

Internal Subsystems

Screen 1:

Introduction to Internal Subsystems:

Welcome to the Internal Subsystems module of the 7FDL Diesel Engine Basic course. This module describes the flow paths that water, fuel, combustion air, exhaust air, and lubricating oil take through the 7FDL™ diesel engine.

At the end of this module, you will be able to:

- Define the purpose of each of the internal subsystems within the 7FDL diesel engine.
- Explain the flow of lubricating oil, cooling water, fuel, combustion air, and exhaust air in the 7FDL diesel engine.

Screen 2:

Lubricating Oil Path:

The purpose of the lubricating oil system is to supply pressurized lubricating oil to the moving parts of the engine and to carry away heat produced by friction. The lubricating oil has two distinct flow paths for supplying oil to the internal diesel engine components, with one path directing lubricating oil to the crankshaft main bearings and the other path directing lubricating oil to four of the camshaft bearings. From the lubricating oil filter tank, lube oil passes through the Integrated Front End (IFE) cover on the free-end of the engine to the main oil header. Branch passages within the main frame then direct oil to each of the two internal flow paths.

Screen 3:

Lubricating Oil Path (Cont'd):

In the first oil flow path, internal drilled passageways in the main frame carry the oil from the main oil header to each main bearing location, thus supplying oil to all of the crankshaft main bearings. Oil enters the crankshaft from the main bearings and flows through diagonally drilled holes in the crankshaft to the crankpins and rod bearings. The oil passes from the rod bearings through the master rods to the articulated pins and bushings. Oil then flows through drilled passages in the master and articulated rods to lubricate the piston pins and bushings. From each piston pin, oil passes through the piston skirt to the chamber under the piston crown to carry away heat from the piston crown. Oil then flows out of the piston crown through an orifice and gravity drains back into the crankcase.

Screen 4:

Lubricating Oil Path (Cont'd):

In the second oil flow path, internal drilled passageways in the main frame carry the oil from the main oil header to the number 2 and number 8 cam bearing locations on both sides of the 16-cylinder engine. The oil entering the four camshaft bearings then travels lengthwise through the camshaft sections. Radial holes in the shaft sections supply oil to each of the other camshaft bearings. The camshaft bearings contain annular grooves connecting to passages in the engine main frame, from where the oil flows to the valve and fuel crosshead guides. The oil passage to the right number 7 and 8 (R7/8) camshaft bearings also supplies oil to the oil gauges and sensors. The oil then passes through the crosshead guides and into the crossheads, then up through the hollow push rods to oil the rocker and valve train assemblies to the tops of the cylinders. The oil gravity drains back down around the push rods and over the crosshead rollers and cam lobes before

draining back into the crankcase.

Screen 5:

Lubricating Oil Path (Cont'd):

In addition to the two oil flow paths to the internal engine components, lubricating oil is also supplied to the auxiliary drive gear end, barring-over gearbox, and the free-end components. The auxiliary drive gear is lubricated internally by oil flowing from a passage within the crankshaft through the gear hub. Oil passes through the bearings and returns by gravity to the crankcase. Lubricating oil is supplied to the barring-over gearbox by an internal drilled passageway in the main frame to the gearbox. The oil from the gearbox returns to the crankcase internally. The free-end bearing is lubricated through a passage from the engine oil header to an annular groove around the bearing. Another passage connects the annular bearing groove to a passage in the idler gear shaft to lubricate its bushing. The camshaft and split drive gears are splash lubricated through an orifice and pipe from the engine oil header. The bearings and drive gears of the lubricating oil and water pumps are lubricated by running partially submerged in oil in the free-end cover reservoir.

Screen 6:

Cooling Water Path:

The purpose of the cooling water system is to maintain the operating temperature of the engine under all throttle calls and load conditions. Water flows from the water pump into the front end cover of the engine. Passing through the front end cover, the water then enters the inlet water headers where it is supplied to each of the cylinders. Within each cylinder, water flows through an opening in the cylinder jacket wall and is forced from the lower band of the cylinder liner through drilled passageways to the upper band of the cylinder liner. Cooling water from the top of the cylinder liner then flows to cavities in the cylinder's head. After cooling the head, the water passes through an outlet opening in the top of the head and a core passage in the top portion of the cylinder jacket to the water discharge header.

Screen 7:

Fuel Oil Path:

The purpose of the fuel oil system is to provide fuel to the cylinders for combustion and to provide cooling for the high-pressure fuel equipment. Fuel oil is supplied through parallel low-pressure fuel lines to the inlets of each high-pressure fuel pump. The pumps, driven by the camshafts, pressurize the fuel to over 18,000 psi. A solenoid, located on each high-pressure pump, is electronically controlled to open and close based on control signals from the Electronic Fuel Injection (EFI) computer. When the solenoid is open, pressurized fuel oil is fed to the fuel injector through the high-pressure fuel line. At a preset pressure, the fuel is sprayed into the combustion chamber where it combines with compressed air and ignites, causing combustion to occur. Fuel that is not used for combustion cools the high-pressure fuel components and then returns to the fuel tank through low-pressure return lines. Low-pressure fuel paths also exist to lubricate the internal parts of each high-pressure pump and to prevent excess fuel system pressure from damaging the high-pressure pumps.

Screen 8:

Combustion Air Path:

The purpose of the combustion air system is to supply compressed air to the power assembly for combustion. At low speeds, the engine draws air through the turbocharger. At high speeds and

increased loads, the energy produced by the hot exhaust gases drives the turbocharger's turbine, rotating the compressor. The heated air, up to as much as 350°F (177°C) at Notch 8, passes through the intercooler cores. These heat exchangers can cool the intake air to as low as 145°F (63°C). At idle or at light loads in cold weather, the air may actually be warmed by heat transferred from the water in the intercooler cores. From each intercooler, the air runs through an air manifold to the power assemblies. Within each power assembly, the air is supplied to the combustion chamber when the corresponding intake air valves are open.

Screen 9:

Exhaust Air Path:

The purpose of the dual-pipe exhaust manifold is to channel the exhaust gases from the combustion chambers to the turbocharger to supply the energy needed to compress the combustion air. As the exhaust valves open, the exhaust gases exit into the exhaust manifold. The pressure created by the hot exhaust gases turns the turbine in the turbocharger. Then the exhaust gases exit to the atmosphere through the muffler assembly.

Screen 14:

Summary:

You have reached the end of this module!

In this module, you learned to:

- Define the purpose of each of the internal subsystems within the 7FDL engine.
 - The lubricating oil system supplies pressurized lubricating oil to the moving parts of the engine.
 - The cooling water system maintains the operating temperature of the engine under all throttle calls and load conditions.
 - The fuel oil system delivers fuel to the cylinders for combustion and provides cooling to the high-pressure fuel equipment.
 - The combustion air system supplies compressed air to the power assembly for combustion.
 - The exhaust air system channels the exhaust gases from the combustion chamber to the turbocharger to supply the energy needed to compress the combustion air.
- Explain the flow of lubricating oil, cooling water, fuel, combustion air, and exhaust air in the 7FDL diesel engine.
 - Lubricating Oil Path
 - The lubricating oil has two distinct flow paths.
 - In the first oil flow path, internal drilled passageways in the main frame carry the oil from the main oil header to each main bearing location, thus supplying oil to all of the crankshaft main bearings. Through diagonally drilled holes in the crankshaft, oil flows to the crankpins and rod bearings. The oil passes from the rod bearings through the master rods to the articulated pins and bushings. Through drilled passages in the master and articulated rods, oil flows to the piston assembly and lubricates it. The oil is then drained back into the crankcase by gravity.
 - In the second oil flow path, internal drilled passageways in the main frame carry the oil from the main oil header to the number 2 and number 8 cam bearing locations on

both sides of the 16-cylinder engine. The oil entering the four camshaft bearings then travels lengthwise through the camshaft sections. The camshaft bearings contain annular grooves connecting to passages in the engine main frame, from where the oil flows to the valve and fuel crosshead guides and crossheads. The oil then flows up through the hollow push rods to oil the rocker and valve train assemblies. The oil drains back down around the push rods and over the crosshead rollers and cam lobes before draining back into the crankcase. The oil passage to the right number 7 and 8 camshaft bearings also supplies oil to the oil gauges and sensors.

- In addition to the two oil flow paths to the internal engine components, lubricating oil is also supplied to the auxiliary drive gear end, barring-over gearbox, and free-end components.
- Cooling Water Path
 - Passing through the water pump and the front end cover of the engine, cooling water enters the inlet water headers. From the inlet headers, cooling water is supplied to an opening in the cylinder jacket wall of each cylinder, from where it passes to and cools the lower and upper bands of the cylinder liner. Cooling water from the top of the cylinder liner then flows to cavities in the cylinder's head. After cooling the head, the water passes to the water discharge header.
- Fuel Oil Path
 - The fuel flows to the inlets of the high-pressure fuel pump, where the fuel is pressurized and fed to the fuel injectors. At a predetermined pressure, the fuel is sprayed into the combustion chamber where it combines with compressed air and ignites, causing combustion to occur. Fuel that is not used for combustion cools the high-pressure fuel components and then returns to the fuel tank through low-pressure return lines.
- Combustion Air Path
 - To provide air for combustion, at low speeds, the engine draws air through the turbocharger. At high speeds and increased loads, the energy produced by the hot exhaust gases drives the turbocharger. The heated air passes through the intercooler cores and runs through an air manifold to the power assemblies, where the air is supplied to the combustion chamber when the intake air valves are open.
- Exhaust Air Path
 - The exhaust gases exit into the dual-pipe exhaust manifold. The pressure created by the hot exhaust gases turns the turbine in the turbocharger. Then the exhaust gases exit to the atmosphere through the muffler assembly.