

# BUILT FOR THE NEXT GENERATION

CAT® TIER 4 INTERIM / STAGE IIIB TECHNOLOGIES

HAWTHORNE



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# ADVANCING TECHNOLOGY

## BUILDING CUSTOMER VALUE

With decades of diesel engine innovation and expertise behind us, Caterpillar takes another critical step into the future with Cat® Tier 4 Interim/Stage IIIB technologies.

Successful businesses know they must meet customer expectations today as well as work toward the emerging needs of the future. Leaders are integrators—not just of engine systems, but of industry-best practices, service and support and sustainable value.



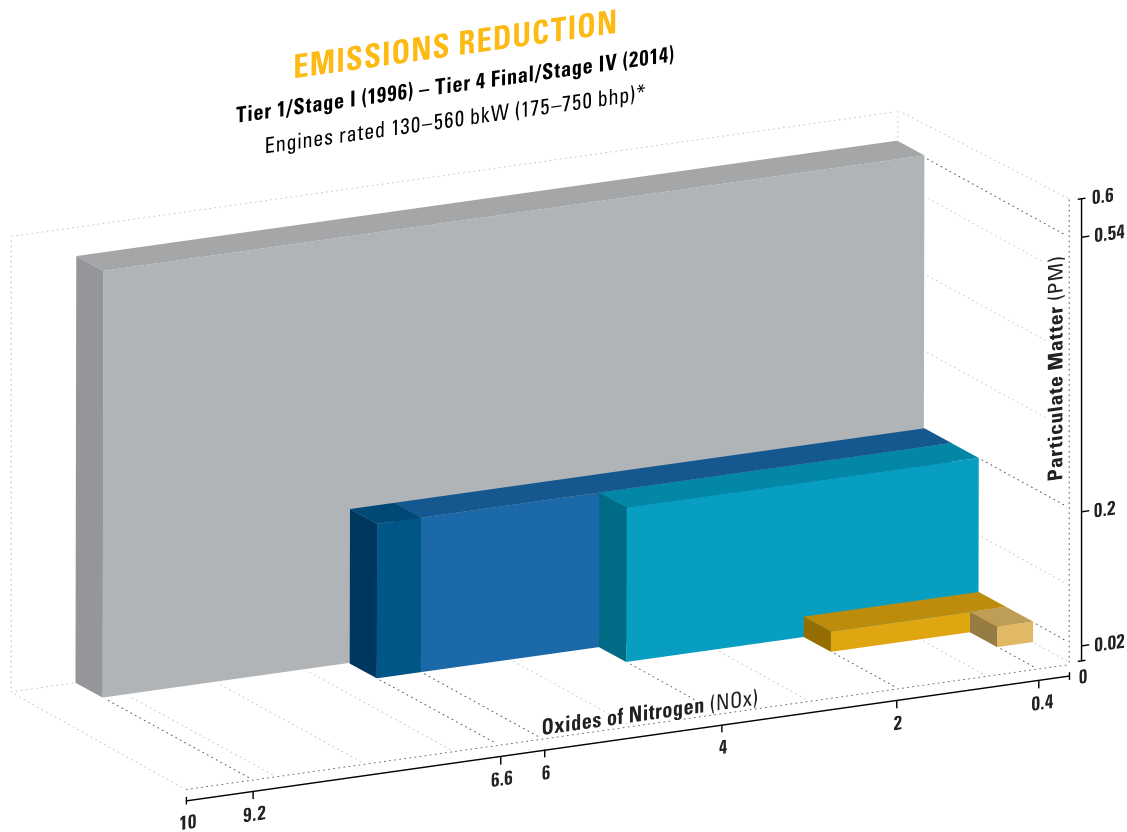
## The Next Phase in Emissions Reduction

Cat Tier 4 Interim/Stage IIIB engines meet tough emissions standards and deliver the performance and efficiency that successful businesses demand.

Like all manufacturers of diesel engines, Caterpillar is required to deliver engines that meet government emissions standards that are being phased-in throughout the United States, Canada, Europe and Japan.

## Cleaner Fuel & Oils

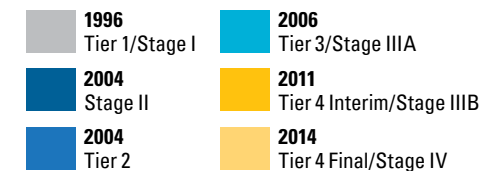
Also part of the upcoming emissions standards, industry technology requires  $\leq 15$  parts per million (mg/kg) Ultra Low Sulfur Diesel Fuel (ULSD) for use in Tier 4 Interim/Stage IIIB engines. In Cat engines, not only will ULSD need to be used, but also low sulfated ash oils. These cleaner fuels and oils will help reduce ash and maintain service intervals, contributing to low emissions and reduced operating costs. The new Cat engines will also have B20 biodiesel capability, adding even greater sustainability where desired or required.



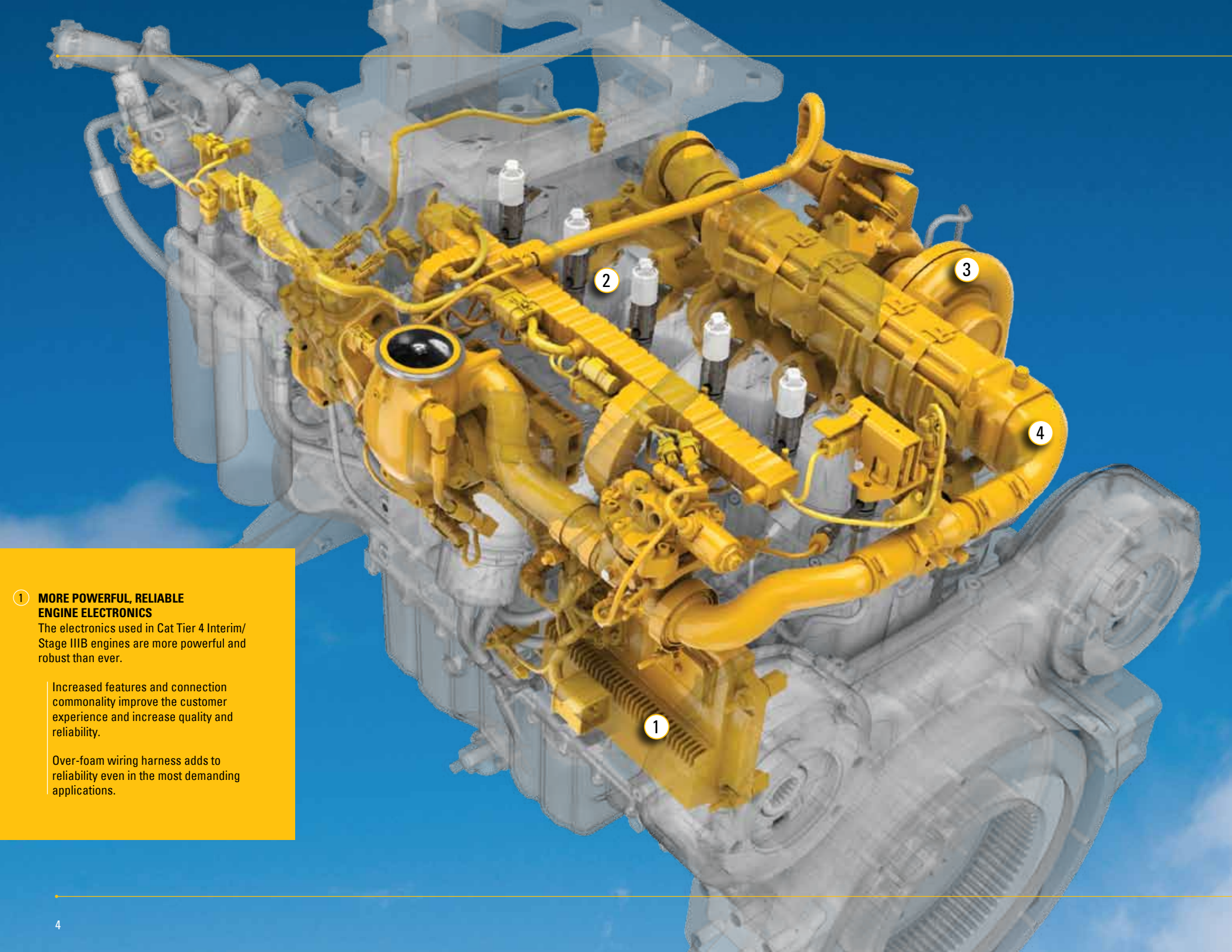
Emissions standards have been systematically reducing levels of Particulate Matter (PM) and Oxides of Nitrogen (NOx) since 1996 when the first standards went into effect.

From Tier 1/Stage I (1996) levels to Tier 3/Stage IIIA (2006), emissions standards required an approximate 65 percent reduction in PM and a 60 percent reduction in NOx.

The next phase of emissions standards, called Tier 4 Interim in the U.S. and Canada and Stage IIIB in the European Union, take effect in 2011. Compared to Tier 3/Stage IIIA levels, Tier 4 Interim/Stage IIIB standards require a 90 percent reduction in PM and a 50 percent decrease in NOx. Tier 4 Final/Stage IV standards, which will become effective in 2014, reduce NOx by an additional 40 percent, taking PM and NOx emissions to near-zero levels.



\*Engines rated 56–130 kW (75–175 bhp) are required to meet Tier 4 Interim/Stage IIIB standards in 2012 and Tier 4 Final regulations in 2015. Engines rated >560 kW (750 bhp) will meet Tier 4 Interim standards in 2011 and Tier 4 Final regulations in 2015 (EPA only). Standards differ by power category.



**1 MORE POWERFUL, RELIABLE ENGINE ELECTRONICS**

The electronics used in Cat Tier 4 Interim/ Stage IIIB engines are more powerful and robust than ever.

Increased features and connection commonality improve the customer experience and increase quality and reliability.

Over-foam wiring harness adds to reliability even in the most demanding applications.



## HELPING YOUR BUSINESS REACH

# THE NEXT LEVEL

We believe that part of our commitment to our customers is to understand your needs and your business. We know that engine maintenance, service and support are critical not just to power and performance but to achieving the lowest total cost of ownership. Value is cumulative, and Hawthorne is dedicated to delivering this for the life of your engine.

### **World-class Service and Support**

The worldwide Cat Dealer network supports your engines and your operations anywhere in the world. And field technicians worldwide have been expertly trained to support the technologies of Tier 4 Interim/Stage IIIB engines.

The parts commonality built into the Tier 4 Interim/Stage IIIB line of engines enables common service tooling and parts stock coverage, further enhancing the value that product support can deliver. With industry-leading parts availability, cost-saving Reman options and Cat Certified Rebuild programs, you can keep your engine performance high and your operating costs lower.



**High Pressure Common Rail Fuel System**

## 2 NEXT GENERATION FUEL SYSTEM OPTIONS

As a key component of Cat Tier 4 Technology, injection timing precisely controls the fuel injection process through a series of carefully timed microbursts. This injection timing provides more control of combustion for the cleanest, most efficient fuel burn. To maximize customer value, Cat engineers specified fuel systems based on the power and performance demands for each engine.

**High Pressure Common Rail Fuel Systems** with full electronic injection improve precision and control that boost performance and reduces soot for the C4.4 ACERT, C6.6 ACERT, C7.1 ACERT and C9.3 ACERT.

**Advanced MEUI-C injector platforms** handle increased injection pressures and more precise fuel rates. These durable injectors enhance responsiveness while controlling soot in the C13 ACERT, C15 ACERT, C18 ACERT, C27 ACERT and C32 ACERT.

## 3 INNOVATIVE AIR MANAGEMENT

Cat Tier 4 Interim/Stage IIIB engines feature innovative air-management systems that optimize airflow and enhance power, efficiency and reliability. We apply a range of simple, reliable turbocharging solutions, based on engine size and application. This allows us to match turbo performance to rated output for high productivity, excellent fuel efficiency, long life and low operating costs.

## 4 CAT NO<sub>x</sub> REDUCTION SYSTEM

The Cat NO<sub>x</sub> Reduction System captures and cools a small quantity of exhaust gas, then routes it back into the combustion chamber where it drives down combustion temperatures and reduces NO<sub>x</sub> emissions. The result of more than a decade of Caterpillar engineering research into this technology, the Cat NO<sub>x</sub> Reduction System is designed to be the most reliable system of its type.



**Air Management and Cat NO<sub>x</sub> Reduction System**

# BUILDING BLOCKS DELIVER FUEL EFFICIENCY



Inside the DPF, particulate matter, sometimes referred to as "soot," is trapped until it is burned off through regeneration.

5

**Cat Regeneration System (CRS) meets specific engine requirements.** CRS allows for fast, accurate control of regeneration independent of engine exhaust temperatures. CRS provides an ideal solution in all operating conditions, including low load, cold ambient temperatures and extended idle time.

# TECHNOLOGIES

## PRECISION, RELIABILITY AND DURABILITY

The **DOC** does not require maintenance because it is a “flow-through” device and the pollutants do not get trapped in the component.



### 5 AFTERTREATMENT TECHNOLOGIES

To meet Tier 4 Interim/Stage IIIB emissions standards and beyond, Cat aftertreatment components have been designed to match application needs.

#### For small to medium applications:

- Service-free compact systems
- Passive regeneration
- No supplemental fuel needed

#### For medium to large applications:

- Durable packaged systems designed to withstand even the most demanding applications
- Fuel-efficient, reliable regeneration
- Operates automatically

Cat Aftertreatment components include:

#### Diesel Oxidation Catalyst (DOC)

The DOC uses a chemical process to transform pollutants in the exhaust stream into less harmful components.

#### Diesel Particulate Filter (DPF)

A DPF traps additional particulate matter that’s carried in the exhaust stream, preventing it from being released into the atmosphere.

#### Passive Regeneration System (C4.4 ACERT, C6.6 ACERT)

All Cat Tier 4 Interim/Stage IIIB engines use a passive regeneration system that continually regenerates at a slow rate, during normal machine operation, using the heat from the engine’s exhaust gas.

#### Cat Regeneration System (C7.1 ACERT–C18 ACERT)

The Cat Regeneration System (CRS), is an active regeneration system used in engines rated 130–560 kW (175–750 bhp) when supplemental regeneration is needed. CRS elevates exhaust gas temperatures to promote oxidation and burn off soot in the DPF.



### CAT CLEAN EMISSIONS MODULE (CEM)

The CEM is a flexible Caterpillar designed modular system that can include the following components: DOC, DPF, CRS, muffler and air cleaner. The CEM, designed to withstand the most severe applications and conditions, is available on C7.1 ACERT–C18 ACERT engine models. (For C4.4 ACERT and C6.6 ACERT engines the configuration is a single can, including a DOC and DPF, with a simple passive regeneration system.) The CEM protects the components, minimizes the aftertreatment footprint and simplifies maintenance.

# COMMITTED TO CUSTOMER SUCCESS

Caterpillar equips every Tier 4 Interim/Stage IIIB engine with ACERT™ Technology with an ideal combination of electronic, fuel, air and aftertreatment components, based on engine size, the type of application and the geographic location in which it will work. Applying technologies systematically and strategically optimizes them to meet our customers' high expectations for productivity, fuel efficiency, reliability and service life. The right technology fine-tuned for the right application results in:

**IMPROVED FUEL EFFICIENCY** Up to 5 percent improvement in fuel efficiency

**POWER AND PERFORMANCE** Integrated design boosts power and performance across applications

**RELIABILITY** through commonality and simplicity of design

**MAXIMIZED UPTIME AND REDUCED COST** with world-class support from Hawthorne

**LONG LIFE** Cat durability and long life to overhaul

**MINIMIZED IMPACT** of service and maintenance on operating costs

**SMOOTH TRANSITION** Design and modular aftertreatment pave the way for a smooth transition to Tier 4 Final/Stage IV solution. No additional space required.

**REDUCED EMISSIONS** Up to 90 percent reduction in particulate matter (PM) and 50 percent reduction in Oxides of Nitrogen (NOx)

The entire line of Cat Tier 4 Interim/Stage IIIB engines is precisely engineered, rigorously tested and validated and built for the reliability and durability you count on from Cat.

- 1 More Powerful Engine Electronics** Common features and connections increase quality, reliability and ease of use.
- 2 Next Generation Fuel System Options** Precise injection systems deliver maximum fuel efficiency and soot control.
- 3 Innovative Air Management** Simplified turbocharging optimizes productivity, fuel efficiency and reliability.
- 4 Cat NOx Reduction System** Rugged, reliable system lowers combustion temperatures and reduces NOx emissions.
- 5 Aftertreatment Technologies** Durable components, designed to withstand demanding applications, reduce pollutants in exhaust stream.

## UNPARALLELED MANUFACTURING AND INTEGRATION EXPERTISE

No one knows more about systems integration than Caterpillar. From the concurrent design of components, systems and the electronics that control them, we are always looking to the future: What specifications need to be met? What types of conditions will occur? What will be the most effective way to manufacture what we design? What kind of support will be required?

And, then, when we answer those questions, we field-test with our customers. This is the most critical step: **integrating product with application needs and customer expectations.**

This approach is how we ensure that Cat Tier 4 Interim/Stage IIIB products, like the generations before them, deliver working advantages that are real, measurable and sustainable over time.



# MOVING FORWARD ON A PROVEN PATH

Caterpillar is the largest vertically integrated manufacturer in the world. As each new family of engines moves us forward, it also sustains the advantages learned from decades of manufacturing, testing and product support.

## Cat Tier 4 Interim/Stage IIIB Testing and Validation

The testing and validation program of Cat Tier 4/Stage IIIB engines is the largest in Caterpillar history. This industry-leading engine validation program will ensure that all new Cat engines deliver reliable performance from the first day on the job.

Multi-segment, multi-phase validation of **prototype, pilot and support machines** conducted in a wide variety of the most demanding applications.

Reliability validated with **over a million accumulated operating hours.**

Developed a new manufacturing plant process designed to **improve production and quality.**

Advanced power system simulators provide **extensive modeling, analysis and testing.**

**Next generation simulation techniques** enhance cooling system design, increase electronics capabilities and optimize power train integration.





Caterpillar has taken every possible step to effectively manage service and maintenance issues and minimize the impact of those activities on operating costs.

Eliminated 500-hour initial **valve lash service requirement**.

**Basic oil and filter change** intervals have not changed.

Engines are required for use with **Ultra Low Sulfur Diesel (ULSD)** fuel and also accommodate **B20 biodiesel** when blended with ULSD.

New emissions standards drive new **service intervals and maintenance activity**:

- 5,000 hours (C7.1 ACERT–C18 ACERT) for DPF ash removal. Removal options:
  - Mobile ash-removal tool
  - Stationary ash-removal tool
  - Cat exchange
- 2,000 hours for Open Crankcase Ventilation filter

CEM aftertreatment is designed with a removable center section to allow easy access to the DPF for **ash service**.

Hawthorne also offer Customer Support Agreements and fleet and business management expertise that can help you reduce overall costs and manage your business even more effectively...which may take your success to a whole new level.

**Tier 4 Interim/Stage IIIB engineering minimizes additional maintenance and maximizes efficiency to stabilize operating costs.** Testing and analysis results suggest that total owning and operating costs will remain fairly stable, because improvements in fuel efficiency are expected to offset costs associated with aftertreatment maintenance.

# TIER 4 INTERIM/STAGE IIIB ENGINE PRODUCT LINE

## C4.4 ACERT



**Power**  
60–130 kW (80–174 bhp)

**Fuel System**  
Common Rail

**Air System**  
Smart Wastegate

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
DOC/DPF

**Regeneration Technology**  
Passive System

## C6.6 ACERT



**Power**  
89–130 kW (120–174 bhp)

**Fuel System**  
Common Rail

**Air System**  
Smart Wastegate

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
DOC/DPF

**Regeneration Technology**  
Passive System

## C7.1 ACERT



**Power**  
130–225 kW (175–300 bhp)

**Fuel System**  
Common Rail

**Air System**  
Series/Smart Wastegate

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC/DPF

**Regeneration Technology**  
Cat Regeneration System

## C9.3 ACERT



**Power**  
205–305 kW (275–410 bhp)

**Fuel System**  
Common Rail

**Air System**  
New High-Efficiency  
Turbocharger

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC/DPF

**Regeneration Technology**  
Cat Regeneration System

## C13 ACERT



**Power**  
287–354 kW (385–475 bhp)

**Fuel System**  
MEUI-C

**Air System**  
New High-Efficiency  
Turbocharger

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC/DPF

**Regeneration Technology**  
Cat Regeneration System

## C15 ACERT



**Power**  
328–433 kW (440–580 bhp)

**Fuel System**  
MEUI-C

**Air System**  
New High-Efficiency  
Turbocharger

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC/DPF

**Regeneration Technology**  
Cat Regeneration System

## C18 ACERT



**Power**  
429–571 bkW (575–765 bhp)

**Fuel System**  
MEUI-C

**Air System**  
New High-Efficiency  
Turbocharger\*

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC/DPF

**Regeneration Technology**  
Cat Regeneration System

## C27 ACERT



**Power**  
597–800 bkW (800–1050 bhp)

**Fuel System**  
MEUI-C

**Air System**  
New High-Efficiency  
Turbocharger

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC only

**Regeneration Technology**  
Not Required

## C32 ACERT



**Power**  
705–950 bkW (950–1200 bhp)

**Fuel System**  
MEUI-C

**Air System**  
New High-Efficiency  
Turbocharger

**NOx Reduction Technology**  
Cat NOx Reduction System

**PM Reduction Technology**  
Cat CEM with DOC only

**Regeneration Technology**  
Not Required

\*Single High-Efficiency Turbocharger below 522 bkW (700 bhp). Series above 522 bkW (700 bhp); first is fixed, second is the new High-Efficiency Turbocharger.

# DELIVERING VALUE TODAY AND FOR FUTURE GENERATIONS

From the beginning of Tier 4 Interim/Stage IIIB engine development, our commitment has been to keep the needs of our customers in sharp focus—always.

**UNPRECEDENTED RESOURCES AND TECHNOLOGY** have been focused on addressing customer needs and building value.

**STATE-OF-THE-ART FACILITIES AND VIRTUAL TOOLS** drive velocity and quality assurance throughout development, test and production cycles.

**THE MOST EXTENSIVE VALIDATION PROGRAM** in Caterpillar's history is designed for one purpose: provide our customers with high levels of confidence that their concerns have been addressed.

We are ready to deliver this rugged, dependable line of engines that boosts performance and efficiency, remains easy to operate and maintain, delivers long service life, provides low total cost of ownership and reduces emissions.



# GENERATIONS AHEAD

## PERFORMANCE. RELIABILITY. VALUE.

As we considered each advancement in our building block technologies, we never lost sight of our commitment to performance, reliability, improved fuel efficiency and value for our customers.

Caterpillar offers a full line of Tier 4 Interim/Stage IIIB engines for every application—with optimized emissions solutions tailored for each application. With Cat Tier 4 Interim/Stage IIIB engines in your fleet, you can have even more confidence in your business's economic and environmental performance.

So no matter where you do business and no matter where your business takes you, Caterpillar will deliver solid, bottom line results...today and in the generations to come.

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