Simple and Easy Cleaner Emissions Options
Many hard rock mines focus on the reduction of Diesel Particulate Matter (PM) from their mobile equipment because this value often drives a mine’s required ventilation rate. The level of PM in the underground environment is carefully managed in order to meet regulatory requirements imposed by mine safety and health agencies around the world. Ventilation in the underground environment is a large percentage of a mine’s operating cost and can affect the viability of a greenfield project or an expansion. The Ventilation Reduction engine utilizes selective engine hardware and software to minimize diesel particulate matter in selected Load Haul Dump (LHD) and Underground Articulated Truck (UAT) machines.
Cat® Ventilation Reduction (VR)  
Cleaner Air for Hard Rock Underground

Lowering Operation Costs
In development of the VR Package, customer value and requirements determined that selectively applied robust technology enhancements was applied to the already proven Cat engine line. By carefully considering the challenging underground environment as well as regulatory requirements for diesel engine emissions in underground mines, the VR engine ultimately drives down ventilation rates required by weighted PM (Particulate Matter). By achieving substantial decreases in ventilation rates, the VR Package option represents a great advancement in the underground mining industry. Underground mining customers find value in lower emissions and decreased ventilation rates, and this option will be a positive outcome for customers looking for reducing operation costs.
What Drives Ventilation?
Around the world, many different agencies regulate mine ventilation for a specified engine exhaust level. These ventilation requirements can be based on personal exposure limits (PEL) for operators in the mine. The CANMET regulation used in Canada is generally accepted as the most comprehensive representation of actual engine emissions. CANMET measures 18 points throughout the engine’s operating cycle, giving a broader range of sample points. This allows for a thorough and detailed comparison between engines in the underground environment. Therefore, the next generation of engines for LHD’s and UAT’s will be optimized for the lowest possible CANMET ventilation rate. The CANMET measurement provides the following advantages:

- Weighted heavily towards PM among all other exhaust gases
- Largest number of sampling points in the machine operating curve
- Published figures are based on the highest vent rate samples
- Accounts for fuel sulfur levels and altitude effects

Many mining industry regulations require adequate ventilation underground to keep the level of NOx, PM, HC, and CO at acceptable levels.

Ventilation in the underground environment is a large percentage of a mine’s operating cost. Caterpillar is committed to supplying Hard Rock Underground Loaders and Trucks with engine packages that minimize the level of ventilation required.
Caterpillar has developed a specifically tuned Diesel Particulate Filter (DPF) for fitment to Cat® Ventilation Reduction engines to further reduce diesel particulate matter output.

- Optimized to reduce particulates greater than 50% and maintain NO2 emissions.
- Meets Cat engine backpressure requirements
- Utilizes current muffler space claim
- Does not require specialized services
- Requires Ultra Low Sulfur Diesel (ULSD) and low ash oil (ECF-3, CJ-4)

**DPF Breakdown**

- Uses flow through filter technology and catalytic conversion to effectively reduce particulate matter emissions
- Incorporates a metal filter medium to trap particles and effectively oxidise them by means of a catalytic coating
- No additional service intervals for cleaning
- Muffler / flow through filter offers the same or better noise attenuation
- No increased NOx emissions as compared to the existing DOC muffler

**Ventilation Reduction Engine Technology**

The Ventilation Reduction Package utilizes selective engine hardware and software to minimize diesel particulate matter. Depending on the machine and the engine, it involves a combination of two or more of the following (compared to today’s Tier 3 engines):

- New engine software
- New injectors
- New turbo
- New camshaft
Systems Overview
Selecting VR as a factory option or upgrading an existing engine in the field has multiple performance improvements and cost saving incentives.

VR
- Reduced Certified Ventilation Rate
- Reduced Diesel Particulate Output
- 3 – 7% Fuel Economy Improvement *
- Ventilation Rate Energy Saving
- Retrofitable to Existing Fleets **
- Fuel Sulfur Level Flexibility

VR + DPF
- Reduced Certified Ventilation Rate
- 50%+ Reduction in Diesel Particulate Output
- 3 – 7% Fuel Economy Improvement *
- Energy Savings From Reduced Ventilation
- Fuel Sulfur Level 15ppm or Better
- ECF-3 (CJ-4) Engine Oil
- Retrofitable to Existing Fleets **

* Over non-VR engine packages
** Depending on model prefix and serial number
Cat® Ventilation Reduction (VR)
Cleaner Air for Hard Rock Underground

Key Advantages of the VR Package:
- Significant CANMET Ventilation Rate Reduction
  - Up to 58%+ reduction compared to Tier 3, when used with the Cat DPF
- Significant Diesel Particulate Matter (DPM) Reduction
  - Up to 81%+ reduction compared to Tier 3, when used with the Cat DPF
- Improved fuel economy
  - 3% to 7% reduction compared to today’s engines, depending on the model
- Maintained / Improved Machine Performance (increased rimpull)
  - Machine performance will not be impacted and in some cases will be improved
- Fuel quality flexibility – not limited to 15ppm fuel – can use higher sulfur fuels (non DPF only)
- Compatible with Diesel Particulate Filter (DPF) after treatment systems
- Existing Tier 3 engines can be converted to VR engines
- Engine service intervals and component life to overhaul will remain the same

Ease of Maintenance
The VR engine package has little to limited customer impact depending on whether a standard VR engine is used or the addition of a Cat DPF. The Cat DPF has the same service life as the standard Tier 3 purifier muffler.

VR Engine
1. Fuel (500 ppm sulfur)
   Biodiesel up to B20 can also be used
2. Standard ECF-2 (CI-4) Engine Oil

VR Engine + DPF
1. Ultra Low Sulfur Diesel (ULSD)
   Fuel (15 ppm sulfur)
   Biodiesel up to B20 can also be used
2. API CJ-4 (ECF-3) Low Ash Engine Oil

For more complete information on Cat products, dealer services, and industry solutions, visit us on the web at mining.cat.com and cat.com.

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