

ACERT® TECHNOLOGY FOR OFF-ROAD APPLICATIONS



PROVEN TO PERFORM



CATERPILLAR®

CLEAN AIR, CLEAR ADVANTAGES

The development of ACERT Technology began with the search for new ways to reduce diesel engine emissions, but it culminated in a revolutionary engine design breakthrough that does more than help clean the air.

ACERT Technology actually enhances diesel engine performance. Cat® engines with ACERT ultimately run cleaner because they burn fuel more precisely and more efficiently – while maintaining engine performance and offering proven reliability with long-term durability.

And ACERT offers a key advantage over solutions aimed at meeting only *today's* emissions standards. ACERT has a clear path to meeting even tougher standards in the future – so it won't become obsolete as emissions regulations tighten.



OFF-ROAD ENGINES WITH ACERT

Cat engines with ACERT have already logged millions of miles in on-highway truck applications. There, they've proven to be both reliable and economically viable – delivering the same long service life with the same maintenance levels as the Cat engines they replaced.

Now, owners of Cat machines are seeing the benefits of ACERT Technology. In the fall of 2004, Caterpillar began producing machines featuring ACERT Technology.

Naturally, off-road Cat engines with ACERT meet the new Tier 3/Stage IIIA emissions reduction standards. They're also positioned to meet the very strict Tier 4/Stage IIIB standards for off-road machine when the time comes (see sidebar).

Simply put, ACERT Technology works for off-road applications today, and it will continue to deliver the power to lead for Cat engine users in the years to come.



How The Regulations Work

The EPA in the United States and the European Union (EU) have passed a series of stringent diesel engine emissions standards. Each organization implemented two separate standards, one for on-highway truck engines, another for off-road use.

The off-road standards have been phasing in over a number of years, gradually reducing the legal levels of emissions for various sizes of diesel engines. In the US, these phases are identified as “Tiers” (Tier 1 – Tier 4). In the EU, they are identified as “Stages” (Stage I – Stage IIIB).

Off-road standards are now less stringent than those for on-highway vehicles. Over time, the differences will narrow, and the two sets of standards will eventually converge.

What The Regulations Mean

The EPA estimates that, by 2010, Tier 3 standards will reduce nitrous oxide (NO_x) emissions from diesel engines by about a million tons per year – equivalent to taking 35 million passenger cars off the road.

Tier 4 standards are dramatically more stringent, reducing NO_x emissions by 90% *beyond* Tier 3 restrictions – enough so that, in some locations, the exhaust coming out of a Tier 4 engine may have less NO_x than the air going in.



HOW ACERT WORKS

A REVOLUTION THROUGH EVOLUTION

To understand what ACERT Technology *is*, it's helpful to first recognize what it isn't.

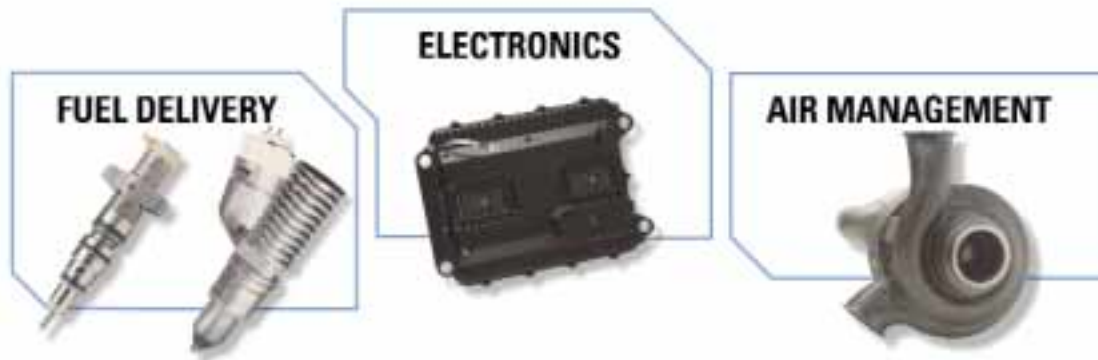
ACERT *is not* a single, add-on system for reducing emissions.

Instead, ACERT is a *refined combination of technologies*, some brand new and some that have seen millions of hours of on-the-job use.

Think of ACERT as a revolution through evolution. For off-road applications, the technology takes advantage of both major discoveries and subtle enhancements in three major "building block" engine technologies:

- Fuel delivery
- Electronic control
- Air management





Advanced Fuel Delivery

The major breakthrough of ACERT is the highly precise way it delivers fuel to the combustion chamber.

ACERT Technology starts with advanced electronic engine control, a technology pioneered by Caterpillar. A programmable Cat ADEM™ A4 controller governs highly precise mechanically- or hydraulically-actuated fuel injectors (another Cat innovation). These injectors introduce fuel in a series of carefully timed “microbursts” to control combustion temperatures and regulate the entire combustion process.

By instantly adjusting the time and quantity of fuel delivery, ACERT can match engine output to job needs with the highest possible efficiency. That dramatically cuts emissions while maintaining (or even enhancing) power, engine performance and fuel efficiency.

Along with advanced fuel delivery and electronic control, all Cat engines with ACERT have crossflow heads. Crossflow air routing inside the cylinder head helps the engine “breathe” more efficiently, which adds to its overall performance.

Flexibility For Today And Tomorrow

As emissions regulations tighten in the future, elements can be enhanced or replaced as required to meet stricter standards – without changing the core technology.

A truly revolutionary and unique concept in engine design, ACERT Technology can readily adapt to today’s wide-ranging job needs and evolve to meet tomorrow’s challenges.



BUILT ON EXPERIENCE

Off-road engines with ACERT Technology benefit from the experience Caterpillar has in on-highway applications. With more than 170,000 truck engines on the road at the end of 2004 – and over 36 million miles per day under their wheels – ACERT has demonstrated proven performance.

Truck engines with ACERT Technology by the numbers

| | July 2004 | December 2004 |
|------------------------|------------|---------------|
| Engines w/ACERT | 90,000 | 170,000 |
| Miles per day | 17 million | 36 million |
| Hours per day* | 440,000 | 840,000 |

*Based on six hours per day for each C11/C15 engine and four hours for each C7/C9.



That performance translates directly into off-road applications, because corresponding off-road and on-highway Cat engines with ACERT share ninety percent of their core iron. The only differences arise in application iron, chassis installation and programming.

In addition, many of the components in today's off-road engines with ACERT have already logged millions of hours in earlier Tier 2-compliant off-road engines. Again, Caterpillar is building on a foundation of proven success.



ON-HIGHWAY AND OFF-ROAD ENGINES COMMON COMPONENTS

- Crankshaft
- Block
- Cylinder Head
- Valves and mechanisms
- Camshaft (different profile)
- Injector (tips)
- Rods
- Bearings
- Front Gear Train
- Water Pump
- Oil Pump
- Sensors

Percentage of parts shared between engines with ACERT and Tier 2 predecessors

| | |
|----------------|-----|
| C27 | 44% |
| C15/C18 | 59% |
| C11/C13 | 68% |
| C7/C9 | 70% |

Percentage of common part numbers among Tier 3 engines

| | |
|---------------------------|-----|
| Between C15/18 and C11/13 | 37% |
| Between C15/18 and C27 | 47% |

Engines with ACERT share proven technologies and a high percentage of parts with other Cat engine platforms, so you can count on the reliable performance and long engine life you expect from Cat engines.

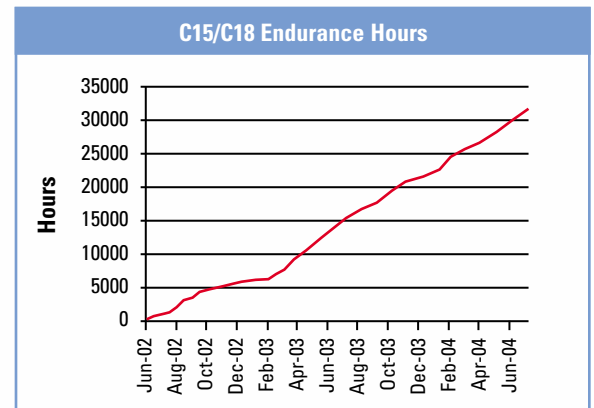
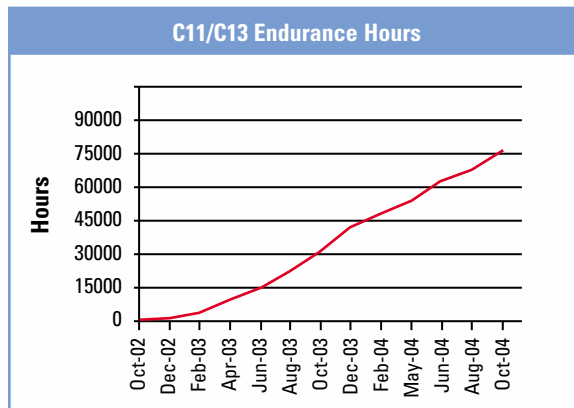


TESTING FOR SUCCESS

CAT ENGINES WITH ACERT ARE THE MOST TESTED ENGINES IN CATERPILLAR HISTORY.

Caterpillar doesn't take a breakthrough technology like ACERT to market without exhaustive testing.

So, by the time the first Tier 3 off-road engines with ACERT made it into production, they had been analyzed in the lab three times longer than their Tier 2 predecessors...making them the most tested engines in company history.



Cat engines with ACERT Technology are the most heavily tested engines in Caterpillar history.



24-HOUR WORK CYCLES

And that testing was rigorous. For example, to develop new piston rings and liners, Cat engineers ran a test engine through a very high number of wheel loader cycles – the toughest work cycle an off-road engine can face.

The engine ran 24 hours a day, seven days a week. Oil samples were taken every 50 hours. Engineers disassembled the engine every 500 hours to measure wear, then rebuilt it and put it back to work. As a result, you can count on those rings and liners to deliver long life in your toughest jobs.



EXTREME CONDITIONS

Caterpillar® engine test cells are able to recreate the toughest environments in the world. The engines are started up, brought to optimal operating temperature, shut down, frozen, and started again. This cyclical process is repeated again and again to simulate continual use in severe climates.

The engines are run up to 150% of rated RPM and fueled to 120% of rated peak cylinder pressure. They are operated on a tilt table to ensure full lubrication at all potential machine operation angles.

They are subjected to vibration and fed a variety of oils and fuels. They're tested for performance with dirt in the air and contamination in the lines. They're also checked to make sure the seals function properly in all conditions.

If any engine or component fails these tests, it's back to the drawing board for further research and refinement.



HALF A MILLION HOURS

In the first year and a half that preproduction off-road engines were available, ACERT Technology posted 230,000 hours in 145 machines on actual jobsites. That adds up to a lot of experience, long before the first production engine came down the line.

By year-end 2005, that total is expected to reach 500,000 hours in 300 machines. Every aspect of those early engines was examined, measured and used to improve the technology.

All this testing means that, when you fire up a Cat engine with ACERT in one of your machines, you can be sure it will deliver on its promise of clean, efficient power and performance.



TESTED ON THE LINE

Developing off-road engine technology is one thing. Actually producing working engines for the real world is another job altogether.

To bridge the gap between theory and production of off-road engines with ACERT, Cat engineers redesigned the entire production process. Then, they built preproduction engines right on the production line, instead of assembling them by hand.

Procedures and parts were tested, refined and approved before the first customer engine was produced. Suppliers were also evaluated on their ability to deliver parts and materials on time and to specification.

In total, Caterpillar has so far spent well over \$500 million in research, development and testing to make certain that Cat engines with ACERT are built right, reliable and long-lasting in whatever job you have to do.

Breakthrough design. Proven technology. Exhaustive testing. It all comes together to give Cat engines with ACERT Technology the proven performance you want with the regulatory compliance you need. That's the power to lead.





**CATERPILLAR ACERT TECHNOLOGY—
THE POWER TO LEAD.**



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