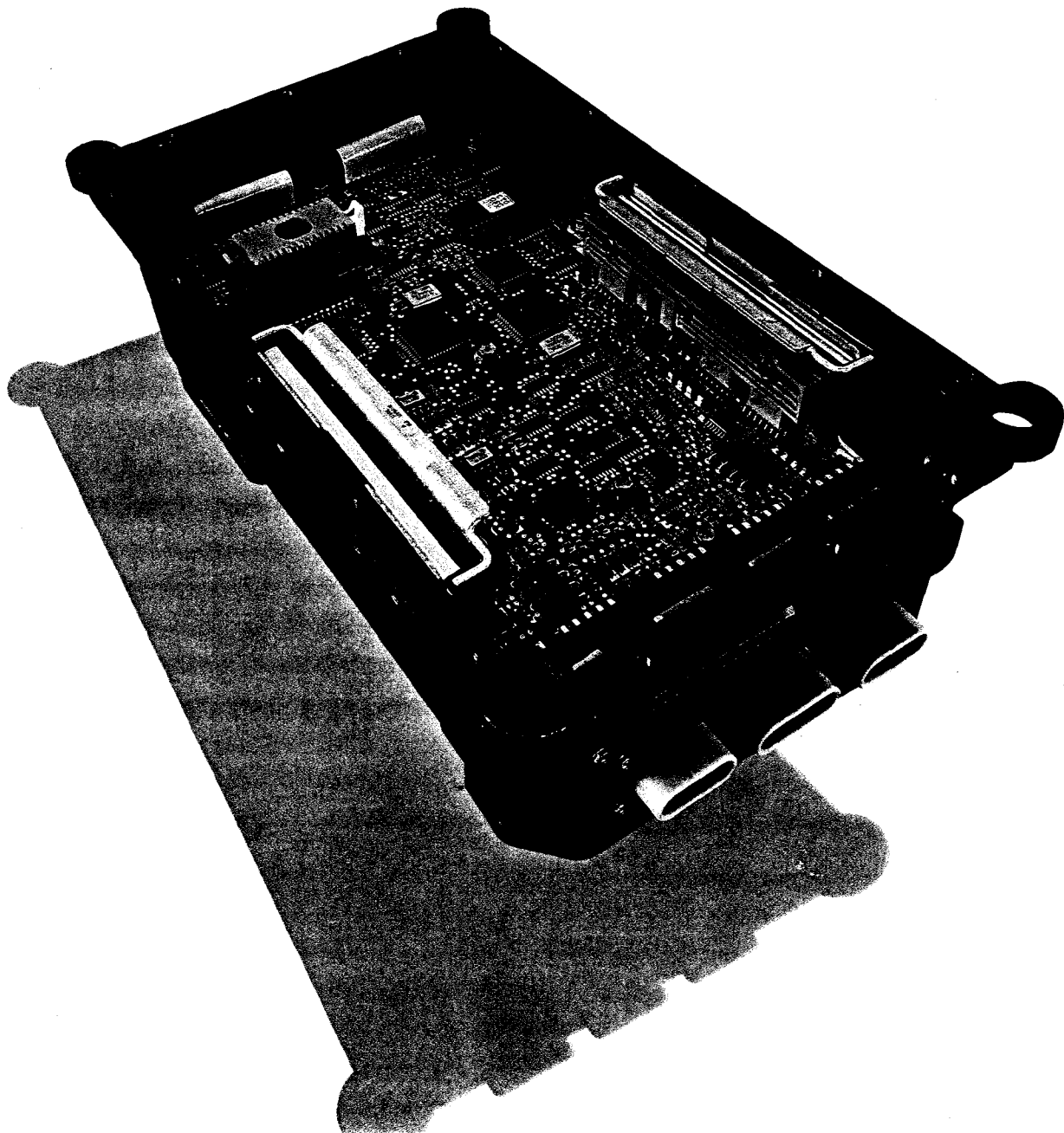
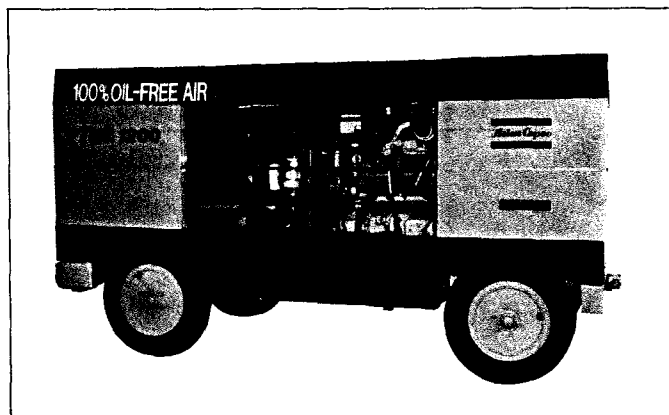
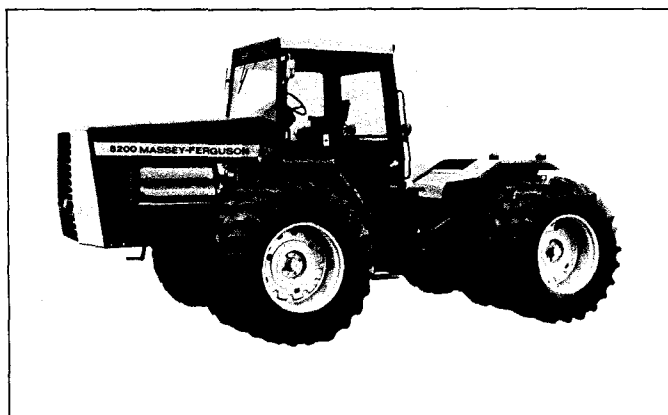


DETROIT DIESEL

Electronic Controls for Construction and Industrial Power



Detroit Diesel Electronic Controls DDEC



Benefits of Tomorrow's Technology—Today

- Integral Engine Protection
- Improved Fuel Economy
- Reduced Smoke and Emissions
- Customized Performance

DDEC is the most sophisticated, tested and innovative advancement ever developed for diesel engine control. DDEC is a computerized electronic engine governing and fuel injection system that replaces mechanical controls in a Detroit Diesel engine. Within its onboard computer, DDEC offers engine protection and self-

diagnostics to identify malfunctions, and also provides the operator the ability to troubleshoot engine problems. Today, with over 30,000 DDEC engines in operation throughout the world, it remains the most advanced electronic unit fuel injection and engine management system in the industry.

Integral Protection

DDEC provides integral engine protection to insure maximum engine uptime by recognizing potential problems before they occur.

■ Self Diagnostics

DDEC performs a complete system check at startup to be

certain that all sensors, warning lights and electronics are in proper working order and continually monitors these components during engine operation.

■ Automatic Engine Shutdown

This optional feature can save thousands of dollars by shutting down or powering down the engine before a failure occurs. The ECM will begin the shutdown/powerdown process when it receives a signal from the oil temperature sensor, oil pressure sensor, crankcase pressure sensor (149 only) or the coolant level sensor advising it that an operating condition is out of specification. Initially, the operator will receive a "check engine" light and, depending on the problem, a "stop engine" light, which will begin to shutdown or powerdown the engine as prescribed by the particular application. An optional engine shutdown override switch can be provided to allow the operator to maintain power, so the equipment can be moved to a safe location.

Conditions which activate the Engine Warning and Protection System

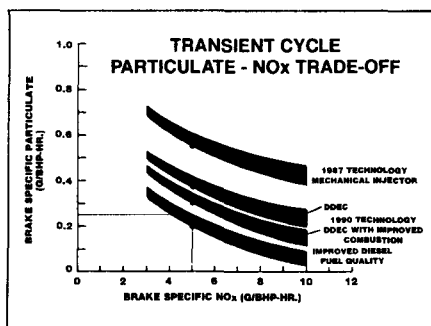
Check Engine	Stop Engine
Oil Temperature	Excessive Oil Temperature
Injector Operation	Low Oil Pressure
Low Fuel Pressure	High Crankcase Pressure (149 Only)
Engine Overspeed	Loss of Coolant
System Self-Diagnostics	
<p>"The DDEC Engine Protection System saved our 1800 h.p. haul truck engine. The electronics powered down the engine when the coolant dropped to a dangerous level."</p> <p><i>Clarence Bishop, Manager of Maintenance, AMAX Eagle Butte Mine</i></p>	

Improved Fuel Economy

- DDEC continually optimizes the fuel rate to match the application's power requirements. The electronically controlled injector delivers the precise amount of fuel at the right time, resulting in a possible 3%-5% increase in fuel economy.
- DDEC engines are always in tune. Mechanical governor parts which can wear or become misadjusted are not found in a DDEC engine. Also, the injector rack has been replaced by an electronic solenoid which is self-compensating for mechanical wear which occurs over the life of the assembly.

Reduced Smoke and Emissions

DDEC's ability to perpetually monitor engine operating characteristics and instantaneously adjust to changing conditions results in lower emissions and top performance with little visible smoke.



DDEC reduces smoke and emission levels

Customized Performance

Utilizing DDEC, engine torque and power levels can be custom tailored to particular application requirements allowing equipment to be engineered for precise con-

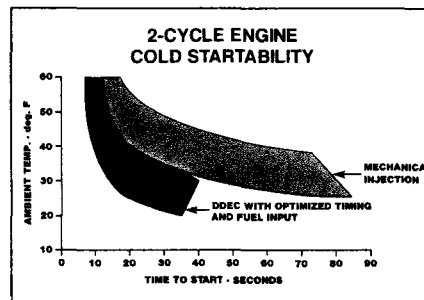
trol, faster response and optimized productivity. Additional performance benefits include:

■ Multi-Power Ratings

Multiple horsepower, rated speed and torque levels can be preset for your construction and industrial application. This feature allows for a burst of horsepower to overcome initial load resistance and allows you to meet the changing power requirements of your worksite.

■ Improved Startability

DDEC equipped engines start at significantly lower temperatures than mechanically injected engines because engine temperature is monitored to optimize engine timing.



DDEC improves cold startability

■ Improved Transient Response

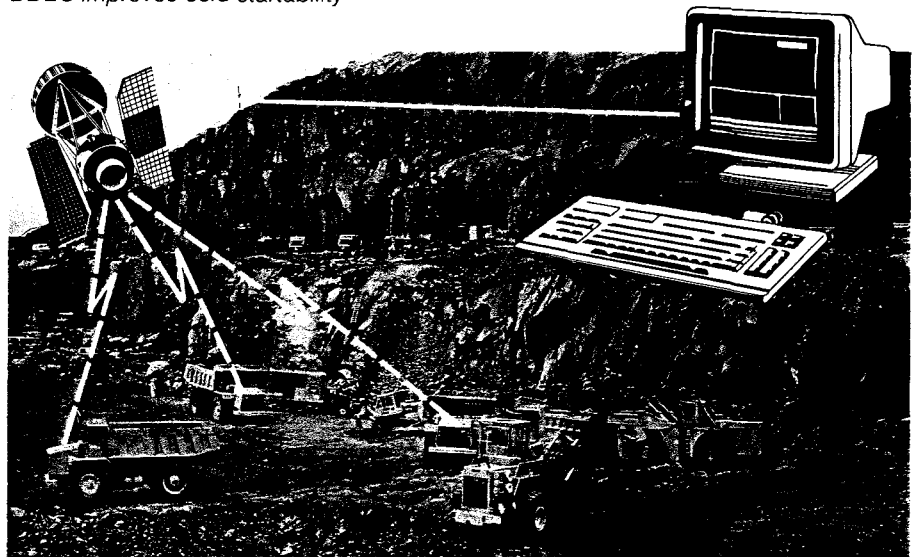
Milli-second feedback on changes in engine load provides minimal fluctuations in RPMs as load is applied to the engine.

■ Isochronous Idle

Precise control of engine idle speed is maintained even with load fluctuation (zero droop).

Flexibility

- DDEC engines can interface with other electronically controlled components such as transmissions utilizing the Pulse Width Modulated (PWM) ports which are located on the ECM. These ports enable a fleet tracking and dispatch system to maintain operating records of the entire DDEC equipped fleet.
- Engine performance can be reprogrammed using the electronically erasable prom. Horsepower and torque can be modified by a DDC distributor.



DDEC allows for computerized management and dispatch systems

DDEC — How it Works

Simple Operations

Both the function and operation of DDEC is simple. The major components of the system consist of the electronic control module (ECM), the electronic unit injectors (EUI) and the various system sensors. The ECM is the "brain" of the system receiving electronic inputs from the operator as well as from the engine and machine mounted sensors. This information is then used to precisely control both the quantity of fuel injected and injector timing.

Electronic Control Module

The engine mounted ECM includes control logic to provide overall engine management. Within the ECM is contained an electronically erasable program-

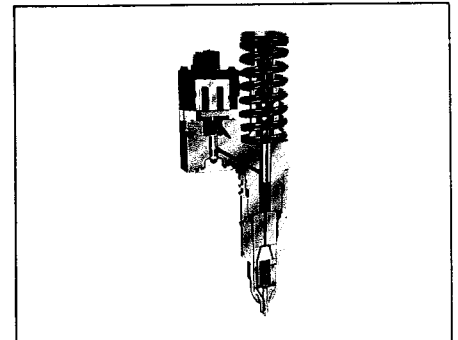
mable read only memory (EEPROM). The EEPROM controls the basic engine functions such as rated speed and power, injection timing, engine governing, torque shaping, cold start logic, transient fuel control, diagnostics and engine protection. The control logic determines duration and timing of current pulses to the injector solenoids which control fuel delivery characteristics and improved economy.

Twelve and Sixteen Cylinder DDEC Application

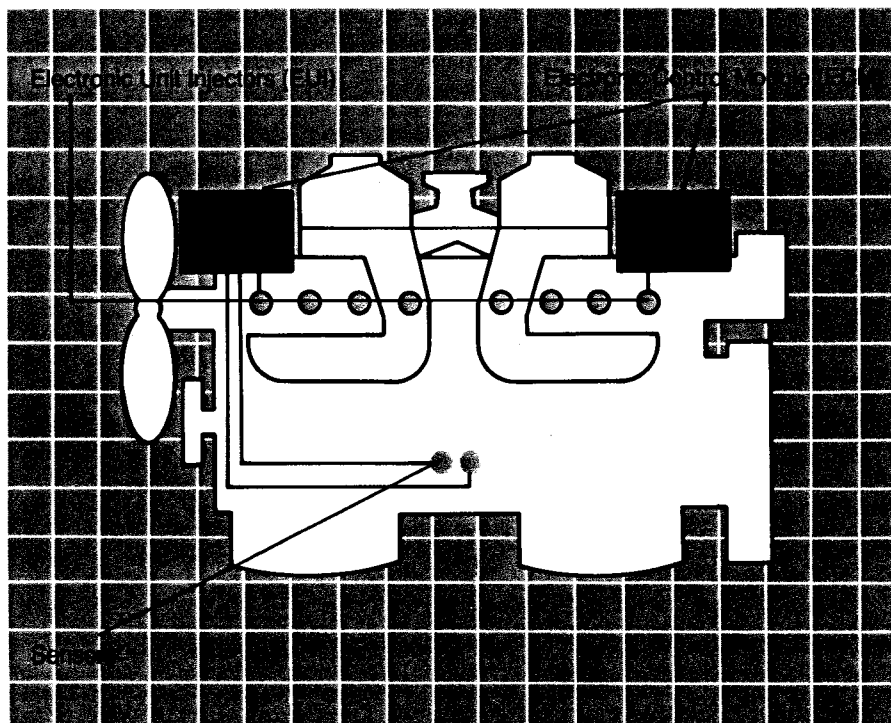
Twelve and sixteen cylinder engines operate with two ECMs, one mounted on each engine block. One ECM is called the master ECM, while the other is referred to as the receiver ECM. The master ECM is the primary controller of the engine. It receives input from the various sensors, then de-

termines proper timing and communicates this information to the six or eight injectors it controls. The master ECM then sends this information to the receiver ECM so it can instruct its six or eight injectors to operate in the same manner. The master ECM is in charge of all engine functions while it is properly communicating with the receiver ECM. However, in the unlikely event that the communication between these two ECMs fails, they do have the capability to operate independently of each other.

Electronic Unit Injectors



The electronic unit injectors used with the DDEC System operate on the same basic principle as the injectors which have been used in Detroit Diesel engines for over fifty years. In an electronic injector a solenoid operated poppet valve performs the injection timing and metering functions as opposed to the helices and ports which are machined into the plunger and bushing of the mechanical injector. When the solenoid valve is closed, pressurization and fuel injection is initiated. Opening the solenoid valve dissipates injection pressure, ending injection. The duration of valve closure determines the quantity of fuel injected.



DDEC Puts Money in Your Pocket

■ **Protection Against High Cost Repairs**

DDEC's engine protection system can save tens of thousands of dollars in engine replacement costs by warning the operator of impending problems before they occur.

■ **Reduced Maintenance Costs**

Saves thousands of dollars by eliminating costly tune-ups.

■ **A 3% - 5% Increase In Fuel Economy is possible**

■ **Quicker and More Efficient Trouble-Shooting**

Using the diagnostic reader, problems are quickly identified, reducing labor hours and costs. The cylinder cutout test alone can save up to five hours in resolving a low power problem.

■ **Automated Fleet Management**

Communicates with computerized management systems to maintain complete fleet records for all DDEC equipped equipment.

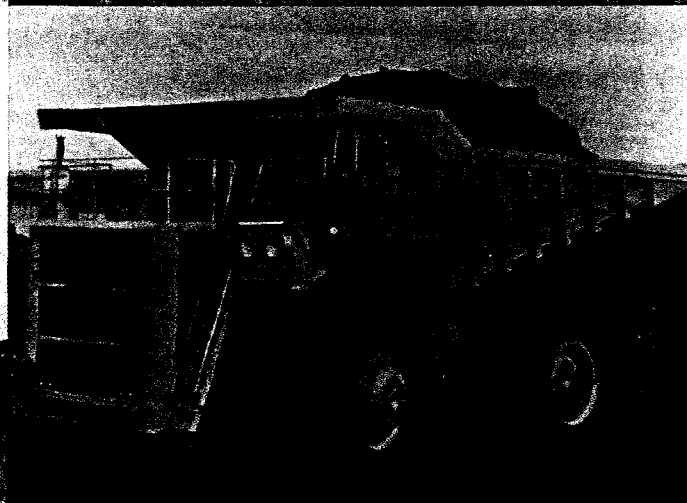
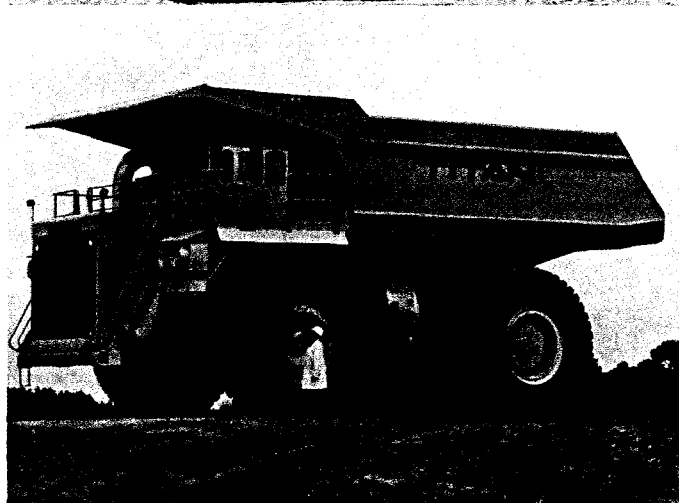
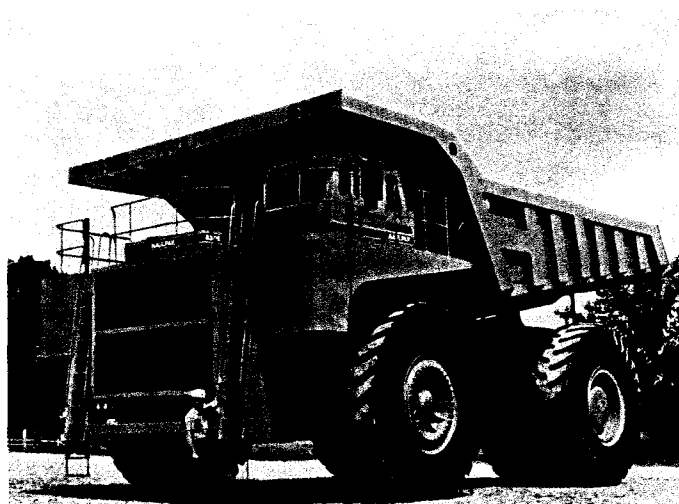
■ **Higher Resale Value**

Offering the technology of the future today, DDEC equipment commands a higher price in the resale market.

■ **Ability to Interface with Other Electronic Systems**

■ **Reduced Smoke and Emissions**

DDEC allows you to remain environmentally responsible by reducing emissions and smoke.

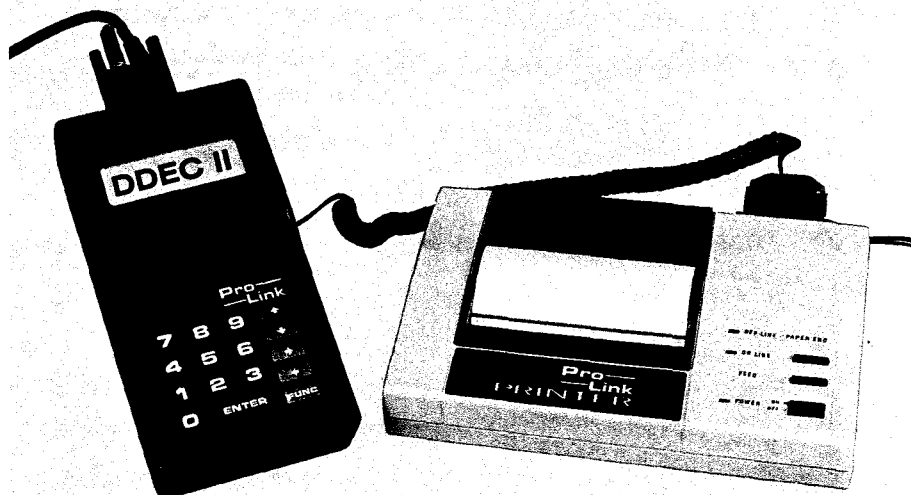


DDEC — Reduced Maintenance Time and More Efficient Serviceability

The DDEC system provides the capability for fast, efficient maintenance and trouble shooting. System memory stores and displays codes that identify current out of specification conditions. Diagnostic codes are stored which indicate past problems or intermittent, usually hard to diagnose situations. The system records the length of the occurrence, the time it occurred and the frequency of the occurrence.

As the codes are logged, an audit trail is developed enabling the service technician to correct problems before they become severe. This audit trail allows for the design of a history and maintenance file for all DDEC equipped machinery.

The diagnostic codes are displayed by the check engine light. These codes can also be easily obtained with the diagnostic reader. The diagnostic reader can save up to five hours of maintenance time in locating many injector problems with the cylinder cutout test. During this test, the electronic system automatically cuts out each cylinder to determine which one is causing the problem and allows the technician to spend his time resolving the problem. The diagnostic reader also allows system options such as engine droop, automatic shutdown/powerdown and password choice to be reprogrammed without changing system hardware. Total engine hours and fuel consumption at any speed or load can be obtained through the reader.



"The fuel pressure sensor on the engine helped us locate a clogged fuel filter in a fraction of the usual time. DDEC saved the customer two hours in repair costs."

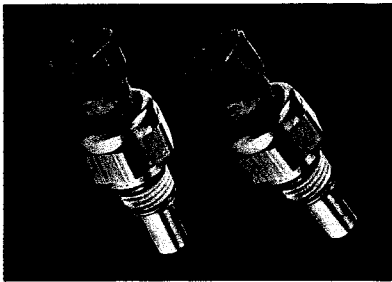
**David Polsfuss, Branch Manager
Interstate Detroit Diesel**

■ Oil Temperature Sensor

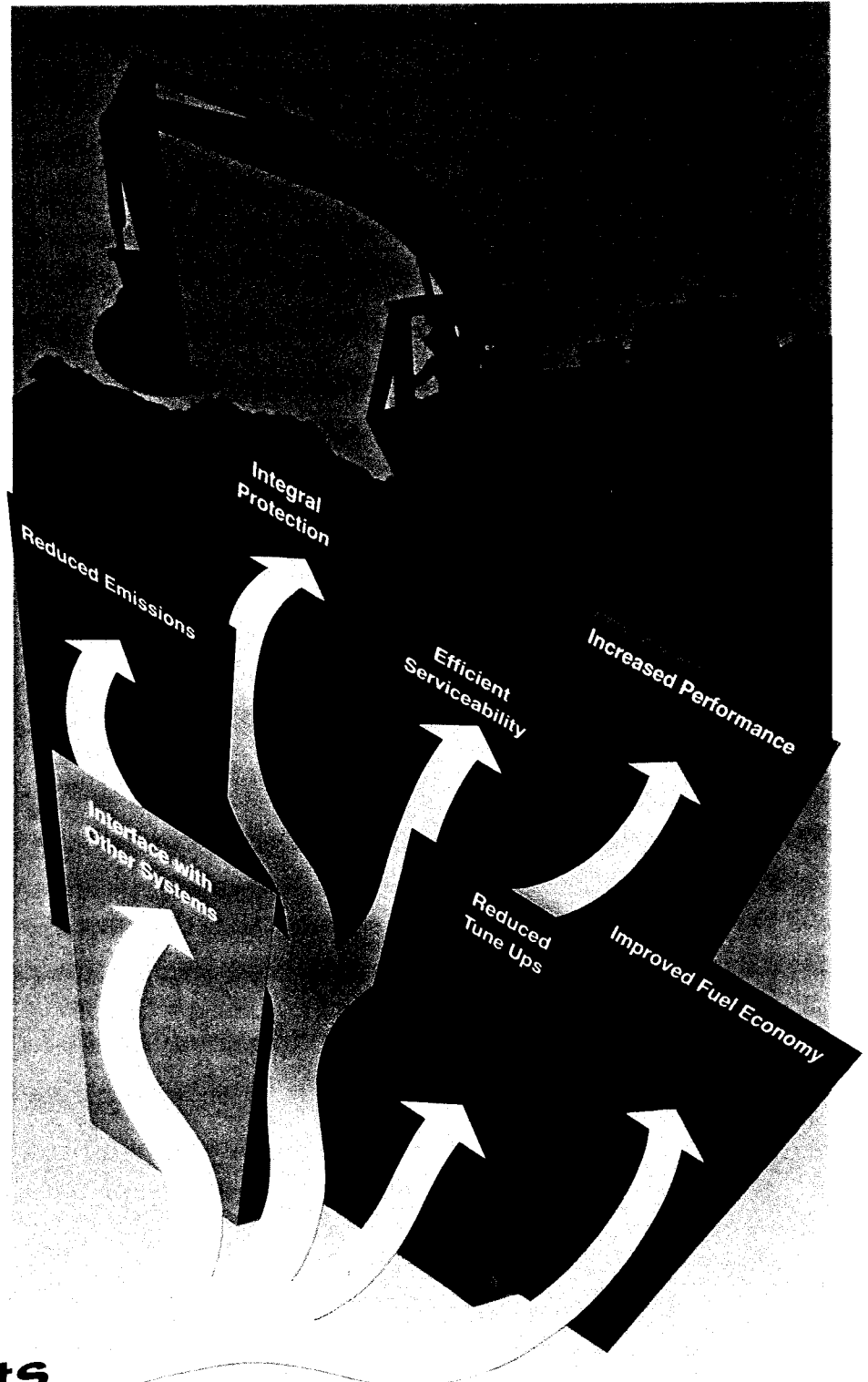
The oil temperature sensor optimizes idle speed and injection timing to improve cold startability. These adjustments also eliminate white smoke at start-up. This sensor will activate the engine protection system if high oil pressure is recorded.

■ Oil Pressure Sensor

This sensor will activate the engine protection system if the oil pressure falls below specification at a given load and speed.



Engine sensors



Benefits

DDEC Engine Sensors

A number of different sensors are used with the DDEC system. The purpose of the sensors is to provide information to the ECM regarding various engine performance characteristics. The information sent to the ECM is used to instantaneously regulate engine and machine performance, provide diagnostic information and activate the engine protection system.

■ Timing and Synchronous Reference Sensors (TRS/SRS)

These sensors control the timing of the engine. The TRS sensor provides a "once per cylinder" signal and the SRS sensor provides a "once per revolution" signal. Working together, these sensors tell the ECM which cylinder is at top dead center for cylinder firing. This positioning of the cylinder allows for optimal combustion which translates into greater fuel economy and reduced emissions through a cleaner burn.

■ Throttle Position Sensor

The throttle position sensor is part of the hand throttle or foot pedal assembly and replaces the mechanical cab to engine throttle linkage. This sensor converts the operator's throttle input into a signal to the ECM. This sensor offers the advantages of self-calibration, no required lubrication and the elimination of linkage freeze-up problems.

■ Turbo Boost Sensor

In monitoring turbocharger compressor discharge pressure, this sensor provides data to the ECM for smoke control during engine acceleration. Additionally, this sensor can be used to trouble-shoot air system problems.

■ Fuel Temperature Sensor

The fuel temperature sensor provides a signal to the ECM to optimize fuel consumption. The ECM utilizes the fuel temperature signal to adjust the fuel consumption rate calculations for changes in fuel density as a function of temperature. Fuel consumption and temperature can be displayed with other appropriate readings on an OEM installed electronic dashboard.

■ Fuel Pressure Sensor

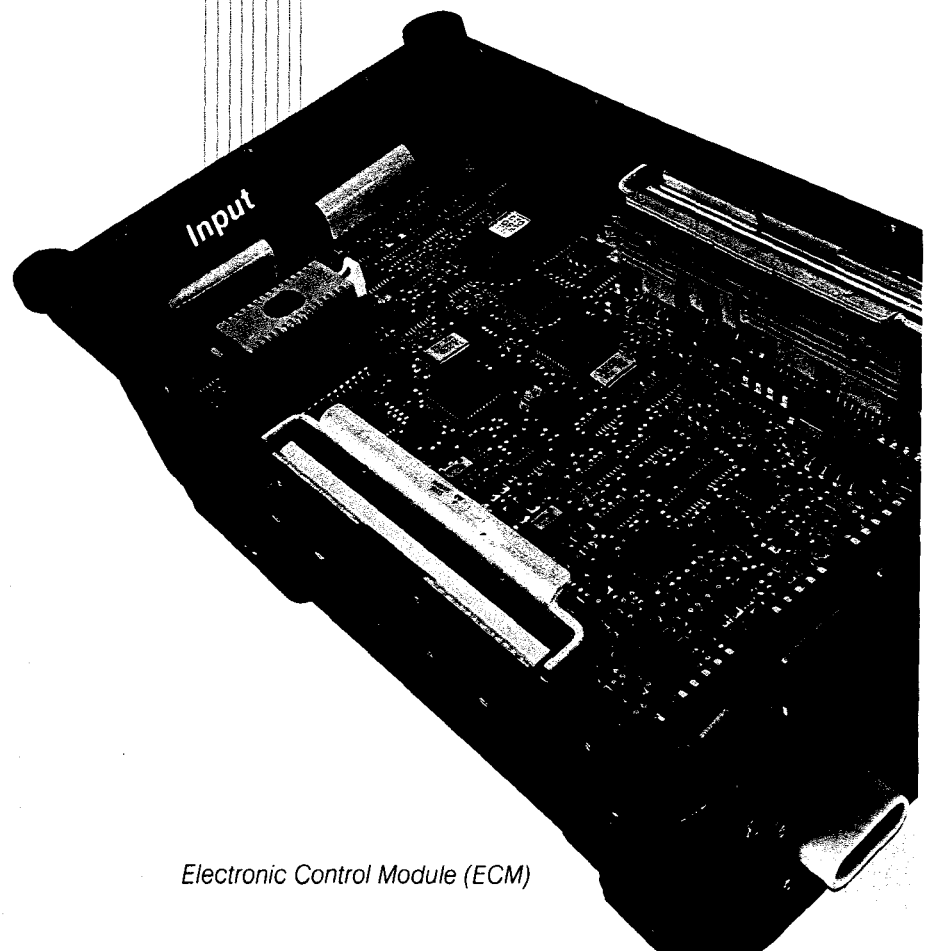
This sensor monitors fuel pressure and warns the operator of impending power loss resulting from dirty fuel filters.

■ Coolant Level Sensor

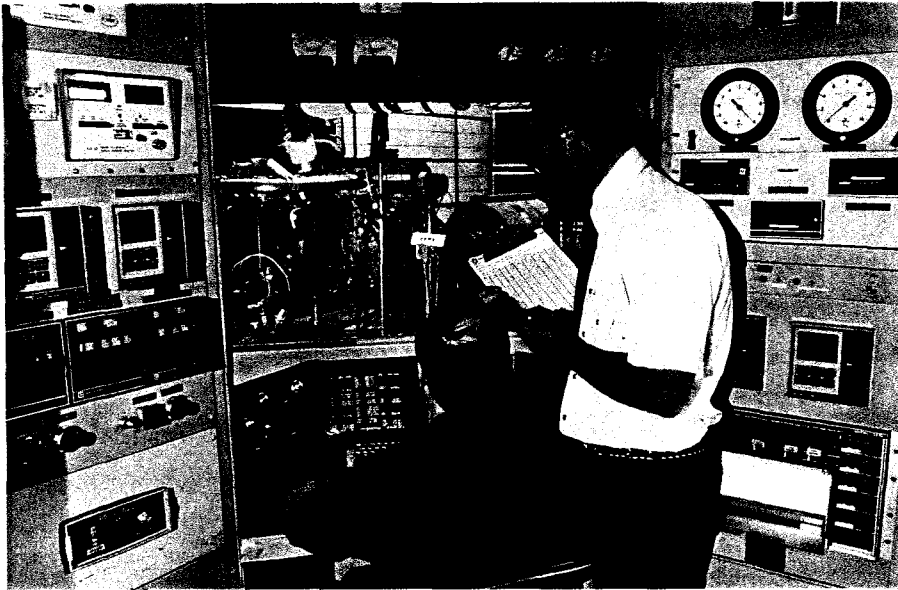
The engine shutdown/powerdown feature will be triggered if this sensor detects a low coolant level.

■ Crankcase Pressure Sensor (Series 149 Only)

This sensor monitors engine crankcase pressure, and will activate the engine shutdown/powerdown feature if it senses conditions which would ordinarily lead to a catastrophic engine failure.



Electronic Control Module (ECM)



Reliability

Detroit Diesel knows the construction and industrial marketplace demands an engine that will perform day in and day out in many of the harshest operating conditions in the world. We have designed DDEC to be tough. Its reliability and durability have been proven in the lab and on the job.

- Prior to its release in 1985, DDEC was thoroughly tested in the laboratory and in real world conditions. During the 22 million miles of testing, DDEC was subjected to power/temperature cycling; high temperature endurance; mechanical and electrical stress; humidity and moisture susceptibility; salt, dust and fluid compatibility and cleaning spray/steam exposures.
- With over 30,000 DDEC engines in operation today, this system is proving itself in some of the world's most critical applications including: fire and rescue equipment, military

vehicles, marine vessels and oil service equipment.

- Further testing has been completed in mining, drilling and other severe applications around the world prior to DDEC's release in construction and industrial equipment.
- The DDEC system is tested three times prior to customer use. Reliability is verified by the supplier, Detroit Diesel and the OEM to ensure a quality product.

In the unlikely event that the primary microprocessor chip should fail, the DDEC system contains a backup microprocessor chip which maintains fuel control and the governing features of the engine.

System Security

DDEC provides three security options to ensure that only authorized personnel can change system options.

■ No Password

This allows anyone to change selected DDEC options with the diagnostic reader.

■ Changeable Password

Only those individuals with access to the password can make selected changes utilizing the diagnostic reader.

■ System Lockout

A DDC password is provided allowing only an authorized DDC representative to make changes to the options.

Parts Support

Detroit Diesel Corporation's worldwide parts distribution center in Canton, Ohio is the hub of DDC's worldwide parts distribution network. It serves over 3,500 distributors and dealers throughout the world. The close proximity of the parts distribution center to air, rail and truck service assures the immediate availability of all Detroit Diesel components including those found in the DDEC system.



DDEC — Backed by the World's Most Sophisticated Parts and Service Network

All components of the DDEC system are covered under the standard engine warranty and the extended service coverage agreement.

DDEC is supported by our distributors and dealers trained in the servicing of the Detroit Diesel engine package. For further assistance, worldwide Detroit Diesel regional offices are listed below.

Eastern Region

Red Bank, New Jersey

176 Riverside Avenue
P.O. Box 8877
Red Bank, NJ 07701
Phone: (201) 758-6615

Southeastern Region

Atlanta, Georgia

100 Galleria Parkway
Suite 1170
Atlanta, GA 30339
Phone: (404) 953-3696

Central Region

Detroit, Michigan

13400 Outer Drive, West
Detroit, MI 48239-4001
Phone: (313) 592-5990

Southwestern Region

Dallas, Texas

2711 LBJ Freeway
Suite 1036
Dallas, TX 75234
Phone: (214) 247-4313

Western Region

Downey, California

10645 Studebaker Road
Downey, CA 90241
Phone: (213) 929-7016

Canadian Region

London, Ontario

Detroit Diesel of Canada Ltd.
150 Dufferin Ave.
Suite 701
London, ON N6A 5N6
Phone: (519) 661-0149

Latin America/Mexico Region

Coral Gables, Florida

2655 LeJeune Road
Coral Gables, FL 33134
Phone: (305) 447-1707

Asia, Pacific Region

Singapore

7 Jurong Pier Rd.
Singapore 2261
Phone: (65) 265-4697

Europe, Middle East,

Africa Region

United Kingdom

P.O. Box No. 63, Riverside House
Northampton, England NN1 5NX
Phone: (44) 604-22872

DETROIT DIESEL

CORPORATION



13400 Outer Drive, West / Detroit, Michigan 48239-4001

Telephone: 313-592-5000

Telex: 4320091 / TWX: 810-221-1649

FAX: 313-592-7288