ELECTRONICALLY CONTROLLED DIESEL ENGINES, C. O. Henriksen, *Detroit Diesel Corporation*

Electronically controlled diesel engines are designed to meet customer performance requirements and emission control standards. The basic approach used by various engine manufactures to produce these engines should be similar since each is attempting to satisfy the same customer requirements and emission standards.

Electronic Components

Electronically controlled diesel engines represent the integration of basic diesel engine design with the speed and accuracy of modern computer technology. The electronic system is composed of an electronic control module and several sensors used to monitor the engine's performance. The control module is the brain of the electronically controlled engine and contains the system memory and programming elements. There is also an electronic foot pedal assembly which contains a potentiometer. It senses the request for power from the operator. There is also a coolant level sensor which monitors the coolant level of the system. If it gets below a safe level, it will notify the operator of the problem. There are two temperature sensors: one for oil and another for fuel. The oil temperature sensor is used to adjust the engine timing on cold starts to allow rapid engine warm up. In addition, it provides an engine protection feature. If the engine gets too hot, the engine can be powered down to reduce the potential for engine damage. The fuel temperature sensor is used to calculate fuel consumption. This keeps a running tab on how much fuel has been burned. An oil pressure sensor is used for diagnostic purposes and engine protection. At dangerous oil pressures, the engine can be shut down to protect it. There are also two timing sensors: a synchronous reference sensor and a timing reference sensor. The synchronous reference sensor counts the engine's speed in revolutions per minute (RPM). The timing reference sensor notes when cylinder #1 is at top dead center. This is important when trouble-shooting an engine that will not start. There is also an electronic unit injector. It controls the movement of fuel into the injector plunger.

These sensors and others are located on the engine as well as inside the vehicle. Harnesses go into the cab to the ignition switch, to the foot pedal, and to the cruise control switches. They also go to panel lights for check engine (a yellow light) and stop engine (a red light).

Engine Performance

The amount of hysteresis or reaction time in response to speed and load changes compared to a mechanical system is much shorter for the electronically controlled engine. For pumping or power-take-off (PTO) applications, the system reacts quickly and maintains a stable engine speed. Torque curves can be customized to specific applications. There are preselected power and speed readings to initiate a boost power condition. This can be programmed into the electronics system which is not available in mechanical control engines. The variable speed governor is very load sensitive. With a small change in load it can respond almost instantaneously. For hydraulic pumps powered from the PTO, a maximum speed for the PTO system can be set to avoid excessive RPM of the pump. Minimum and maximum RPM settings can be made. For fire truck applications, the water pump pressure can be the controlling factor. Power control protection can be provided to shut down the engine when certain conditions could cause transmission or rear axle failures. Marine system controls at the rear of the cement mixer or controls at the rear of a fire truck can also be integrated into the protection system.

Recording Events

Diagnostic equipment can be attached to the electronics system to obtain stored data. The data can be used to determine if a specific condition exists now or was present at some time in the past. They can be provided on the complete engine or on a cylinder by cylinder basis. The data can be extracted from the electronic system with a hand held reader.

When the ignition switch is first turned on, two warning lights come on: a yellow, check engine light and a red, stop engine light. They will be on for a couple of seconds and then go off. If either of these lights come on at any other time, it indicates that something is not working properly. The problem could be with a sensor, a loose wire, or in an injector. It could be a non-harmful engine problem, such as an intermittent electrical problem. If this is the case, the check engine light may come on and then go off. The driver does not have to tell the mechanic that the check engine light came on.

The event is stored in the electronic system memory. Before that unit goes back into service, the mechanic has access to all of the sensor data related to the event. If the yellow, check engine light comes on and stays on, the driver can push the engine check button and a defect code will be transmitted to the driver. With a pocket card, the driver can determine the exact nature of the problem and determine if it is safe to continue operating the vehicle.

There are certain events where the engine protection system will shut down the engine. These events include loss of coolant, low oil pressure, or engine overheating. If any of these conditions exist, both the yellow and the red light will come on, indicating that a major problem exists. In the engine shut down mode, the driver has thirty seconds to move the vehicle to a safe position. If additional time is needed, there is an override button. All that does is start the shut down sequence over.

A diagnostic data reader is used to extract the event date from the electronic system memory. The reader is similar to the General Motors or Chrysler electronic cards introduced a few years ago. The reader has some programming capabilities. If a vehicle comes in with a problem, data is recorded just prior and just after the incident. This information will be available for the mechanics and technicians to determine what has happened. It records not only the fuel consumption, but also the number of engine hours, how many times it has been set at idle, and how much time in PTO mode. There is also a printer interfaced. The capabilities of the diagnostic data reader to provide information are extensive.

Electronic System Programming

Programming, modifying, or calibrating the electronic system may involve changing the password security, modifying the idle time or PTO setting, modifying the shut down criteria, or changing the governor procedures. Changing the PTO settings could involve selecting the initial speed, the minimum speed, and the maximum speed. Historical trail codes or audit codes are recorded in memory to describe the time of the event and conditions monitored by sensors. The electronic system can also record when an operator has tampered with the vehicle to make it go faster. It can record at what engine hour an event occurred. The data can be fed into personal computer or transmitted by modem to the home office to assist in diagnosing problems.

Programming security

There are three levels of security which can be programmed into the electronic system. The first is no security. The ID code is set to four zeros. Anyone can gain access to the system. The second level is when the ID code is left blank for operators to program in their own four digit number. Anyone with the four digit code can have access to make system changes. The third level is what is called lock out. This is typically used when a customer has exact specifications. The customer then controls who has access to program. Note that no ID code is needed to obtain data for diagnostics. Programming is a separate function from the diagnostic portion in the reader.

Summary

The use of electronics will continue to increase in the future. The software for the electronics system can be changed for specific customer applications. Diagnostics with an electronic system is similar to investigating why one of the trail lights does not work. The system is checked out one wire or one circuit at a time. The electronic system appears to be complicated but it is no different from any other trouble shooting on any other electrical component on the vehicle.

1990-93 ENGINE TECHNOLOGY

Jeff D. Jones, *Cummins Engines*

The trucking industry is facing a new set of challenges as the 1990s begin: rising operating and equipment costs, increasing competition, more complex systems requirements, driver shortages, and safety and environmental concerns. There is an innovative new lineup of engines to address many of these challenges.

The first step in the process of introducing advanced technology engines began several years ago with a simple goal: to create a new truck engine designed from a customer point of view. This goal led to an extensive 18-month market research effort which laid the foundation for the new generation of diesel engines. During this period, countless truck owners, drivers, dealers and other industry personnel were interviewed to define new products based on customer needs. One point became crystal clear: every truck operator has unique requirements.