



Diesel Retrofits: Today and Tomorrow Off-Road Experience

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Johnson Matthey

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NEDC

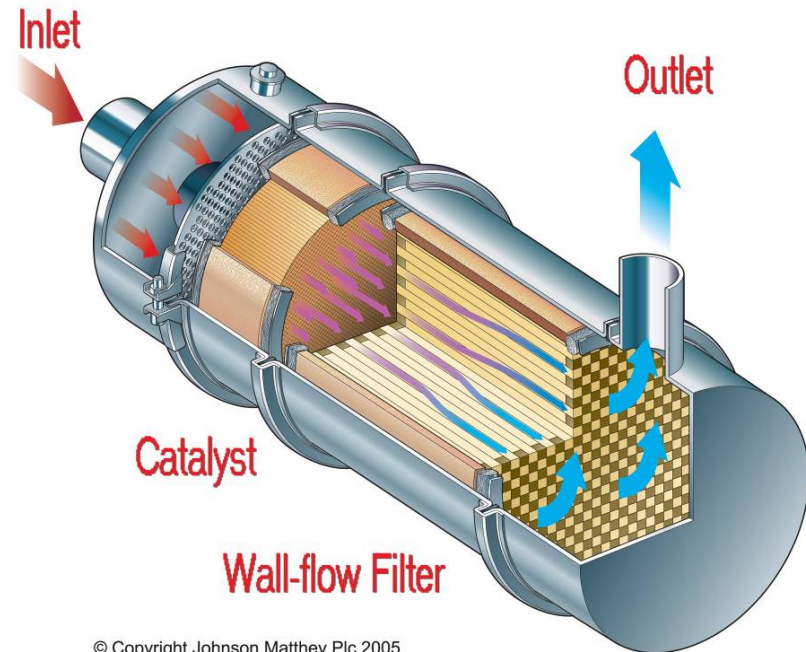


Technology

- **Diesel Oxidation Catalysts - LSD**
 - 25 to 50% PM, 60+% CO / HC Reduction
- **“Partial” Flow Filters - LSD**
 - 50 to 70% PM, 60+% CO, HC Reduction
- **Passive Filters - ULSD**
 - >85% PM, 90%+ CO / HC Reduction
- **Active Filters - LSD**
 - >85% PM, 60%+ CO / HC Reduction
- **EGRT – ULSD**
 - 40 to 50% NO_x, >85% PM, 90+% CO / HC Reduction
- **SCR – LSD w/ DOC**
 - 60 to 90% NO_x, 25 to 50% PM, 60+% CO / HC Reduction
- **SCRT – ULSD**
 - 60 to 90% NO_x, >85% PM, 90+% CO / HC Reduction



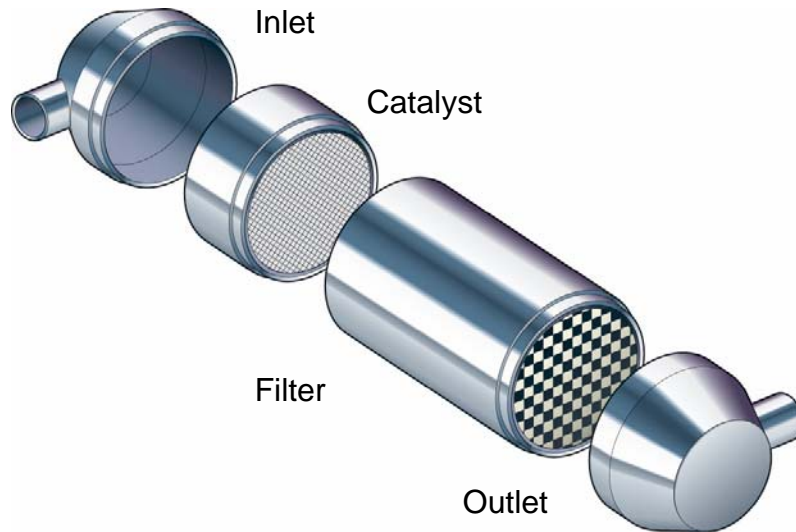
CRT[®] and CCRT[®] Filters



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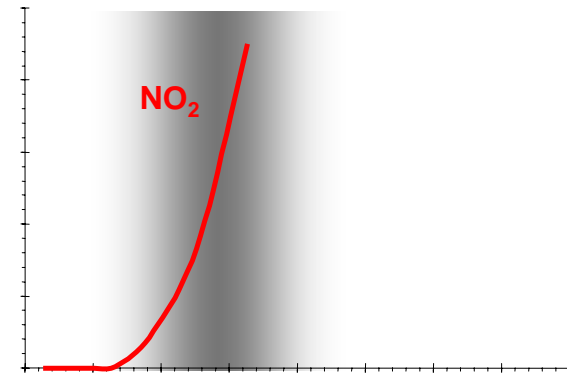
EPA / ARB Verified Level 3 with >85%
CO/HC/PM Reduction





Passive device which requires no maintenance between normal services.

JM patented technology.

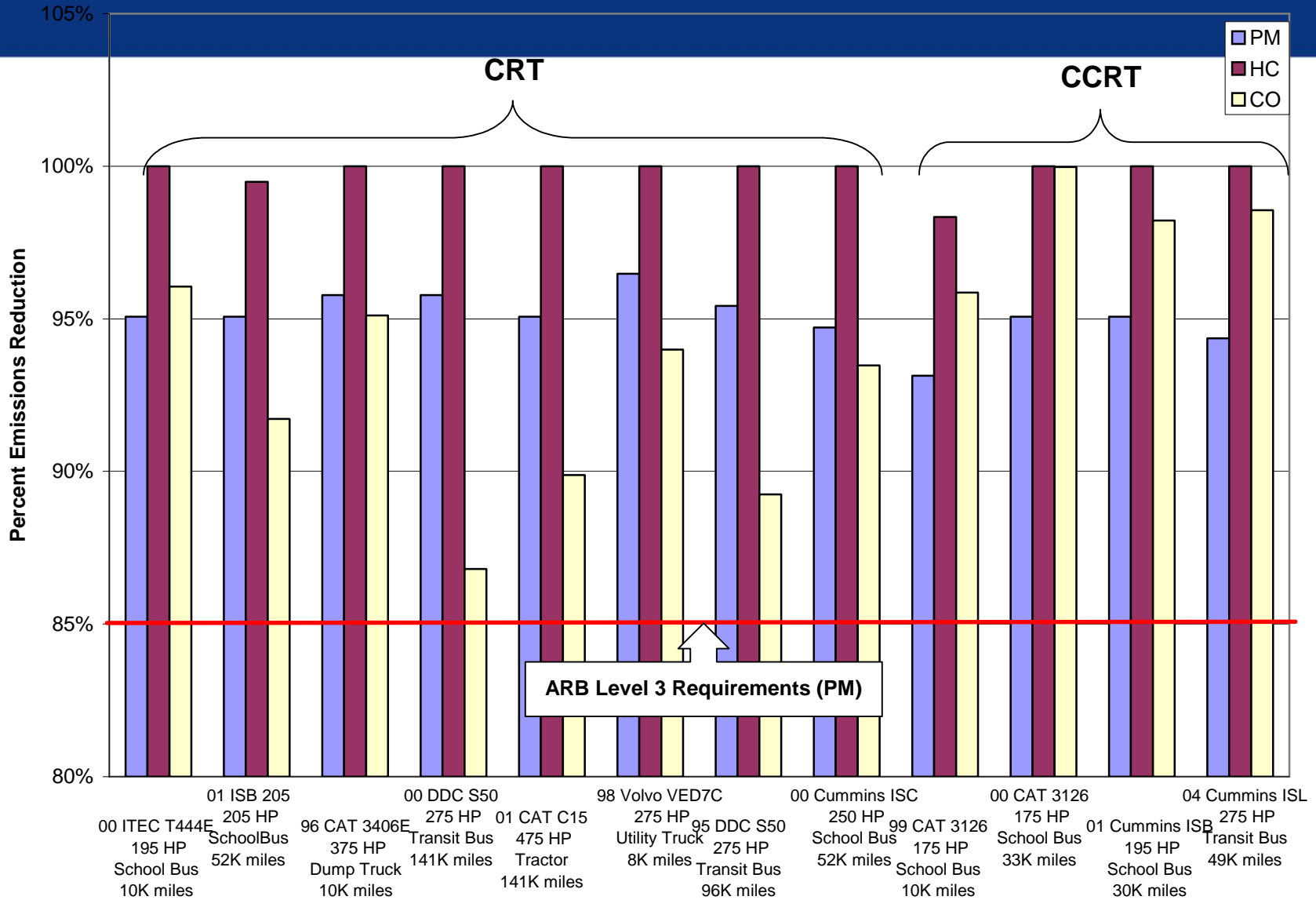


Requirements:

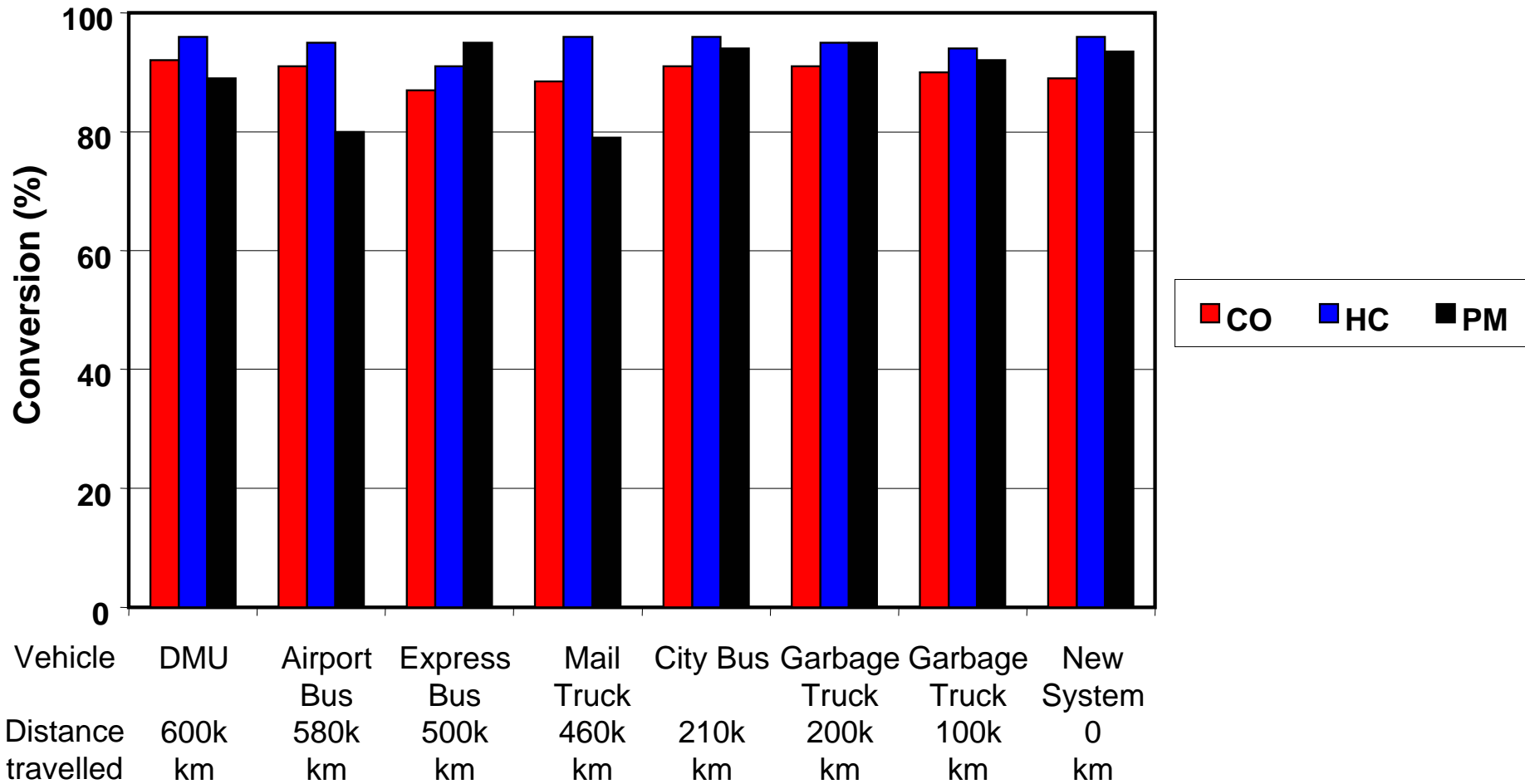
- >240°C catalyst temperature for at least 40% operating time
- 15ppm sulphur in fuel,
- >20-25:1 NO_x/ PM engine out ratio.



Results From EPA/ARB In-Use Testing



Results From European Durability



Source: SAE 2000-01-0480

CONFIDENTIAL



Challenges

- Higher PM
- Environment
 - Vibration
 - Dust
- Line of sight
- Tipping
- Backpressure
- ULSD
- Movement from site to site



Continuation	Approval number suitability test				Deployment duty with manufacturer references					
	VFT1	VFT2	VFT3	VSET	Truck	Bus	Construction site	Fork lift	Ship / Rail	Stationary
HJS PFS Type CRT® F: CORNING DuraTrap™CO after oxidation cat. converter. R: NO ₂ from oxidation cat. converter K: LogLink FCD-02	B053/4.98	B097/10.01	B097/10.01	B111/10.02	•	•	•	•		
JOHNSON MATTHEY PFS Type DPFi/DPFis/DPF-CRT™ F: IBIDEN SiC cell filter R1: NO ₂ from oxidation cat. converter R2: Electric in situ / standstill R3: Fuel additive satacen (Fe) R4: Fuel additive EOLYS (Ce) K: PIO 120	B059/6.99	B090/4.01	B090/4.01	EMPA 167985	•	•	•	•		•
JOHNSON MATTHEY PFS Type DPFi/DPFis/DPF-CRT™ F: CORNING DuraTrap™CO. R1: NO ₂ from oxidation cat. converter R2: Electric in situ / standstill R3: Fuel additive satacen (Fe) R4: Fuel additive EOLYS (Ce) K: PIO 120	B112/10.02	B112/10.02	B112/10.02	B113/10.02	•	•	•	•	•	•

VERT Verifications

On-Road + Non-Road

SiC Filter, Cord Filter

NO₂ based regen

DPFi (electrical regen)

Fuel Additives



- **SCAQMD/ARB program – Scrapers, Dozers**
- **Caterpillar – Wheel Loaders**
- **County of Riverside - CASE Lawn Tractor**
- **American Asphalt – Wheel Loaders**
- **World Trade Center - Excavators**
- **European Experience – Construction, Forklift,
Ship/Rail**



CRT on CASE Tractor



Caterpillar 966G-II Wheel Loader



- **Coordinated by SCAQMD & CARB**
- **Vehicle Types:**
 - CAT 657 Scraper
 - CAT 651 Scraper
 - CAT D90 Dozer
 - CAT 824G Dozer
- **Large 15” and 20” diameter catalyst / filters for CRT**
- **On-road Durability**
- **Engine Dyno Emissions Testing**
- **Filters installed October 2002**



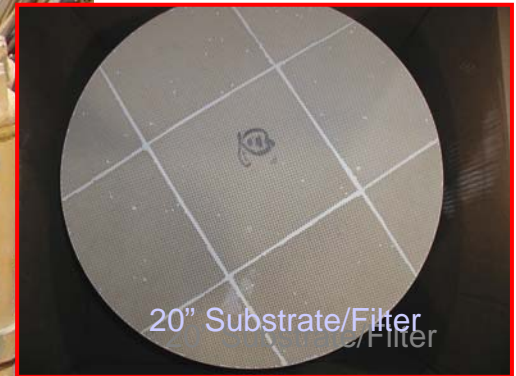
CAT 651 Scraper



CAT 657 Scraper



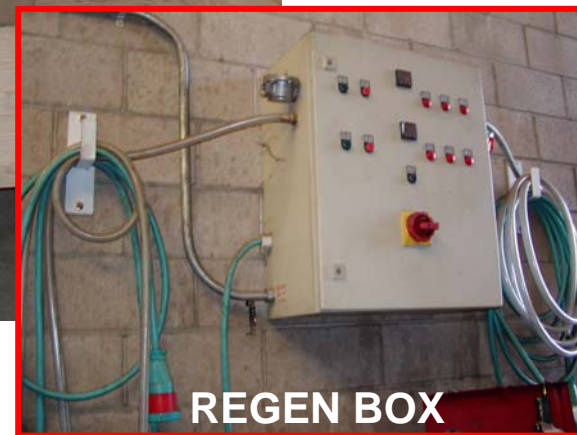
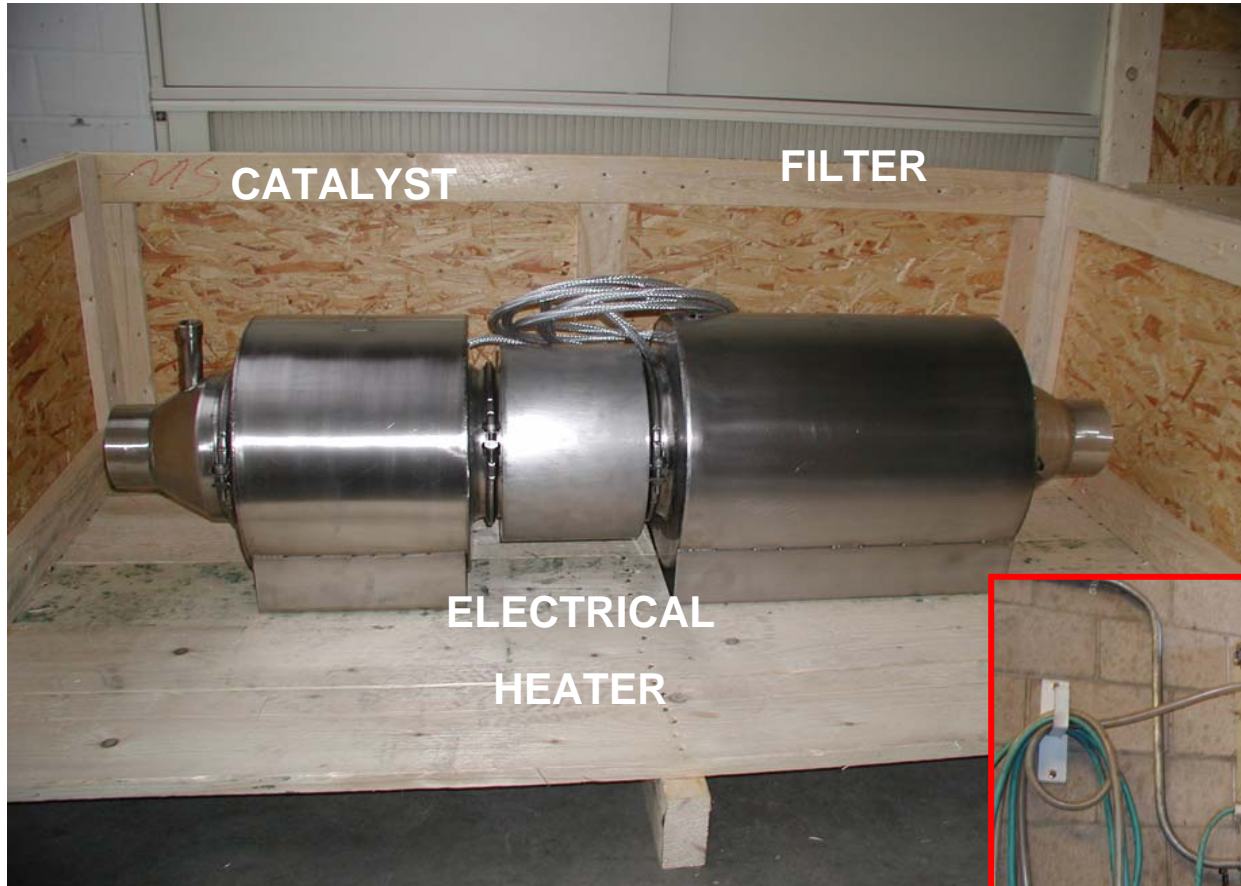
CRT for CIAQC CAT 657 E Scraper



- **Large number of installations in Europe (Germany, Austria, Switzerland)**
- **Approved by the VERT process**
- **US demonstrations on Cummins L-10 and CAT 3208 engines in trash trucks in CA**
- **Possible solutions for fleets with old engines and access to regular regeneration**
- **Fuel sulfur limits:**
 - **DPFi - up to 500 ppm S**
 - **DPFi-CRT - ULSD**



Active DPFi-CRT System



DPFi-CRT System



- Wide range of DPF types for engine power rates > 1000 KW:
 - **durability: > 6000 operating hours**



Various DPFi Filters



Examples of Application for Diesel-Particle-Filter Systems by Johnson Matthey



Wheel Loader, 126 KW



Excavator, 136 KW



Examples of Application for Diesel-Particle-Filter Systems by Johnson Matthey



Dozer, 250 KW



Locomotive, 1000 KW



Examples of Application for Diesel-Particle-Filter Systems by Johnson Matthey



Specialty Construction Machine, 384 KW



Benefits of Clean Diesel Retrofit

- **Allows continued use of diesel engine with all its positive attributes**
- **Reduces diesel exhaust emissions significantly**
- **Immediate reductions in emissions inventory from today's long-lived diesel fleet**
- **EPA / CARB verification allows for SIP Credits**
- **Stimulates technology development**
- **Provides a solid base for technology integration for Off-Road Rule**



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- **Websites:**

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<http://ect.jmcatalysts.com/> for JM HDD

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