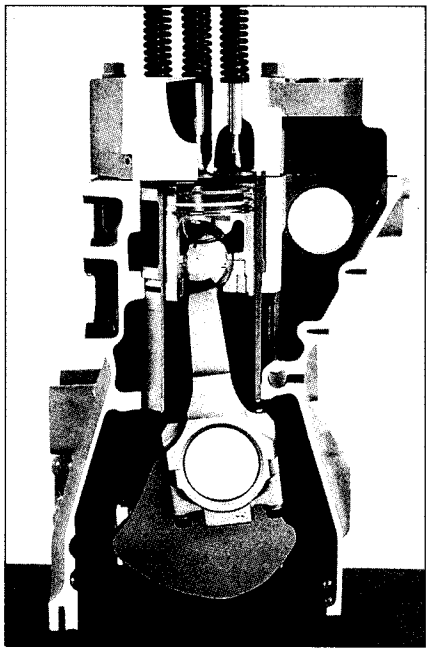
Heavy-Duty Engine Development Program—working toward a cleaner and more efficient diesel engine

For decades, nearly every product that Americans eat or wear has been transported from producer to market by a vehicle equipped with a diesel engine. Diesel engines differ from gasoline engines in that they initiate fuel combustion by use of high pressure rather than by spark. This contributes to the diesel's unmatched efficiency and reliability, traits which, along with a well-established infrastructure, have made the diesel engine the cost-effective backbone of American commerce.

There is one drawback unique to the technology—diesel engines emit tiny, respirable particulates into the air. In addition, like gasoline engines, they emit NOx, a pollutant which can cause urban smog, as well as CO_2, a greenhouse gas.

To improve efficiency and reduce emissions, the diesel engine industry has been continually improving upon the original diesel design, significantly reducing particulate, NOx and CO_2 emissions. However, increasingly stringent environmental legislation is demanding emissions rates that are significantly lower than current diesel designs can achieve.



The innovative design of Cummins' Low Emission–55% (LE-55) Diesel Engine includes a spherically-seated piston, several ceramic components and the use of a synthetic liquid for cooling and lubrication.

What can successfully replace the omnipresent, low cost and durable diesel engine? A team including the U.S. Department of Energy (DOE), the American diesel engine manufacturers and other cost-sharing partners says they have the answer—a new, advanced diesel engine. Their success under the auspices of the Heavy-Duty Engine Development Program will significantly improve the diesel's environmental performance. In addition, their efforts to further improve diesel efficiency will substantially reduce America's dependence on foreign oil. And, a breakthrough diesel engine design will give the United States a valuable export, creating new domestic job opportunities. Indeed, such a design would be in great demand around the world, and countries including Japan and the U.K. also have aggressive diesel engine programs underway, heavily funded by their governments.

A Program with several goals—in the short term

The two major goals of the Program focus on increased efficiency and reduced emissions. However, optimizing the engine for fuel efficiency is not always consistent with emissions goals, so a mix of technologies must be developed in tandem to allow the achievement of both goals.

The Program goal for energy efficiency is 55%, representing a 30% improvement over current production engines. This, in turn, would reduce CO_2 emissions by 20% or more. Low-emissions, 55% efficient (LE-55) engines are in development by the three largest American diesel engine manufacturers—Cummins, Caterpillar and Detroit Diesel Corporation. No specific concepts toward efficiency improvements are defined, but they are likely to include thermal optimization, increased utilization of exhaust and

the use of advanced materials to reduce friction and enable higher temperature operation.

Through joint efforts with industry and academic partners, the Program also seeks to develop technologies leading to greatly reduced levels of particulate and NOx emissions. Based on standards set by the state of California, the goals are to bring particulate emissions down to .05 g/bhp-hr and NOx emissions down to 2.0 g/bhp-hr—a reduction of 50% or more over current mandates. Here too, a wide range of technologies is being identified, evaluated and developed. These include fuel additives, synthetic lube oil, advanced particulate traps, electronic NOx reduction with nonthermal plasma, advanced fuel injection equipment, and possibly catalytic converter technology. One especially impressive and promising technology developed under the Program is a fuel additive that can significantly reduce NOx emissions in both new and existing engines. Principals in the effort include Dr. Rodney Sung and his staff at Texaco.

The Program is also chartered to support development in enhancing alternative fuels capabilities for diesel engines. Additional work in this area is conducted under a different DOE effort, the Alternative Fuel Truck Application Program.

In all cases, the Program emphasizes that every new engine design must demonstrate the levels of cost-effectiveness, durability, maintainability and reliability that have made the diesel engine so valuable to American commerce. In addition, it gives priority to those technological advances that are likely to be commercially viable by the end of the decade.

An emerging mix of technologies can accomplish this and more

DOE and its private sector partners are confident that the goals of the program—regardless of the short timeframe—can not only be met, but exceeded. Prototype designs are within a few percentage points of efficiency goals, and testing under laboratory conditions already suggests diesel technologies which could bring particulate emissions below .01 g/bhp-hr and NOx emissions to below 0.5 g/bhp-hr. If this success continues, the Program will allow America to continue to benefit from the power of the diesel engine—while breathing easier too.

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