Clean Diesel Technologies, Inc.

A technology company supplying fuel additives and emissions control systems technology that reduce harmful emissions from compression ignition engines while improving fuel economy

Connecticut School Bus Retrofit Program
February 25, 2004

What is Retrofit Technology?

- Retrofit technology can be:
  - *any change to an engine system above and beyond what is required by EPA regulations that improves the engine's emission performance:*
    - Catalyst or filter
    - Engine upgrade or engine re-flash
    - Use of early engine replacement
    - Cleaner fuels or additives
    - Idling control equipment
    - *"Neofits"*
    - Combination of above
- Program verifies the effectiveness of retrofit technology

What if I Could?

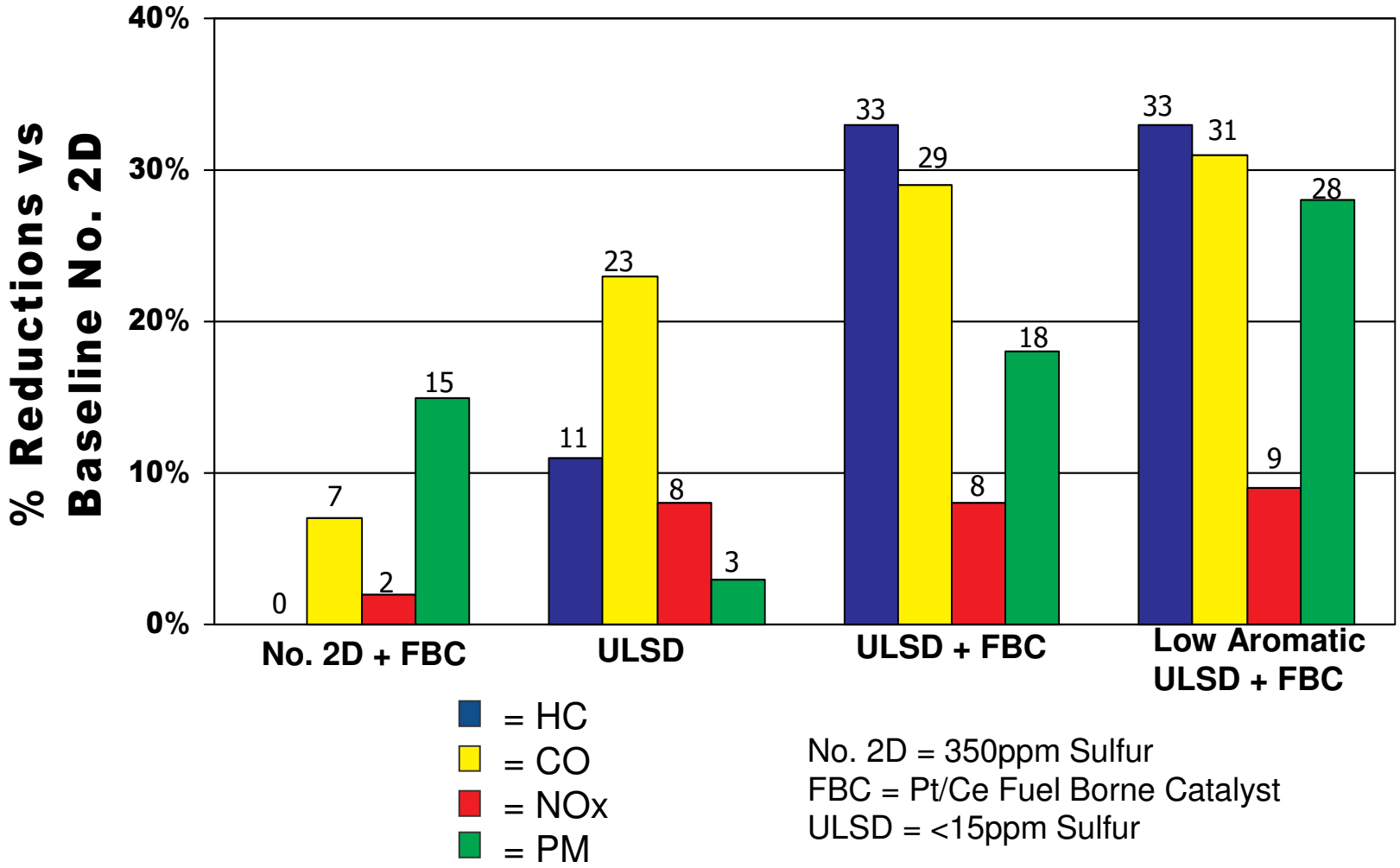
- Reduce emissions 20%-30% with a fuel solution only
- Reduce emissions 50% with ULSD and a $1,000 Device
- Reduce emissions 75% with ULSD and a $5,000 Device
- Reduce fuel consumption 7%

What is Platinum Plus® (FBC)

- A Registered with U.S. EPA for use in on-highway fuel (December 1999)
- Fuel borne Platinum/Cerium catalyst that takes catalytic activity into the combustion chamber which
  - Promotes more complete combustion
  - Reduces engine out emissions
  - Improves fuel economy an average of 8% and off-sets penalty of low-NOx engines
- Compatible with all diesel fuels (No.2D, K-1, ULSD, and bio-diesel
- No harmful metal emissions, ultrafines, or secondary emissions
- 20 million miles of trouble free use

Emissions Reduction of FBC Treated Fuels Versus Baseline No. 2D-1990 DT 466 Engine

(Triplicate FTP Tests)



No. 2D = 350ppm Sulfur
FBC = Pt/Ce Fuel Borne Catalyst
ULSD = <15ppm Sulfur

Clean Diesel Technologies, Inc.

Platinum Plus® Purifier FBC/DOC System

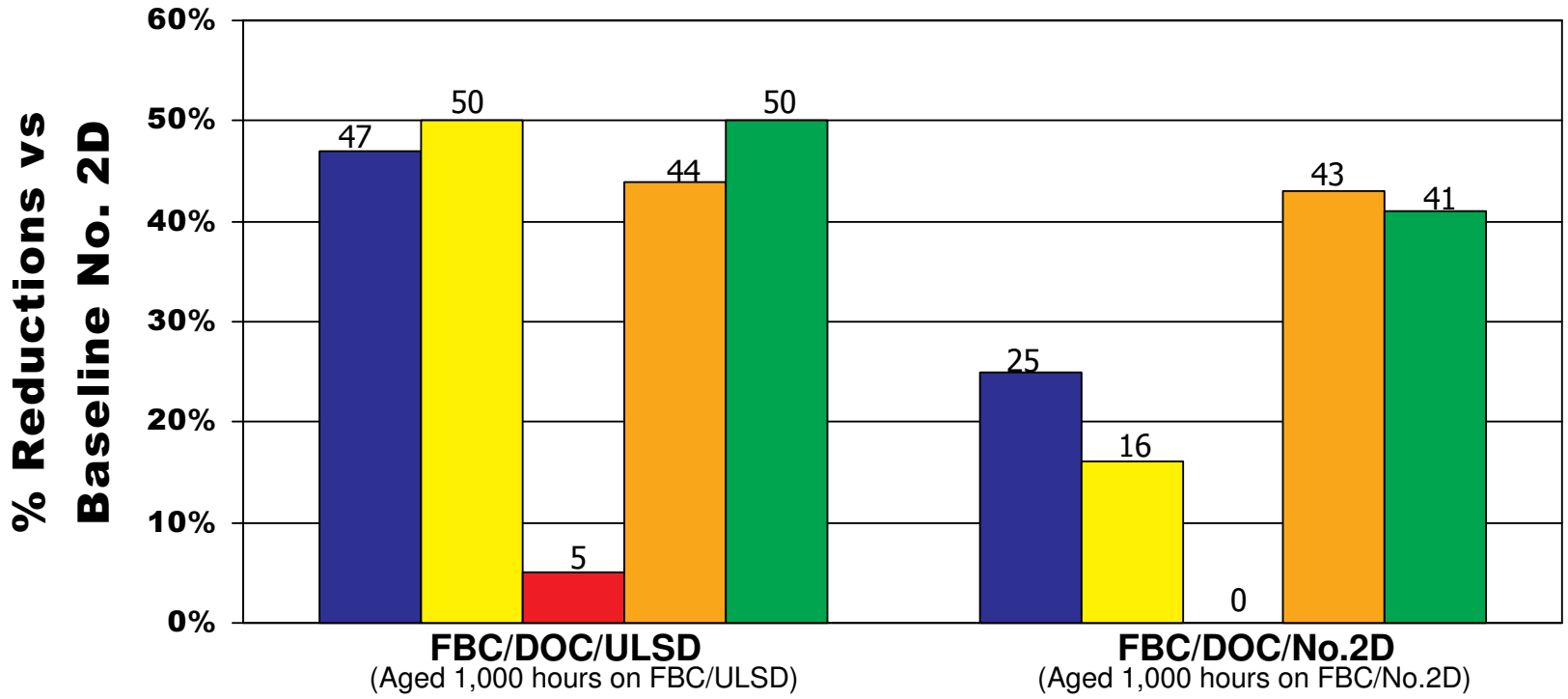
EPA Verified for 40-50% Particulate Reduction

Diesel Oxidation Catalyst Muffler

Platinum Plus
Fuel Borne Catalyst

- Specially catalyzed DOC maximizes PM reduction and minimizes by products
- Verified for use with treated No.2D or ULSD
- Easily installed as muffler replacement
- EPA registered fuel borne catalyst (FBC) is easily added to vehicle tanks or bulk fuel storage
- FBC reduces engine out emissions and maintains highest DOC activity
- Average fuel economy improvement offsets cost of FBC
- Over 1,000 applications and 20 million miles of trouble free FBC use

EPA Verified Platinum Plus® Purifier (FBC/DOC) Emission Reductions
1991 MHDD



■ = HC
■ = CO
■ = NOx
■ = NO_2
■ = PM

No. 2D = <500ppm Sulfur
ULSD = <15ppm Sulfur
FBC = Platinum/Cerium Fuel Borne Catalyst
DOC = Lightly Catalyzed Diesel Oxidation Catalyst

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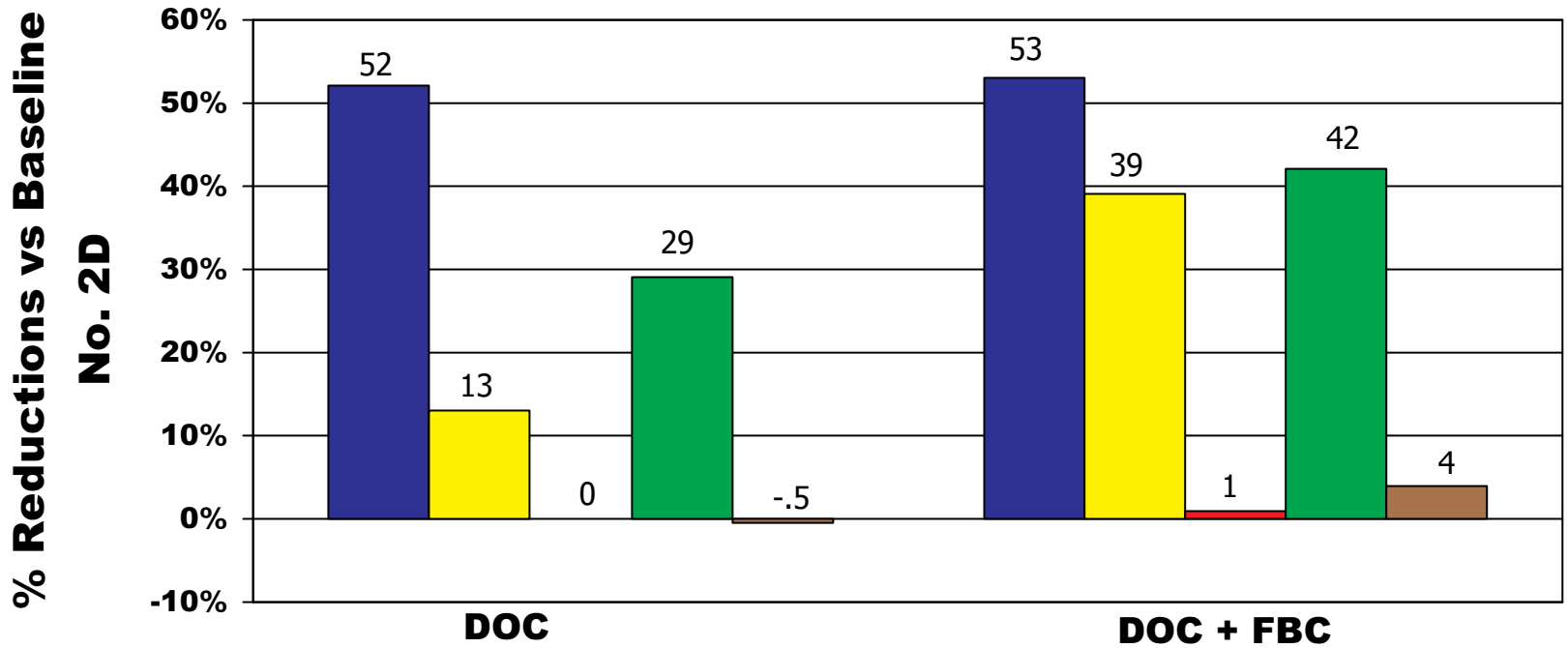
SwRI/Composite Testing
1998 DDC Series 60 (12.7 liter)



■ = HC
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■ = NOx
■ = PM
■ = BSFC

No. 2D = 368ppm Sulfur
FBC = Pt/Ce Fuel Borne Catalyst

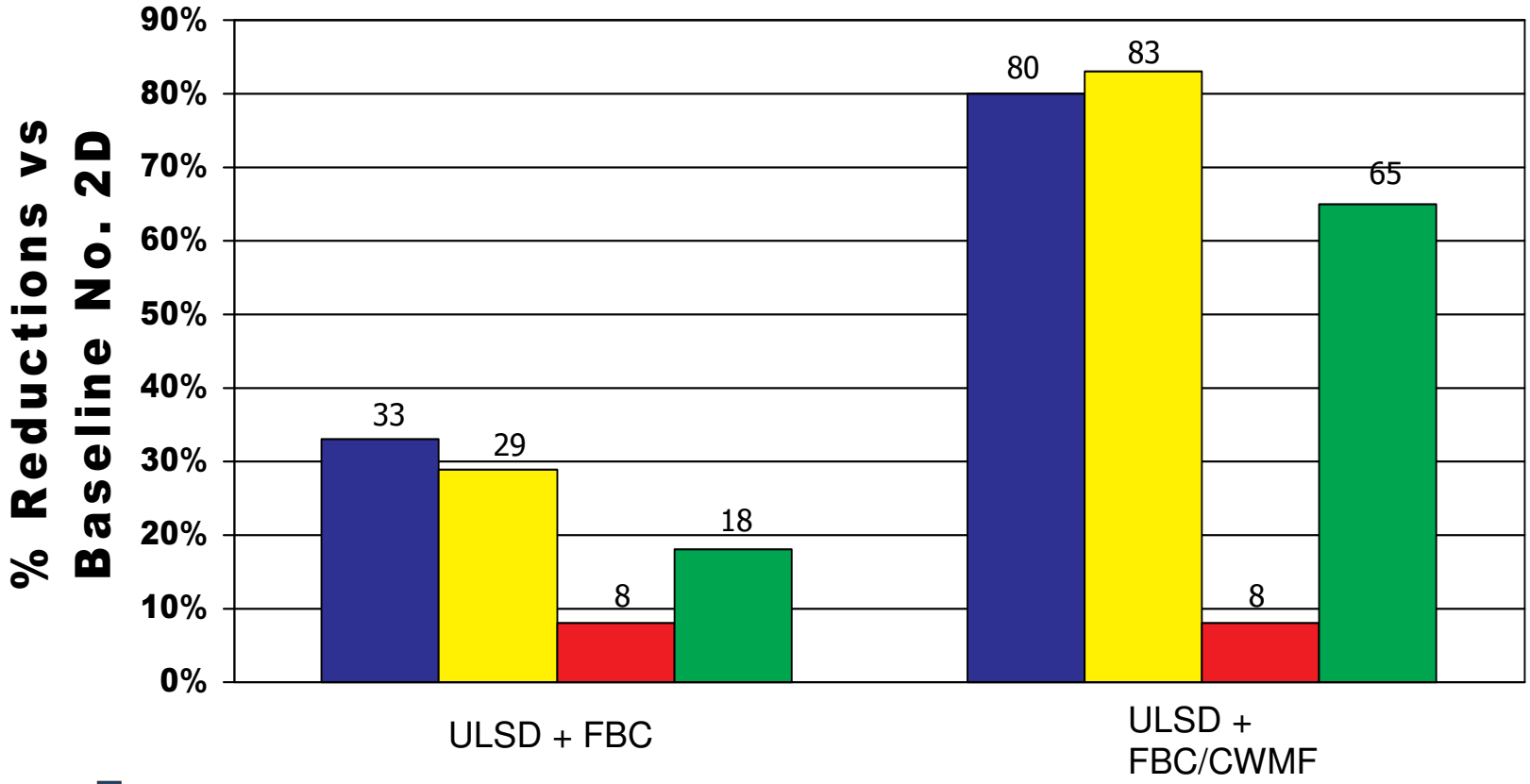
Platinum Plus® Purifier Installation on Delivery Truck

Catalyzed Wire Mesh Filter (CWMF) with FBC

- EPA Verification pending
- PM reduction = 65%-75%
- NOx reduction = 5%-10%
- Little or no temperature restrictions
- Installed as a replacement muffler
- Little or no fuel economy or power penalty
- Little or no increase in NO_2 emissions
- Low level catalyst loading = lower cost
- Proven durability

Platinum Plus/CWMF

Emissions Reduction Versus Baseline No. 2D 1990 DT 466 Engine (Triplicate FTP Tests)



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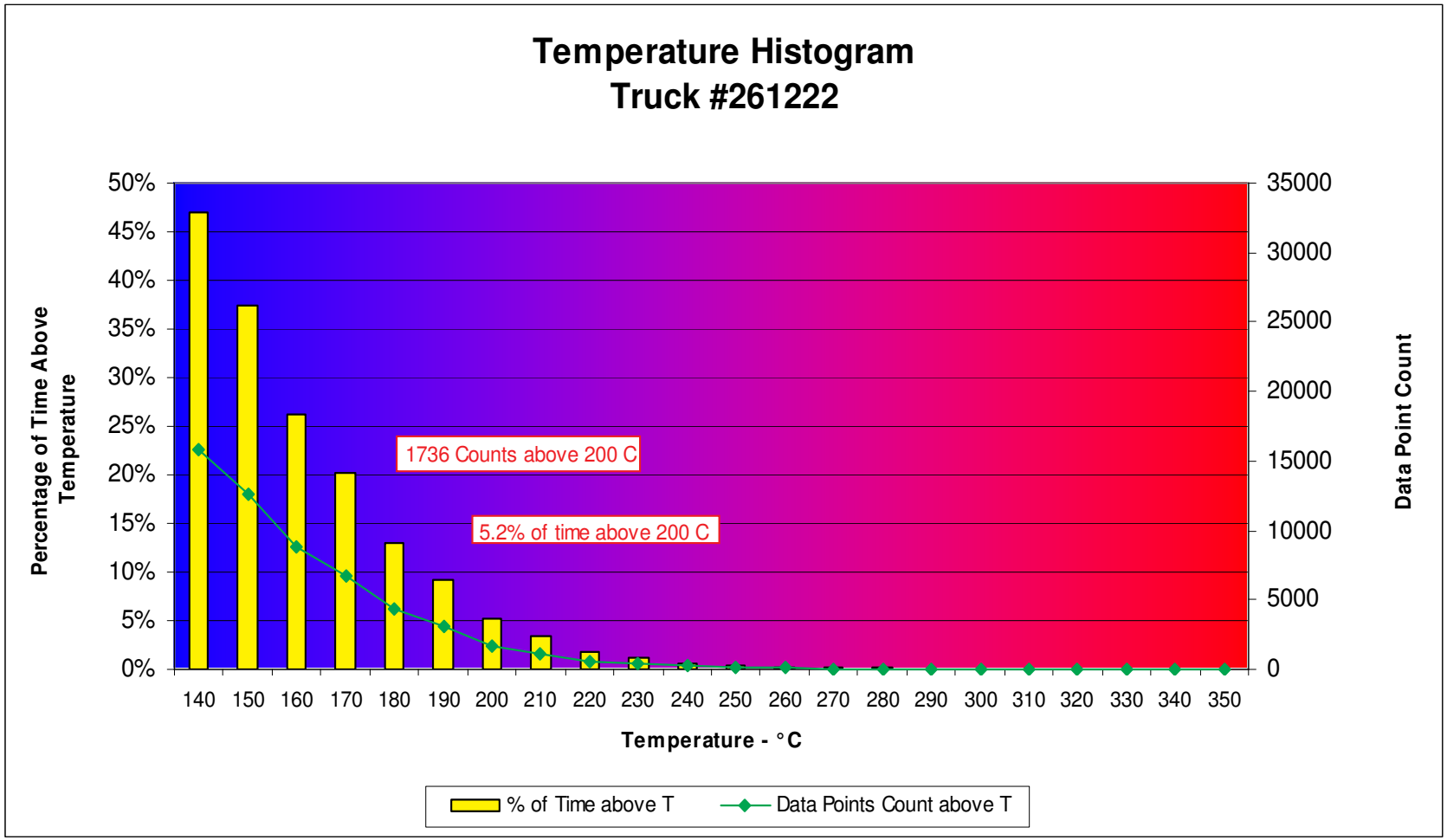
CWMF = Lightly Catalyzed Wire Mesh Filter

Temperature Profile for 1000 hour CWMF Commercial Operation



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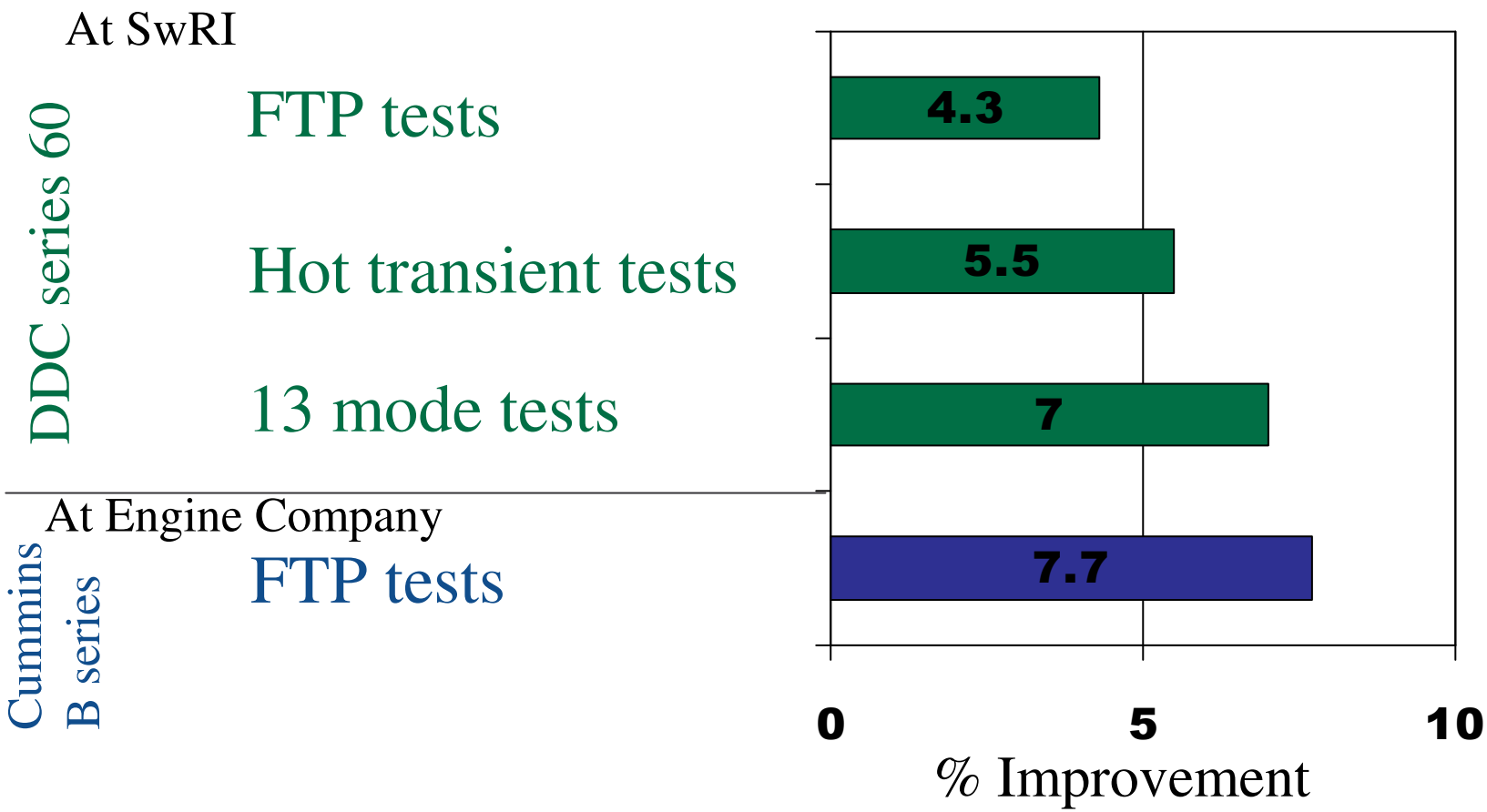
Fuel Economy
Engine Dynamometer Tests

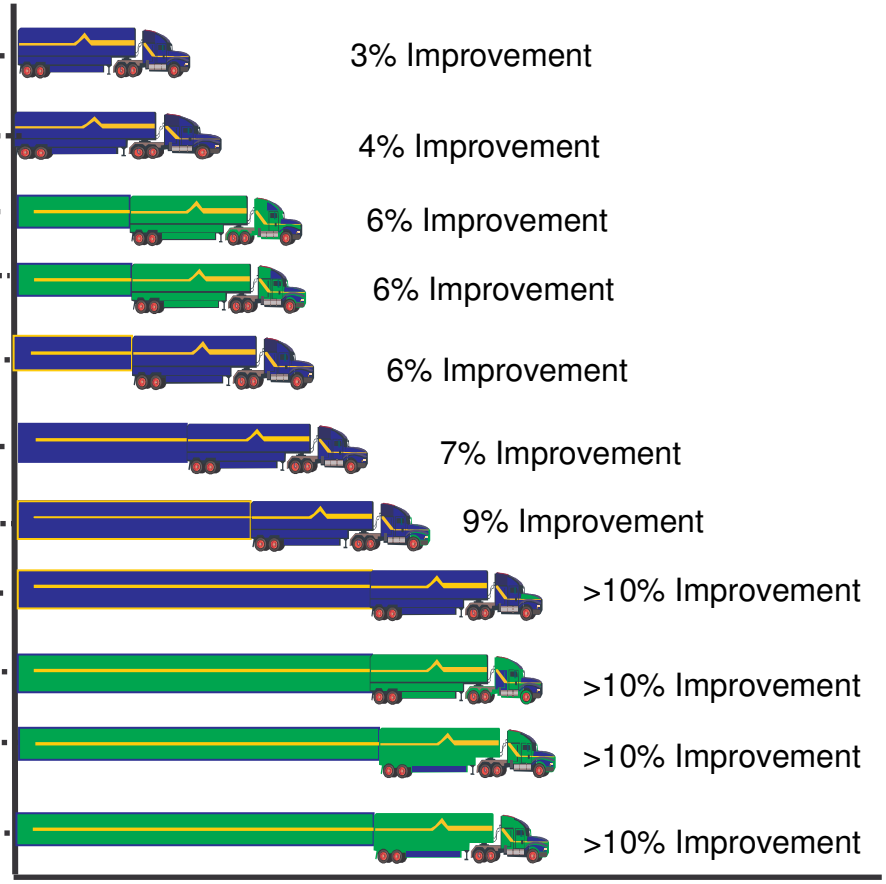
Fuel measurements gravimetric, volumetric or carbon balance



Platinum Plus® Fleet Test Summary

(Average MPG Improvement = 8%)

- Trash Hauling Urban 41 Trucks
- Feed and Livestock Rural 47 Units
- Grocery Distribution Rural 54 Tractors
- Grocery and Fuel Distribution Rural 35 Tractors
- Beverage Deliver Urban/Rural 43 units
- Line Haul Freight 16 Tractors
- Fuel Delivery Urban/Rural 9 Tractors
- Fuel Delivery Urban 10 Units
- Beverage Delivery Urban 72 Vehicles
- Beverage Delivery Urban 41 Vehicles
- Beverage Delivery Suburban 39 Vehicles



FBC Dosing Alternatives

- Bulk fuel pretreatment by licensed fuel suppliers
- Automatic dosing at on-site fuel pump
- Mobile fuel delivery vehicle automatic dosing
- Vehicle on-board dosing systems
- In-Use verification procedures
  - Fuel sample analysis for catalyst levels
  - Dosing system audits

NIOSH-DPF Filter Selection Guide May 15, 2003

"low dosing levels of platinum and cerium (less than 10ppm total), high retention of platinum (94-98%) and cerium (92%) in engines without filters, oxides of platinum and cerium are not bio available and fall into a class of nuisance dust, and no evidence of ultra fine particles provide sufficient justification to conclude that there are no health issues when this additive is used in the fuel used by equipment without a DPF."

"**the reduction in DPM mass achieved (15-30%) when the CDT additive is used (without DPF) far exceeds (by a factor of at least 100) the mass of platinum and cerium ash emitted."**

"MSHA has concluded that the CDT bi-metal additive, when used at the recommended dosage poses no health hazard."

FBC Based Retrofit Systems Performance Summary

- EPA Registered FBC alone 15% - 30% PM reduction
- FBC/DOC (EPA verified under rigorous ETV protocol) – 41% - 50%
- FBC/CWMF (pending EPA verification) – 65% - 75%
- FBC/DPF (MSHA accepted for use in underground mining) - >85%
- Lightly catalyzed = Low NO_2
- Fuel economy gains off-set FBC cost