



## Meeting In-use Regulations with Verified Diesel Emission Control Systems

February 2007

## Engine Control Systems (ECS)

- **Founded in 1980**
- **Locations**
  - Reno, NV (USA office)
  - Newmarket, ON
  - London, ON
  - Malmo, Sweden
- **Market leader in emission control solutions for non-automotive applications for over 25 years**
- **Supplier to Diesel and LPG Cargo Handling Applications since 1983**



## AZ Purifiers and Purimufflers for Non-road

- ARB verified as a Level 1 Technology for Tier 1 Cummins, Case, Komatsu and International non-road engines used in cargo handling applications
- extension to corresponding Tier II engines in process
  - will cover all rubber tire non-road applications



## Combifilter

- Operates independently of duty cycle & fuel sulfur
- Used on lift-trucks in Europe since 1986
- Deployed on construction & utility vehicles since 1995
- Engineered for stationary applications since 1999
- Approved by VERT (Swiss certification)
- Approved Sweden Environmental Zones
- ARB Verified in 2004
- Verification extension to issue soon



## Combifilters in Cargo and Materials Handling



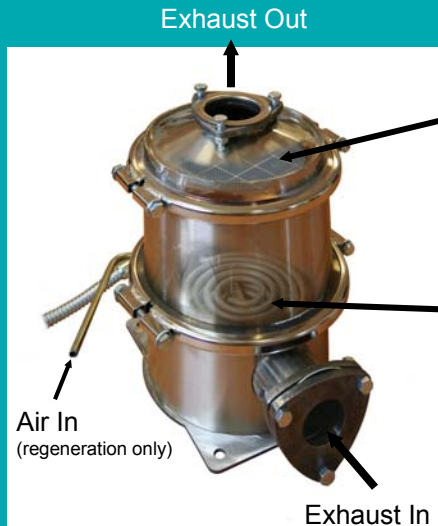
Examples:  
Lift trucks  
Yard tractors  
Container handlers



## Combifilters in Bulk Cargo Handling



# Combifilter Internal Components

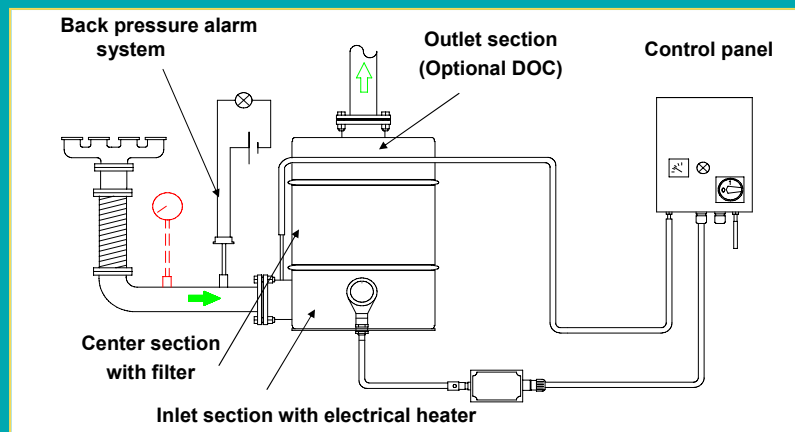


SiC DPF Substrate

Heater Elements

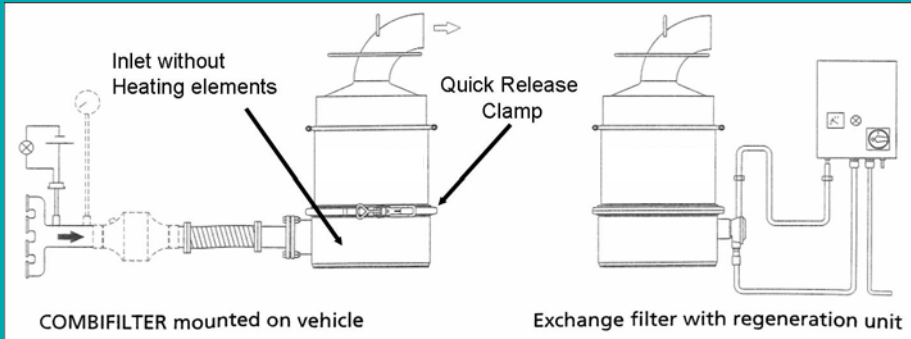
- # of elements = speed of regeneration
- K Model = 8hrs
- S = 60 or 90 min.

# On-board regeneration



# Combifilter™

## Exchange System: Off-board regeneration



- Allows all filters to be exchanged and regenerated off-board

## Off-Board Regeneration



can be used to service passive filters



## Combifilter Durability Test Programs



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

- regenerated daily
- >2200 engine hours



### DEEP Trials: Stobie Mine (report available at [www.deep.org](http://www.deep.org))



## Combifilter Durability: Dual Bank Combifilter for 54 hp Prime Power Generator Set Engine



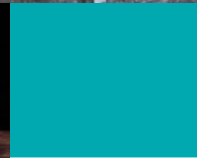
- System above has accumulated >5000 engine hours at Environment Canada Remote Research Site North of Lake Superior
- Smaller system on a 26hp Kubota gen-set has accumulated > 16,000 hrs at same sight site

## Purifilter

- Diesel Particulate Filter with silicon carbide center body
- Reduces Particulate Matter, Hydrocarbons, and Carbon Monoxide
- ARB and EPA Verified for Hwy applications
- For Non-road Engine where  $PM < 0.2$  g/kW-hr and Duty Cycles with  $>25\%$  time  $>280-320^{\circ}C$ 
  - Applicable to some Tier 0 & 1, Most Tier 2 and 3 engines
- Verification Durability Trials in progress



## Purifilters in NY City Croton Demonstration



## Purifiers at LAX



## CombiClean™

- Diesel particulate filter cleaning station designed to safely perform regeneration or maintenance on all DPF's
- Easiest and most efficient way to clean and restore a filter
- Built with over 25 years of proven regeneration technology
- 3-step system of compressed air & vacuum-heat-compressed air & vacuum
- Compressed air & vacuum system removes soot and ash from filters
- Does not allow contaminants to escape into the air
- Clean cordierite & silicon carbide filters between 3 and 20 liters





## Purifier with On-board Assist

Example:

Volvo Loader

In this example, the equipment is plugged in weekly to insure that any accumulated soot is eliminated

Plug-in frequency is determined for each application via data-logging

- reduces the # of panels
- allows duty cycle flexibility
- reduces labor
- reduces downtime



## New ECS Backpressure Monitor / Loggers

- New ECS BP monitors
  - Extended datalogging capability (up to 2 yrs)
    - BP and Temperature
    - Regen. frequency
  - Multi-light displays to indicate system faults, warnings and alarm conditions
  - Real time monitoring
- Systems come with software to allow data analysis



## ARB Verification of TermiNOx

- First ARB LSI verified product
- Closed loop fuel control & 3-way catalyst
- Reduces HC+NOx emissions to 1.0 g/hp-hr (>85% reduction)
- For 1L to 3L in-line configuration engines
- Verification for V configuration engines in progress.



## TermiNOx™ Engine Upgrade Kits for off-road LPG / CNG engines

- **TermiNOx consists of**
  - Electronic Control Module (ECM) with engine specific program, shielded wiring harness, oxygen sensor, fuel actuator valve and OE grade, 3-way catalytic converter or converter muffler
  - can be installed on open loop industrial engines with IMPCO, AISAN, NOLFF or Nikki carburetion
  - ECM is digitally programmable and allows for engine specific programming
  - ECM control results in reduced maintenance on fuel system and up to 20% fuel savings over open loop fuel systems



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