



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# Partners Meeting Breakout Session 2 11:00am-12:00pm, September 30, 2010

- Moderator: Wayne Elson, U.S. EPA Region 10
- Featured Speakers:
  - Jim Halloran, Caterpillar Inc.
  - Robert Wilkosz, Idaho Department of Environmental Quality
  - Duane Bratvold, Pacific Power Products
  - Brad Edgar, Cleaire Advanced Emission Controls
  - Antonio Santos, Manufacturers of Emission Controls Association



## What Does it Take to Complete a Successful Diesel Retrofit Project?

James P. Halloran, Regulatory Affairs  
Manager – Large Power Systems,  
Caterpillar



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### What are the Current Drivers for Projects?

- Regulatory Mandates
  - State – California
  - Job Specific
- Voluntary Efforts
- The Hybrid Approach
  - “Trying to do the right thing”
  - Forward thinking



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### Regulatory Mandates - California

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- Diesel Risk Reduction Plan
  - 75% reduction by 2010
  - 85% reduction by 2020
- Goals
  - Retire the legacy fleet
  - Accelerate to Tier 4
- In-Use Off-Road Rule



## What Does it Take to Complete a Successful Diesel Retrofit Project?

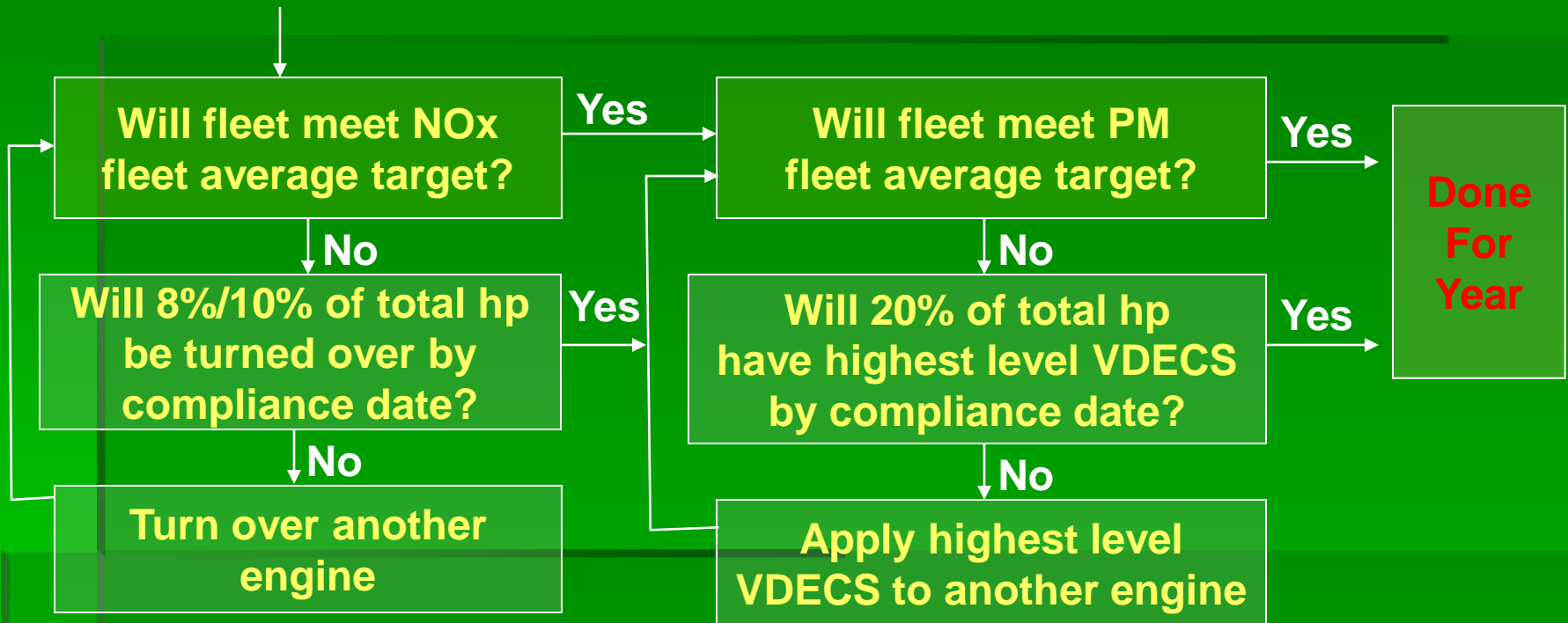
### California In-Use Off-Road Rule

- Self-propelled off-highway diesel vehicles 25+ hp that operate in CA
- Requirements based on fleet size
- Required to meet decreasing fleet averages or BACT
- Will require DPF's and engine/machine turnover
- Will require recordkeeping, labeling and idling provisions
- Annual reporting



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### Off-Road Rule – Compliance Process





## What Does it Take to Complete a Successful Diesel Retrofit Project?

### **Regulatory Mandates - California**

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- Define the goal
  - Near term
  - Long term
- Analyze the options – current succession plan
- Cost effective solutions that make long term sense
  - OSHA visibility/safety standard
- Financial/credit situation
- A partner to guide them along the way





## What Does it Take to Complete a Successful Diesel Retrofit Project?

Robert Wilkosz, Manager, Mobile and Area  
Source Program, Idaho Department of  
Environmental Quality

and

Duane Bratvold, Application Engineer,  
Pacific Power Products





## What Does it Take to Complete a Successful Diesel Retrofit Project?

### **Know the fleet (catalog the vehicles)**

- Know what can and can not be retrofitted
- Know the engine and chassis configurations
- Know what retrofit specifics will be necessary



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### Know the fleet (catalog the vehicles)

- Know what retrofit specifics will be necessary
  - Equipment, installation configuration
  - Vehicle and equipment owners will want to minimize altering the exhaust configuration.
    - Engines > 175 HP require little or no exhaust modification.
    - Engines < 175 HP, especially non-road engines, may require extensive exhaust modifications due to space constraints.
    - Most fork trucks, tractors, mowers, and small construction equipment have small engines tightly tucked under the engine shroud.
      - Locating a retrofit exhaust control outside of the shroud might impair the operator's vision or put the exhaust control at risk for damage.
      - A same side-in/ side-out configuration may create additional space constraints, especially on the smaller engines.
  - May be difficult to locate CCV so mechanic can easily service filter.
    - If mechanic can't easily service the filter, they likely will disconnect the CCV



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### **Engage your customer throughout the process**

- Be sure they know the benefits of diesel retrofits
- Be sure you know what they expect
- Engage mechanics/technicians early in process
  - Make sure you have their buy-in prior to any retrofits.
- Be responsive to their operations and schedules
- Ensure technicians get proper training on retrofits
- Stay in frequent contact before and after retrofit



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### **Ensure there is sufficient expertise on your team**

- Project Manager
  - Knowledgeable, personable, engaging
- Project Administrator for large projects and programs
  - accelerate the processing of work orders, purchase orders, grants, etc.
- Database Technician
  - Large projects generate large amounts of information
  - Absolutely key to proper quality assurance
    - operational integrity
    - fiscal integrity



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# RFP Process

- Be sure bidders receive adequate information
  - vehicle fleet information
  - timeline
  - needs of end customer
  - consider developing convenience contracts that can be used for more than one project.



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# RFP Process

- Score applicants based on:
  - Quality of retrofit technology
  - How retrofit technology meets your needs
  - Contractor's expertise / experience providing and installing technologies
  - Price of technology
    - Scoring bids on price alone is risky, especially with less than perfect bid specifications



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### **Know and discipline your contractor**

- Research their previous performance scrupulously
- Avoid the low dollar-low expertise labor pool & business start-ups.
  - Experienced contractors significantly reduce risk of failure
- Have clear set of expectations
  - Timeline, quality
- Ensure frequent meetings and adequate reports.
  - Requiring regularly scheduled conference calls helps keep the projects on schedule.





## What Does it Take to Complete a Successful Diesel Retrofit Project?

# Know and discipline your contractor

- Make sure project manager, fleet manager, and contractor all sign a document (work assignment) agreeing on:
  - Specific vehicles to be retrofitted
  - Specific technologies at specific costs
- Always budget for the unknown
  - Retrofitting diesel vehicles and equipment is like renovating a house
    - You may not know of additional costs needs until after you have started a project
    - Be prepared to relocate some installs if the mechanics are unhappy with the end result



## What Does it Take to Complete a Successful Diesel Retrofit Project?

**Bradley L. Edgar, Ph.D.,**  
**President and Chief Technology Officer**  
**Cleaire Advanced Emission Controls, LLC**



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# Initial steps for a retrofit project

- ***Step 1: Establish a need/market for retrofits***
  - Regulation (Requirement)
  - Incentives (Funding)
  - Enticements (Reward)
  - Combinations of the above
- ***Step 2: Establish Performance Standards***
  - Best Available Control Technology (BACT)
  - Used in California, New York, and other states



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# What is BACT?

### *Best Available Control Technology\* (BACT),*

- If possible, install highest performing technology first
- If not possible default to second best, third best, etc.

### *For diesel PM retrofits*

Best: Diesel Particulate Filter (DPF)

Second Best: Partial Filter

Third Best: Diesel Oxidation Catalyst

\*Sometimes referred to as “BART” or “Best Available Retrofit Technology”.



## What Does it Take to Complete a Successful Diesel Retrofit Project?

### Examples of Classifications

<b>California Air Resources Board (CARB)</b>		
Level 1	Level 2	Level 3
25%+ PM Reduction	50%+ PM Reduction	85%+ PM Reduction

<b>City of New York</b>			
Level 1	Level 2	Level 3	Level 4
20-24% PM Reduction	25-49% PM Reduction	50-84% PM Reduction	85%+ PM Reduction (or less than or equal to 0.01 g/bhp-hr of diesel PM)



# What Does it Take to Complete a Successful Diesel Retrofit Project?

## Comparison of Retrofit Technologies



No Retrofit System  
**Uncontrolled Diesel Exhaust**



Retrofitted with  
**Diesel Oxidation Catalyst (DOC)**  
CARB Level 1 Device

Verified at 25% PM Reduction  
Little black carbon removal  
Little ultrafine PM removal  
Does not remove lube oil ash



Retrofitted with  
**Diesel Particulate Filter (DPF)**  
CARB Level 3+ Device

Verified at 85%+ PM Reduction  
Used on all new trucks since 2007  
>85% black carbon removal  
>85% ultrafine removal  
>85% lube oil ash removal

**Overview:** The exhibits above are actual PM collection samples from an engine testing laboratory used to collect and measure diesel particulate matter (PM) emissions. Test conditions are:

- Test Cycle: UDDS (Urban Dynamometer Driving Schedule)
- Test Distance: 5.5 miles over 17 minutes
- Fuel Consumed During Test: 1.1 gallons
- Test Vehicle: Heavy-duty truck with a 370 hp Cummins engine (1999 model year)
- PM material on collection samples is 1/1,800th of actual





What Does it Take to Complete a Successful Diesel Retrofit Project?

# PM Reduction Capability

Type of PM	DPF (85-90% PM reduction)	DOC (20-40% PM reduction)
PM10	Very Good	Good
PM2.5	Very Good	Marginal
Ultrafine PM	Excellent	Poor
Black Carbon	Excellent	Poor





## What Does it Take to Complete a Successful Diesel Retrofit Project?

# Myths About DPF retrofits

- **Myth 1: DPFs are experimental and not reliable**
  - **Not True.** Over 26,000 retrofit DPFs have been deployed in the US since 2007, while over 3 million have been deployed on new diesel trucks (light, medium & heavy-duty) during the same period.
- **Myth 2: DPFs don't work in "cold" or light duty cycles**
  - **Not True.** There are ten (10) CARB or EPA verified systems that are "actively" regenerated. This means the DPF doesn't rely on engine exhaust temperature to regenerate or "self-clean." Rather they use fuel burners, catalytic burners, or plug-in electric power to heat and combust collected particulate matter. Active systems are ideally suited for colder applications running lower miles and having significant periods of idle.
- **Myth 3: DPFs are dependent on temperature and duty cycle to reduce PM emissions and be effective**
  - **Not True.** Unlike DOCs, DPFs are physical filters that trap diesel PM and provide non-stop filtering regardless of the engine duty cycle or exhaust temperature.
- **Myth 4: Only a few companies have verified DPF products**
  - **Not True.** Between EPA and CARB, more than ten (10) different manufacturers have verified DPF products to the highest level of PM reduction (85%+).
- **Myth 5: Retrofits aren't effective; only new engines can meet low PM emission levels**
  - **Not True.** Unlike DOCs, a DPF retrofit can bring an older engine to 2007/2010 PM emissions levels. DPF retrofits are typically far less costly than new vehicles or machines.



## What Does it Take to Complete a Successful Diesel Retrofit Project?

Antonio Santos, Director, Special Projects,  
Manufacturers of Emission Controls  
Association



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# 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
  - Filter change generally required at normal oil change intervals<sub>25</sub>



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### **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



## What Does it Take to Complete a Successful Diesel Retrofit Project?

# Challenges for Diesel Retrofit Projects

- Funding for voluntary programs at all levels
  - Becoming more available but still not enough
- Changes in ARB regulations
  - Technology providers make decisions based on regulatory certainty
- Retrofit device verification
  - R&D intensive
  - More resources needed at EPA and ARB





## What Does it Take to Complete a Successful Diesel Retrofit Project?

### 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