7.3L DIT Power Stroke - Part 3

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Part 3 of 4 in a series of articles outlining the Features, Description, and Unique Service Procedures of the original 7.3L DIT Power Stroke

7.3 DIT Power Stroke

Lube System

Lube Flow Chart

- The lubrication system is pressure regulated, cooled and full flow filtered.
- In addition to providing engine lubrication, pressurized lube oil is used to control fuel delivery in the hydraulically actuated electronically controlled unit injectors.
- Lube oil is drawn from the oil sump through the pick-up screen and tube into the oil pump. The oil pump is a Gerotor type with the rotor portion driven directly by flats on the nose of the crankshaft.
- The pump housing is bolted to the front cover. Pump inlet and outlet passages are through ports in the front cover. Lube oil enters the oil cooler header through a passage in the front cover.
- The oil reservoir, used to maintain a ready supply of oil to the high pressure pump, is filled via two passages:
- For initial startup, oil is directed from the oil pump discharge port through a passage in the crankcase which also contains an anti-drain back check ball. This path replenishes oil to the high pressure pump during cold cranking to insure sufficient oil pressure to operate the injectors for quick starts.
- The primary reservoir oil supply is a continuous feed from the left bank tappet gallery up through the front cover and discharges oil near the top of the reservoir.
- Pressurized lube oil reaches the turbocharger bearings from the rear main oil gallery through a passage in the turbocharger pedestal (mounting pad). Oil drains from the turbocharger through another passage in the pedestal directly back to sump. This oil supply and drain eliminates need for external lube lines to the turbocharger.

High Pressure Lube Flow Chart
Injector Oil System

- Oil Pump (Gerotor)
- Check Valve
- Reservoir
- High Pressure Pump
- High Pressure Hoses
- ICP Injection Control Pressure Sensor

- Cylinder Head High Pressure Gallery
- Injector (8)
- Gallery (Crankcase Main)
- Oil Filter
- Oil Cooler
- Injector Pressure Regulator (IPR)
- The reservoir makes available a constant supply of oil to a high pressure hydraulic pump mounted to the front cover located in the engine "V". The high pressure pump is a gear driven, seven plunger, swash plate pump. High pressure oil is delivered by the high pressure pump to oil galleries machined into the cylinder heads.

Fuel System

Fuel System

- Fuel is drawn from the tank to the engine by the diaphragm stage of the tandem lift pump.
- The diaphragm stage pressurizes the fuel to 4-6 psi while pushing it into the filter housing.
- Filtered fuel is then directed to the piston stage of the tandem pump, where its pressure is increased to between 40-70 psi.
- The fuel is now directed through steel lines to the rear of each cylinder head, and it enters the fuel galleries.
- The fuel galleries intersect with the injectors and when the fill check unseats in the injector, the plunger cavity is filled with fuel pressurized to 40-70 psi.
- To maintain flow into the galleries, fuel return flow is directed to the fuel pressure regulator attached to the filter.
- The spring-loaded spool valve regulates system pressure between 40-70 psi.
- At the regulator, some fuel passes through an orifice (.020") to continuously vent air from the system.
- Most of the fuel is directed back into the line delivering fuel to the piston side of the tandem pump.
- Any air trapped in the filter housing is vented through an orifice (.035") to the return to tank line.
- **Important**
  The nylon strainer insert located inside the strainer cup must be kept in place to prevent plugging of the 0.020 inch orifice. Should this orifice become plugged, engine performance may be adversely affected since the fuel system will not de-aerate properly.

Fuel Pump

- The 7.3 DIT incorporates a two-stage fuel supply pump, i.e., diaphragm/vacuum and piston/pressure stages.
- The diaphragm stage of the tandem lift pump draws fuel from the tank and transfers it to the primary fuel filter housing. Fuel pressure created in the diaphragm stage is 4 to 6 psi.

Fuel Filter

- Fuel is directed from the diaphragm stage of the tandem pump to the filter housing. It passes through the filter element to a standpipe in the center of the filter assembly. Clean fuel then passes to the inlet fo the piston stage of the tandem pump.
- The fuel filter element is attached to the threaded filter cover. When clogged with debris, the element can be separated from the cover and replaced with a new element.
- **Important**
  The engine will not run without the fuel filter element in place. The standpipe in the center fo the housing contains a shut-off valve which is open only when the filter element is in place.
- The base of the filter housing contains an electric heating element to warm fuel to prevent waxing during cold weather.
- Also located in the base of the housing is a sensor to detect presence of water in the fuel. When sufficient water has collected in the bottom of the filter, the sensor illuminates a water in fuel lamp on the instrument panel, indicating the need for the operator to stop the vehicle, turn off the engine, and drain the water from the housing.

Fuel Pump

- The piston stage of the tandem pump raises fuel pressure to 40 to 70 psi to insure proper filling of the injectors.
- Fuel from this stage is delivered through steel lines to the back of each cylinder head. This supplies fuel to a gallery drilled in each head.
- Cross drillings in the heads connect the fuel gallery to each injector.

Return Lines

- Excess fuel from the two fuel galleries is piped through hoses, from the front of each head to the pressure regulator located onthe left side of the filter housing.
- These hoses, of a special rubber compound, provide flexibility in the fuel system, by absorbing and smoothing pressure pulses from the piston stage of the pump.
- **Important**
  Use only certified replacement hoses of the correct part number when repairing the 7.3 DIT fuel system. Substantial hoses may not meet pressure and/or flexibility requirements needed for proper fuel system operation.

Air Flow System

Air Flow For Intake And Exhaust System

- The intake and exhaust systems consist of those components that flow filtered air to the engine cylinders and exhaust gases to the atmosphere.
- The turbocharger is used to increase engine performance output by increasing air supply to the engine. It is a simply designed oil-cooled exhaust-driven compressor that allows filtered air to enter the compressor housing and is forced under pressure to the combustion chamber. After combustion, hot and expanding exhaust gases move through

the turbine housing causing the turbine wheel to spin. The turbine wheel drives the compressor wheel through a common single shaft.
- The turbocharger responds directly to the engine loads. During heavy load, increased flow of exhaust gases and heat turns the turbine wheel faster causing the compressor impeller to turn faster and supply more air (greater boost) to the in take manifold. Conversely, with light engine load, flow of exhaust gases decrease and less air is pumped into the intake manifold.

Cooling System

Cooling System Flow

- Coolant flows from the radiator to the water pump, through the front cover to the crankcase, cylinder head, oil cooler and on to the engine thermostat.
- When the thermostat is closed, coolant flows through a bypass back to the water pump without going through the radiator. This provides for rapid engine warm-up. When the coolant reaches 205° F (96.1° C) the thermostat starts to open and the coolant begins to flow to the radiator. The thermostat is fully open at 230° F (110° C).

Glow Plug System

Glow Plug System

- The purpose of the glow plug system is to warm-up the engine cylinders to improve/enhance cold engine starting.
- The Powertrain Control Module (PCM) is programmed to turn the "WAIT" to start light on and energize the glow plugs (via the glow plug relay) each time the ignition switch is placed in the "ON" position prior to starting an engine.
- The PCM monitors battery voltage and uses information from the engine oil temperature (EOT) and barometric (BARO) sensors to determine the amount of "Wait to Start" light, and glow plug activation time.
- The glow plugs are self limiting, eliminating the need for a controller.
- Inside the plugs are 2 coils (resistance) connected in series. One to create heat and one to control heat at its peak.

Engine Features

Front Of Engine

- The **CMP sensor** mounts through the front cover, is attached by a single bolt, and is sealed by an O-ring. The sensor's installed depth (clearance) is established by its body and is not adjustable.
- The **oil reservoir** stores approximately one quart of engine oil, used to actuate the injectors, at its position above the timing gears. Mounted to the reservoir are the EOP sender and EOT sensor.

Left Front Of Engine

- **Threaded Plugs** and O-rings seal the oil and fuel galleries at the ends of each cylinder head and may be removed during major engine service to facilitate cleaning.

Left Side Of Engine

- Crankcase vapors are routed into the intake system from the **breather**, attached to the left valve cover.
- The remote mounted air cleaner connects to the engine's intake system.
- A **peto tube** is mounted in the intake air stream to contribute to crankcase pressure regulation.
- Filtered air maximum restriction remains 25" H_20.
- The vehicle electronic system is connected to the **engine through a single forty-two (42) pin connector**.

Left Rear Of Engine

- The large **"Extender"** oil filter uses micro-glass filter media.
- Lab tests confirm micro-glass filters are 3 to 4 times better than previous filters.
- The **engine coolant heater** is threaded into the rear oil cooler header and operates on 110 volts/AC to assist cold starts.

Rear Of Engine

- The engine features an aluminum **transmission adapter**.
- The **exhaust manifolds** are connected to the turbine housing by formed steel pipes and a **cast collector** which is tuned to dampen exhaust pulsations prior to driving the turbine wheel.

Right Rear Of Engine

- The **exhaust back-pressure device** will provide faster engine warm up in cold ambient temperatures by restricting exhaust and increasing engine load during warm up only.
- The EBP device is a hydraulically-activated, electronically-controlled servo in the base of the turbocharger.
- To enhance serviceability, **cup plugs** are used throughout the engine in core clean out holes.
- Fuel from the piston stage of the fuel pump enters the heads at the rear of the engine.

Right Side Of Engine

- The **oil fill cap** is at the front of the right valve cover.
- The **oil level dipstick** is mounted through the oil pan for easier dipstick removal and installation.
- The dipstick is calibrated to indicate 2 quarts between add and full.

Right Side Front Of Engine

- The PCM (Powertrain Control Module) controls the glow plugs through an engine-mounted relay. The **glow plug relay** supplies 12 volts to the self-limiting glow plugs, located under the valve cover.
- A steel line connects the **back-pressure sensor** to the right exhaust manifold. In cold ambient temperatures, the PCM uses back-pressure sensor information to determine back-pressure device butterfly position which enhances the warm-up characteristics of the engine.

Top Of Engine (Electrical)

- Both the **ICP (Injection Control Pressure)** and **IPR valve (Injection Pressure Regulator)** are used by the PCM to monitor and control the high pressure oil system.
- **EOT (Engine Oil Temperature** sensing is used by the PCM to make timing and fuel rate adjustments based on engine temperature.
- **EBP (Exhaust Back-Pressure** sensor monitors exhaust restriction during the operation of the exhaust back-pressure control system in cold ambient temperatures.
- Connections for the glow plugs and injectors are accomplished through the valve cover gasket. Electrical connections are made both inside and outside of the re-usable valve cover gasket.

Top Of Engine (Mechanical)

- The low pressure fuel system supplies fuel to the injectors at 40 psi pressure.
- High pressure oil, delivered by special lines to galleries in the heads, is used to generate 21,000 psi fuel injection pressure in the HEUI injectors.
- **Important**
  High Pressure Hoses
  The hoses are made specially to withstand the pressure and temperature of this system. Use only FORD certified replacement hoses.
- Formed steel intake manifolds direct turbocharged air to each cylinder.

Top Of Engine

- The **engine lifting eyes** are bolted to the cylinder heads.
- The **fuel filter** is mounted low in the center of the engine and is equipped with a manual water drain, fuel heater, restriction sensor, and WIF sensor.
- The fuel filter will be accessed through a hinged panel in the engine cover.
- The oil used to create injection pressure is charged by a **gear driven pump** bolted to the front cover.

Crankcase - Top

- The potential for oil leakage has been reduced through the design of a **closed crankcase valley**.

- The base of the turbocharger bolts directly to the crankcase. The turbochargers **oil supply** and **drain passages** are integral to the base and the passages are sealed by O-rings at the crankcase, eliminating external feed and drain lines.
- The **fuel transfer pump** mounts in the valley and is driven by a dedicated lobe on the camshaft.
- A **short circuit** exists in the oil feed to the high pressure lube system. This short circuit keeps the reservoir full at start up until oil pressure is attained.

Crankcase

- This short circuit **oil gallery** is connected directly to the gerotor pump discharge. This provides a quick fill of the high pressure pump reservoir for fast cold starting.
- The ball check unseats momentarily during cold cranking until engine oil pressure is equalized on both sides of the ball check. When the ball seats, it prevents unfiltered oil from entering the reservoir during engine operation.

Crankshaft

- The oil pump's inner **gerotor** is driven by the front of the crankshaft. This high efficiency pump provides higher pressures and volumes.
- The **flywheel bolts** thread into **blind holes** in the crankshaft, eliminating the need for sealant on the bolts.
- The width of each **main bearing** has been increased 7% to improve service life. The 7.3 DIT continues to use crankshafts with hardened journals and fillets on the main and rods.
- The crankshaft utilizes 5 main bearings.

Camshaft

- The **fuel pump eccentric** is machined as part of the camshaft and is located between the third and fourth bearing journals.
- The camshaft is supported by 5 cam bearings. The camshaft is forged steel with induction hardened lobes.

Front Gear Train

- The **camshaft** is timed to the crankshaft by aligning the dot on each gear. Timing of the high pressure oil pump drive gear is NOT required.
- The **timing disk** is pressed into and bolted tot he front face of the camshaft gear. Windows on the timing disk are sensed by a hall effect CMP (CAM Position) sensor to determine engine speed. One narrow "window" and an opposing wide "window" provide sync pulses to the CMP sensor to indicate camshaft position for correct cylinder timing. The timing disk and gear are service as an assembly.

Connecting Rod

- The **connecting rod bearing** width has been increased 9% for improved bearing and journal life.

Piston

- The engine utilizes **direct injection**. Fuel is injection into the combustion chamber at the top of the piston. The swirl needed for combustion is created by the "Mexican Hat" design of the piston.
- Under head of the piston utilizes a **Tee-Pee design** pin bore to allow maximum load distribution during combustion and the power stroke.
- The DIT piston incorporates durable Ni resist top ring inserts and a plasma coated top ring.
- The underside of the piston is cooled by a stream of oil from the piston cooling nozzle.

Tappets / Lifters

- The engine's **closed valley** requires cylinder head removal to gain access to the cam tappets.
- The **tappet guides** completely encircle the tappets to ensure proper orientation to the camshaft lobe.
- Cylinder **head gasket clamp load** has been increased through the use of 6 head bolts per cylinder.
- The **tappet retainers** hold the push rods in place and have holes in them to guide the push rods into the tappets.
- Due to the **increased clamp load**, the graphite head gaskets do not require grommets.
- The **clamp load** on the cylinder head has been increased. There are now six (6) metric head bolts around each cylinder bore as opposed to the previous 7.3's five per hole.

Cylinder Head (Deck)

- Changes in the cylinder head due to direct injection include:
- Elimination of pre-chambers.
- Due to the combustion chamber in the piston, injectors protrude through surface of head deck.
- Glow plugs protruding through the head.
- Injectors and glow plugs can have tips damaged if they are in removed cylinder heads.
- The intake valves are identified by a dimple in the center of the head. **Intake and exhaust valves are not interchangeable**.
- As with previous 7.3's, the cylinder heads on the 7.3 DIT's cannot be resurfaced.

Cylinder Head

- The **positive valve stem seals** are of a new design. They are secured by the valve spring and cover the guide.
- **Valve rotators**, mounted at the top of the valve spring, are used to extend valve life.
- The self limiting temperature **glow plugs** are located under the valve cover.
- To accommodate injector removal, **oil drain plugs** located under the valve covers are used to drain the high pressure oil galleries.

Cylinder Head Nozzle Hole

- The **fuel gallery** is charged from the rear of each head and the rail intersects each injector bore.
- Each injector is connected to the **oil gallery** by a drilled passage.
- The injector's intersections with the fuel and oil galleries are sealed by O-rings.
- The injectors are installed in brass sleeves in the heads. Coolant flows around the outside of the sleeve to cool the injectors. When servicing sleeves, they must be sealed with LOCTITE® No. 609 sealant.

Cylinder Head

- **Fuel galleries** in the cylinder heads are sealed at both ends by plugs using O-rings.
- The oil galleries in the cylinder head are sealed by plugs using O-rings and back up rings. The oil plugs are also sealed with LOCTITE® No. 609 sealant on the threads.

Cylinder Head

- The **inboard injector hold down bolts** (toward the valley) must be installed prior to injector installation.
- The **injector fuel and oil passages** are separated and sealed by O-rings.
- The fuel section of the injector is below the oil section.
- The **copper gasket** at the bottom seals the injector to the combustion chamber.
- The **injector O-rings and gaskets** must be replaced each time the injector is removed.

Cylinder Head

- **Rocker arms** are mounted on pedestals and pivot on steel balls. A spring steel clip holds the assembly together. The rocker arm assembly can be assembled for either an intake or exhaust using the same parts by changing orientation of the components.
- The position of the rocker arms should be identified and reinstalled in the same position to avoid abnormal wear.
- **Push rods** continue to have a copper colored upper lip.

Cylinder Head

- The reusable **valve cover gasket** has electrical conductors molded into it. The gasket is made with a silicone bead on each side to conform to surfaces and provide the seal. Two harnesses under the valve cover provide the connections to the glow plugs and injectors.

Cylinder Head

- The **valve cover gaskets** are marked "reusable."
- Oil used to actuate the injectors is discharged following the fuel injection event through spill spouts.
- The **UVC** (Under Valve Cover Harness) connects to two glow plugs and two injectors. The center wire on the UVC is a common voltage supply for two injectors.
- Each injector head requires two UVC harnesses (four injectors, four glow plugs).

Cylinder Head

- The lightweight **intake covers** are stamped steel and are bolted to the cylinder heads. The manifolds are sealed with Wacker® T-95 RTV sealant.

Front Cover

- The areas of the front cover which intersect with engine coolant and positive oil supply pressure are sealed with formed O-rings in formed grooves.
- Areas of the front cover which are exposed to engine oil splash are sealed by Wacker® T-95 RTV sealant.
- The front cover is aligned to the crankcase with **dowel pins**.
- The CMP (Camshaft Position) sensor is mounted in the front cover.
- The lube oil pickup tube bolts directly to the front cover and is sealed to the front cover with a formed O-ring resting in a groove.

Water Pump

- The die cast **water pump housing** contains the heater return port.
- The water pump's direction of rotation is counter-clockwise, opposite of the water pump on previous 7.3 engines.
- **Important:**
  The fan clutch threads onto the water pump hub using right hand threads.
- The engine's **thermostat** housing is integral with the water pump.

Oil Pump

- On the nose of the crankshaft there are two flats used to drive the **gerotor oil pump's** inner rotor. The inner rotor has fourteen teeth and the outer rotor has fifteen spaces. As the pump rotates and the rotors separate, oil is drawn into the pump, then continued rotation causes the rotors to mesh on the opposite side of the pump. When the rotors mesh, the area inside the pump decreases and oil is forced into the oil cooler.
- The **oil pump housing** is located by dowel pins in the front cover for proper alignment and is sealed by an O-ring in a groove.
- The crankshaft front seal is located in the oil pump housing. The seal may be replaced by removing the vibration damper. Removal of the oil pump housing is not required for seal replacement.

Vibration Damper

- The **vibration damper** will have a replaceable wear sleeve on its sealing surface.
- The vibration damper is located on the crankshaft with a keyway.

Rear Plate

- The **rear seal plate** is aligned to the crankcase with dowel pins and sealed to the crankcase with Wacker® T-95 RTV sealant.

- The **flywheel** is located on the crankshaft by a dowel pin to ensure proper position for balance.

Rear Seal

- The **rear seal** is molded into a bolt-on carrier simplifying rear seal replacement.
- Five bolts secure the **rear seal carrier**.

Oil Pick Up Tube

- The **oil pump pick up tube** is bolted directly to the engine's front cover and is sealed by an O-ring. The pick up tube is also secured by a bracket fastened to a main bearing cap.

Oil Pan

- The **oil pan** is secured by 12 bolts and is sealed with Wacker® T-95 RTV sealant.
- A **windage tray** is used to minimize oil aeration within the crankcase.
- The **dipstick mount** is sealed with a replaceable O-ring.

Oil Cooler

- The **oil cooler** assembly is sealed to the front cover and the crankcase with reusable gaskets.
- The **coolant heater** is threaded into the rear header of the oil cooler.

Exhaust Manifold

- The nodular iron **exhaust manifolds** will not be sealed by gaskets in production. Exhaust gaskets will be available for service.
- To ease manifold installation, one manifold bolt hole is smaller in diameter to accurately position the manifold. This bolt should be installed first.

High Pressure Pump

- The **high pressure oil pump** is sealed to the front cover with a reusable gasket.
- The high pressure oil pump drive gear is not timed to the camshaft or to the pump.
- The gear is attached to the pump's shaft by a bolt requiring proper torque.

High Pressure Pump Drive

- The **reservoir** which supplies oil to the high pressure pump is filled by a passage in the engine's front cover.
- The reservoir tower, sealed by an O-ring on the pressure side and Wacker® T-95 RTV sealant on the splash side, holds a constant supply of engine oil for the high pressure pump.
- The bolt securing the high pressure pump drive gear must be accessed by removing a plate on the front cover.

Reservoir

- The **reservoir** contains approximately one quart of oil which is available to the high pressure pump for quick starting.
- The reservoir covers the top of the gear train. Mounted to the aluminum front cover, the attaching bolts must be properly tightened.
- Engine lube oil pressure is monitored by a sending unit in the reservoir.

Thermostat

- The **bypass** in the cooling system is incorporated into the water pump housing as the thermostat opens, the "hat" moves downward and seals the bypass closed, directing all coolant to the radiator.
- The thermostat incorporates a ball check type deaeration feature that facilitates engine coolant fill.

IPR Valve

- The **IPR Valve** (Injection Pressure Regulator) is controlled by the PCM to vary the oil pressure used to actuate the injectors.

High Pressure Hose

- **Hoses which have been specifically designed to withstand the high pressures and temperature differentials are used to direct the high pressure oil to the oil galleries in the heads.**

  Important
  Use only FORD certified replacement hoses for this application.

Transfer Pump

- The **fuel transfer pump** has two stages. The low pressure diaphragm stage lifts fuel from the tank and pumps it to the fuel filter. The high pressure stage raises fuel pressure to 40 to 70 psi in the cylinder head fuel galleries.
- The transfer pump mounts in the crankcase valley and is operated by a lobe of the camshaft using its own tappet.
- The fuel is directed into the rear of each cylinder head **fuel gallery**.
- The **banjo fitting** is sealed by coated aluminum gaskets on both sides. Steel lines are used to deliver the fuel.

Fuel Filter

- The ports at the top of the transfer pump are the low pressure inlet (left) and outlet (right). Outlet pressure (5-10 psi) is directed to the fuel filter. Filtered fuel is directed back to the transfer pump where its pressure is raised for delivery to the fuel galleries in the heads.

- **Return fuel** from the fuel galleries in the heads is directed to the pressure regulator on the filter housing. This pressure regulator also controls the quantity of fuel returned to the tank.

Fuel Return Hoses

- **Use only certified replacement hoses of the correct part number when repairing the 7.3 DIT fuel system. Substituted hoses may not meet pressure and/or flexibility requirements needed for proper fuel system operation.**

Turbocharger

- The **turbocharger mounting pedestal** bolts directly tot he crankcase and its internal passages for turbocharger lube and drain are sealed by O-rings. The pedestal may be removed from the turbocharger.
- Contained in the pedestal are the EBP (Exhaust Back-Pressure) regulator solenoid and the EBP piston. Oil regulated by the EBP solenoid actuates a piston which in turn operates the back-pressure control valve.

Crankcase Breather

- The closed **crankcase breather** allows crankcase vapors to be drawn into the air intake system by intake air flow. The breather filter keeps oil from migrating into the intake system. The crankcase breather is sealed to the valve cover by O-rings.

Turbocharger

- Exhaust gases are directed from the exhaust manifolds to the turbocharger through stainless **steel exhaust pipes**. The pipes are connected to the turbine collector which is designed to dampen exhaust pulsations prior to the turbine wheel.

Dipstick

- The **dipstick tube** is bracketed to the valve cover bolts and goes through a mount on the oil pan. The mount in the oil pan is sealed by O-rings to the pan and to the tube.