Light Duty Truck Aftertreatment - Experience and Challenges

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Detroit Diesel Corporation

Detroit Diesel's test experience on light duty truck PM aftertreatment technology development will be presented. The Tier-II extremely low emissions standards combined with the light-duty test cycle impose a significant challenge for the development of production-viable emissions technologies.

A robust general path to achieve these emissions targets will be outlined.

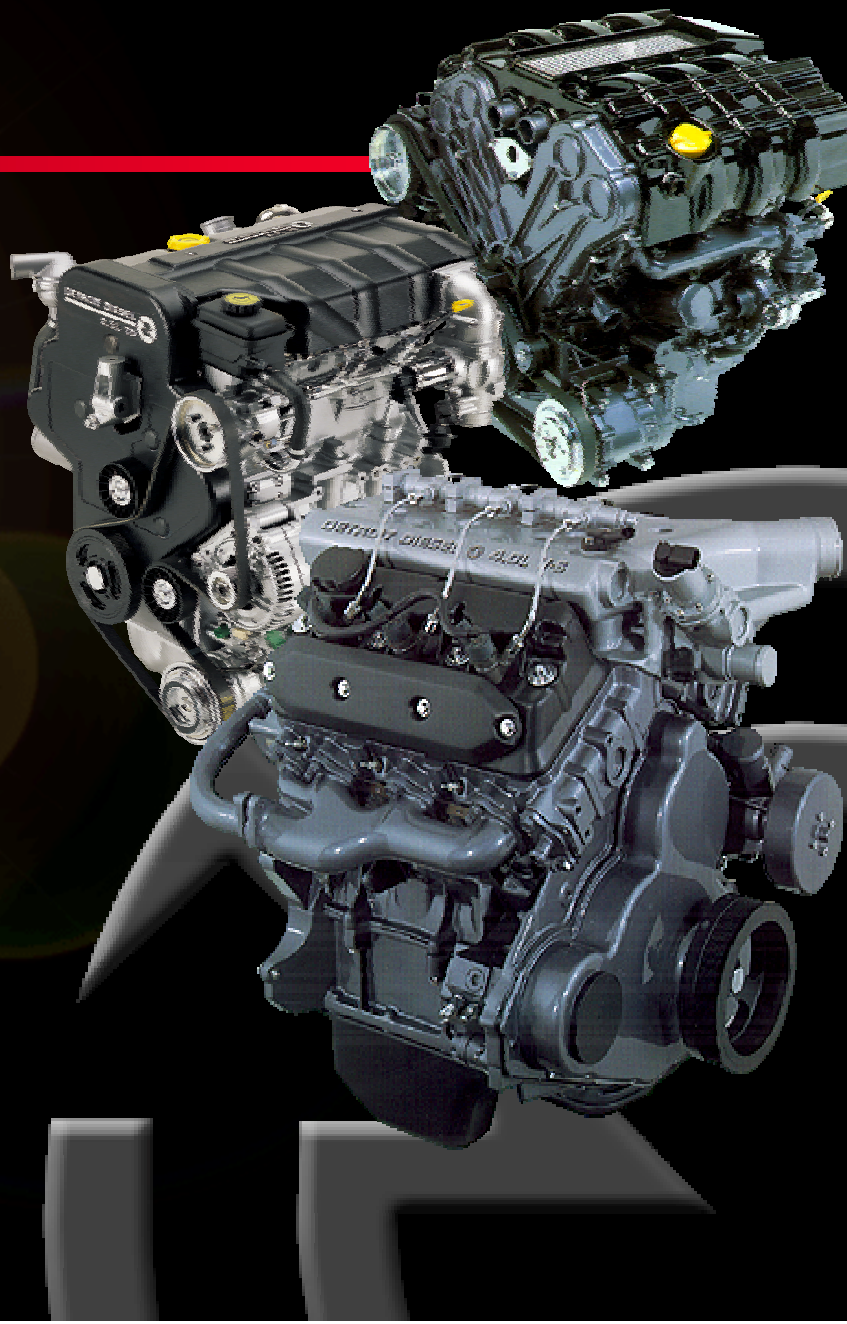
DEER

Light Duty Emissions Aftertreatment

Houshon Zhang
Fabien Redon

Presented by: **Charles Freese**

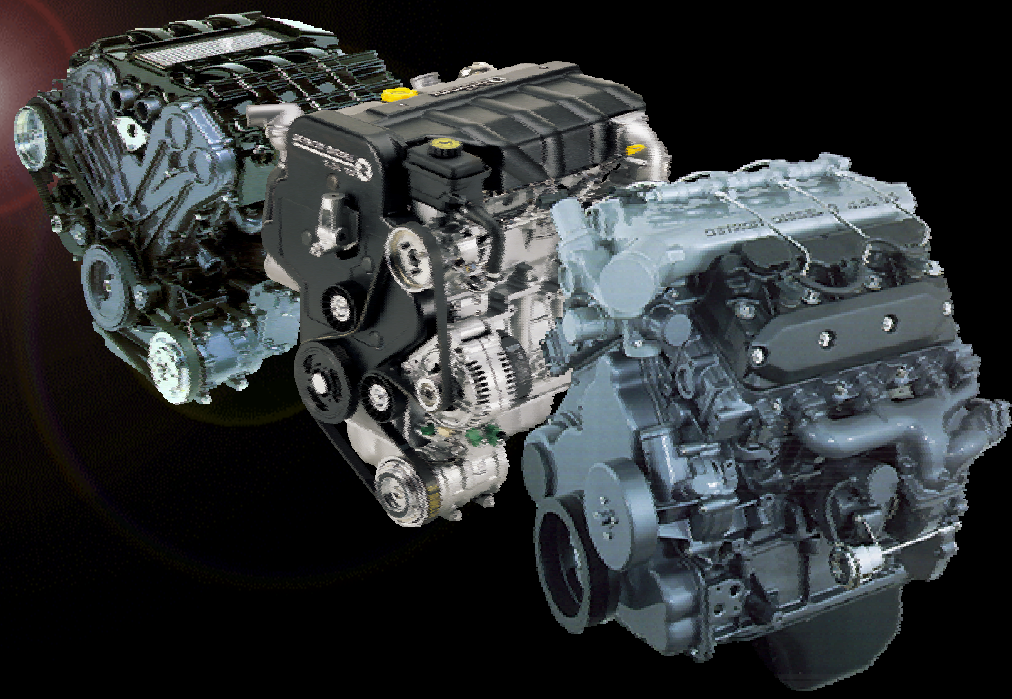
Detroit Diesel Corporation



DETROIT DIESEL
AUTOMOTIVE POWER

Outline

- Light Duty Emissions Challenges
  - Tier 2 Targets
  - Vehicle Inertia
  - Fuel Quality
  - Light Duty Cycle
    - » Effects on Regeneration
- Progress Toward Targets
- Future Technical Path



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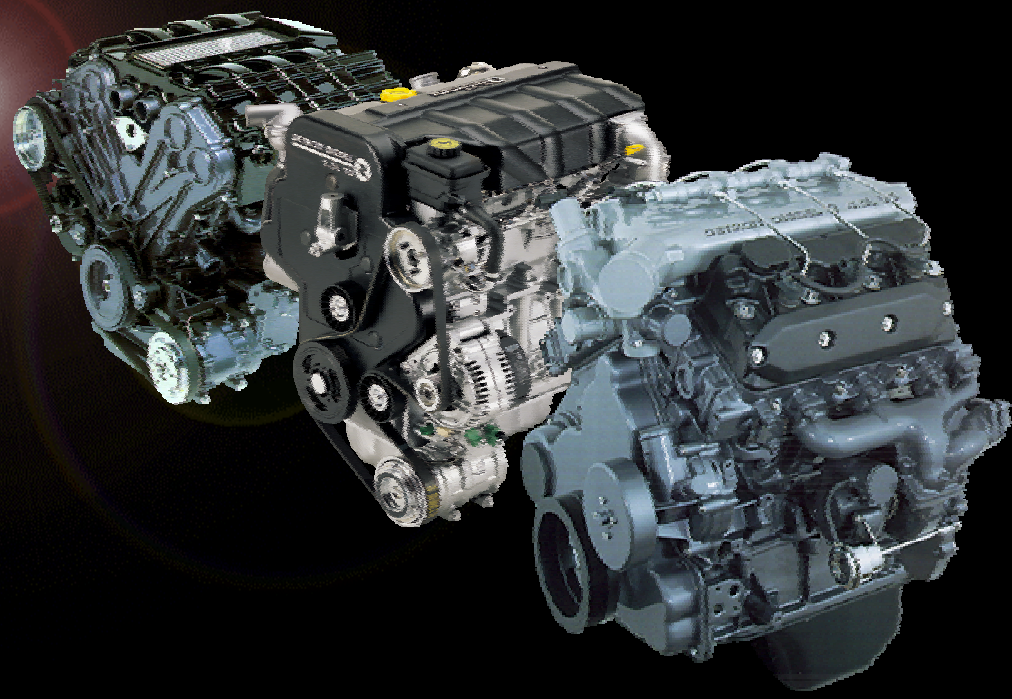
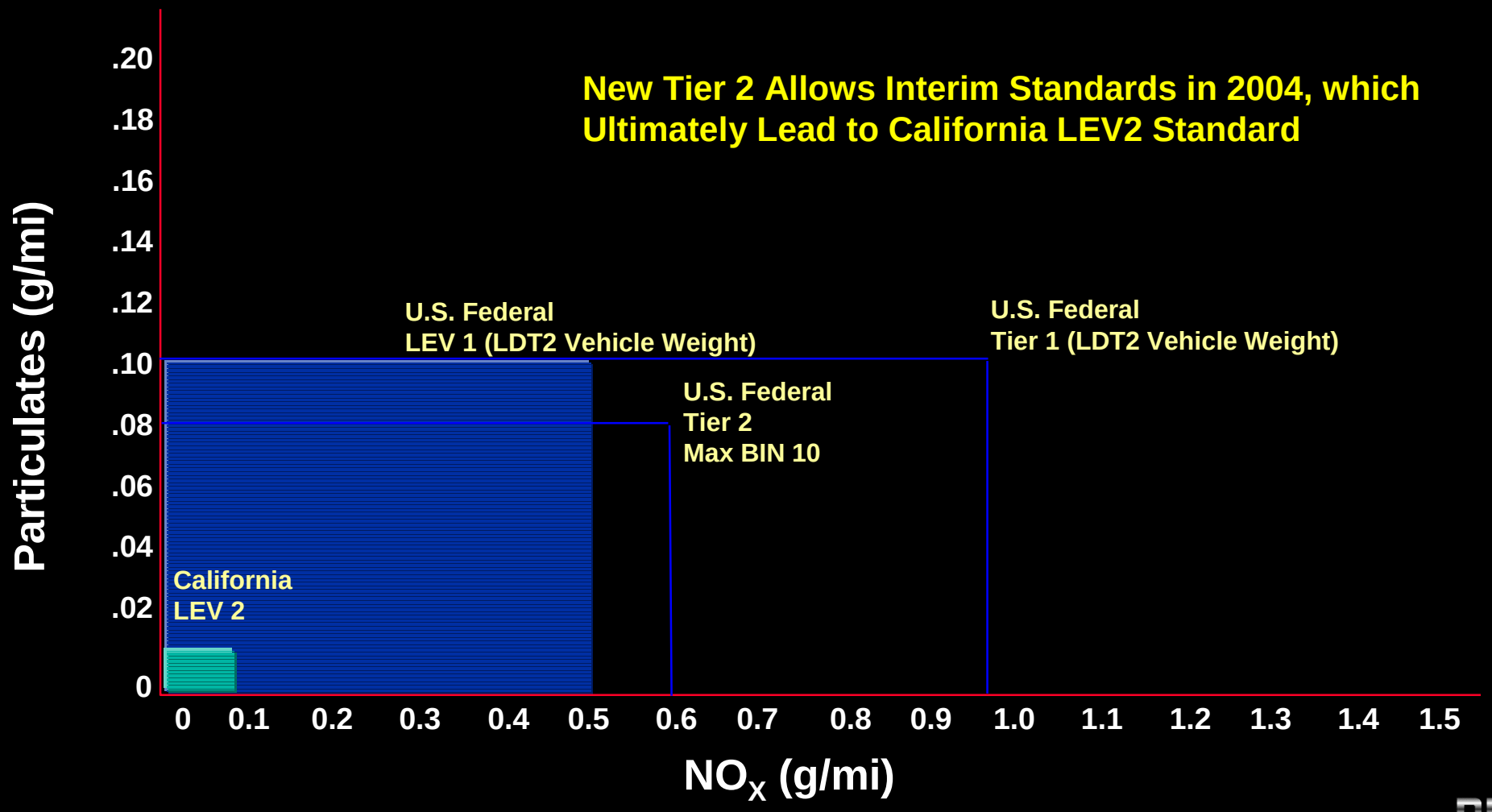


U.S. Light-Duty Standards

Automotive Emissions (Under 8,500 lb GVW)



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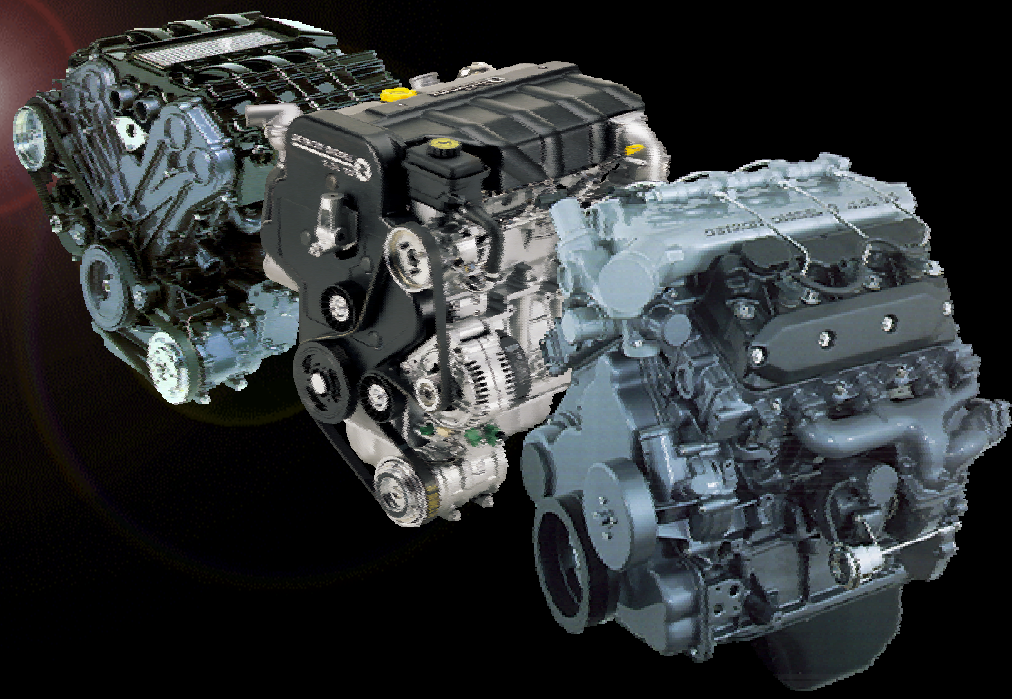
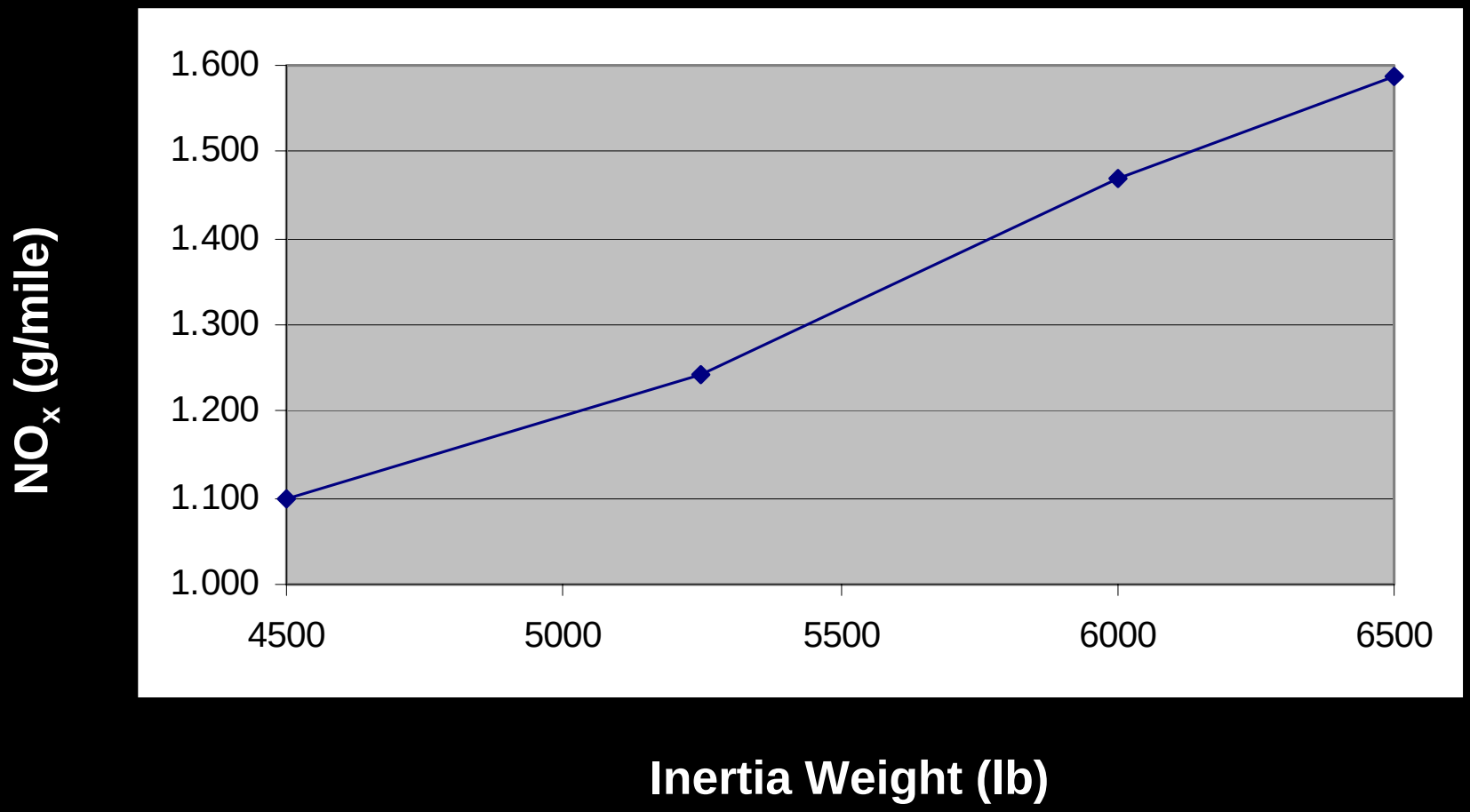


Vehicle Inertia Effects

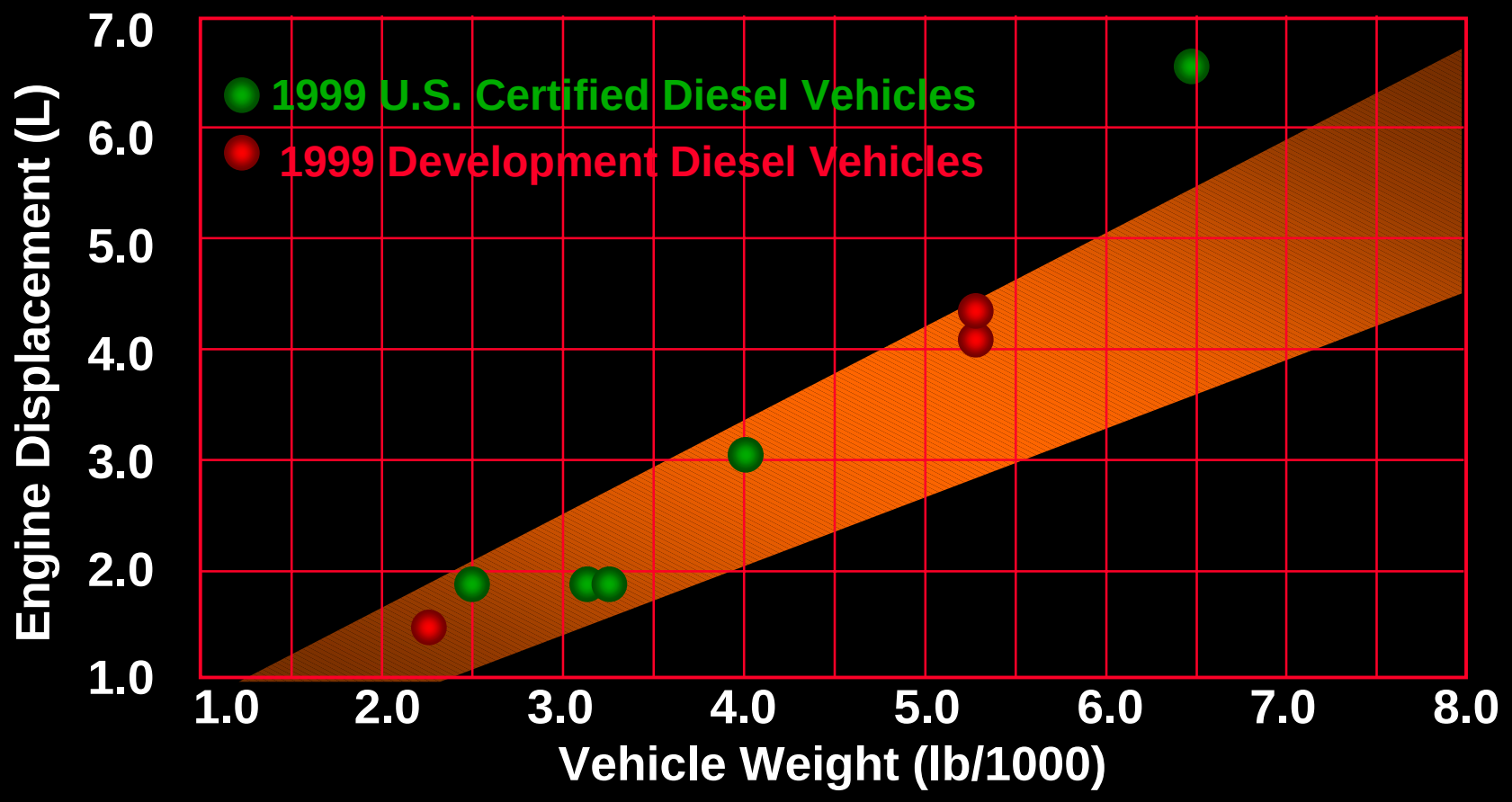
- Vehicle Inertia Dramatically Affects Vehicle Emissions
- ≤ 8,500 lb Held to Same Standards
- Must Demonstrate Technology Scalability

Effect of Vehicle Inertia Weight

NO_x Emissions

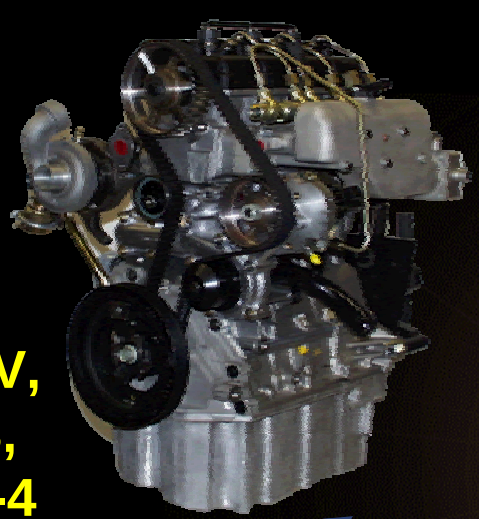


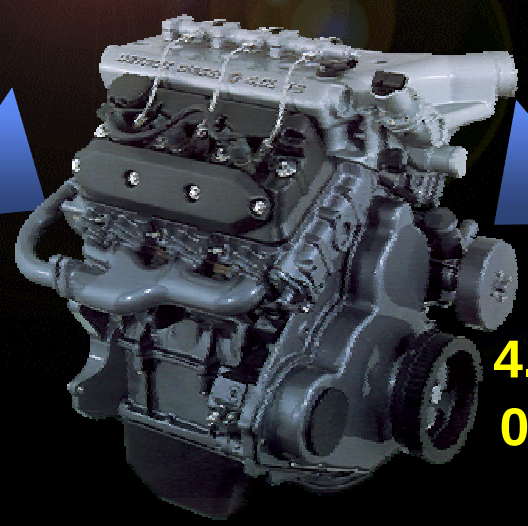
Displacement vs. Vehicle Test Weight



Personal Transportation Engine Technologies

Scalability





Share

0.5L per Cylinder

Technology

1.5L HEV,
1.5L I-3,
& 2.0L I-4
0.5L/cylinder

Scale

Technology

3.0L V6 VECTER
0.5 L/cylinder

Scale

Technology

4.0L V6 DELTA
0.67 L/cylinder

Other Available Engines:

2.5L 4-Cylinder

4.2L 6-Cylinder

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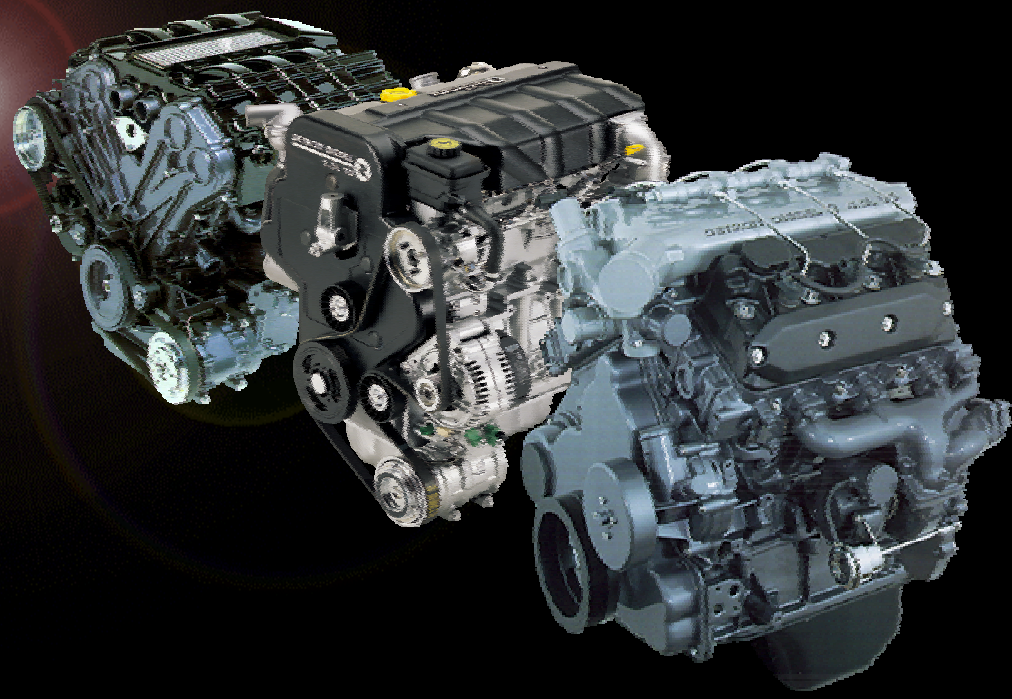
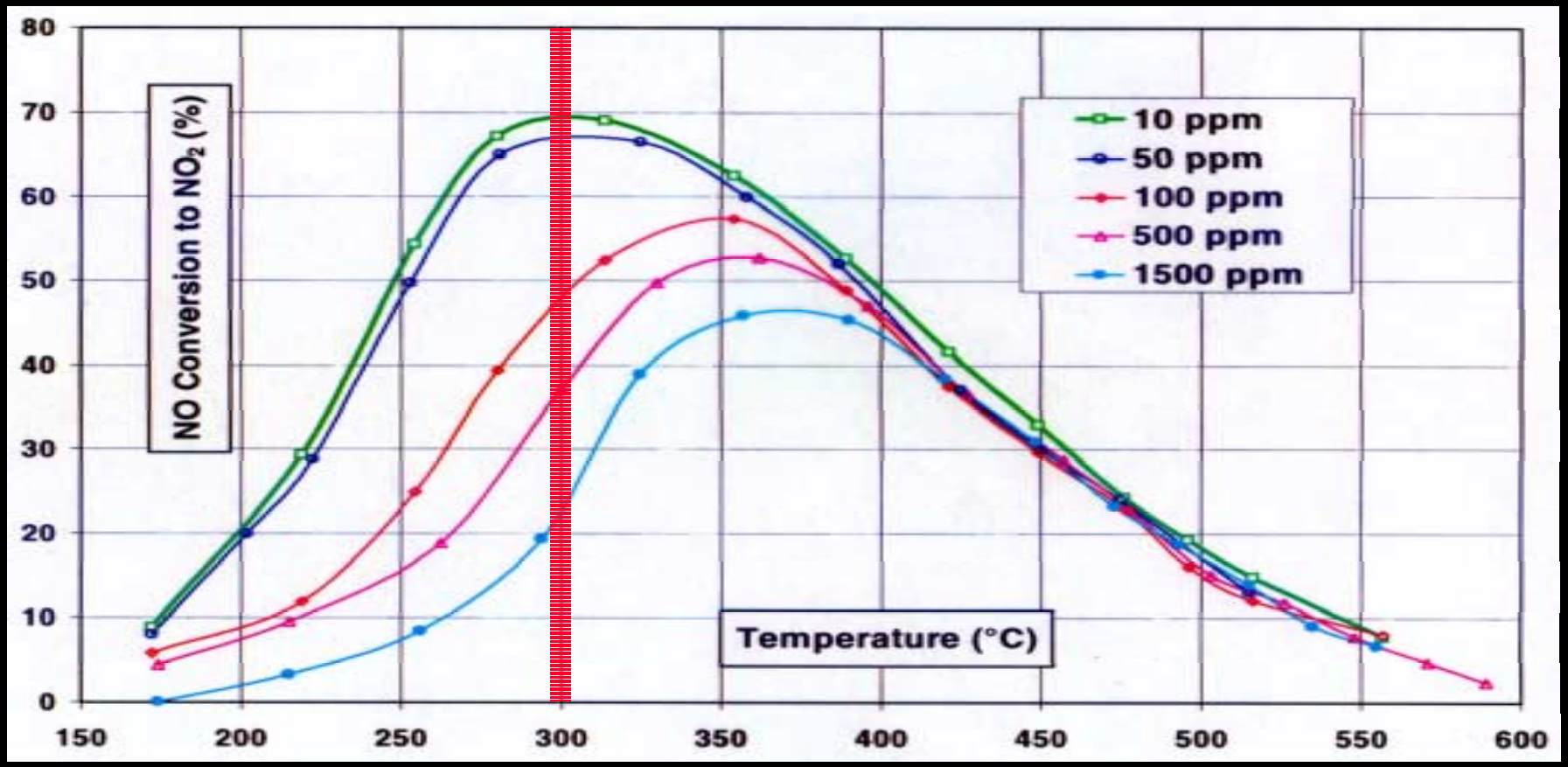


Aftertreatment

CRT Sulfur Sensitivity



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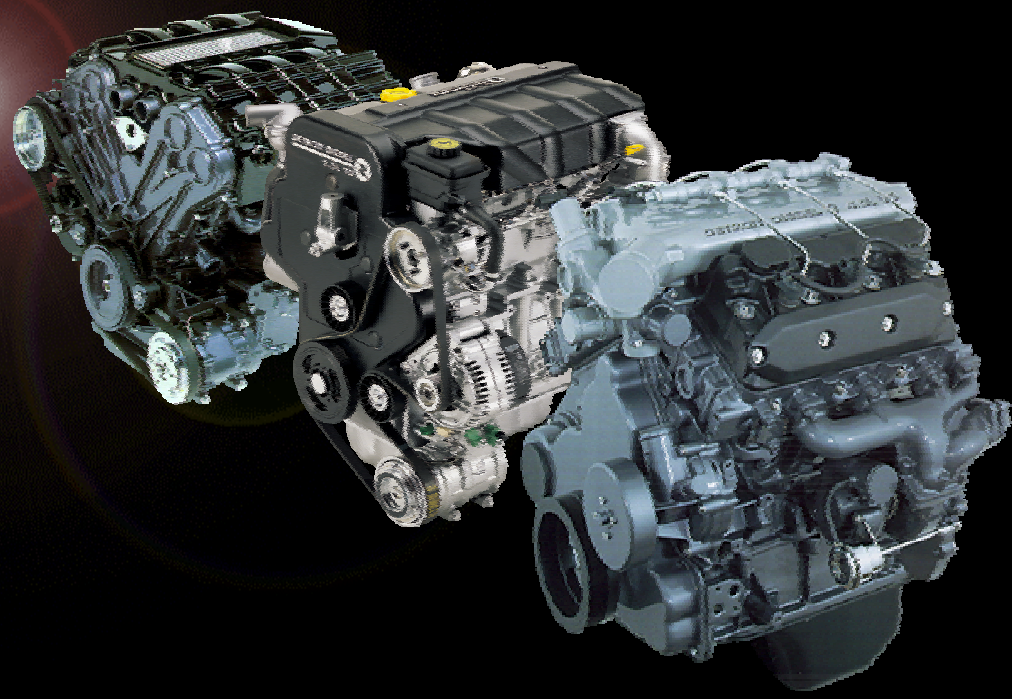
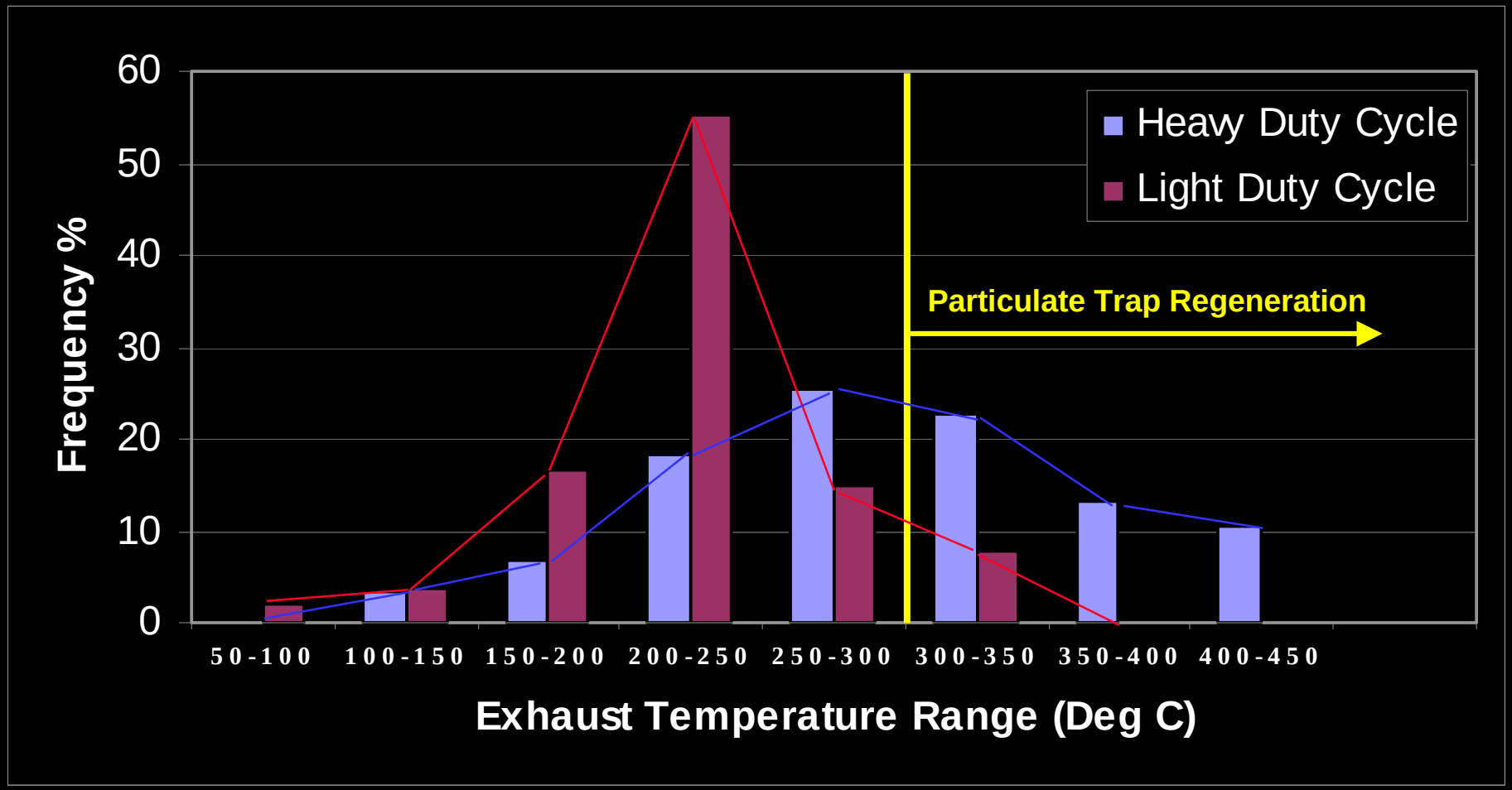


Exhaust Temperature Distribution

Light-Duty vs. Heavy-Duty



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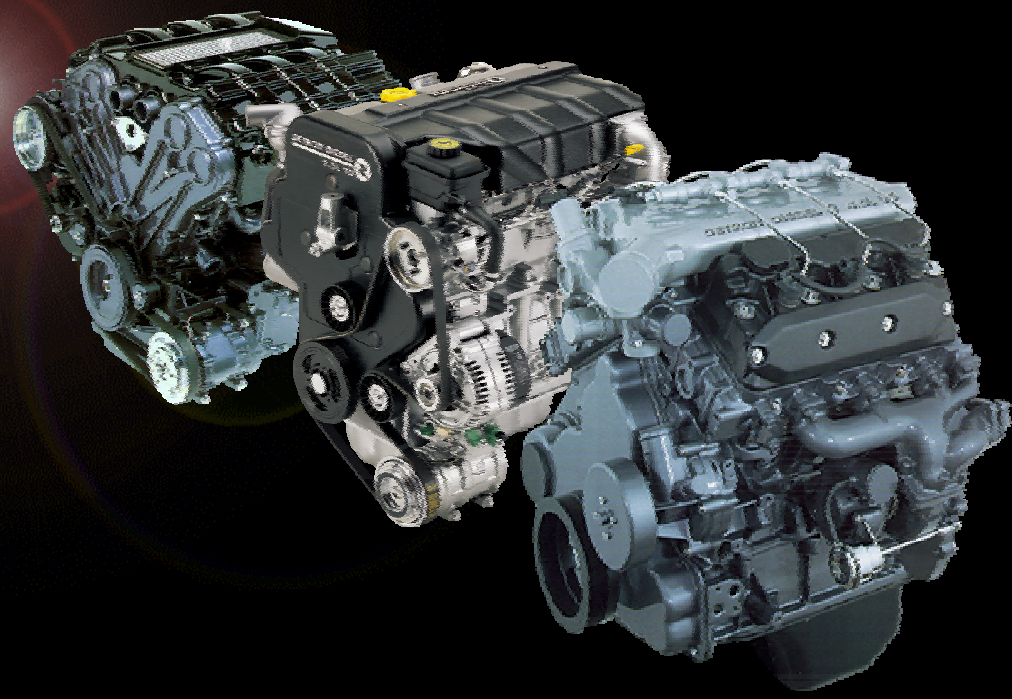
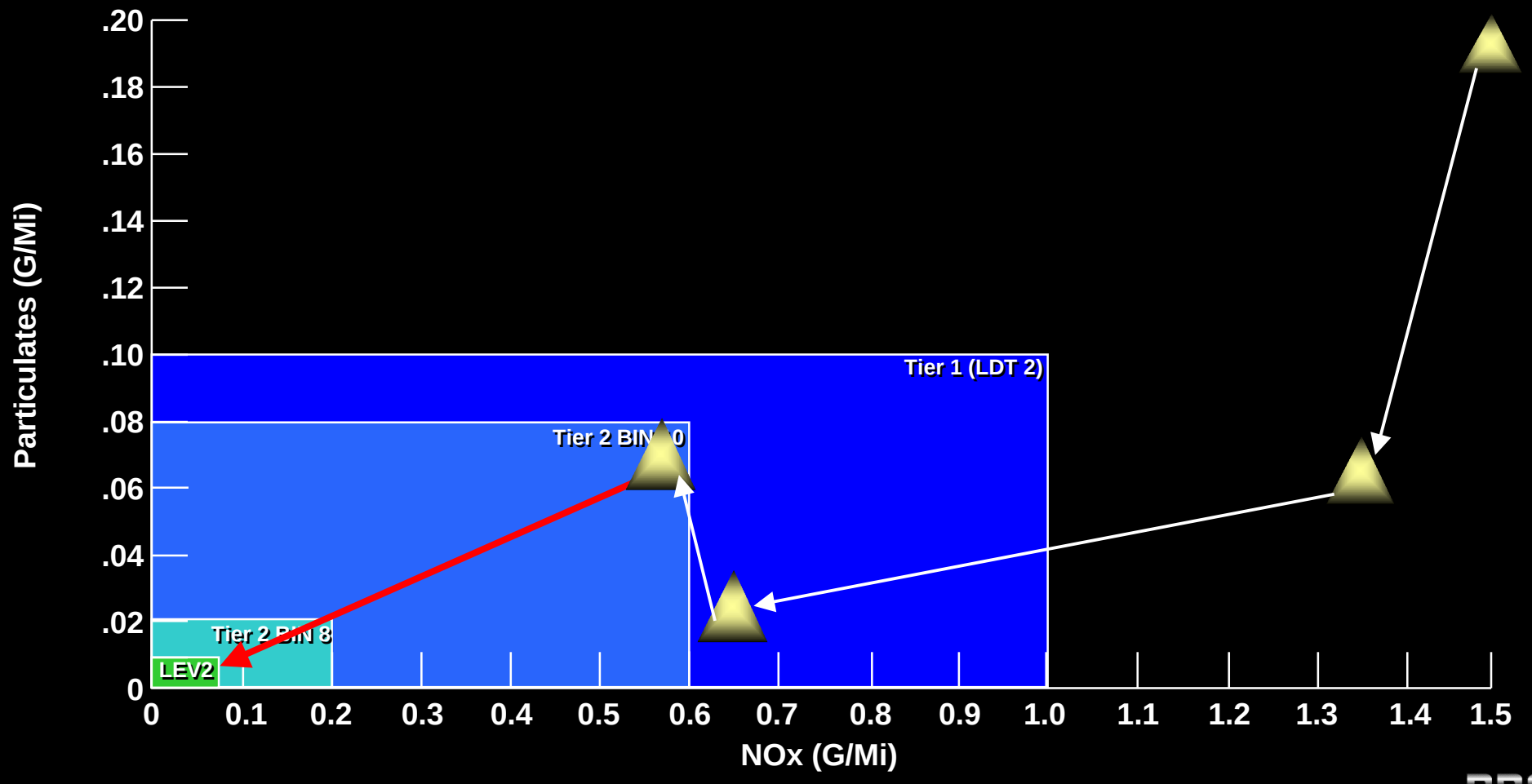


Light-Duty Emissions

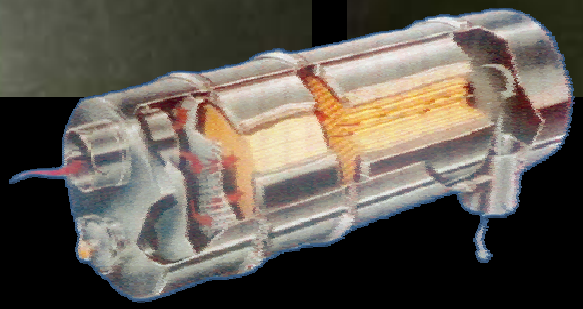
4.0L V6 Vehicle Results



Exhaust System

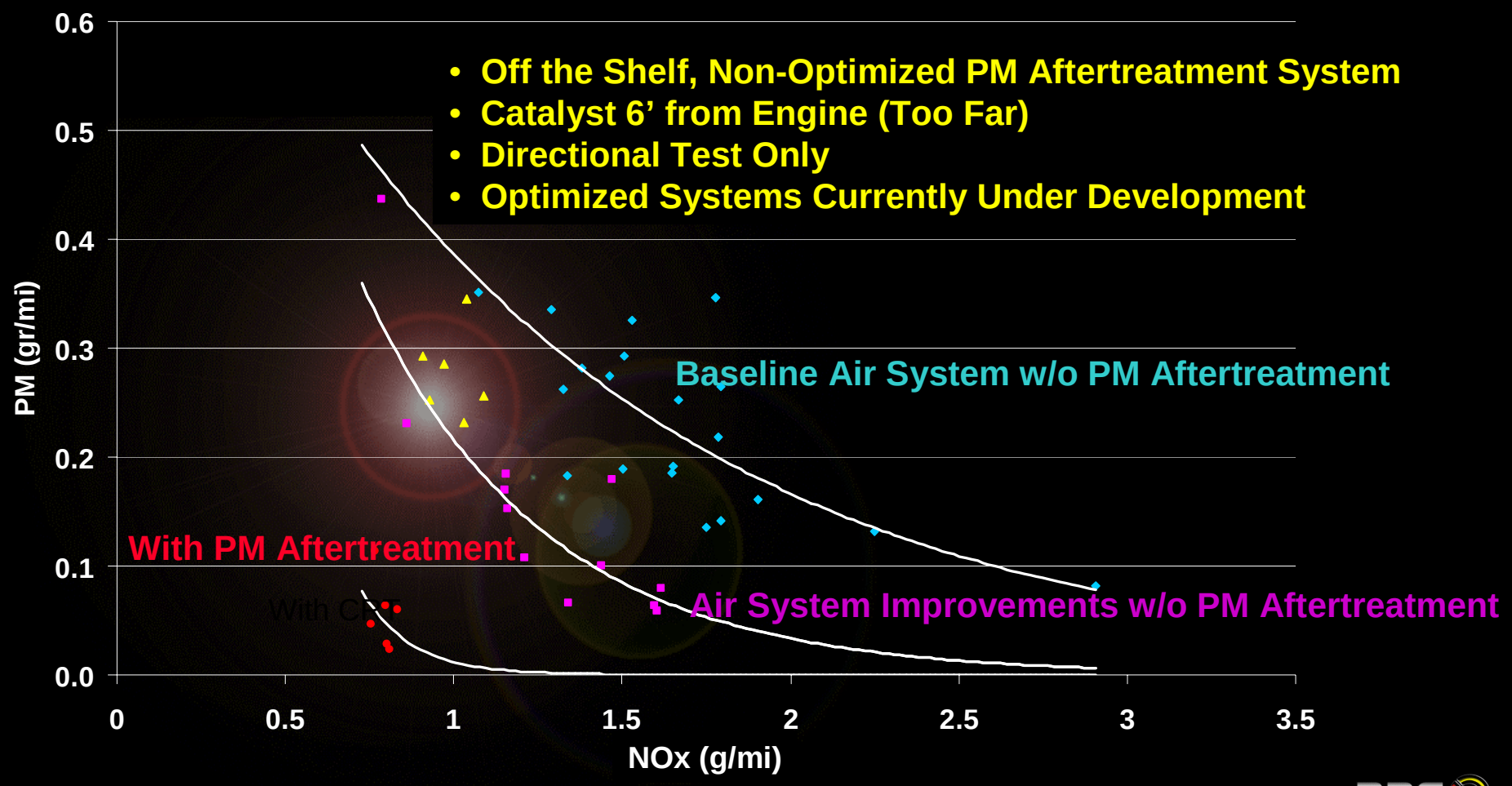
Eliminated Exhaust Muffler

- Replaced Muffler with a Continuously Regenerating Trap (CRT)



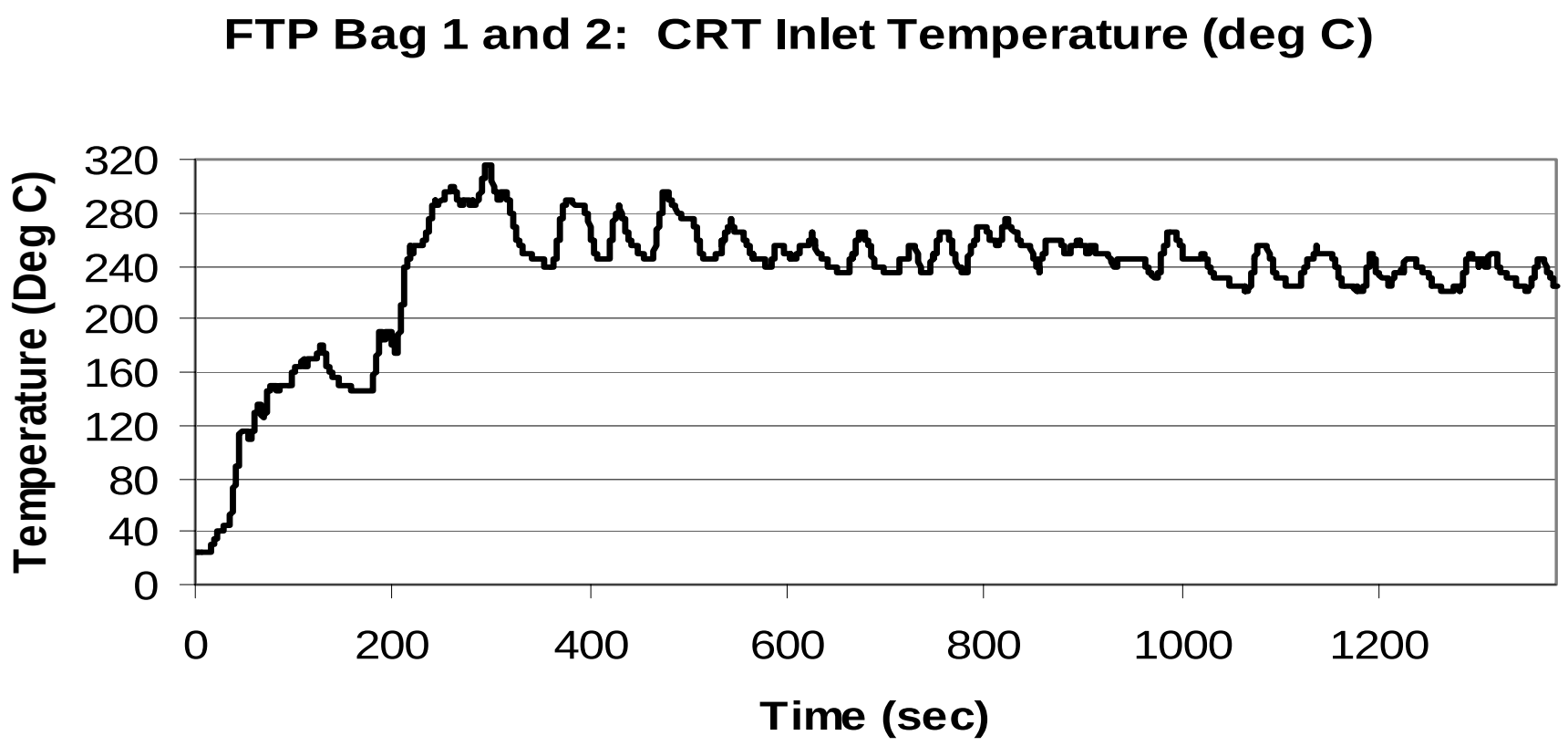
Detroit Diesel DELTA 4.0L V6

Preliminary PM Aftertreatment Results



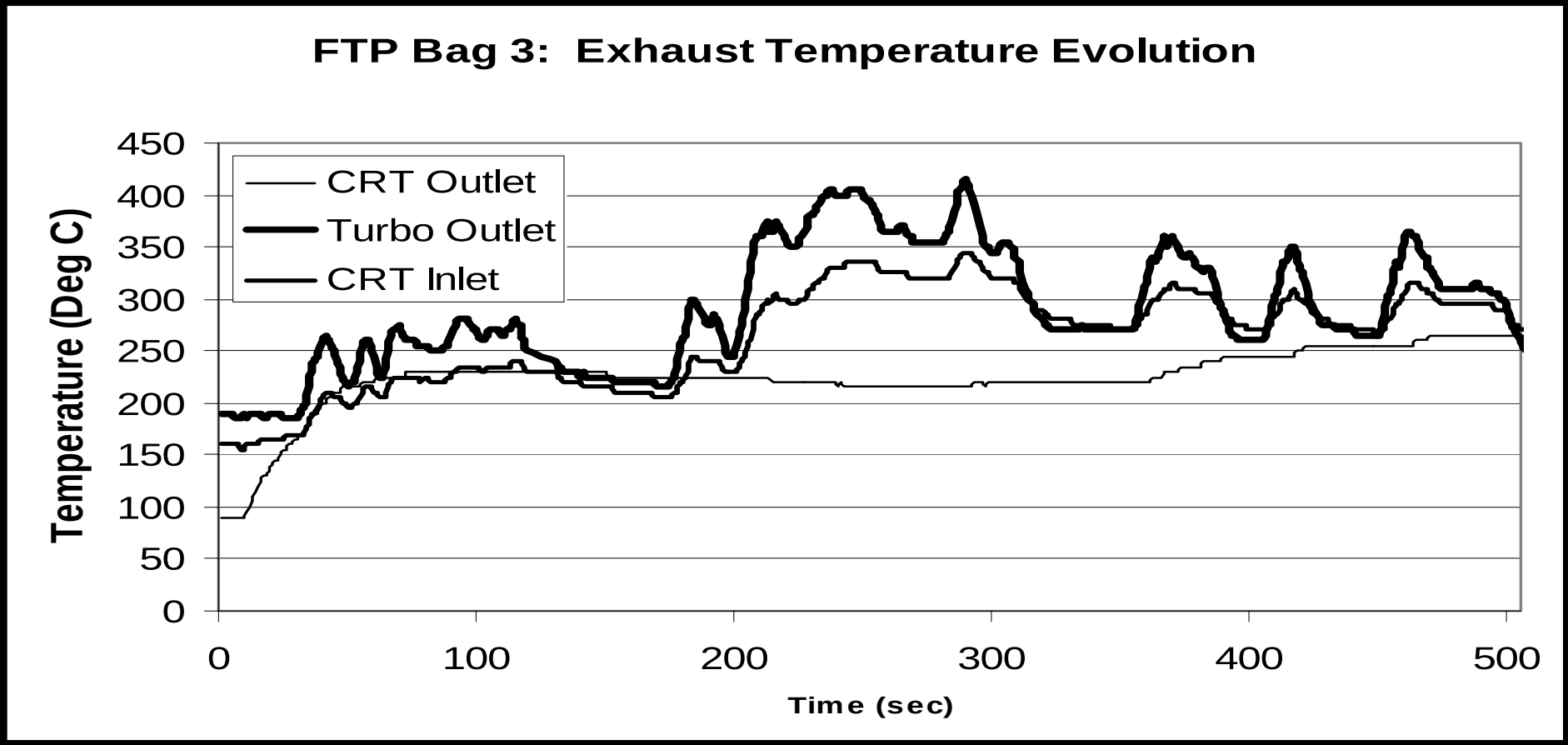
Aftertreatment Performance

Cycle Effects



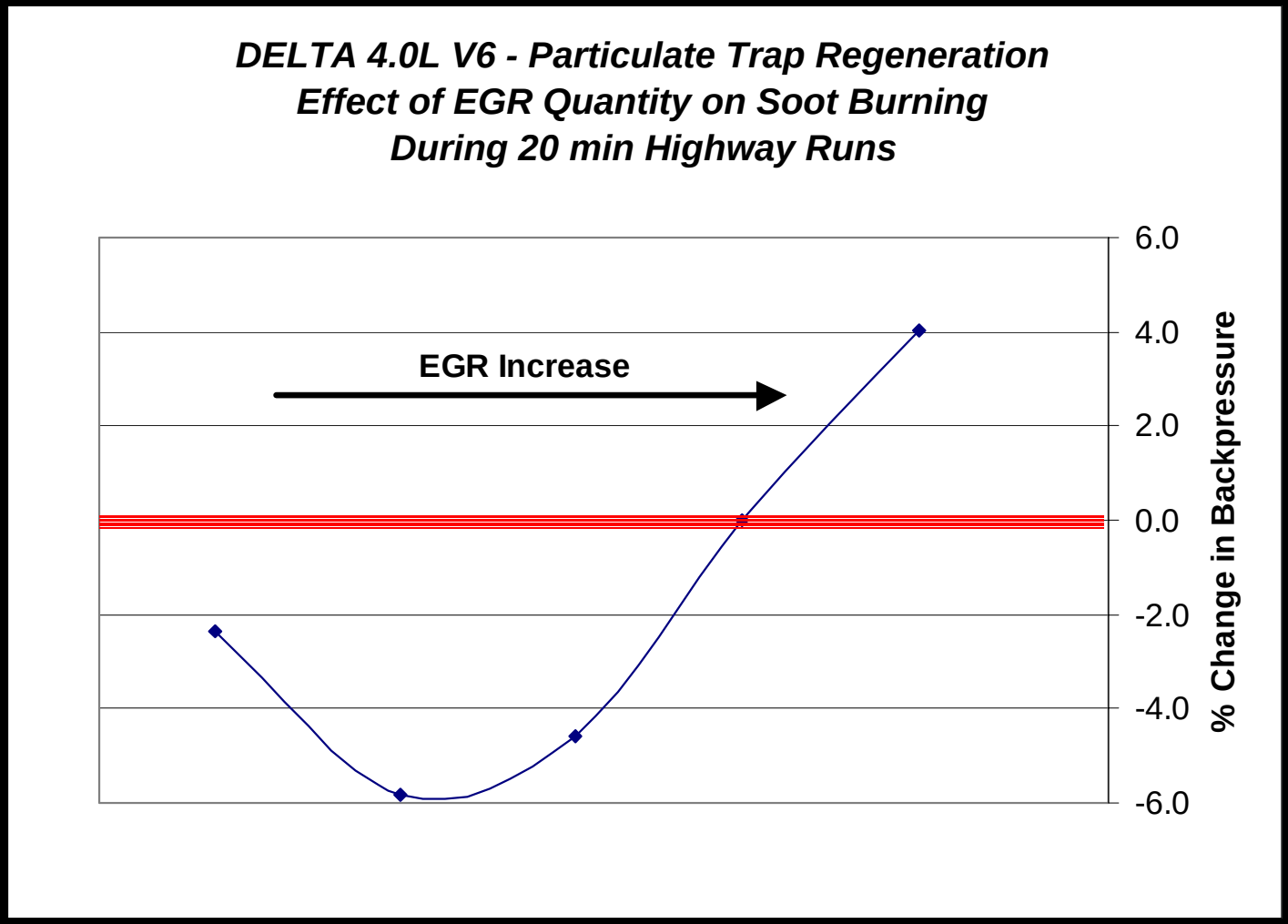
Aftertreatment Performance

Cycle Effects & Catalyst Position



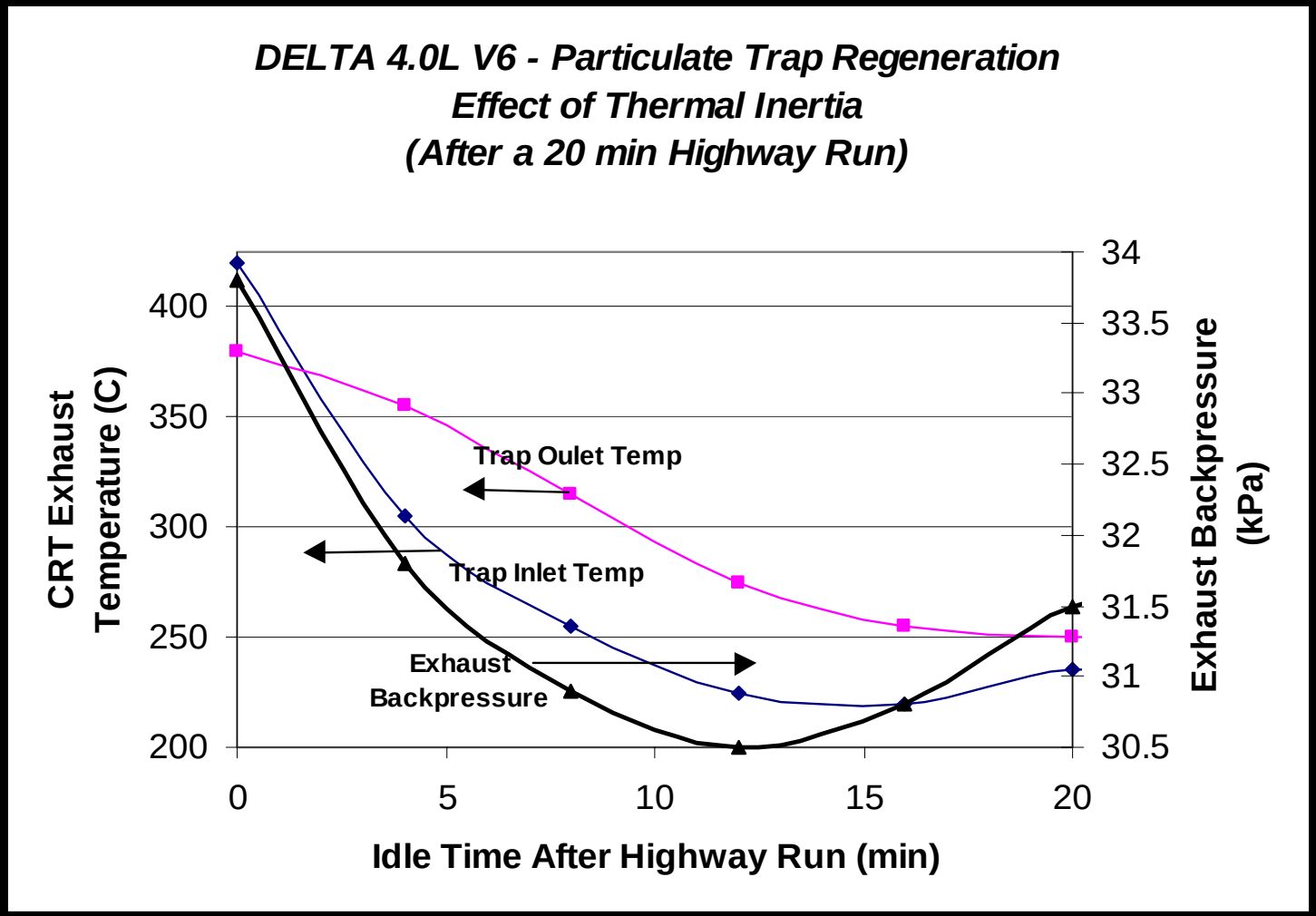
Particulate Aftertreatment Regeneration

EGR Influence



Particulate Aftertreatment System

Thermal Inertia Effects on Regeneration



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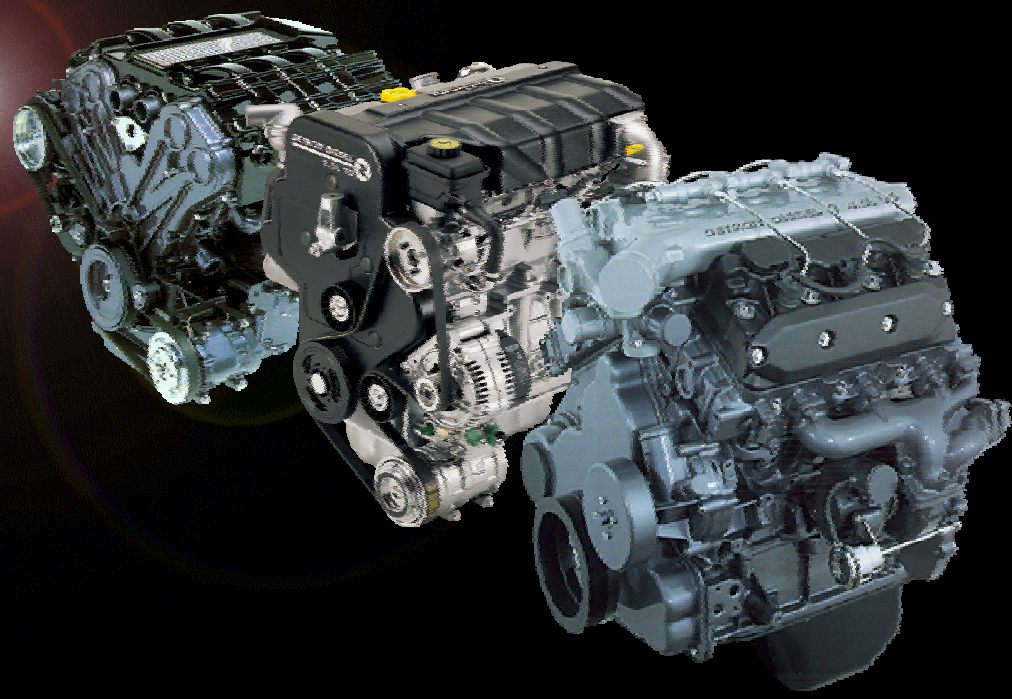
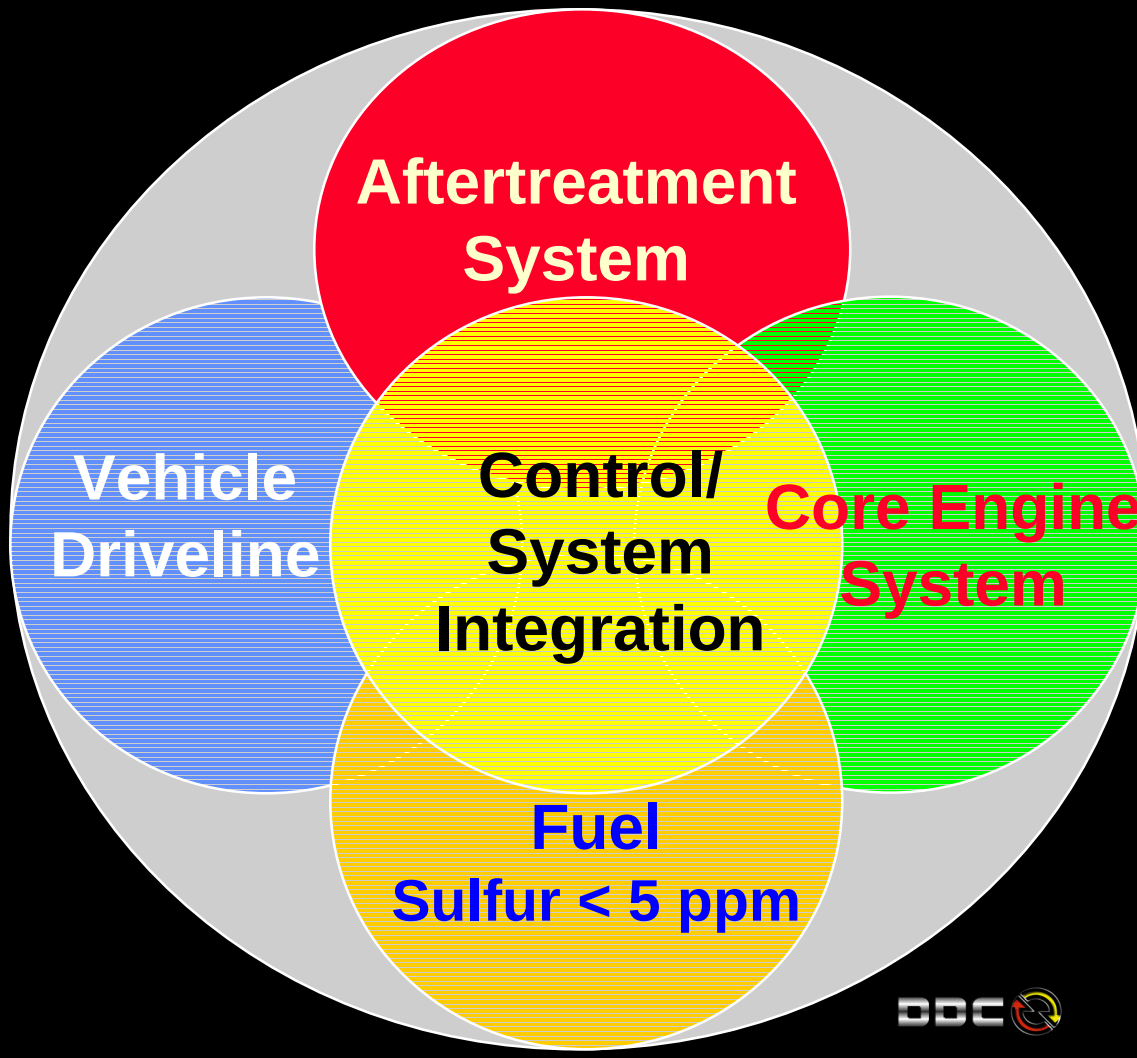


Aftertreatment Development Program

Systems Approach

- Aftertreatment Focus
- Low Light-Duty Exhaust Temperatures Complicate Aftertreatment Operation
- Developing Analytical Tools



Aftertreatment Virtual Lab Technical Path

Three-Level Development Strategy

3D- CFD Base

- Detailed physics & design
- Extremely time consuming
- Technology is not mature yet

1D- CFD Base

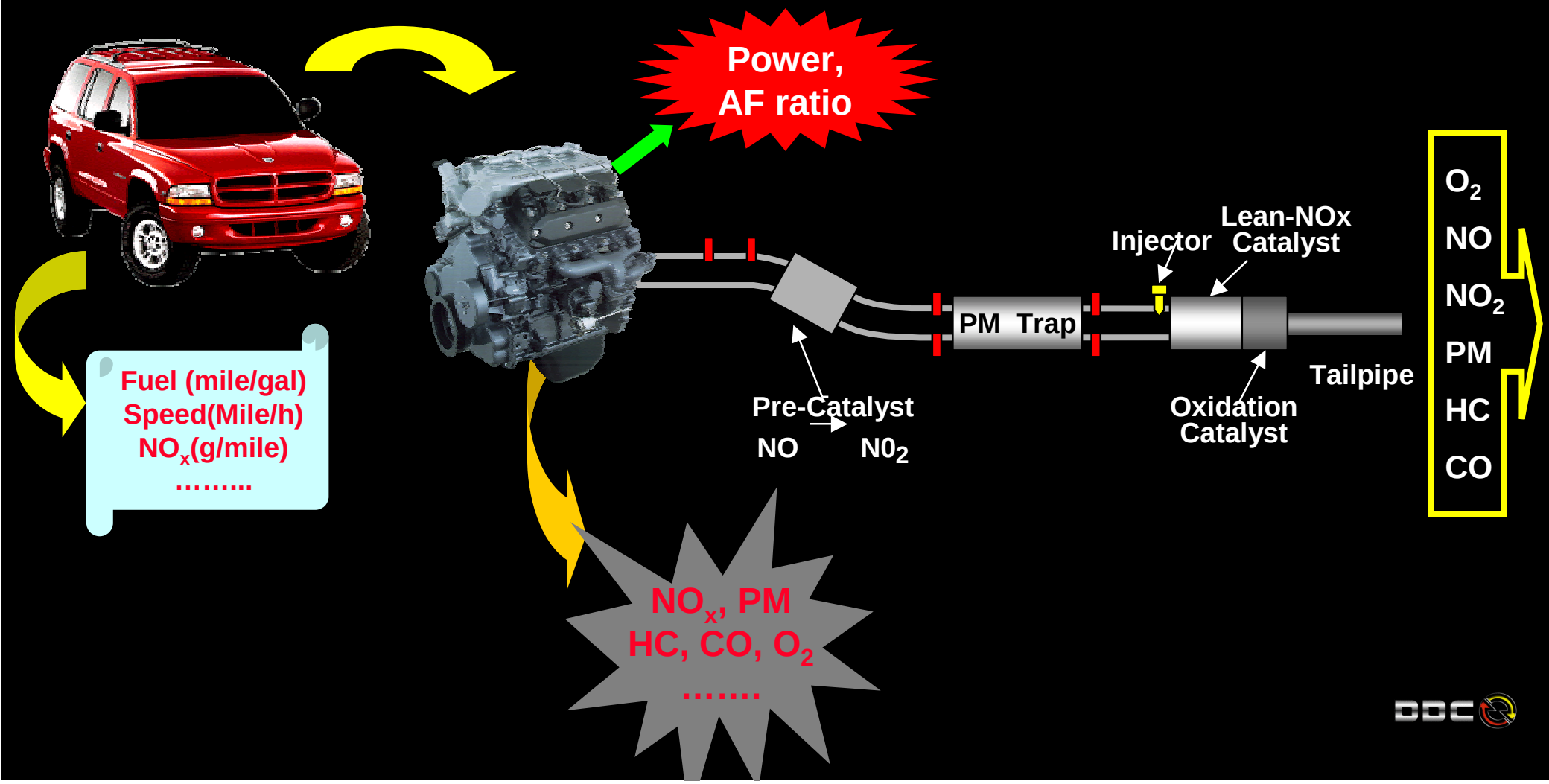
- Focus on system integration with
- Overall physical dimensions
- General control strategies
- Practical & fast, but sacrifices detail

0D- Mean Value Base

- Focus on Detailed Control Strategies
- Considers Engine, Vehicle, & Aftertreatment
- Practical & Computationally Fast
- Relies on test data & 1-D results for look-up tables

Integrated System Modeling

Complete Vehicle, Engine, & Aftertreatment System



Conclusions

- Light-Duty PM Aftertreatment Remains a Challenging Goal
- Progress is Encouraging
- Regulations are Problematic with Respect to Vehicle Weight
- Must Address Fuel Quality Issues
- Unique Light-Duty Cycle Parameters Must Be Addressed, to Achieve Reliable Regeneration
- Analytical Tools Required to Optimize Complete System