Electronic Fuel Injection

Screen 1:

Introduction to Electronic Fuel Injection System:

Welcome to the Electronic Fuel Injection module of the 7FDL Diesel Engine Basic course. This module describes the function and major components of the Electronic Fuel Injection or EFI system of the 7FDL Diesel Engine.

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

- Define the purpose of the EFI system.
- State the purpose and location of each EFI system major component.
- State the purpose and location of each EFI system instrumentation device.
- Describe how the EFI system works.

Screen 2:

Purpose of the EFI System:

In the 7FDL diesel engine, the EFI system is an important design feature that reduces emissions and creates a more fuel-efficient engine. The primary purpose of the EFI system is to deliver an appropriate amount of fuel, at the correct time, to each of the cylinders of the diesel engine. The secondary purpose of the EFI system is to monitor and identify certain engine operating parameters and provide engine protection capabilities. In addition to fuel efficiency and reduced emissions, the EFI system also provides improved diagnostic capabilities.

Screen 3:

Purpose of the EFI System (Cont'd):

The EFI system monitors and identifies certain operating parameters and, if those parameters are detected as being outside normal limits, will alert the microcomputer system to reduce engine speed and/or alternator load and excitation. Sensors within the EFI system send the information related to the engine's operating conditions to the Smart Displays. The difference between the EFI system and a mechanical fuel system is the ability of the EFI system to control fuel delivery timing. A solenoid, which receives electrical signals from the EFI computer, can tightly control fuel delivery timing.

Screen 4:

The EFI Controller:

The EFI system consists of four major subgroups. They are the EFI controller, the diesel engine speed sensors and top dead center probe, system sensors, and mechanical components. The EFI controller is the microprocessor that controls the EFI system. The EFI controller is a part of the Electronic Governing Unit or EGU. The primary function of the EGU is to control engine speed by controlling the high-pressure fuel pump solenoid located on each cylinder assembly. Through the control of the solenoids, the EGU can vary the fuel timing and the amount of fuel delivered to each cylinder. Along with controlling engine speed, the EGU performs some other important functions. Several inputs are sent to the EGU from sensors on the locomotive.

Screen 7:

Diesel Engine Speed Sensors and Top Dead Center Probe:

In order to calculate the correct fuel delivery timing, the EFI controller must know two

things - engine position in relation to rotational position on the left cam and the engine speed (RPM). This information is gathered by the top dead center probe, also known as the engine position sensor (EPS) and the diesel engine speed sensors, also known as the number 1 and number 2 crankshaft speed sensors (CNK1 and CNK2).

Screen 8:
Diesel Engine Speed Sensors and Top Dead Center Probe (Cont'd):
The engine position sensor, located on the left cam gear cover, is a magnetic pickup that sends pulses to the EGU. The EGU uses this information to determine the rotational position of the engine. The crankshaft speed sensors are magnetic pickups that detect engine speed by means of a tone ring located at the alternator end of the split gear on the crankshaft. The speed sensors are located at one of two possible locations on the 7FDL engine: either on a bracket inside the crankcase at the alternator end of the engine reading off a tone ring on the split gear, or outside the crankcase on the left alternator end of the engine reading off a timing ring assembled to the crankshaft. Note that only one of the two speed sensors is required to run the engine; the second sensor is a backup in case of a sensor failure.

Screen 11:
System Sensors:
System sensors send valuable information to the EGU. There are two types of system sensors – fuel management sensors and engine protection sensors. The inputs from the fuel management sensors are used to calculate the correct air-to-fuel ratio and set fuel limits for the cylinders. The EGU uses information supplied from the air intake manifold sensors to do this. The inputs from the engine protection sensors are used to provide engine protection. The EGU does this by monitoring certain engine support parameters. The sensor box, which holds the fuel management and engine protection sensors, is located at the left side alternator end of the engine. The system sensors include the fuel injection manifold air pressure (FIMAP) sensor, the fuel injection manifold air temperature (FIMAT) sensor, the fuel injection oil pressure (FIOP1) sensor, the fuel injection water pressure sensor (FIWPS), and the fuel injection engine water temperature (FIEWT) sensor.

Screen 12:
FIMAP Sensor:
The FIMAP takes a pressure tap off the air intake manifold located at the left 8-cylinder location. The pressure tap feeds into a sensor box located next to the L8 cylinder. Inside the sensor box, a transducer supplies information to the EGU.

Screen 13:
FIMAT Sensor:
The FIMAT is a thermistor that is used to sense the air temperature in the air intake manifold. The EGU uses this air temperature information and the pressure reading information to calculate the density of the air supplied to the cylinders for combustion. It is located in the sensor box next to the L8 cylinder location.

Screen 14:
FIOP1 Sensor:
The FIOP1 sensor supplies lubricating oil pressure information to the EGU. This information is used to protect the engine from serious damage resulting from low oil pressure. If the EGU receives

information that the engine's oil pressure does not support the throttle and load call, it will adjust the engines speed to match the present oil pressures. If the minimum pressure is not present to run the diesel engine, the EGU will shut down the engine.

Screen 15:
FIWPS Sensor:
The FIWPS sensor supplies engine cooling water pressure to the EGU. This information is used to protect the engine from serious damage resulting from low water pressure. If the EGU receives information that the engine's water pressure does not support the throttle and load call, it will adjust the engines speed to match the current water pressure.

Screen 16:
FIEWT Sensor:
The FIEWT sensor provides engine water temperature information to the EGU. The EGU uses the water sensor information to determine the right fuel-to-air ratio when the engine is cold.

Screen 17:
Mechanical Components:
The purpose of the mechanical components is to deliver the correct amount of fuel to each cylinder for combustion. Each cylinder on the 7FDL diesel engine is equipped with a high pressure fuel pump, a high-pressure fuel line, and an injector. The injector works as a check valve releasing fuel into the combustion chamber when the required pressure is reached.

Screen 18:
High-Pressure Fuel Pump:
The high-pressure fuel pump is a solenoid controlled booster pump. The pump receives a steady supply of fuel from the locomotive's low-pressure fuel system. The low-pressure fuel (90 psi) is boosted by the high-pressure pump to very high pressures (18,000 psi). The signals from the EGU control the closing point of the solenoid, thus providing the means to vary fuel timing. The EGU signals also control the duration for which the solenoid is opened, thus controlling the amount of fuel delivered.

Screen 19:
High-Pressure Fuel Line:
The high-pressure fuel line connects the high-pressure fuel pump to the injector. It transfers fuel from the pump to the injector.

Screen 20:
Injector:
The injector receives the high-pressure fuel from the high-pressure fuel pump. After the fuel in the injector reaches a predetermined pressure, the fuel will be injected directly into the combustion chamber.

Screen 24:
Summary:
You have reached the end of this module!

In this module, you learned to:

- Define the purpose of the EFI system.
  - The primary purpose of the EFI system is to deliver an appropriate amount of fuel, at the correct time, to each of the cylinders of the diesel engine.
  - The secondary purpose of the EFI system is to monitor and identify the operating parameters and provide engine protection capabilities.

- State the purpose and location of each EFI system major component.
  - The EFI system consists of four major subgroups:
    - The EFI controller is the microprocessor that controls the EFI system. The EFI controller is a part of the EGU. The main function of the EGU is to control engine speed by controlling the high-pressure fuel pump solenoid located on each cylinder assembly. Through the control of the solenoids, the EGU varies the fuel timing and the amount of fuel delivered to each cylinder. The EGU is located in the aux cab.
    - The purpose of the diesel engine speed sensor and the top dead center probe is to provide information to the EGU to determine the engine position in relation to rotational position on the left cam and the engine speed (RPM). The speed sensors are located at one of two possible locations on the 7FDL engine: either on a bracket inside the crankcase at the alternator end of the engine, or outside the crankcase on the left alternator end of the engine. The engine position sensor is located on the left cam gear cover.
    - The purpose of the system sensors is to calculate the correct air-to-fuel ratio and set fuel limits for the cylinders and to provide engine protection by monitoring certain engine support parameters.
    - The purpose of the mechanical components is to deliver the correct amount of fuel to the cylinders for combustion. The mechanical components include a high-pressure fuel pump, a high-pressure fuel line and an injector. The high-pressure fuel pump is mounted to the cylinder strongback. The injector is mounted to the cylinder head. The fuel lines connect the two components.

- State the purpose and location of each EFI system instrumentation device.
  - There are two types of system sensors:
    - Fuel Management sensors
      - The FIMAP takes a pressure tap off the air intake manifold located at the left 8-cylinder location. The pressure tap feeds into a sensor box located next to the L8 cylinder.
      - The FIMAT is a thermistor that is used to sense the air temperature in the air in-take manifold. The EGU uses this air temperature information and the pressure reading information to calculate the density of the air supplied to the cylinders for combustion. It is located in the sensor box next to the L8 cylinder location.
    - Engine Protection sensors
      - The FIOP1 sensor supplies lubricating oil pressure information to the EGU. This information is used to protect the engine from serious damage resulting from low oil pressure.

        - The FIWPS sensor supplies engine cooling water pressure to the EGU. This information is used to protect the engine from serious damage resulting from low water pressure.
        - The FIEWT sensor provides engine water temperature information to the EGU. The EGU uses the water sensor information to determine the right fuel-to-air ratio when the engine is cold.
    - These sensors are located in a sensor box at the left side alternator end of the engine.

- Describe how the EFI system works.
    - Fuel, from the low-pressure fuel system, flows into the high-pressure fuel pump, and is released into the combustion chamber after passing through the high-pressure fuel line and injector.
    - The EGU controls the high-pressure fuel solenoids located on each cylinder assembly to vary the fuel timing and the amount of fuel delivered to each cylinder.
    - The engine position sensors provide information to the EGU to determine the rotational position of the engine. The crank sensors 1 and 2 provide information to the EGU about engine speed. The EGU uses this information to calculate the correct fuel delivery timing.
    - The fuel management sensors, FIMAP and FIMAT, provide information to the EGU to calculate the density of air supplied for combustion, determine the air-to-fuel ratio, and thus control the amount of fuel delivered to the combustion chamber.
    - The engine protection sensors, FIOP1, FIWPS, and FIEWT, provide diagnostic information to the EGU for engine protection.