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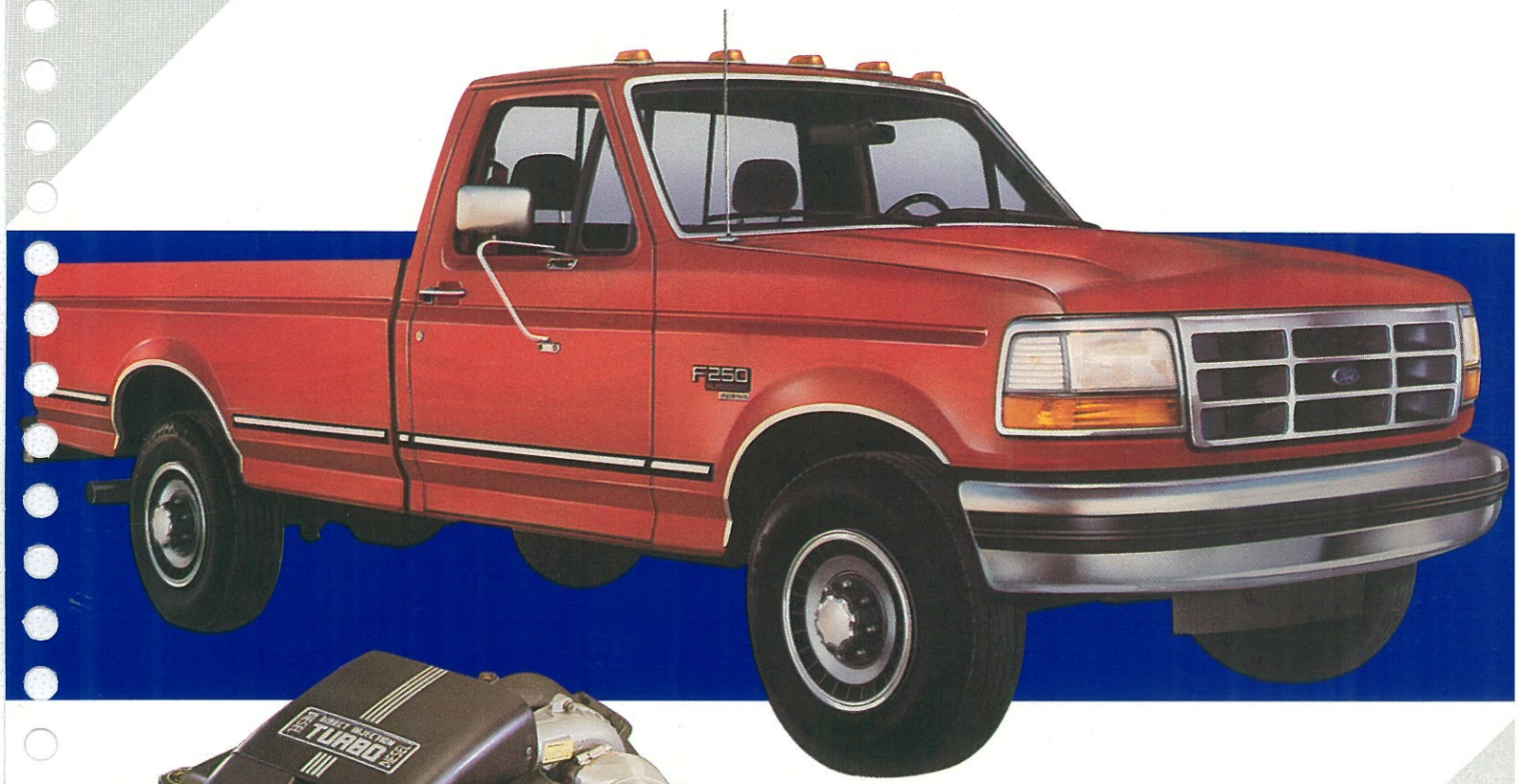

7.3 DIT
DIRECT INJECTION TURBOCHARGED DIESEL ENGINE

FOREWORD

This publication is intended to provide technicians and service personnel with the latest technical advancements incorporated in the 7.3 DIT Diesel Engine. The information contained in this publication will supplement information contained in available service literature.

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as, the personal safety of the individual doing the work. This manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as, in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

The following list contains some general **WARNINGS** that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the **OFF** position, unless otherwise required by the procedure.
- Never perform any service to the engine with the air cleaner removed and the engine running unless a turbocharger compressor inlet shield is installed.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in **PARK** unless instructed otherwise for a specific service operation. If you have a manual transmission, it should be in **REVERSE** (engine OFF) or **NEUTRAL** (engine ON) unless instructed otherwise for a specific service operation.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan, belts, and the turbocharger compressor.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, turbocharger pipes, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades.

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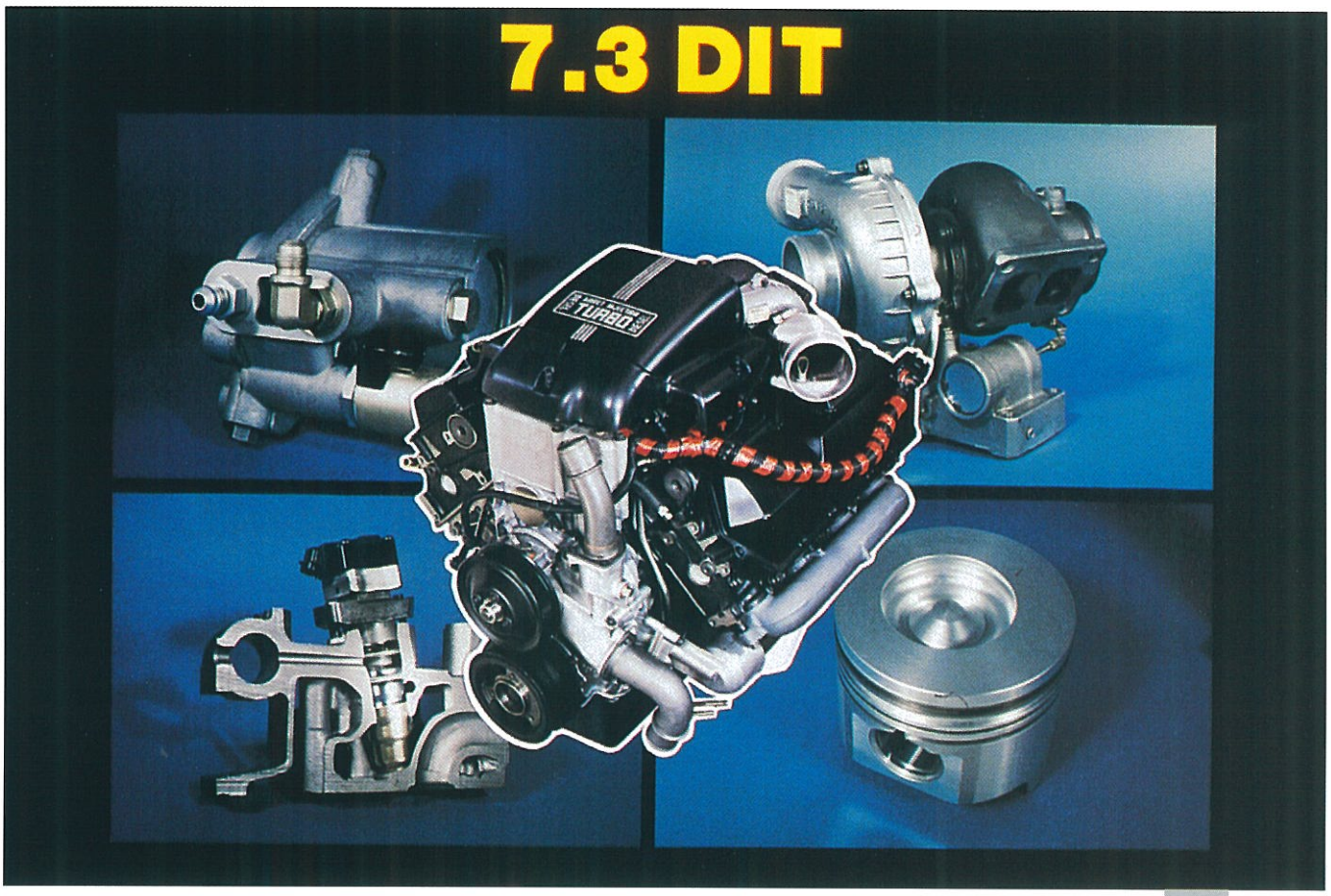

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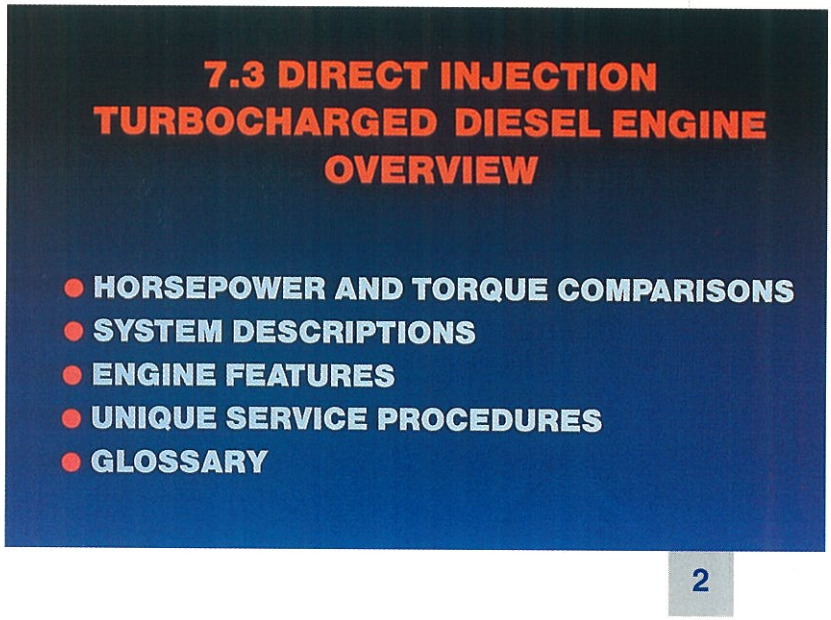
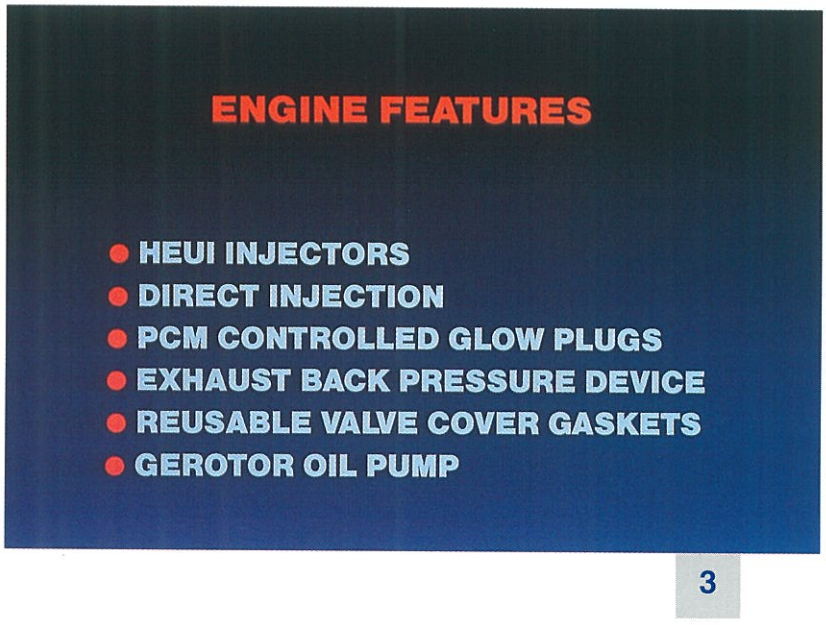
7.3 DIT DIRECT INJECTION TURBOCHARGED DIESEL ENGINE

7.3 DIT DIESEL ENGINE

7.3 DIT OVERVIEW

- This publication is not intended to replace the Service Manual but to introduce the 7.3 DIT.



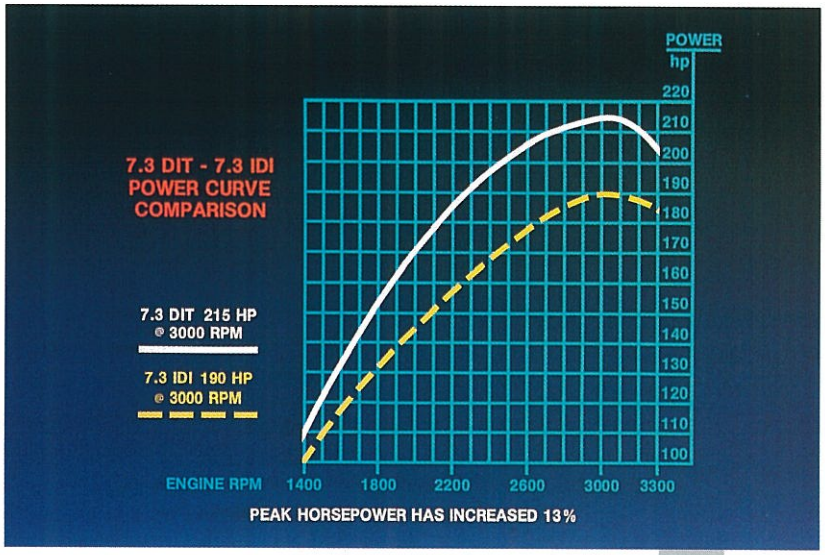


ENGINE FEATURES

- The 7.3 DIT has been designed to meet customer expectations for increased performance.

- New features used in this engine are discussed in detail.

7.3 DIT DIESEL ENGINE



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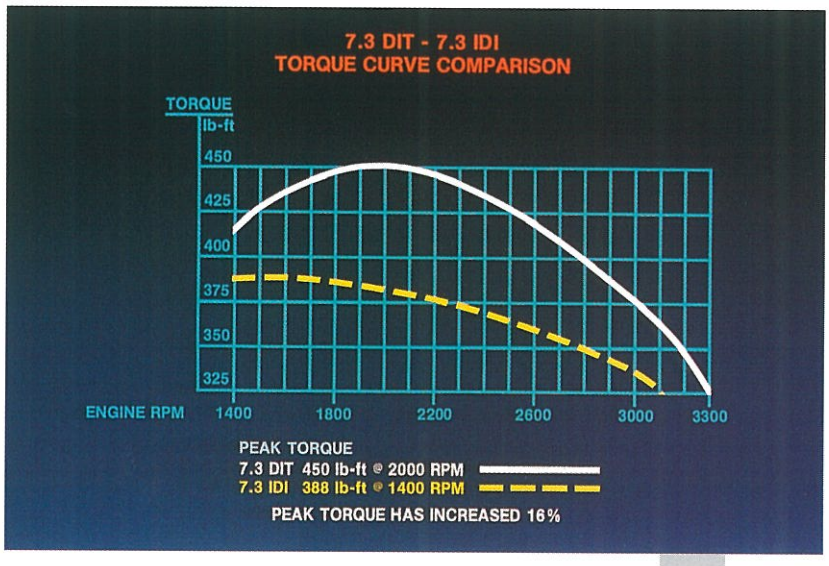
HORSEPOWER COMPARISON

- The 7.3 DIT engine will consistently produce 215 peak horsepower @3000 rpm at sea level and up to elevations of 10,000 feet.
- This is a 13% increase over the 7.3 IDI Turbocharged engine.
- Electronic engine management combined with turbocharging and more robust power cylinders provides an increase in horsepower over previous 7.3 engines, and accomplishes this at lower emission levels.

TORQUE COMPARISON

- The 7.3 Direct Injection Turbocharged Diesel engine produces 450 lb./ft. of torque between 1900 and 2100 rpm compared to the 7.3 IDI's 388 lb./ft. at 1400 rpm. This is a 16% increase over the 7.3 IDI Turbocharged engine.
- The 7.3 Direct Injection Turbocharged Diesel engine provides significantly increased performance, without sacrificing reliability of the drivetrain components.



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7.3 DIT DIESEL ENGINE

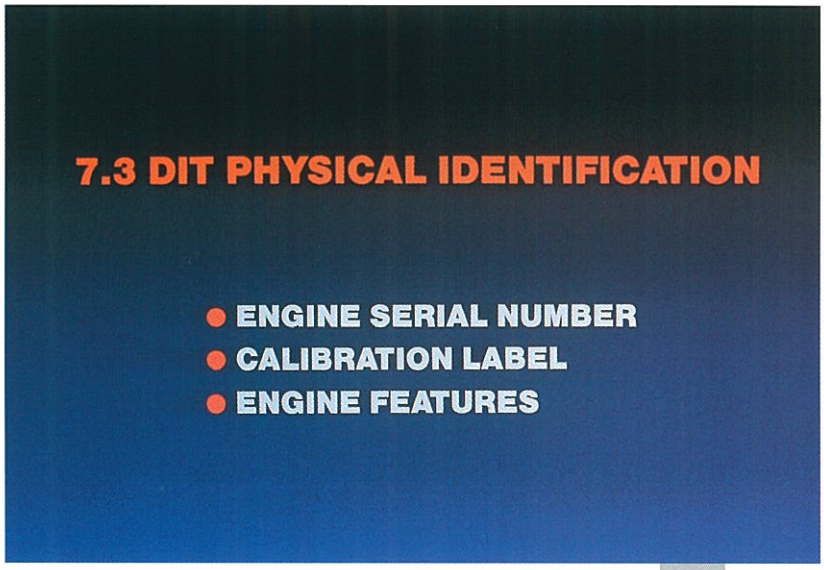
7.3 DIT DIESEL ENGINE SPECIFICATIONS

ENGINE TYPE	DIESEL, 4-CYCLE
CONFIGURATION	OHV-V8
DISPLACEMENT	444 cu. in. (7.3L)
BORE AND STROKE	4.11 x 4.18 (10.44 x 10.62cm)
COMPRESSION RATIO	17.5:1
ASPIRATION	TURBOCHARGED
RATED POWER @RPM	215 @ 3000 RPM
PEAK TORQUE @ RPM	450 @ 1900 RPM
ENGINE ROTATION, FACING FLYWHEEL	COUNTER CLOCKWISE
COMBUSTION SYSTEM	DIRECT INJECTION
TOTAL ENGINE WEIGHT (DRY)	920 LB. (417.6 Kq)
COOLANT FLOW	80 GPM (302.8L/min) @ 3300 RPM
FAN-TO-CRANK RATION	1.1:1
HEAT REJECTION	30 BTU/Hp-Min
AIR FLOW @ RPM	548 CFM (15.5 m^3/min.) @ 2600 RPM
EXHAUST FLOW @ RPM	1600 CFM (45.3 m^3/min.) @ 3000 RPM
COOLING-SYSTEM CAPACITY (ENGINE ONLY)	12 QUARTS (11.4 LITERS)
LUBE-SYSTEM CAPACITY (INCLUDING FILTER)	12 QUARTS (11.4 LITERS)

SPECIFICATIONS

- The 7.3 DIT Diesel engine is a totally new engine design that will provide improved fuel economy, durability, and performance.

7.3 DIT DIESEL ENGINE PHYSICAL IDENTIFICATION



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PHYSICAL IDENTIFICATION

- Three ways to identify are:
- ENGINE SERIAL NUMBER
- CALIBRATION LABEL
- ENGINE FEATURES

ENGINE SERIAL NUMBER

- The engine serial number is located on rear oil cooler pad.
- 7.4 - is the engine family identifier
- JU2U is a manufacturing designator
- 000501* is a sequential build number

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7.3 DIT DIESEL ENGINE PHYSICAL IDENTIFICATION

CALIBRATION LABEL

- The calibration label Is located on the front of the high pressure oil reservoir.
- The manufacturing date is identified.

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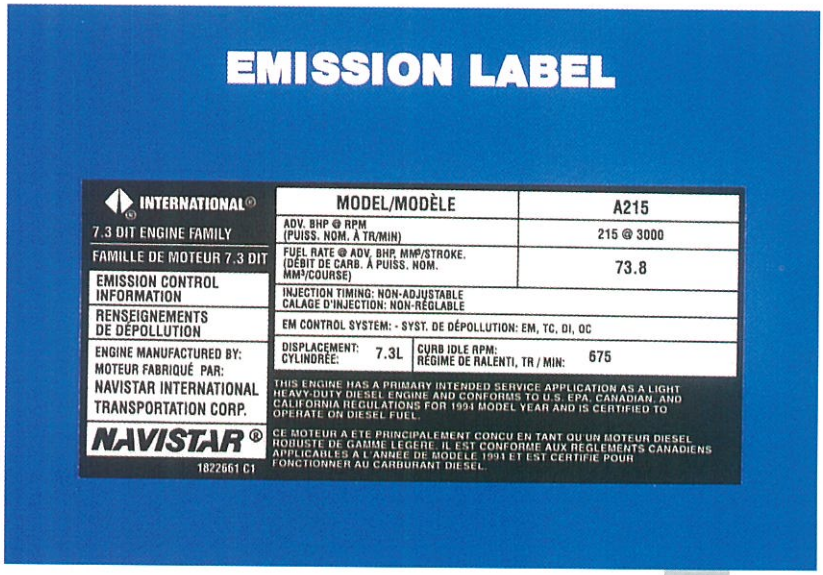
EMISSION LABEL

- The emission label is located on the Right Valve Cover and identifies the engine model, horsepower, and fuel delivery rate.



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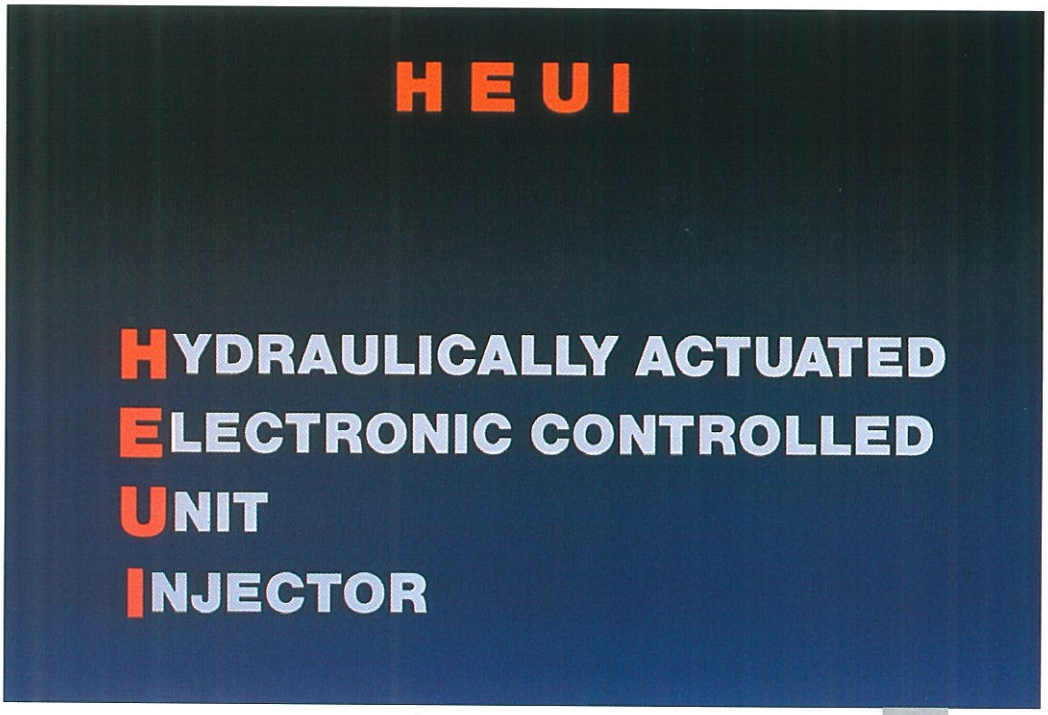
HEUI FUEL SYSTEM OPERATION



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SYSTEM OVERVIEW

- Demands for greater fuel economy and lower exhaust emissions, in the 90's and beyond, require improved fuel system performance. The HEUI system (Hydraulically Actuated, Electronically Controlled, Unit Injection) meets these requirements. Three critical factors that lead to enhanced performance are:

- RATE OF CONTROL

- TIMING CONTROL

- HIGHER INJECTION PRESSURES

HEUI FUEL SYSTEM OPERATION

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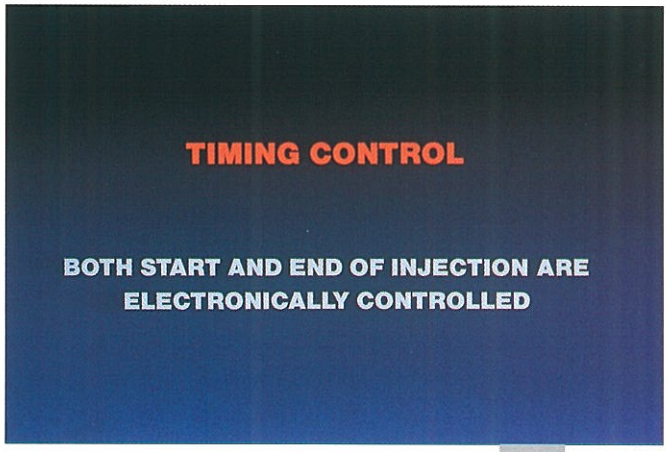
RATE CONTROL

- The rate of injection can be controlled to meet any engine condition.
- Because the HEUI is hydraulically actuated rather than mechanically actuated, its rate of injection does not depend on engine speed.

TIMING CONTROL

- Both start and end of injection are electronically controlled.
- Unlike conventional electronically controlled mechanically actuated unit injectors, the HEUI plunger does not move until the solenoid is energized.
- This means that plunger movement is not limited to the speed or duration of a cam lobe.



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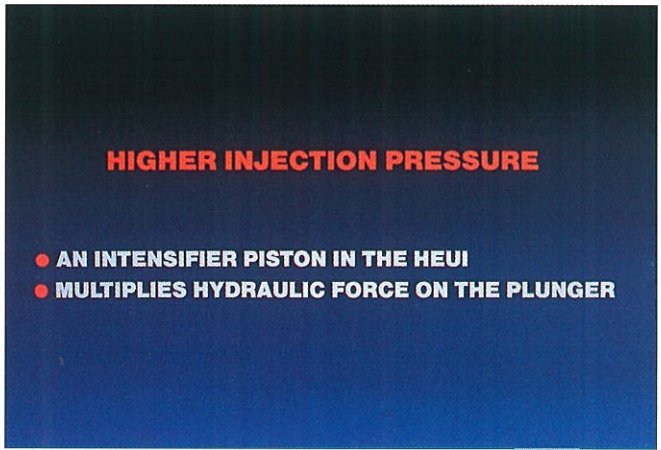

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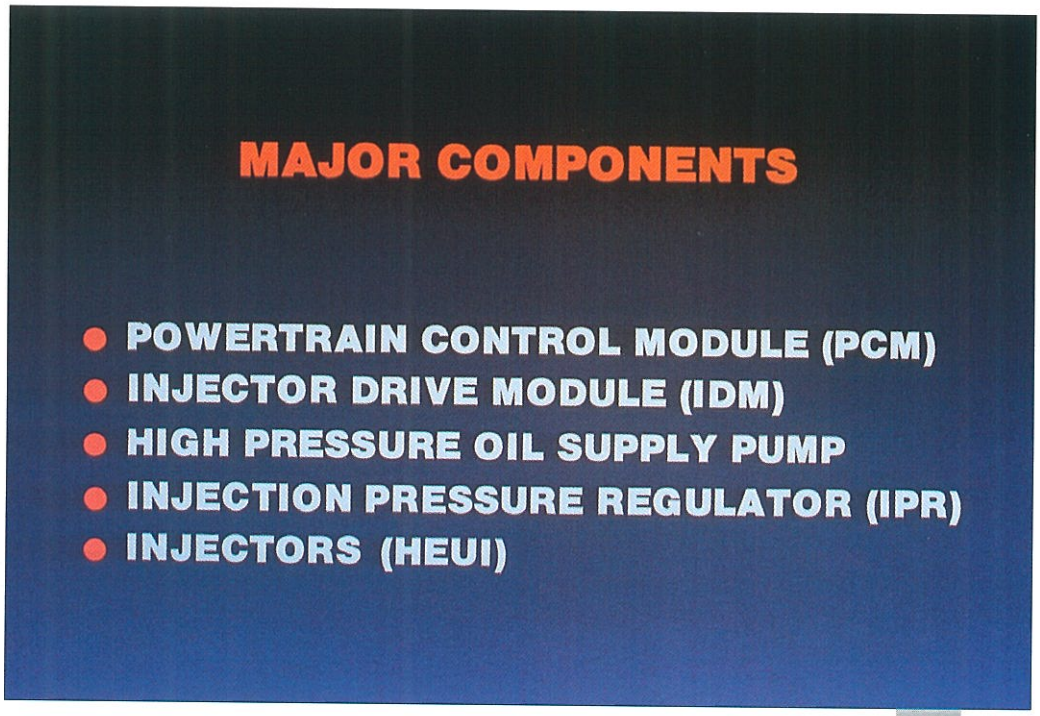
HIGHER INJECTION PRESSURES

- An intensifier piston in the HEUI multiplies hydraulic force on the plunger.
- By varying hydraulic input pressure, injection pressure can be controlled in a range from 3,000 to 21,000 psi.
- These high pressures are available throughout the entire engine operating range, at idle, as well as, high engine speeds.

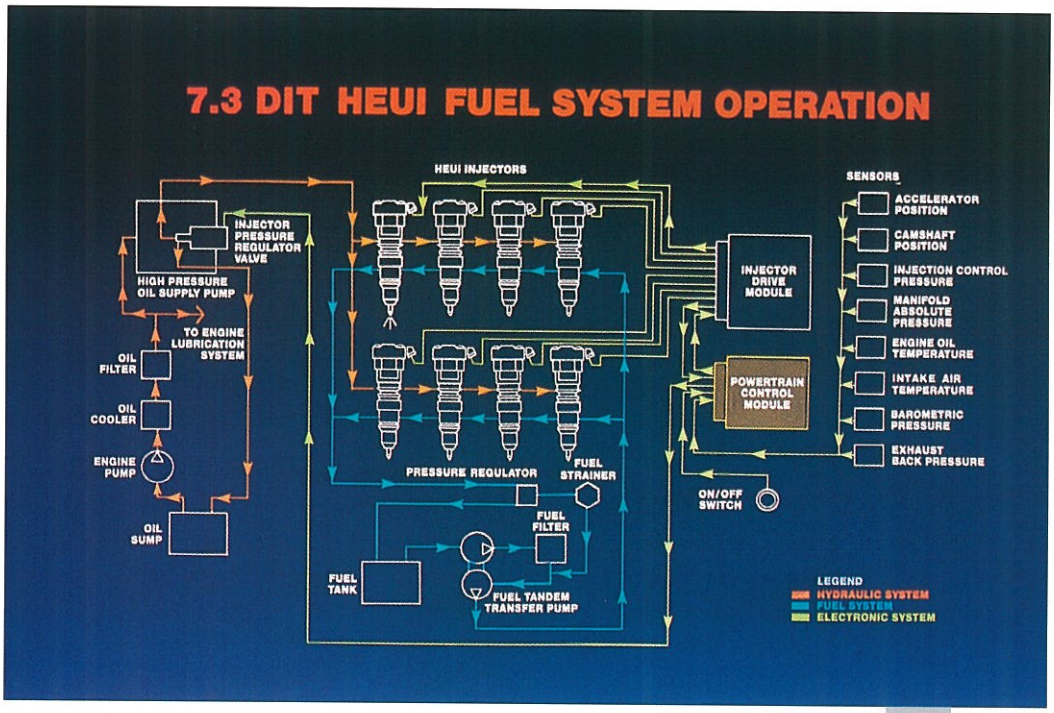
HEUI FUEL SYSTEM OPERATION



THE HEUI SYSTEM CONSISTS OF FIVE MAJOR COMPONENTS:

- **POWERTRAIN CONTROL MODULE (PCM)**
  Previously referred to as EEC utilizing 104 pin connector.
- **INJECTOR DRIVE MODULE (IDM)**
  Steps up signal from PCM to drive injectors.
- **HIGH PRESSURE OIL SUPPLY PUMP**
  A separate high pressure pump with exclusive purpose to power injectors.
- **INJECTION PRESSURE REGULATOR (IPR)**
  Located on high pressure pump, controlled by PCM.
- **INJECTORS (HUEI)**
  One per cylinder under the valve covers.

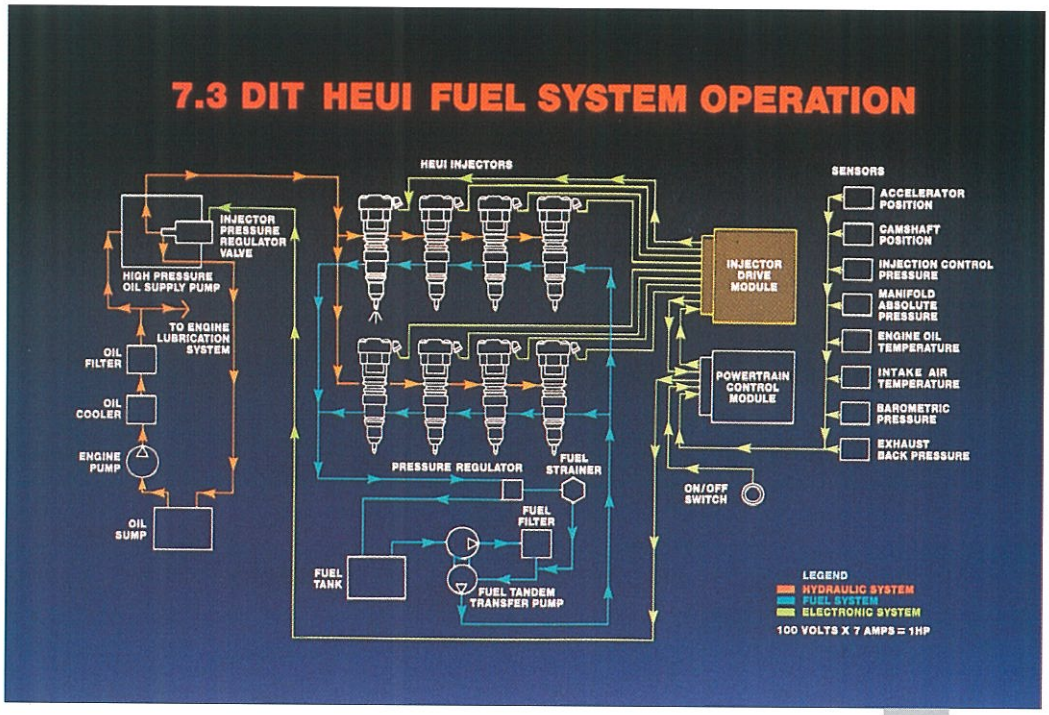
HEUI FUEL SYSTEM OPERATION



POWERTRAIN CONTROL MODULE (PCM)

- The PCM is a microprocessor which monitors various sensors from the vehicle and engine as it controls the operation of the entire fuel system.
- Sensors Monitored Include:
- Accelerator Position Sensor (APS)
- Camshaft Position Sensor (CMP)
- Injection Control Pressure Sensor (ICP)
- Manifold Absolute Pressure Sensor (MAP)
- Engine Oil Temperature Sensor (EOT)
- Intake Air Temperature Sensor (IAT)
- Barometric Pressure Sensor (BARO)
- Exhaust Back-Pressure Sensor (EBP)

HEUI FUEL SYSTEM OPERATION



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INJECTOR DRIVE MODULE (IDM)

- The IDM sends a precisely controlled current pulse to energize the injector solenoid.
- The timing and duration of the IDM pulse are controlled by the PCM.
- The IDM pulse consists of 100 Volts, 7 Amps, equal to 1 horsepower per injection.

HEUI FUEL SYSTEM OPERATION

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- In addition to the crankshaft driven gerotor oil pump that supplies lube oil to the engine, the fuel system features a high pressure lube pump and an injection pressure regulator.

HIGH PRESSURE OIL SUPPLY PUMP

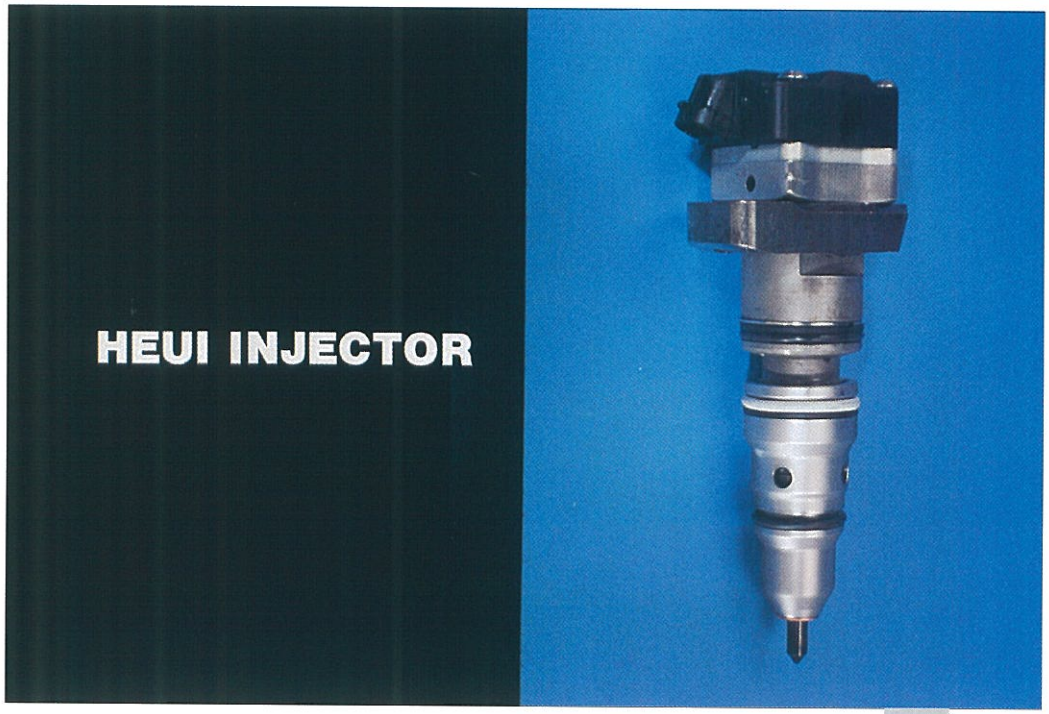
- The hydraulic supply pump is a seven piston fixed displacement axial piston pump.

INJECTION PRESSURE REGULATOR (IPR)

- The IPR is an electrically operated dump valve which closely controls pump output pressure, between 450 and 3,000 psi, by dumping excess flow to the return circuit.

- The IPR is mounted on the high pressure oil pump.

HEUI FUEL SYSTEM OPERATION



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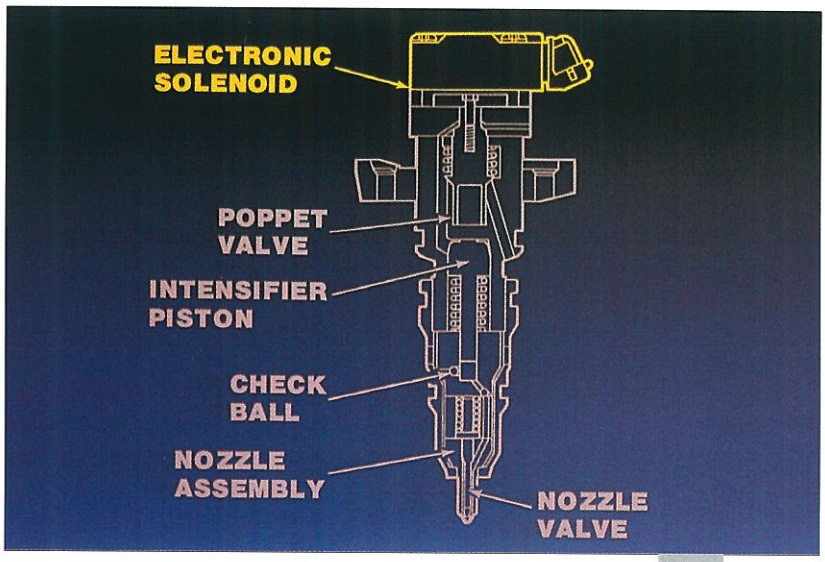
HEUI INJECTOR

- The HEUI Injector is hydraulically actuated by high pressure engine oil supplied by the high pressure oil pump.

- The Injector has four major components which contribute to higher injection pressure needed to satisfy increased customer expectations for performance, while improving fuel economy and meeting emissions regulations.

  - Solenoid
  - Poppet Valve
  - Intensifier Piston and Plunger
  - Nozzle Assembly

HEUI FUEL SYSTEM OPERATION



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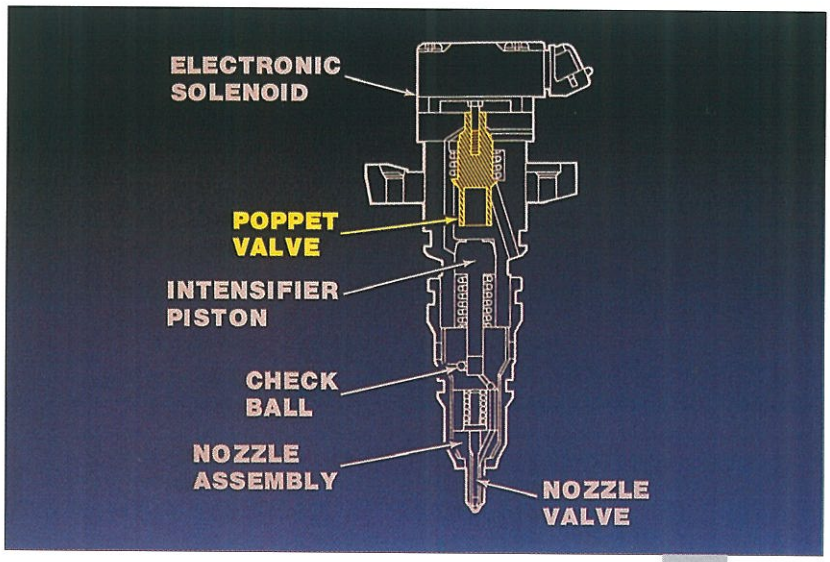
ELECTRONIC SOLENOID

- The solenoid is a very fast acting electro-magnet, which when energized, pulls the poppet valve off its seat.
- The injector is actuated 27 times per second at rated speed.
- 100 VOLTS • 7 AMPS
  1 HORSEPOWER

POPPET VALVE

- The poppet valve is held on its lower seat by a spring. In this closed position, high pressure inlet oil is blocked and the intensifier cavity is opened to drain.
- When the solenoid is energized, the poppet is quickly lifted off its lower seat to its upper seat. The path to drain is closed and the inlet for high pressure oil is opened.



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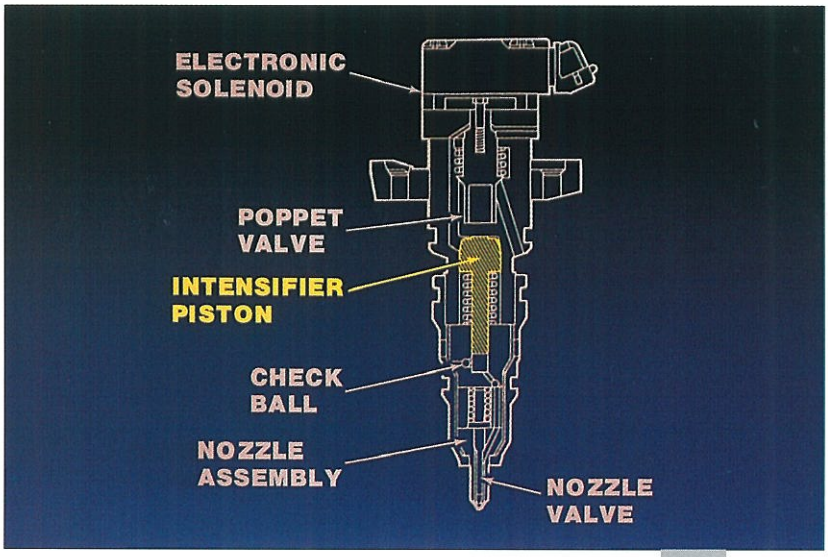
HEUI FUEL SYSTEM OPERATION

INTENSIFIER PISTON AND PLUNGER

- When the poppet valve opens the inlet port, high pressure oil enters the injector and acts on the top of the intensifier piston. Pressure builds on the intensifier, pushing it and the plunger down.
- The intensifier is 7 times larger in surface area than the plunger; providing an equal multiplication of force, i.e. injection pressure.
- The downward movement of the plunger pressurizes the fuel in the plunger cavity, causing the nozzle to open.



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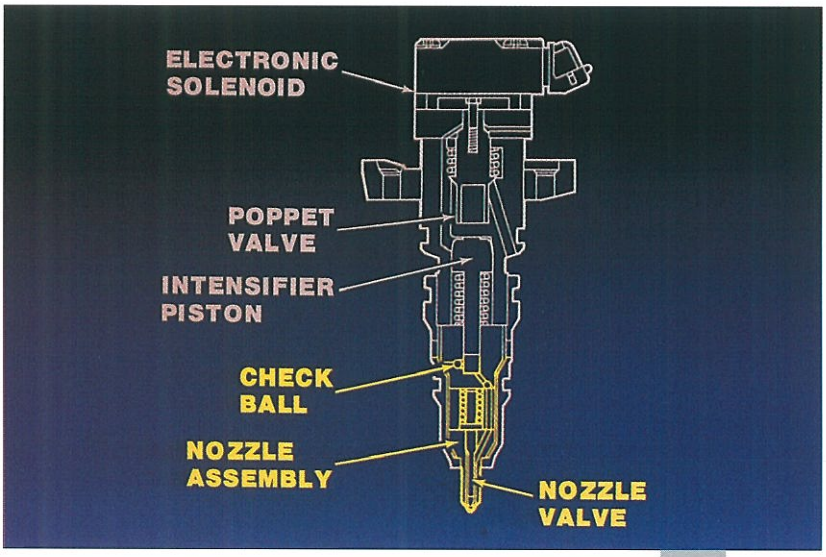

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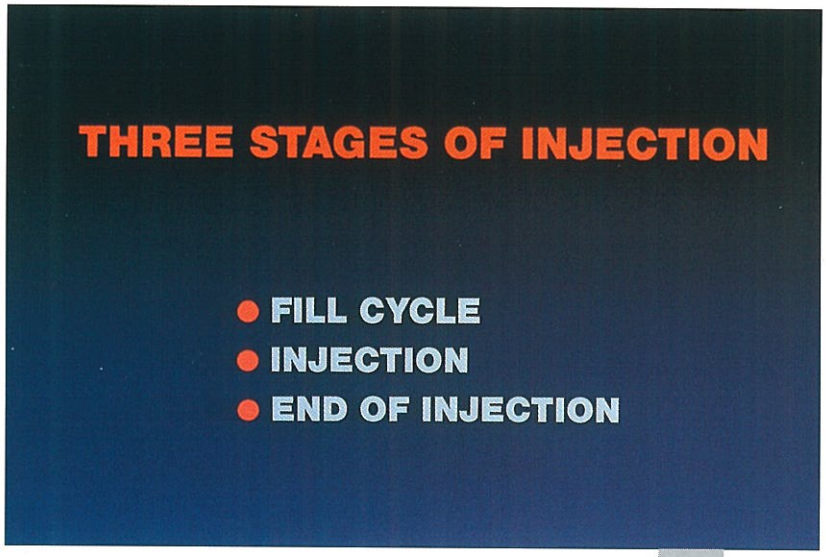
NOZZLE ASSEMBLY

- The nozzle assembly is of conventional design with the exception of the fill check. This check ball seats and seals during the downward stroke of the plunger to prevent leakage of the high pressure fuel.
- During the return stroke, it unseats allowing the plunger cavity to fill.
- The nozzle valve is an inwardly opening type which lifts off its seat when pressure overcomes the spring force. Fuel is then atomized at high pressure through the nozzle tip.

HEUI FUEL SYSTEM OPERATION



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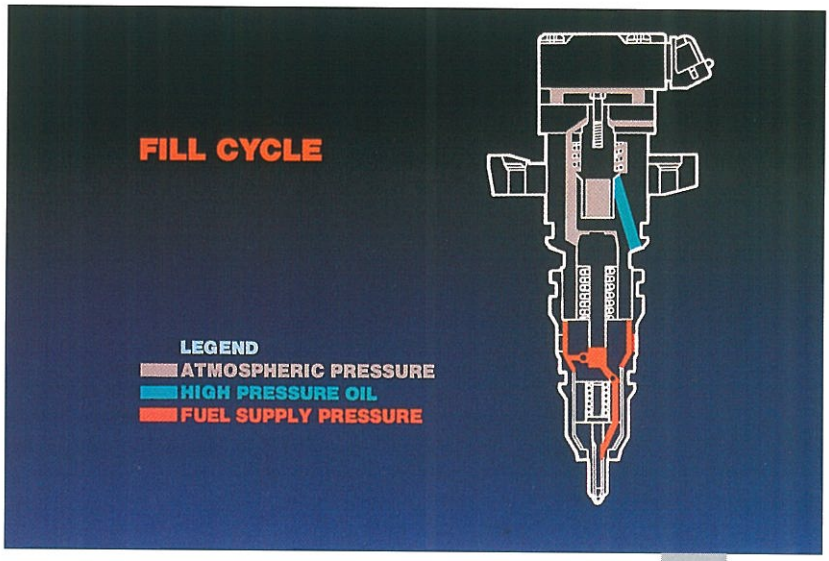
STAGES OF INJECTION

- THERE ARE THREE STAGES OF INJECTION WITH THE HEUI:
- FILL CYCLE
- INJECTION
- END OF INJECTION

FILL CYCLE

- During pre-injection all internal components have returned to their spring loaded positions. The poppet valve is blocking high pressure oil from entering the injector.
- The plunger and intensifier are at the top of their bore and the plunger cavity is full of fuel. Fuel pressure in the plunger cavity is the same as fuel gallery pressure, 40 to 70 psi.



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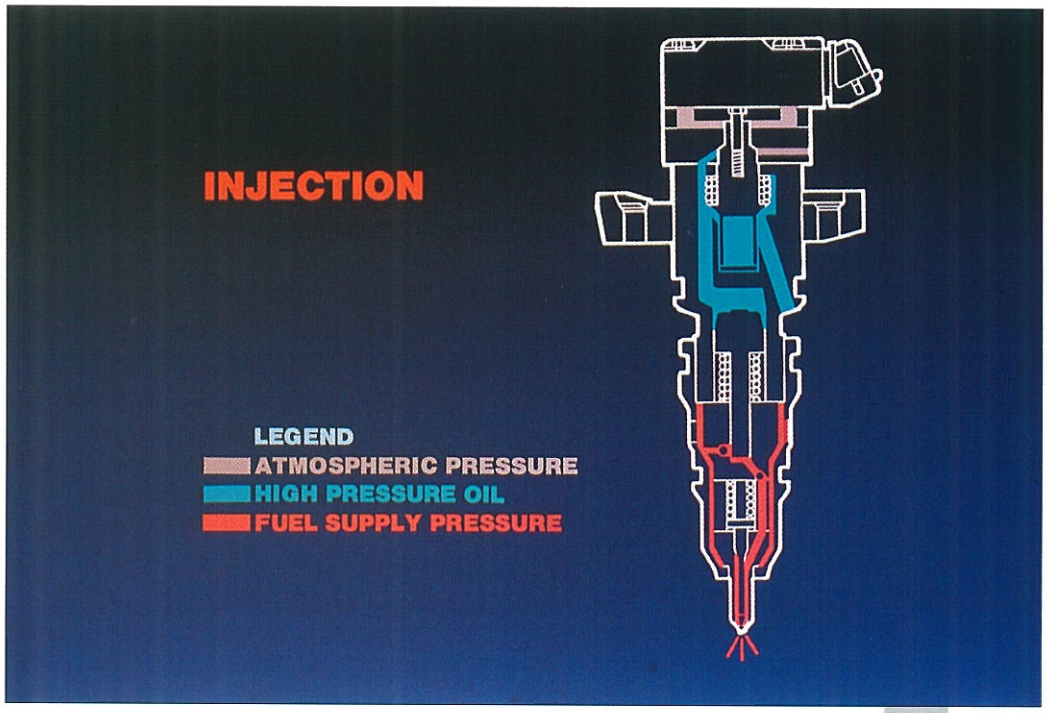
HEUI FUEL SYSTEM OPERATION



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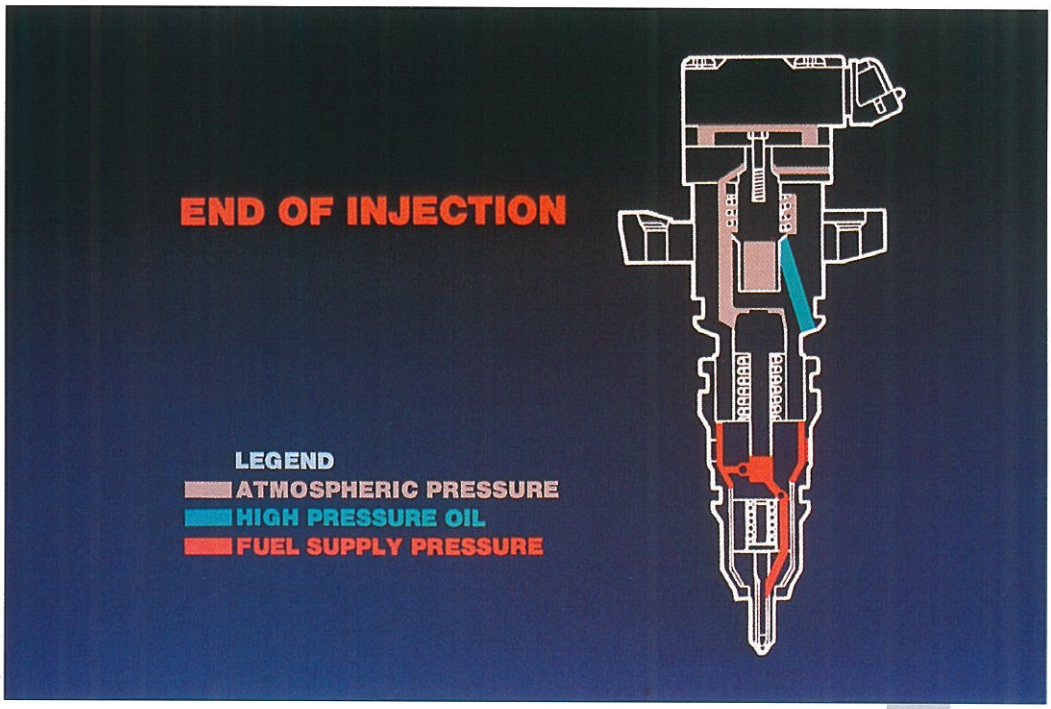
INJECTION

- When the PCM determines that the injector should be fired, the following sequence of events occur:
- PCM sends Fuel Delivery Control Signal (FDCS) to IDM.
- IDM sends electric current pulse to injector solenoid.
- Solenoid is fully energized almost instantly creating a strong magnetic pull on the armature.
- Magnetic pull of solenoid overcomes spring tension holding the poppet closed.
- Poppet is quickly raised off its seat.
- Upper poppet land closes off path to drain.
- Lower land opens poppet chamber to incoming high pressure oil.
- High pressure oil flows around poppet to the top of intensifier piston.
- Pressure on the top of the intensifier forces it down along with the plunger. The downward movement of the plunger pressurizes the fuel in the plunger cavity and nozzle. When the fuel pressure reaches Valve Opening Pressure (VOP) of about 2,700 psi, the nozzle valve lifts off its seat and injection begins.
- Injection pressures may be as high as 21,000 psi depending on engine requirements.

HEUI FUEL SYSTEM OPERATION



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END OF INJECTION DRAIN CYCLE

- The end of the injection cycle begins when the PCM terminates the fuel delivery control signal to the IDM. The IDM then terminates the electric pulse to the solenoid. The following events occur:

- The magnetic field of the solenoid collapses and is no longer able to overcome poppet spring tension to hold the poppet off its seat.

- The poppet closes, shutting off high pressure oil from entering the injector.

- When the poppet is seated, the upper land of the poppet opens the poppet cavity to drain.

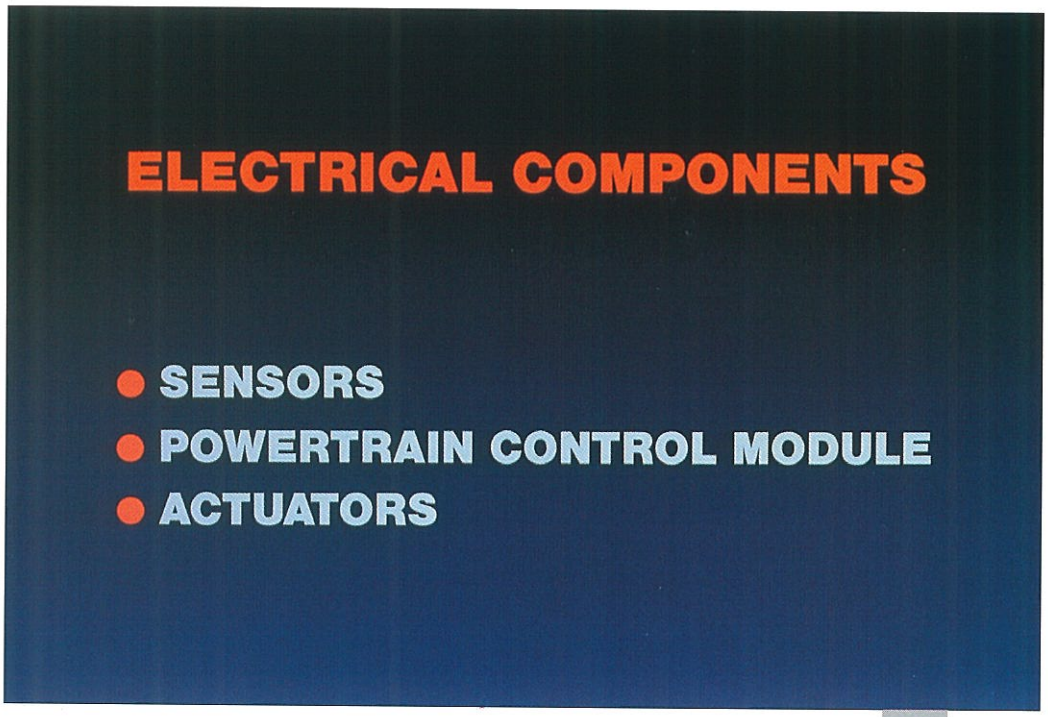
- Pressurized oil in the intensifier chamber and poppet chamber flows upward around the poppet seat, through the vent holes in the poppet sleeve and out the adapter drain hole.

- The pressure of the fuel in the plunger cavity exerts an upward force on the plunger and intensifier. As the pressure of the pressurized oil above the intensifier drops, so does the downward force on the intensifier.

- The upward force from the pressurized fuel almost instantly becomes greater than the downward force on the intensifier so the downward motion of the intensifier and plunger stops.

- When the plunger stops, fuel flow also stops and spring tension closes the nozzle valve.

HEUI FUEL SYSTEM OPERATION



HEUI ELECTRONIC CONTROL SYSTEM

- Let's take a closer look at the electronic components that control the HEUI Injectors. There are three basic types of components:

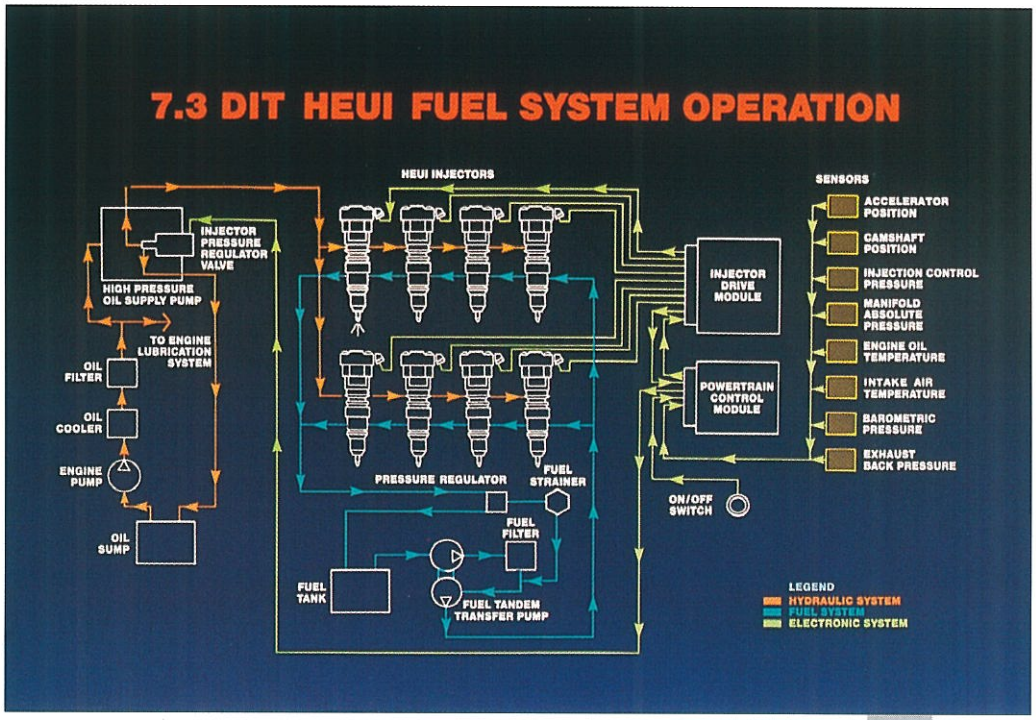
- SENSORS

- POWERTRAIN CONTROL MODULE

- ACTUATORS

- These components and their associated harnesses, form a control system that determines optimum injection timing, injection pressure, injection duration and fuel delivery.

HEUI FUEL SYSTEM OPERATION



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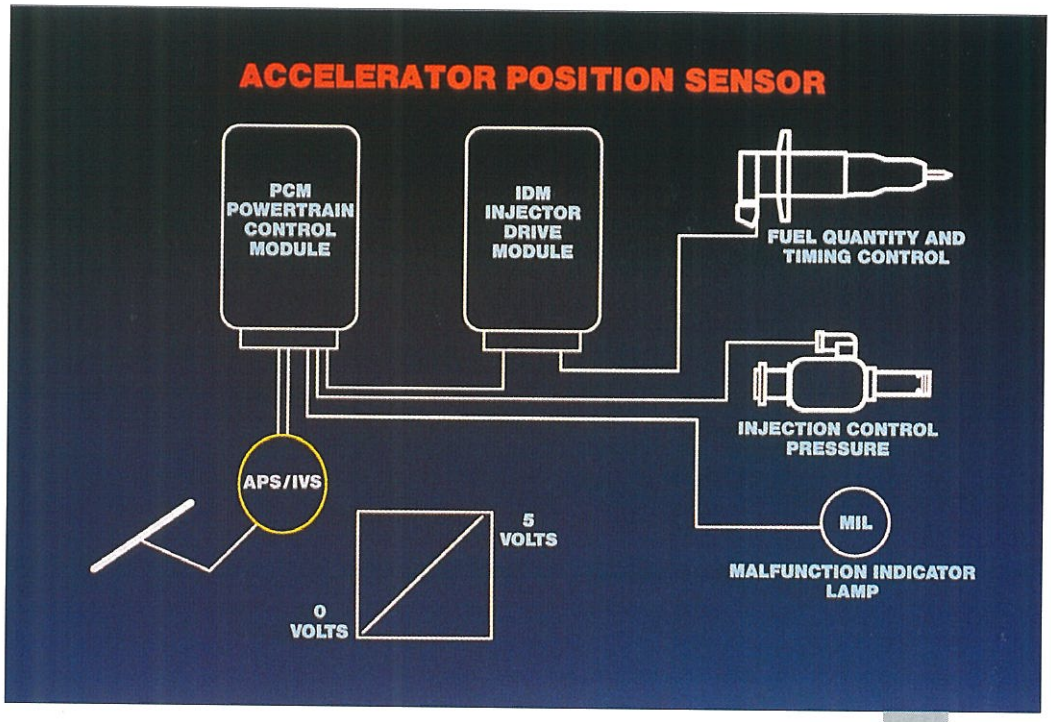
SENSORS

- The engine has eight sensors which constantly monitor performance and operating conditions.
- The job of each sensor is to accurately monitor a specific engine condition and generate a signal voltage to send through the vehicle wiring harness to the PCM
- The sensors provide the information necessary for the PCM to make decisions to control engine performance.

HEUI FUEL SYSTEM OPERATION



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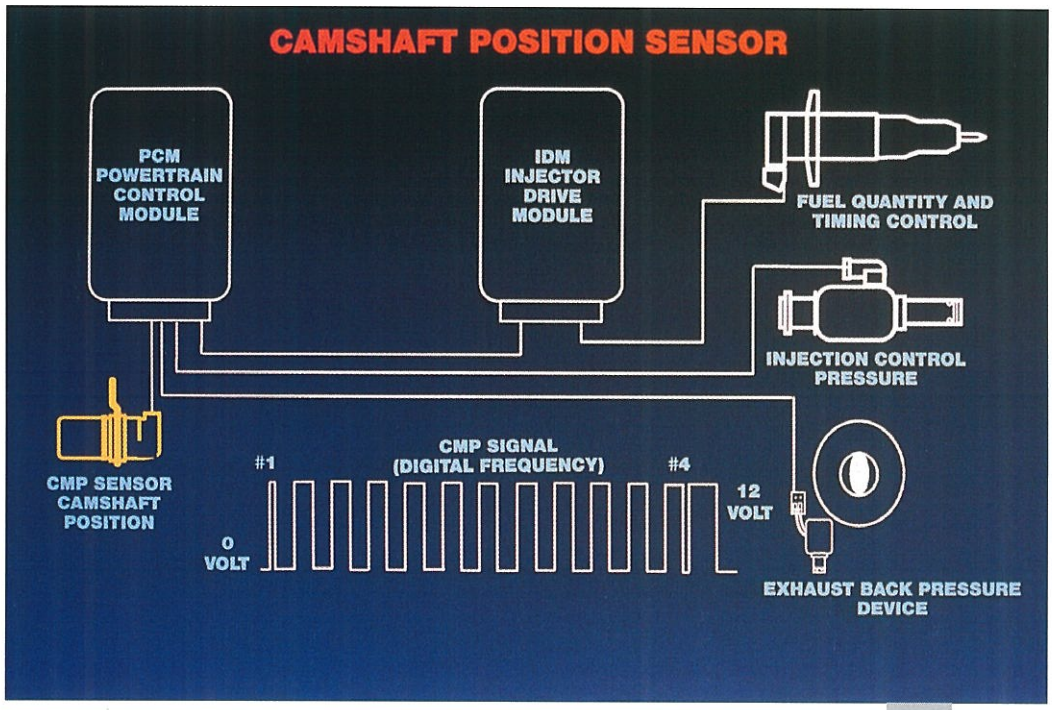
ACCELERATOR POSITION SENSOR (APS)

- The accelerator position sensor (APS) attached to the pedal assembly, provides the PCM with the driver's demand for power.
- The APS signal is used in calculating desired fuel quantity,injector timing and injection control pressure.
- The idle validation switch (IVS) provides the PCM with a redundant signal to verify when the pedal is in the idle position.
- An APS signal that is detected out of range, high or low, by the PCM will cause the engine to ignore the APS signal and will only allow the engine to operate at low idle.
- If a disagreement in the state of IVS and APS is detected by the PCM the engine will be allowed to operate at low idle only and a fault code will be registered by the on board diagnostics.

HEUI FUEL SYSTEM OPERATION



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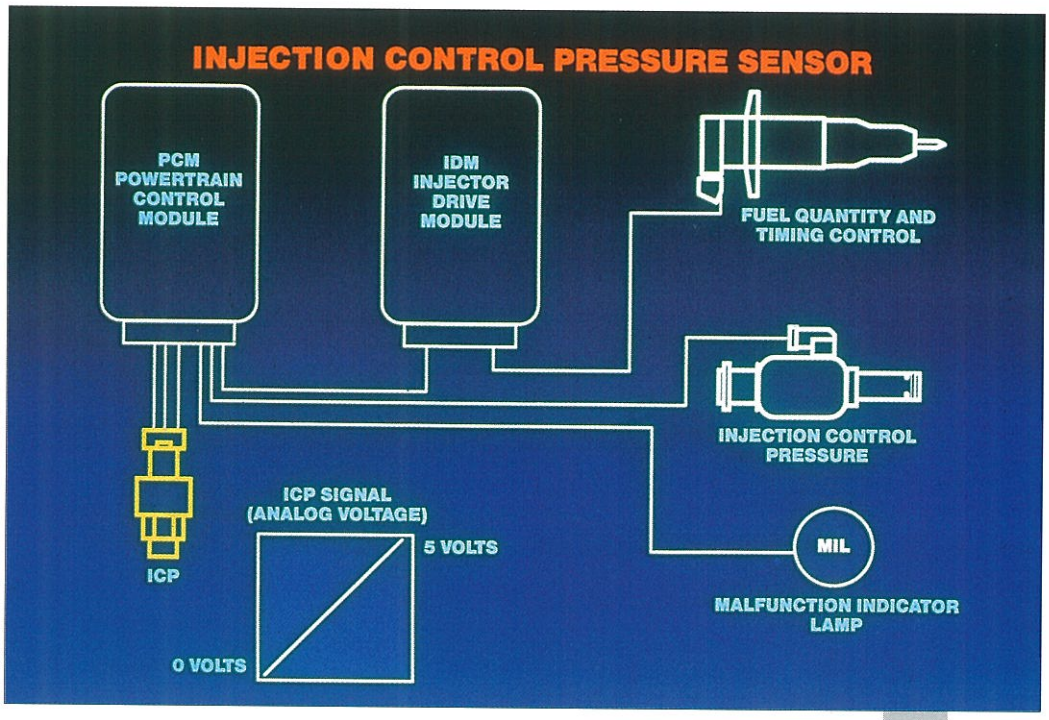
CAMSHAFT POSITION SENSOR (CMP)

- The CMP (Camshaft Position) sensor is a hall effect type sensor, located in the front cover. This generates a digital frequency as windows in a target wheel, on the cam gear, pass through it's magnetic field.
- The frequency of the windows passing by the sensor, as well as, the width of selected windows allows the PCM to detect engine speed and cylinder/piston position.
- An inactive CMP signal during cranking is detectable by the PCM.
- An inactive CMP signal will cause a no start condition.
- The CMP sensor can be made inactive by a faulty ground.
- A corresponding fault code will be set if a defect is found by the on board diagnostics.

HEUI FUEL SYSTEM OPERATION



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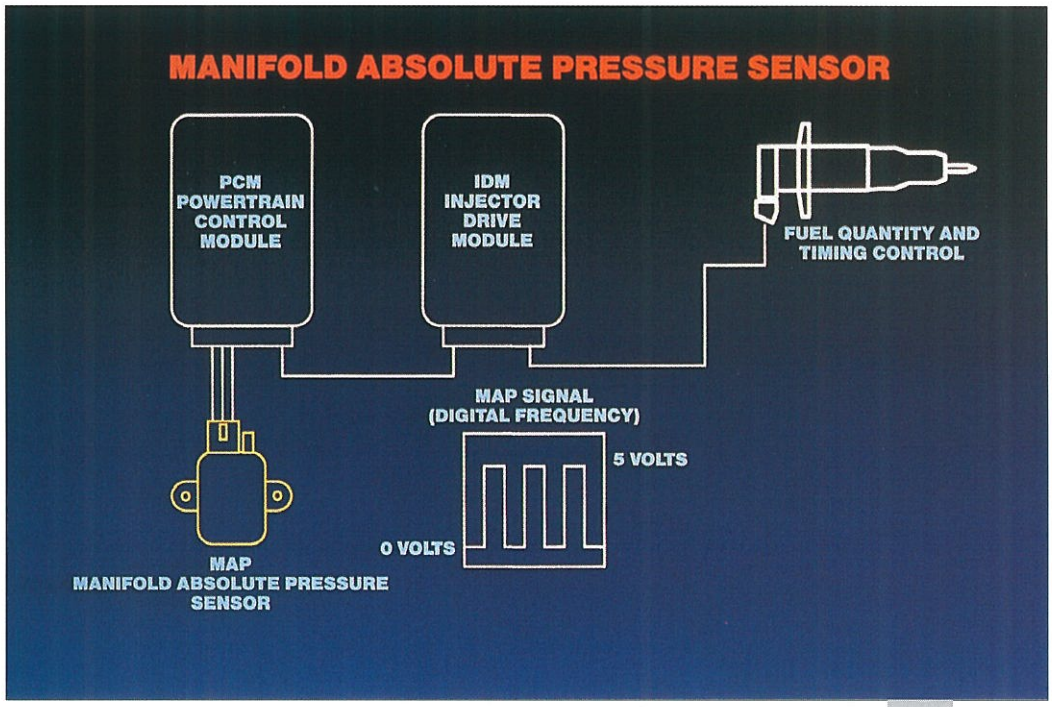
INJECTION CONTROL PRESSURE SENSOR (ICP)

- The ICP sensor provides the feedback signal for the closed loop control of the high pressure oil.
- The ICP sensor is a ceramic disk type pressure sensor that converts pressure into a 0 to 5 volt analog signal that the PCM uses to determine injection control pressure.
- The ICP sensor is threaded into the high pressure oil galleries on the left cylinder head.

HEUI FUEL SYSTEM OPERATION



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MANIFOLD ABSOLUTE PRESSURE SENSOR (MAP)

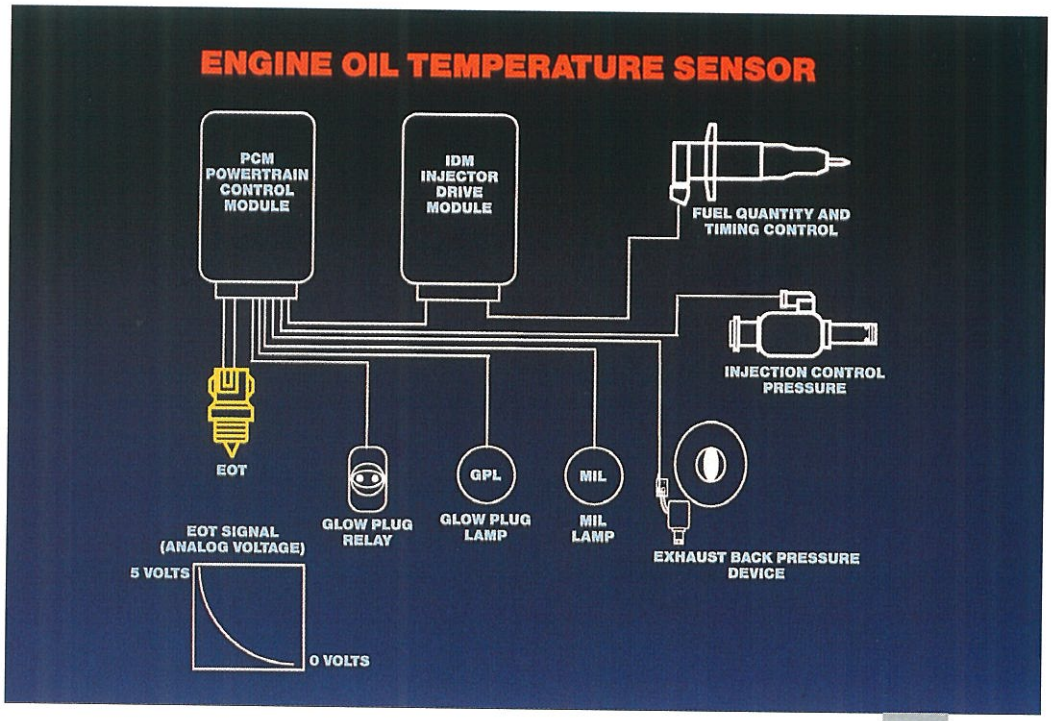
- The Manifold Absolute Pressure (MAP) sensor is a variable capacitance (pressure-sensing) disc, mounted on the cowl near the right hood hinge, that sends a frequency to the PCM relative to intake manifold pressure. The sensor frequency increases as pressure decreases.

- The MAP sensor allows the PCM to determine engine load to calculate fuel quantity.

- A MAP signal malfunction detected by the PCM will cause the PCM to ignore the MAP signal and calculate an estimated manifold pressure based on known engine conditions.

- A fault code can be set if the on board diagnostics detect a defect.

HEUI FUEL SYSTEM OPERATION



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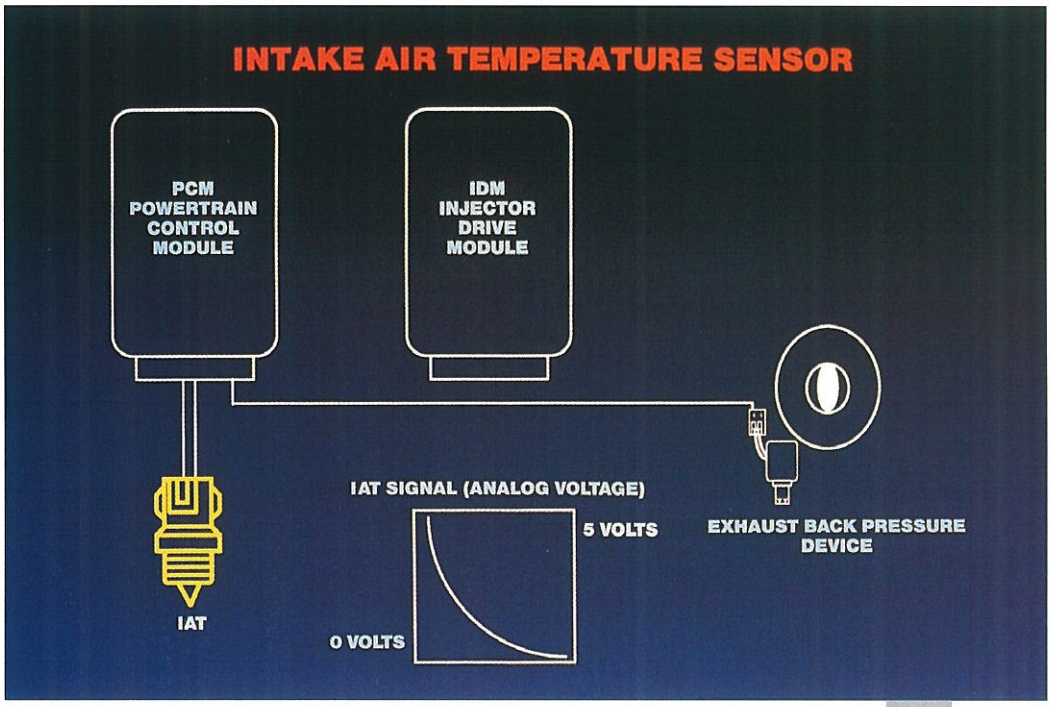
ENGINE OIL TEMPERATURE SENSOR (EOT)

- The Engine Oil Temperature (EOT) sensor is a thermister whose resistance decreases as engine oil temperature increases.
- The EOT signal is one of the sensors used by the PCM to calculate fuel quantity, injection timing, glow plug operation and exhaust back pressure.
- At oil temperatures below 122° F (50° C), low idle is increased to a maximum of 900 RPM to insure faster engine warm-up.
- Fuel quantity and timing is controlled throughout the total operating range to insure adequate torque and power are available.
- An EOT signal detected out of range, high or low, by the PCM will cause the PCM to ignore the EOT signal and assume an engine oil temperature of 68° F (20° C) for starting purposes and 212° F (100° C) for operating purposes.
- Engine oil temperature is measured in the reservoir.
- A fault code can be set if the on board diagnostics detects a defect.

HEUI FUEL SYSTEM OPERATION



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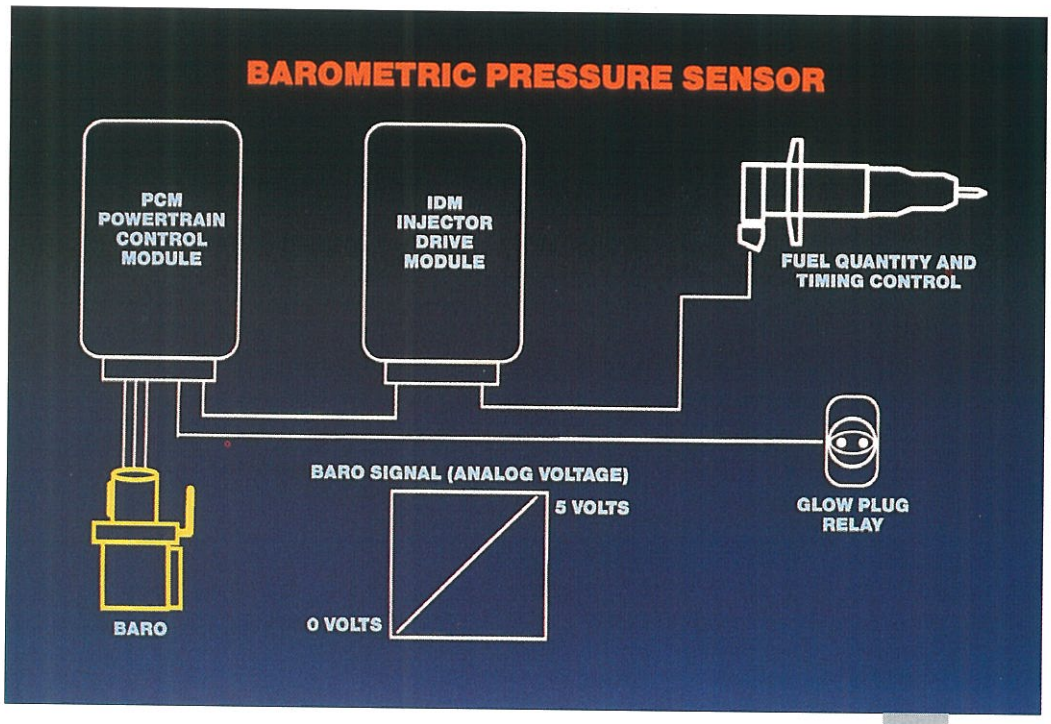
INTAKE AIR TEMPERATURE SENSOR (IAT)

- The Intake Air Temperature (IAT) sensor is a thermister whose resistance decreases as temperature increases.
- Mounted in the air cleaner, the IAT sensor's function is to provide ambient air temperature information to the PCM.
- The PCM uses IAT output voltage drops to enable exhaust back-pressure control for faster engine warmup.
- An IAT signal detected out of range, high or low, by the PCM will result in the PCM ignoring the signal and assuming an ambient air temperature of 59° F (15° C) while setting a fault code.
- The assumed ambient temperature of 59° F (15° C) will provide sufficient performance to return for service.

HEUI FUEL SYSTEM OPERATION



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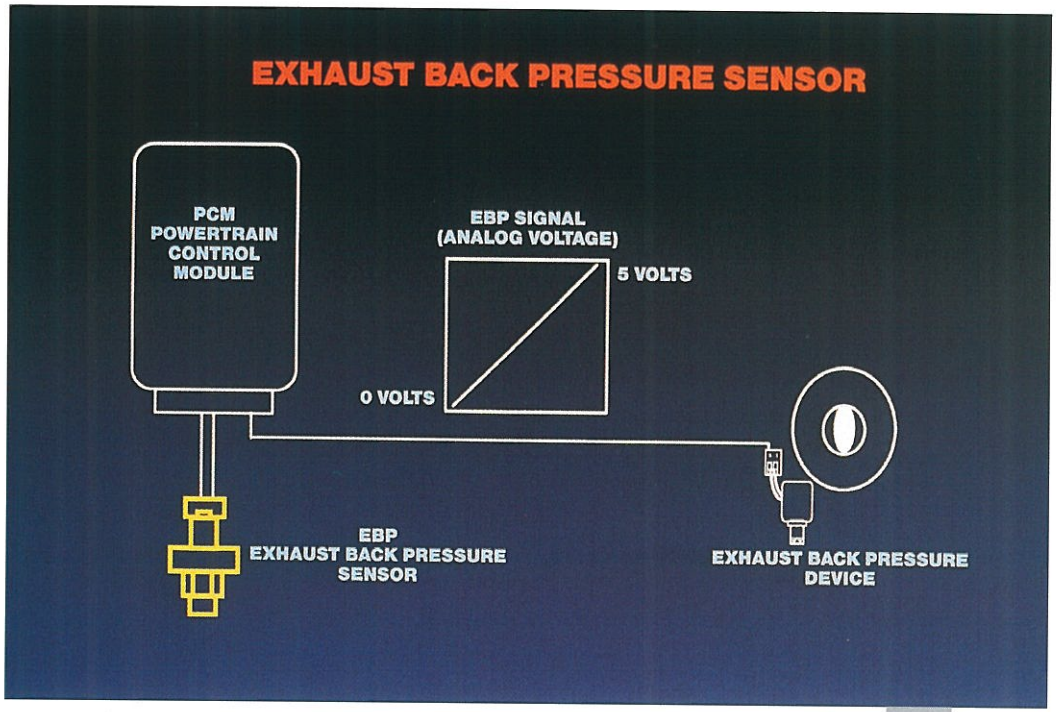
BAROMETRIC PRESSURE SENSOR (BARO)

- The Barometric Pressure (BARO) sensor is an analog device, located under the dash above the accelerator pedal, which senses atmospheric pressure which allows the PCM to compensate for altitude.
- The PCM uses this information to calculate injection timing and control glow plug "on" time.
- An open in the BARO sensor circuit will result in an out of range low signal to the PCM.
- Any other wiring faults will result in an out of range condition. The PCM will assume a default value of 14.5 psi (100 kpA).
- The assumed value of 14.5 psi will allow sufficient performance to return for service.

HEUI FUEL SYSTEM OPERATION



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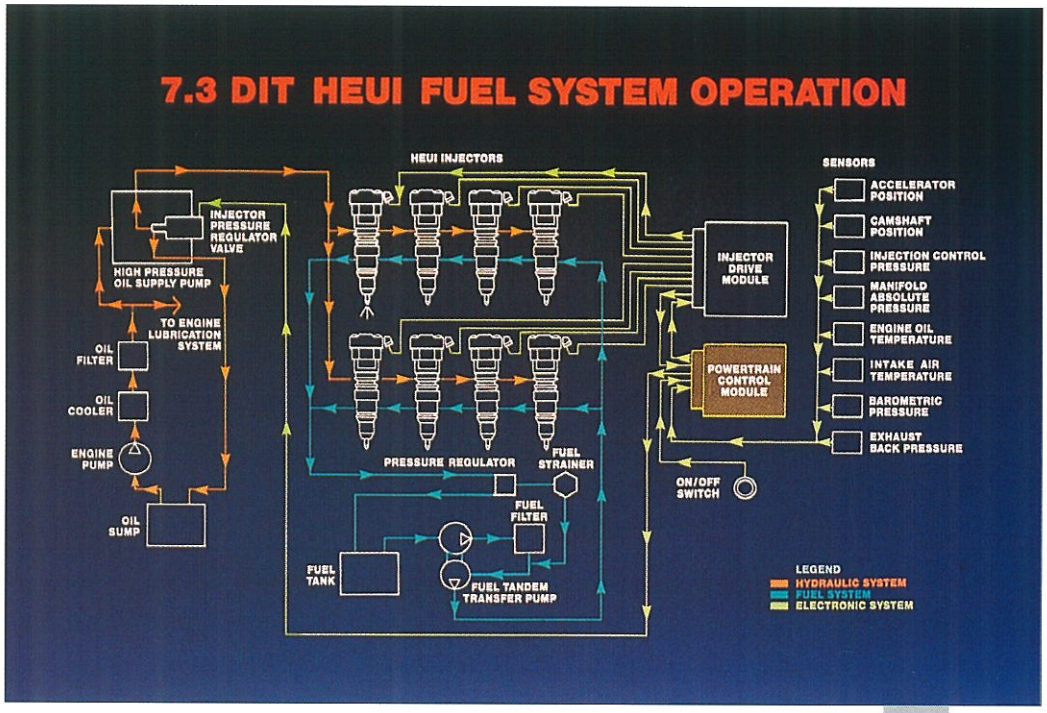
EXHAUST BACK-PRESSURE SENSOR (EBP)

- The Exhaust Back-Pressure (EBP) sensor measures pressure in the right exhaust manifold and is located next to the oil reservoir.
- This sensor is used in conjunction with the exhaust back-pressure regulator to form a closed loop exhaust back pressure control system. The EBP sensor is also used for diagnosis of the turbocharger.
- Exhaust back-pressure is controlled to provide more heat to the coolant for cab heating when ambient air temperature is below 45° F (7° C) and engine oil temperature is below 167° F (75° C) during low load, low speed operating conditions.
- An open or short in the EBP sensor wiring will result in a low out of range voltage at the PCM.

HEUI FUEL SYSTEM OPERATION



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POWERTRAIN CONTROL MODULE (PCM)

- The control module (formerly called EEC) receives the input voltages from the various sensors. These input voltages are known as input signals.
- The input signals are used by the control module to make decisions on how to control the engine.
- These decisions are translated into output signals which are sent to the actuators to change engine performance.

- Sensors Monitored Include:
- Accelerator Position Sensor (APS)
- Camshaft Position Sensor (CMP)
- Injection Control Pressure Sensor (ICP)
- Manifold Absolute Pressure Sensor (MAP)
- Engine Oil Temperature Sensor (EOT)
- Intake Air Temperature Sensor (IAT)
- Barometric Pressure Sensor (BARO)
- Exhaust Back-Pressure Sensor (EBP)