



**Sustainable  
solutions for  
engines that  
power the world**

**Off-Road Retrofit Presentation  
CDTi Tips for a Successful Retrofit Project  
July 2014**

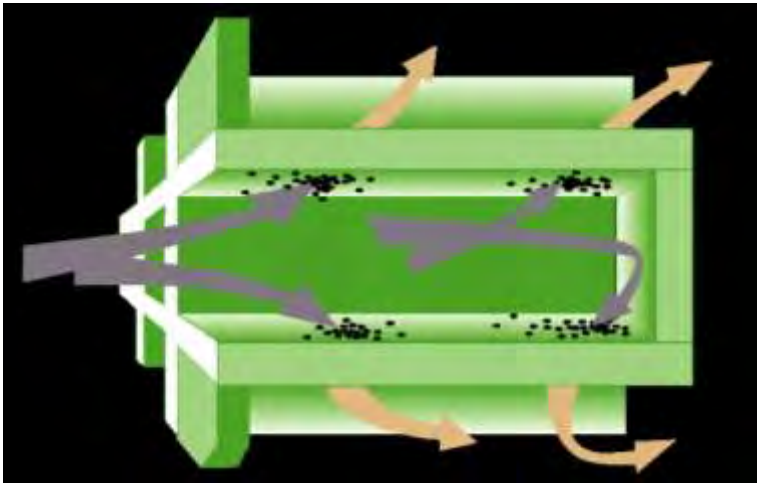
## HDD DIVISION OVERVIEW (FORMERLY ENGINE CONTROL SYSTEMS LIMITED)

- **Over 30 years of severe-duty emissions and installation experience**
  - Buses
  - Refuse trucks
  - Material transportation
    - Long haul & short haul trucks
    - Ports / drayage
    - forklifts
  - Construction & Mining
- **Broad portfolio of emissions products**
  - OEM systems
  - Retrofit emission systems
  - Aftermarket hardware and other products
- **Global footprint**
  - USA, Canada, Sweden, Europe



## DPFs: AN IMPRESSIVE EXPERIENCE BASE

### Wall-flow DPF's



- DPF's first deployed in underground mines in the late 1980's
- Subsequently deployed in indoor materials handling applications
- In late 1990's DPF's cross over to highway urban buses and construction applications

- 85+% PM Reduction
- Large Reduction in Toxics
- > 250,000 Retrofits Worldwide
- > 1 Million OE Applications

# Combifilter in DEEP Trials at Stobie Mine

report available at [http://www.camiro.org/DEEP/Project\\_Reports/stobiedpf.pdf](http://www.camiro.org/DEEP/Project_Reports/stobiedpf.pdf)



**Wagner ST-8 Loader  
DDC Series 60  
with Combifilter  
Model 2xS18**

- regenerated daily
- operated over 2000 engine hrs



**Kubota Service Tractor  
with Combifilter Model S10**

- regenerated as required
- operated over 500 engine hours and three years under DEEP program

# CHALLENGES FOR OFF-ROAD RETROFITS

- Higher emissions than on-road heavy-duty engines
  - Uncontrolled before 1996
- More diverse engine/equipment applications than on-road
  - More older equipment
  - Wide horsepower range
  - Equipment stability
  - Emissions profile can change with application
- More rigorous operating environment (vibrations, dust, uneven surfaces)
  - Can require extensive use of high-grade vibration isolators, especially in track-drive equipment
- Packaging constraints
  - Maintaining driver visibility
  - Safety
- Equipment operators can vary by day



## RETROFITS HAVE BEEN PROVEN FOR OFF-ROAD APPLICATIONS

- Technical Considerations for Successful Off-Road Retrofit Projects
  - Application engineering – Matching the right technology to the specific vehicle or piece of equipment
  - Proper professional installation
  - On-vehicle monitors – Provide important user feedback on performance
  - Maintenance – Vehicle/equipment and retrofit device require frequent inspection and maintenance

Successful Retrofits Require a Cooperative Effort  
Between Fleet Owners, Operators, and  
Technology Providers



## ALL RETROFIT DEVICES REQUIRE MAINTENANCE

- DPFs
  - Ash cleaning at regular intervals
  - Periodic inspections should include:
    - Warning lights from backpressure monitor
    - Mounting brackets and clamps
    - Presence of soot in tailpipe
    - Condensation in tubing associated with pressure sensors/monitors
- DOCs
  - Generally maintenance free; periodic inspections recommended
- Crankcase filters (CCV)
  - Filter change generally required at normal oil change intervals



## OTHER RETROFIT MAINTENANCE ITEMS

- Proper engine maintenance is critical for retrofit device to function effectively
  - Both pre-installation and on-going engine maintenance
- Currently verified retrofit technologies are generally compatible with biodiesel
  - Typically, B20 or less (biodiesel blend needs to meet current ASTM specifications)
- Retrofit devices must not be operated with fuel additives
- Re-datalog vehicle if change in duty cycle
- Filter swapping needs to be approved by technology vendor





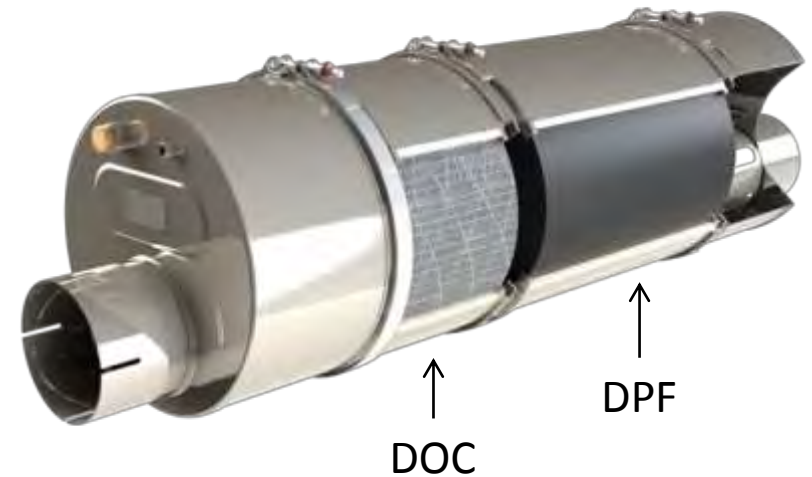
# NY CITY CROTON DEMONSTRATION



# PURIFILTER OR

## ■ Passively Regenerating DPF Technology

- Off-road version of Purifilter EGR
- MPC™ precious metal coating on diesel oxidation catalyst
- Base metal-coated DPF
- 10% of duty cycle  $>300^{\circ}\text{C}$
- Tier 1, 2 and 3 engines up to 603hp
- US EPA Verified Emission Credit Levels
  - PM: 90% HC: 90% CO:85%



# Purifilter OR Durability Massachusetts DOT Wheel Loaders

- **Wheel Loaders that work**
  - in a salt shed during winter
  - road projects during summer
- **In-use over 2 years / 2 winters**



# PURIFILTER

- **Passively Regeneration DPF Technology**
  - 25% of duty cycle  $>280^{\circ}\text{C}$
  - Compact catalyzed DPF
- **1st Verified DPF with Silicon carbide substrate (2003)**
- **1st DPF Verified at 90% PM Reduction Level by US EPA**
  - HC: 85%, CO:75%
- **Verified for Off-road Applications by CARB**



# RETROFITS CAN BE INSTALLED SAFELY

- Excellent safety record for off-road retrofits to date
- Retrofit manufacturers using best engineering judgment and installation practices to ensure safe installation of devices
  - Do not obstruct operator “line of sight”
  - Do not obstruct equipment operation
  - Do not obstruct operator access
  - Do not mount on safety cages
  - Use of proper heat shields to avoid accidental contact with operator or flammable materials (i.e., fuel lines, hydraulic lines, rubber hoses, etc.)
  - Inspect as per manufacturer’s instructions on a regular basis



## ARB’s Regulation Provides a Process for Retrofit Safety Oversight



## SUMMARY

### Technical Considerations for Successful Diesel Retrofit Projects

- Application engineering – Matching the right technology to the specific vehicle or piece of equipment
- Installation – Proper professional installation
- On-vehicle monitors – Provide important user feedback on performance
- Maintenance – Vehicle engine and retrofit device require frequent inspection and maintenance



**Successful Retrofit Projects Require a Cooperative Effort Between Fleet Owners, Operators, and Technology Providers**

**CDTi offers custom design, engineered installation and training to ensure customer satisfaction**

**CONTACT:**

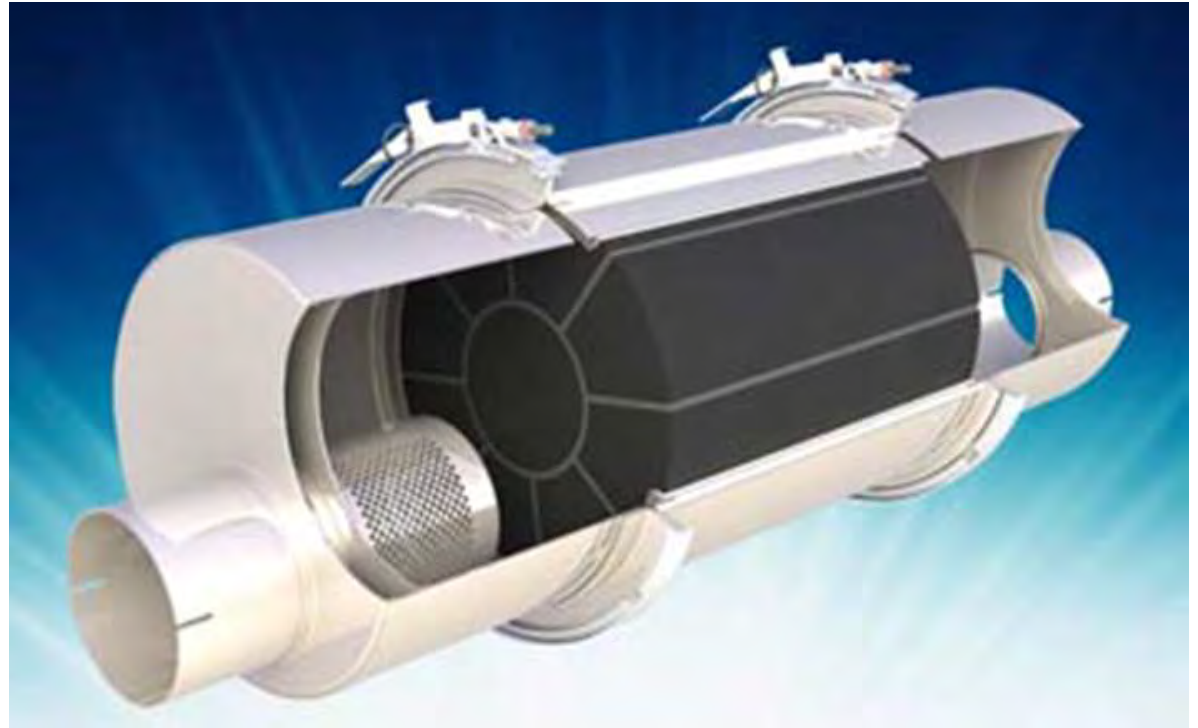
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**Thank You – please feel free to contact CDTi  
for Additional information.**