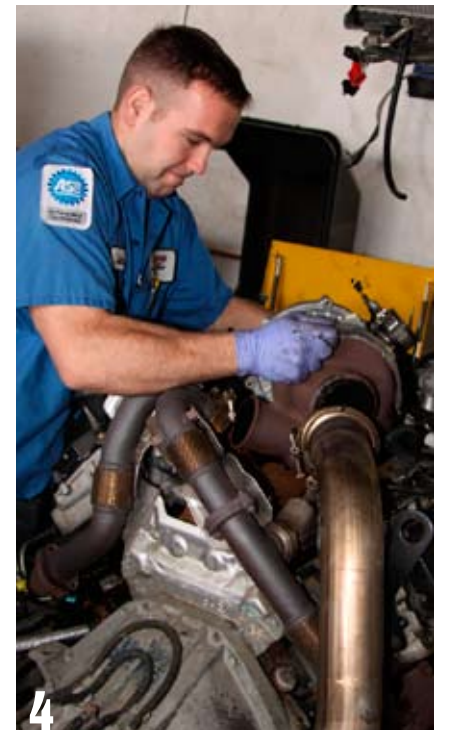


2 To solve the coolant restriction issue, many companies offer aftermarket coolant filtration devices that mount between the engine and radiator. While these units do in fact remove contaminants from the cooling system, they do not address the corrosion issues common to aluminum heat exchangers and coolant. However, the approach Bulletproof Diesel took is different. Rather than simply filtering contaminants from the coolant, they redesigned the system so that engine coolant and oil circuits are completely separate from one another. The Bulletproof kit utilizes airflow to regulate oil temperature. Shown here, the system features an aluminum air-to-liquid cooler that mounts just behind the grill, in the front of the vehicle. The secondary benefit of this system is that it eliminates the often-troublesome OE oil filter and cooler assembly and replaces it with a patented oil transfer block, with a remotely mounted spin-on-style oil filter that offers several benefits over the factory setup. We will discuss these a little later.



3 At the heart of Bulletproof Diesel's 6.0L oil system upgrade is a trick billet aluminum transfer block. The unit completely replaces the factory cast aluminum oil filter housing. In doing so, engine oil is redirected to the front of the vehicle where a large aluminum cooler and filter assembly further improve upon the factory design. This block is manufactured on a CNC mill to specific design tolerances established by the engineers at Bulletproof Diesel. To the best of our knowledge, nobody else offers a unit of this kind. We like the fact that the transfer block utilizes the OE gaskets and hardware to retain the assembly to the engine. Once the cab of the vehicle is free from the chassis, the installation of the transfer block is a simple bolt-on affair.

4 Here, you can see Bulletproof Diesel's ASE certified technician, Justin Aguirre, removing the turbocharger from the top of the engine. This is the first step in the process of disassembly. If the cab of the truck were still attached to the chassis, this procedure alone might take half a day to complete. Instead, Aguirre had our donor truck's engine completely stripped down to a bare block in the same time frame.



## The EGR Cooler and the Domino Effect

The illustration to the right details how coolant moves through the 6.0L Power Stroke engine. Notice that after coolant leaves the oil cooler, it flows to the exhaust gas recirculation (EGR) cooler. The EGR cooler uses engine coolant to remove heat from a portion of the spent exhaust gases as they're directed back to the vehicle's intake to help reduce the creation of NOx (nitrogen oxide) emissions. The EGR system is a vital component of the emissions control system. Some companies sell EGR block-off devices that eliminate the functionality of the EGR system altogether, though these kits are for off-road use only and typically cause the "check engine" light to illuminate. The better solution is a Bulletproof EGR cooler with an improved core structure for better flow characteristics.

▷ This is where most failed EGR coolers eventually end up. Bulletproof Diesel purchases these failed units from repair shops throughout the country. They rebuild them and resell them as Bulletproof EGR coolers.

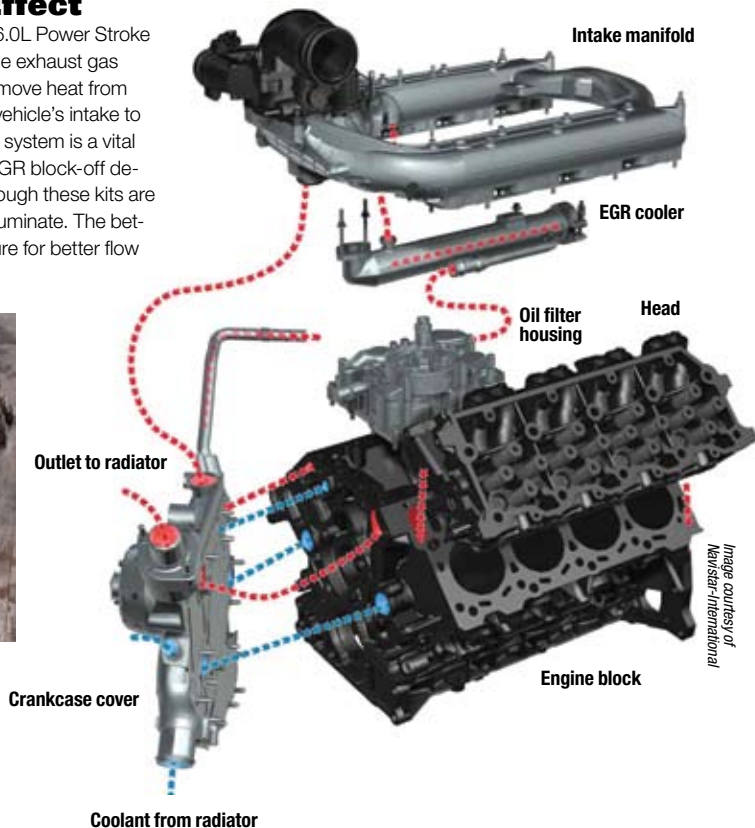


Image courtesy of Kenyan-Highland

## Inside the EGR Cooler: Two Common Problems

If you have owned a Ford Super Duty pickup with the 6.0L engine, chances are you have experienced an EGR cooler failure. Ford released several technical service bulletins to its dealer network in an attempt to resolve these problems. However, none of them address the root cause of the problem, and though the dealership may replace faulty EGR coolers under warranty, the issues will continue to persist. Once you've seen the inside of one of these EGR coolers as we have, it's easy to understand their shortcomings.

❶ This is an example of a failed EGR cooler that caused a catastrophic engine failure. Notice the cracked coolant passageway (arrow). This unit failed because of a clogged oil cooler and excessive exhaust gas temperatures. This type of failure is typically caused by running an aggressive tuner or chip on a 6.0L with coolant flow issues. You see, the EGR cooler is the next place engine coolant goes after leaving the factory engine oil cooler. When the coolant side of the oil cooler is restricted, the EGR cooler cannot cool hot exhaust gases effectively. The EGR cooler was never designed to handle extreme heat and therefore develops a rupture or crack. When this type of failure occurs, coolant will mix with exhaust gases inside the EGR cooler—not good.

❷ This photo shows the other type of EGR failure that Bulletproof Diesel encounters regularly. Exhaust gases deposit gunk on the cooling fins inside the EGR cooler. This causes restriction within the unit. This restriction cuts down on the EGR's effectiveness, allowing higher exhaust gas temperatures to reach the intake manifold. Generally, this type of failure can be traced back to a clogged engine oil cooler. As the coolant side of the oil cooler becomes restricted, less heat is scavenged from the engine oil. This results in higher coolant temperatures and a lower volume of coolant exiting the oil cooler. As the restricted and hot coolant reaches the EGR cooler, the hot exhaust



gases "flash-boil" the coolant in the adjacent channels of the EGR cooler. This failure usually results in loss of coolant from the coolant reservoir. This condition typically leads to a rupture failure of inside the EGR cooler, and eventually results in blown head gaskets.

❸ The redesigned Bulletproof EGR cooler features a much more robust interior, with six round stainless-steel tubes in place of the factory three oval-shaped tubes. The benefits of this upgrade are staggering. Thanks to improved coolant flow, the EGR cooler can remove heat from exhaust gases effectively. Improved coolant flow cools exhaust gases better, which helps to prevent gunk deposits inside the cooler. The design also prevents the coolant from flash-boiling, thanks to decreased dwell time inside the unit. When coolant and exhaust gases pass through the EGR cooler as intended, heat can be removed from the exhaust gas before it is blended with the air charge. The result is cleaner combustion with fewer emissions.



**Head Problems**

When Bulletproof Diesel started our project, they warned us about the likelihood of cracked valve seats on the heads of our donor rig's engine. If ever there were a time and place to pull the heads and check for this, it was then.



1 Our donor truck had just over 40,000 miles on it when we arrived at Bulletproof Diesel. Despite being completely unmodified, many of the valve seats of the cast-iron heads had developed cracks. While these heads offer great flow characteristics, thanks to having four valves per cylinder, the lack of hardened valve seats makes them prone to premature failure. The porous iron material that was used for the OE heads isn't capable of withstanding the high heat and pressure developed during the combustion process. The result is the formation of small cracks where the valve contacts the machined seat surface. Bulletproof had our donor's heads Magnafluxed to check for cracking. Magnafluxing is a process whereby an electromagnetic field is applied to the material, in this case the cast-iron heads. Once the magnetic field is applied, a small amount of colored metallic dust is spread over the magnetized area.

When the metallic dust meets the surface, it reveals cracks immediately, thanks to interruptions in the



magnetic field. This inspection method allows very small cracks to be visible to the naked eye.

2 This close-up view shows one of the many cracks found in the valve seats of our donor's heads. If not addressed, these cracks can result in loss of compression, decreased power, and increased fuel consumption. If neglected entirely, these cracks eventually grow large enough to damage valvetrain components, and in some cases, they can actually lead to catastrophic engine failure.

3 Bulletproof Diesel stocks a selection of 6.0L heads retrofitted with hardened valve seats. Here, you can see the hardened seat under the open intake valve. The seat material Bulletproof Diesel used to achieve this upgrade is Stellite; a cobalt-chromium alloy that is known for its astounding hardness, toughness, and resistance to corrosion. Each of the engine's 24 valves received this upgrade.

4 This photo shows the newly rebuilt heads after being installed to our donor's engine block.

5 Anytime you remove the heads from an engine, it is a good idea to replace the head gaskets. We sourced a pair of genuine Ford/Motorcraft replacement gaskets from Stephan Eschrich at Berge Ford in Mesa, Arizona, which supplies Bulletproof Diesel with these kits. Aftermarket head gaskets exist, though the type that Ford supplies are preferred because they include a pair of redesigned high-pressure standpipes with built-in check valves to improve engine starting. The multi-layer steel head gaskets feature five individual steel plates that are riveted together, along with a special blue sealant to resist high pressure and extreme heat.



6 This photo shows both the old- (pre-'05) and new-style ('05-and-later) high-pressure oil stands for the 6.0L lubrication system. Notice that the new version (top) includes an integrated check valve (arrow). The primary function of these metallic tubes is to deliver engine oil discharged from the high-pressure oil pump to each of the two high-pressure oil rails on top of each cylinder head. The improved versions retain engine oil at the top of the engine to help the system reach operational pressure as soon as you turn the key. This upgrade reduces the total number of rotations it takes to start the engine—another commonly reported problem with the 6.0L. These pipes are a factory retrofit and are automatically included with all new 6.0L head gasket kits from Ford.



## Head Studs

Like most engines manufactured today, the stock 6.0L utilizes head bolts that are designed to twist and stretch to a specific torque value to do their job. This means that as torque is applied to the head of the bolt, the shank or body of the bolt must twist as the bolt stretches to create clamping force. According to Ford, the 6.0L head bolts should be tightened to 85 ft-lb of torque. Head studs do not twist; instead, they use threaded nuts to stretch the stud and create clamping force. Due to the nature of the design, head studs can provide much greater torque values over standard head bolts. Greater torque helps ensure that the head gaskets remain sealed when cylinder pressure and combustion temperatures spike. The published torque spec for a set of ARP head studs for the 6.0L is 210 ft-lb—more than twice that of OE head bolts.

1 ARP is a leader in high-quality automotive fasteners worldwide. Manufactured in Southern California, ARP stud kits are cheap insurance against fastener-related engine failures. Thanks to extensive quality control, even prior to their manufacturing efforts, ARP has earned a reputation for zero failures across all product lines. We picked up ARP's head stud kit (p/n 250-4202) as well as a tube of ARP Ultra-Torque, a lubricant designed to help fasteners reach a desired torque specification in the first pull.



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2 Ultra-Torque is specially formulated to reduce the friction between fastener threads. The toothpaste-like substance is easy to apply and use. It significantly reduces seizing and galling of threads, and ensures longevity of the fasteners it touches.

3 After installing ARP head studs.

4 Early 6.0L Power Stroke engines have turbo lubrication issues because of a restrictive metal drain tube. Bulletproof Diesel swapped out the factory turbo oil drain tube for a new, less restrictive design available from Ford.

5 When it was time for reassembly, Bulletproof's technicians took great care to ensure that every fastener was tightened to the proper torque spec and in the correct sequence. This kind of attention to detail goes a long way when you consider how easy it is to destroy expensive parts such as the cast aluminum intake manifold shown here. This manifold required a specific two-part sequence and just 8 ft-lb of torque to fasten. Anything more could easily crack the part.

6 Here you can see the Bulletproof Diesel air-to-oil cooler unit after it was installed in our donor truck. The included mounting bracket spaces the factory air-conditioning condenser away from the core support, leaving just enough space for the new cooler to mount between the intercooler and the condenser.

## OE Oil Filter Issues

The Ford 6.0L uses a cartridge-style oil filter element that is located on top of the engine. To access the element, a black plastic cap is turned counterclockwise. As this cap unscrews, the element inside releases a spring-loaded drain valve that allows oil in the filter housing to drain back to the oil pan. One common problem related to this setup involves people trying to perform oil filter changes themselves. Many Power Stroke owners don't realize the importance of oil filter maintenance. Rather than twisting the filter from the housing as is common in a number of OE applications, the 6.0L unit must be pulled straight upwards. Twisting this element can cause big issues for the lubrication system. The filter element has the felt gasket



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material that helps seal the bottom of the element to the filter housing. When the element is twisted, felt particles can scuff off and remain in the lubrication system. This debris can clog the nylon oil screen located above the high-pressure oil pump. When this nylon screen clogs, it usually breaks and allows the entire lubrication system to become contaminated. The 6.0Ls fuel injection system depends on a clean supply of engine oil to function. Enough contaminated engine oil can easily foul up the injection system, resulting in poor fuel delivery and ultimately poor engine operation. Bulletproof Diesel replaces the weak nylon screen with a robust stainless-steel version manufactured and sold by Ford. This upgrade prevents high-pressure oil system and fuel injection system failures.

1 With the factory front bumper removed, it's easy to see the location where Bulletproof Diesel relocates the engine oil filter. The system uses a much larger oil filter that, by design, cannot introduce contaminants into the lubrication system as the factory setup often does.

2 Here you can see the felt pad at the bottom of the oil filter element. This design inevitably introduces

particles of felt into the lubrication system. By eliminating this arrangement altogether, Bulletproof Diesel can assure customers that the 6.0L's oil filtration needs are met.

3 Another part that we like about the Bulletproof Diesel oil upgrade is the additional port arrangement included with the system. Thanks to additional pressure and return ports, the system makes it super-easy to add upgrades such as a gauge or auxiliary cooling unit. We took advantage of this opportunity and added a bypass oil filtration device from Amsoil. A bypass oil filter continuously filters a small volume of engine oil whenever the engine is running. Think of it as an automatic oil change every time you drive the vehicle. The bypass filter shown here removes impurities down to 2 microns and leaves your oil the color of honey.

4 We used fully synthetic 5W-30 Amsoil engine oil for this project because it offers superior protection for the various wear surfaces within the 6.0L Power Stroke. We also replaced the engine's antifreeze with the new Super Duty coolant from Be Cool. This coolant comes premixed and ready for use. It is compatible with all types of engine coolant, has a 267-degree boiling point and protects engines for up to 300,000 miles.



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5 The Amsoil bypass filtration system includes a billet aluminum oil cap with a built-in return fitting. We like this setup because it allows you to physically inspect the oil after the bypass oil filter does its job. With the engine idling, you can open the cap and see the clean oil as it is returned to the engine.

6 With the new Bulletproof Diesel upgrades completed, the technicians reinstalled the factory front bumper and double-checked the fluid levels. A three-hour test drive ensured that the system was functioning properly across a variety of different driving conditions. Needless to say, we left Mesa confident with Bulletproof's work.

## How It Worked

The improvements Bulletproof Diesel made to our donor F-350 required extensive man-hours to complete. All said and done, our bill totaled \$ 7,500 for parts and labor (not including the Be Cool and Amsoil products). But when you stop and consider that this truck is used primarily for hauling expensive construction equipment to and from the jobsite, the expense is easily justifiable. The people at Bulletproof Diesel know their stuff, and with their product solutions installed, this Super Duty's owner has a new restored sense of confidence in his vehicle.

We don't recommend attempting this type of project without a vehicle lift. The process of removing and reinstalling the cab to the chassis requires extensive knowledge of several critical vehicle systems—not something you want to attempt at home with floor jacks. However, the upgrades are straightforward once you have access to all sides of the engine. As with any project of such depth, we expected a few days of driving would shake out anything that may have been overlooked. Much to our surprise, after nearly 5,500 miles of service, the owner of our donor Super Duty reported no major problems associated with the vehicle. The engine oil temperature is no longer tied to the temperature of the radiator coolant, and because of this, the engine runs cooler on long grades and while pulling trailers. Now that we have resolved all the common issues associated with our 6.0L-powered donor rig, we plan to follow up with a selection of power and efficiency upgrades as part of a towing special in next month's issue. Stay tuned. **FW**

## SOURCES

Amsoil  
715/399-6467, www.amsoil.com

ARP  
805/339-2200, www.arp-bolts.com

Be Cool  
800/691-2667, www.becool.com

Bulletproof Diesel  
602/620-1544, www.bulletproofdiesel.com

Berge Ford  
480/497-7663, www.bergeford.com