Full Useful Life (120,000 miles) Exhaust Emission Performance of a NOx Adsorber and Diesel Particle Filter Equipped Passenger Car and Medium-duty Engine in Conjunction with Ultra Low Sulfur Fuel

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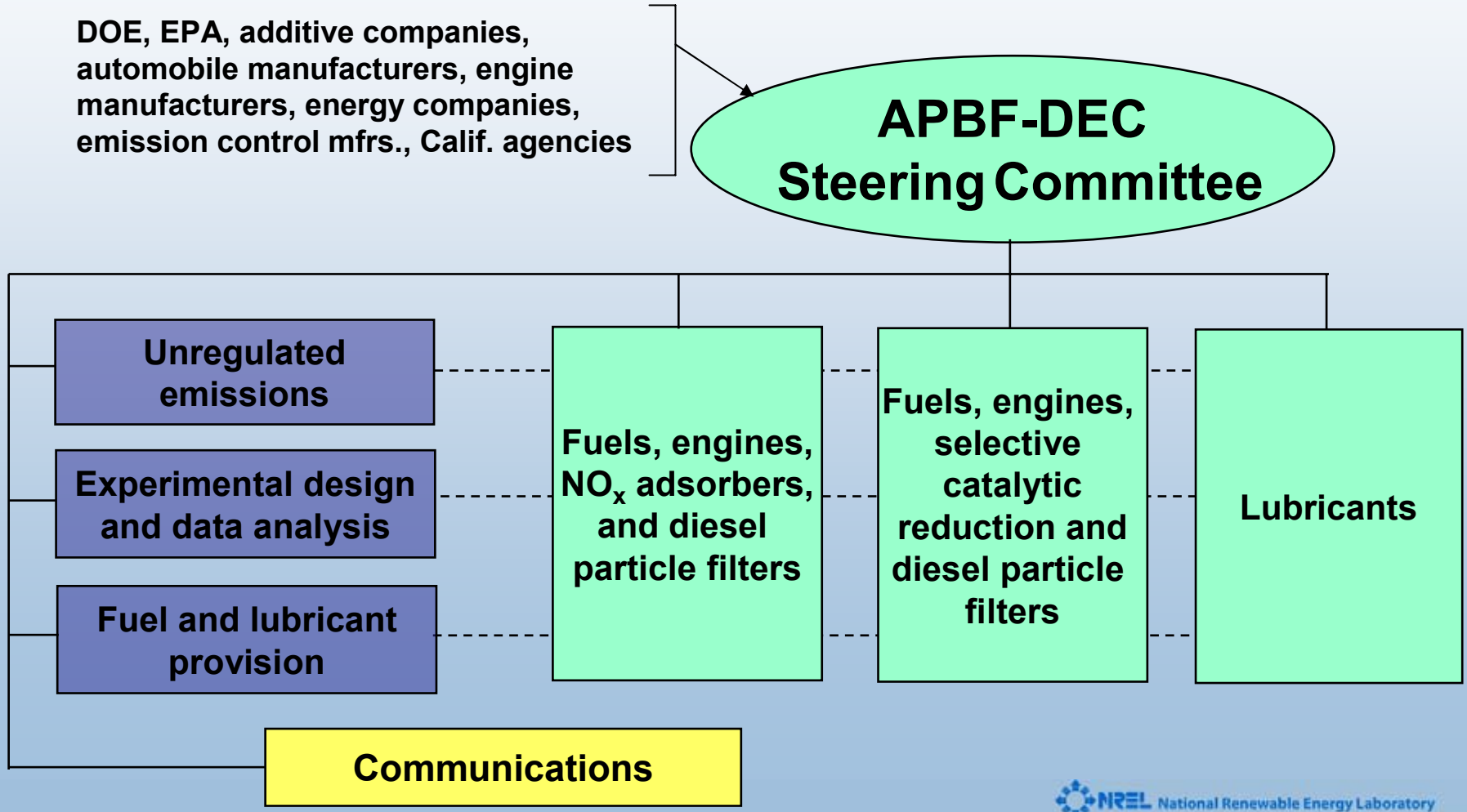
Outline

- Project Overview
- Program goals and objectives
- Hardware overview
- Test procedures
- Test results
- Summary and outlook

APBF-DEC Projects

NO_x Adsorber/DPF			SCR/DPF	Lubes
				
FEV	SwRI	Ricardo	SwRI	AEI
1.9L TDI	6.6L Isuzu Duramax	15L Cummins ISX	Caterpillar C12	Cummins ISB
Audi A4 Avant	Chevrolet Silverado	*No vehicle*		

APBF-DEC Organization



Project Objectives for LD NOx Adsorber Projects : Examine fuel property effects on NAC/DPF systems

Approach:

- Demonstrate low emissions potential of diesel engines equipped with advanced fuel, NOx adsorbers, DPFs, EGR, double-wall exhaust
  - Goal: Tier 2 Bin 5 (0.07 g/mi NOx 0.01 g/mi PM)
- Age systems with Ultra Low S fuel for up to 2200 hrs
  - Periodic emissions evaluations during aging (before and after NOx adsorber desulfation)
  - Periodic unregulated emissions measurement with 15-ppm S refinery product
  - NOx adsorber desulfation performed on time based schedule

Project Outline

Project divided into three Tasks:

- Hardware procurement and operational strategy development
- System integration and optimization
- Performance and aging evaluation
  - Age ECS to 2000-2200 hours with 15-ppm S Fuel
    - 2,200 hours equal full useful lifetime of 120,000 miles
  - Emissions evaluation procedures performed every 100-200 hrs
  - Desulfations performed every 150-200 hours to start then 100 hours (and every 50 hours at the end for the Passenger Car platform)

Project Hardware Overview

Passenger Car

Engine Specification

Arrangement: In-Line 4-Cylinder

Displacement: 1.9 L

Rated Power: 100 kW @ 4000 rpm

Max. Torque: 330 Nm @ 2000 rpm

Medium-Duty Engine

Engine Specification

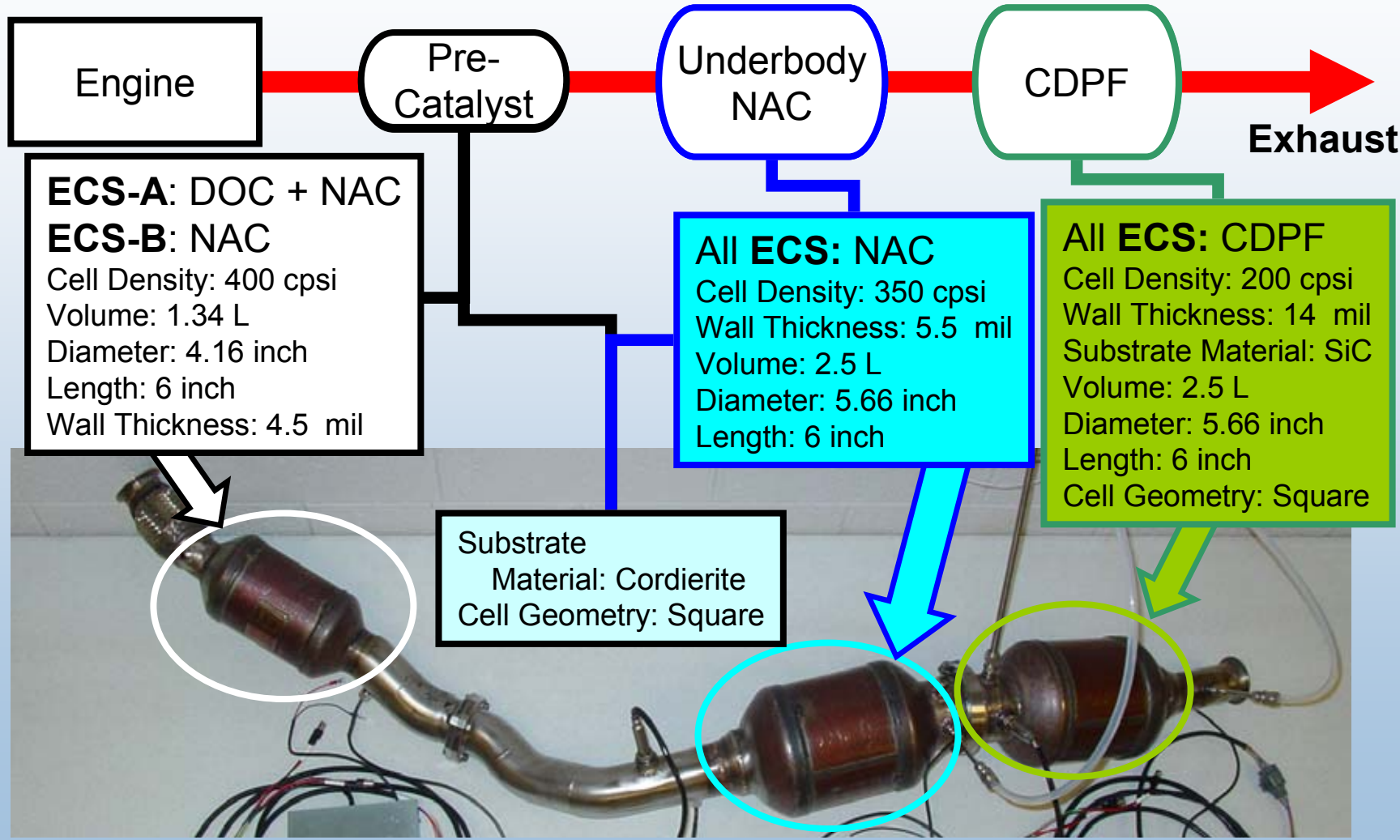
Arrangement: 8-Cylinder V

Displacement: 6.6 L

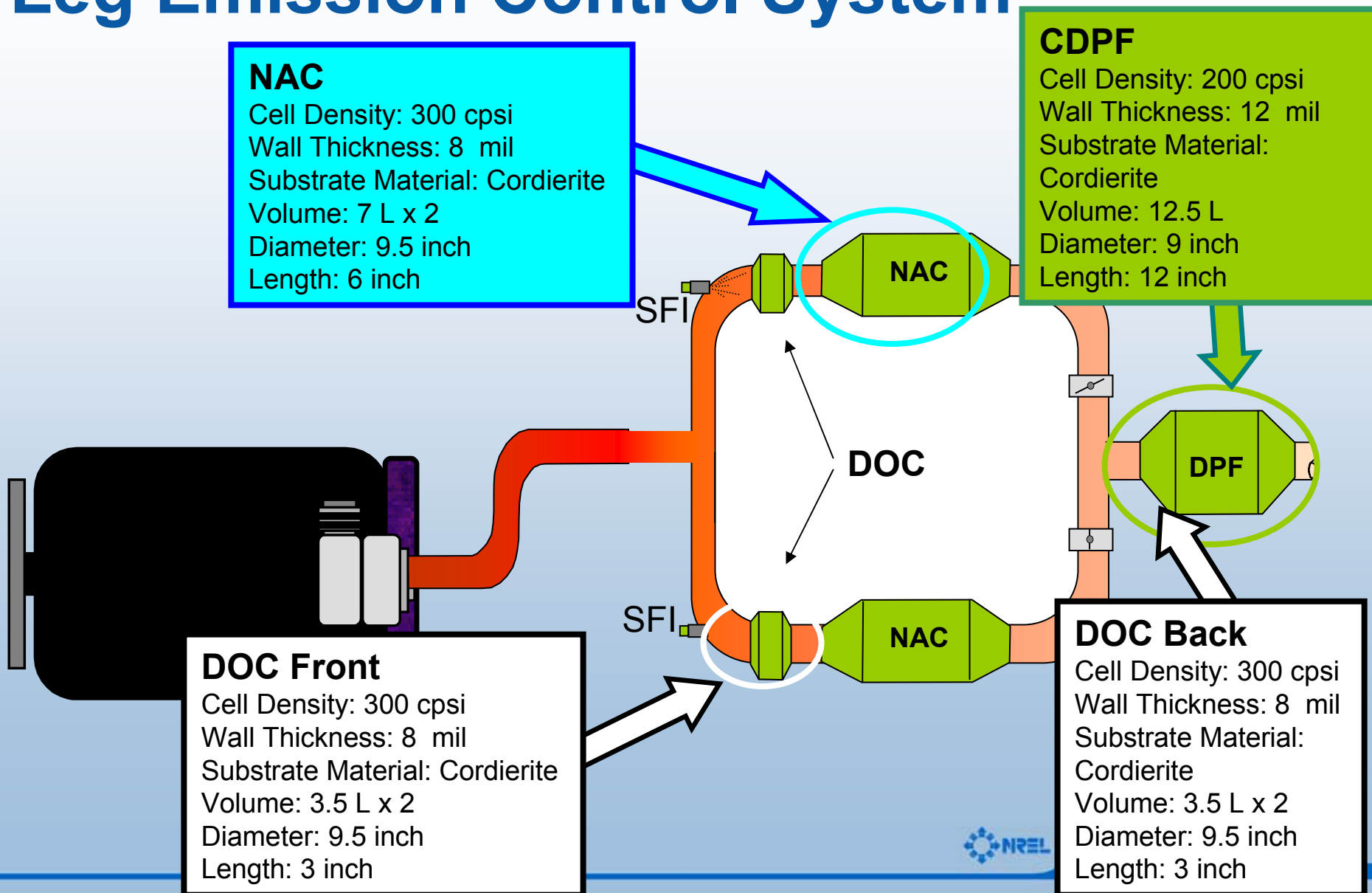
Rated Power: 224 kW @ 3100 rpm

Max. Torque: 705 Nm @ 1800 rpm

Passenger Car Project In-Line Emission Control System



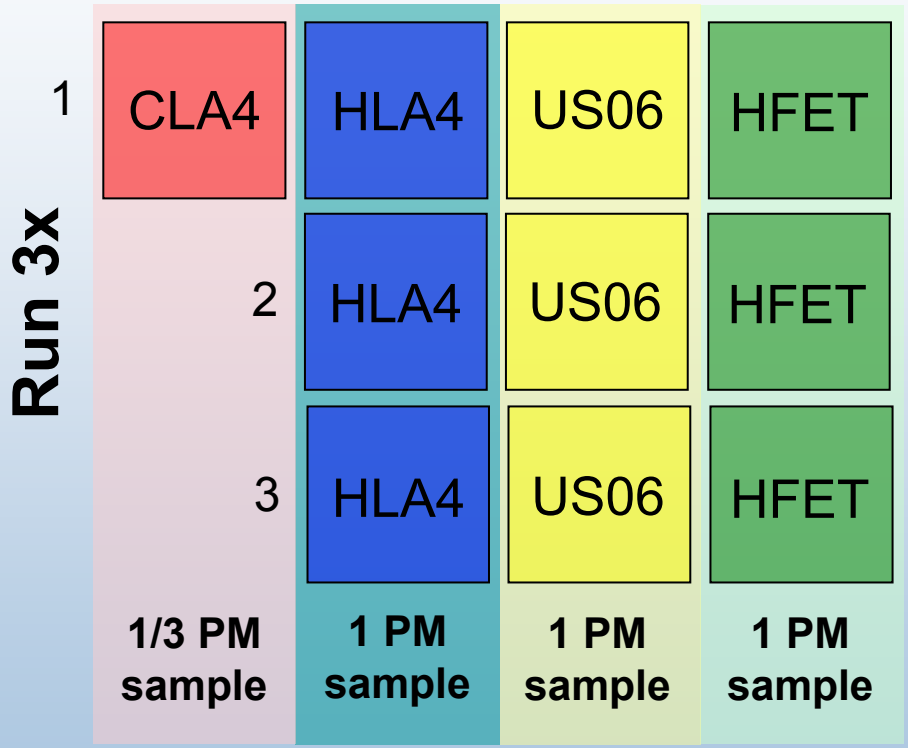
Medium-Duty Engine Project Dual Leg Emission Control System



Test Procedures

Engine Dynamometer Test Cell:

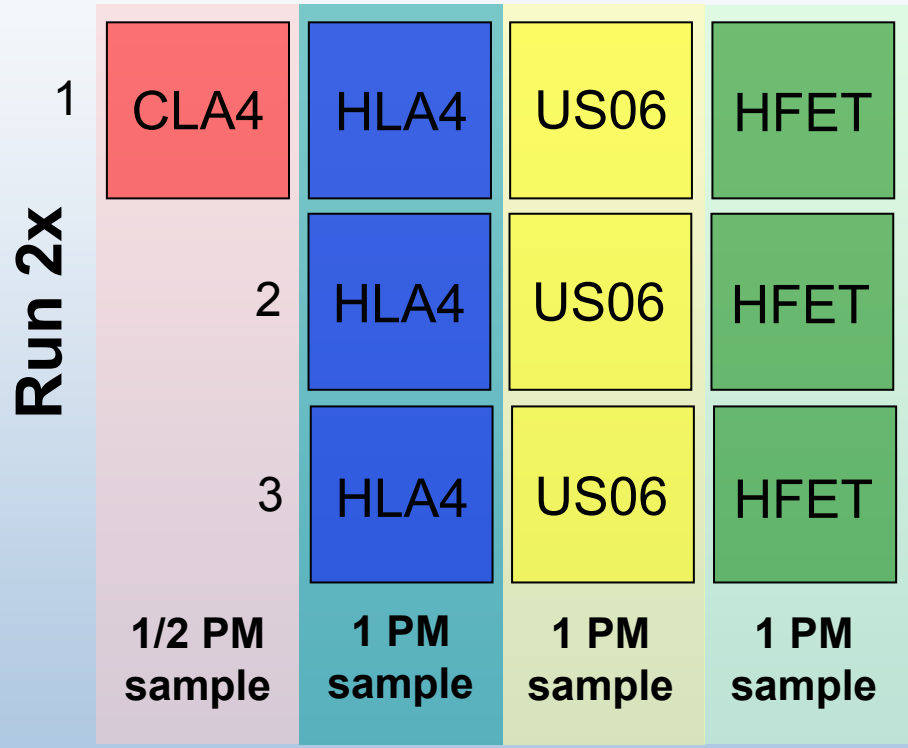
Pre-Desulfation Procedure



1 test cycle = 1 gas sample = 30 gas samples

1 set of cycles = 1 PM sample = 10 PM samples

Post-Desulfation Procedure

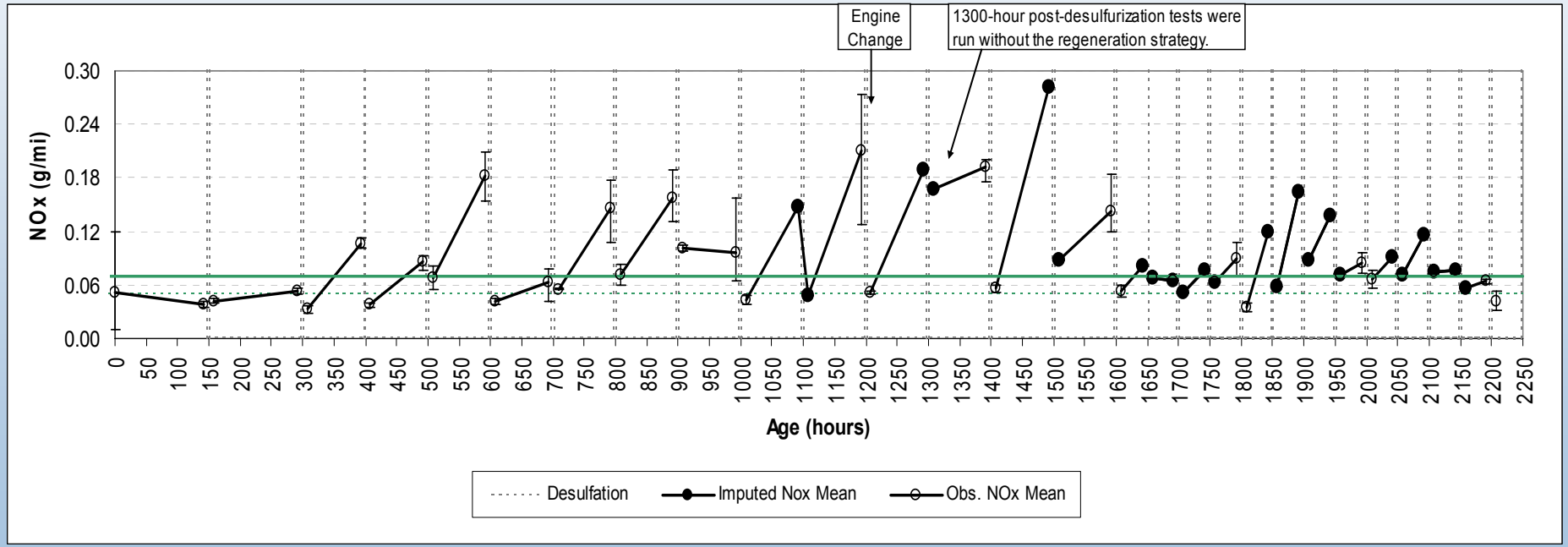


1 test cycle = 1 gas sample = 20 samples

1 set of cycles = 1 PM sample = 7 PM samples

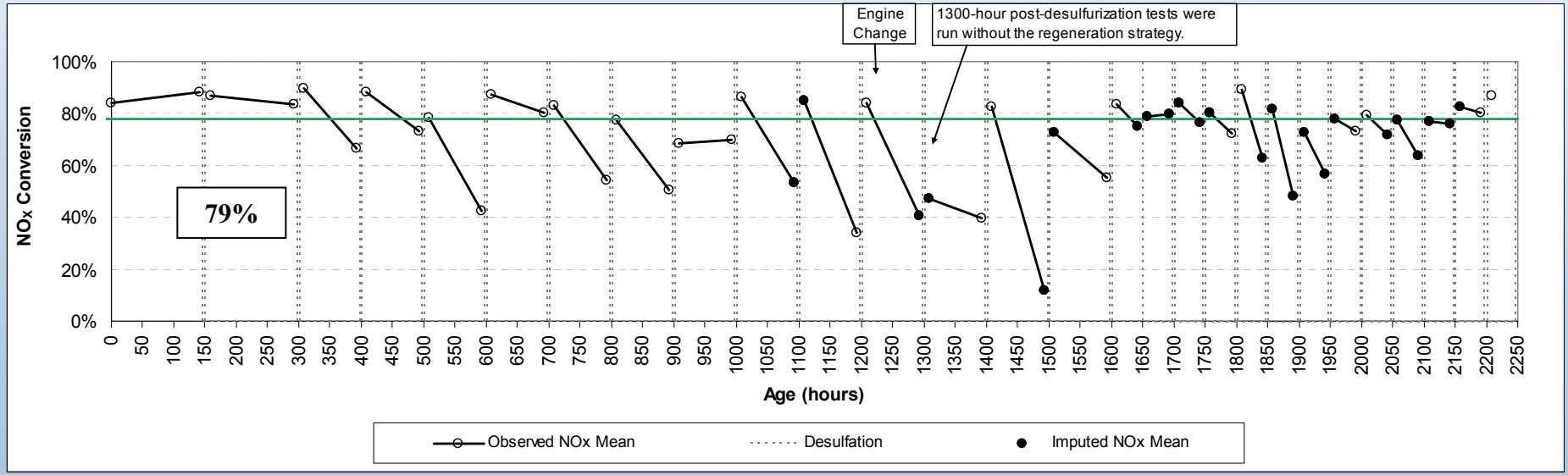
Passenger Car Project Test Results

NOx Emission Trends



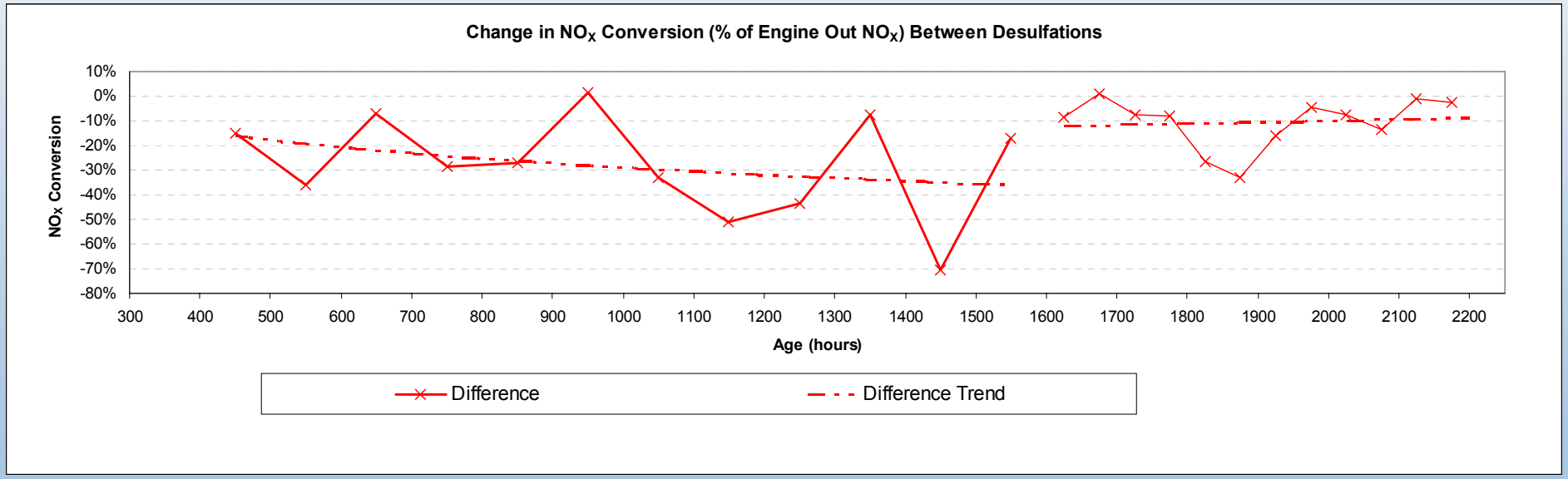
Passenger Car Project Test Results

NOx Adsorber Conversion Efficiency



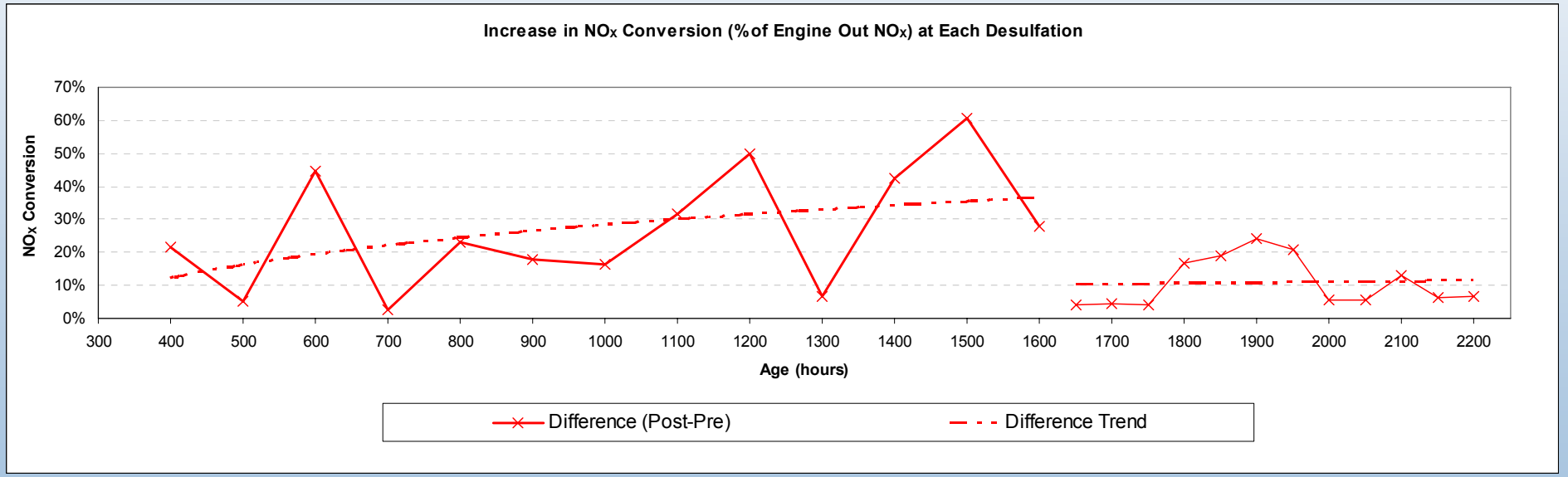
Passenger Car Project Test Results

NOx Adsorber Deterioration



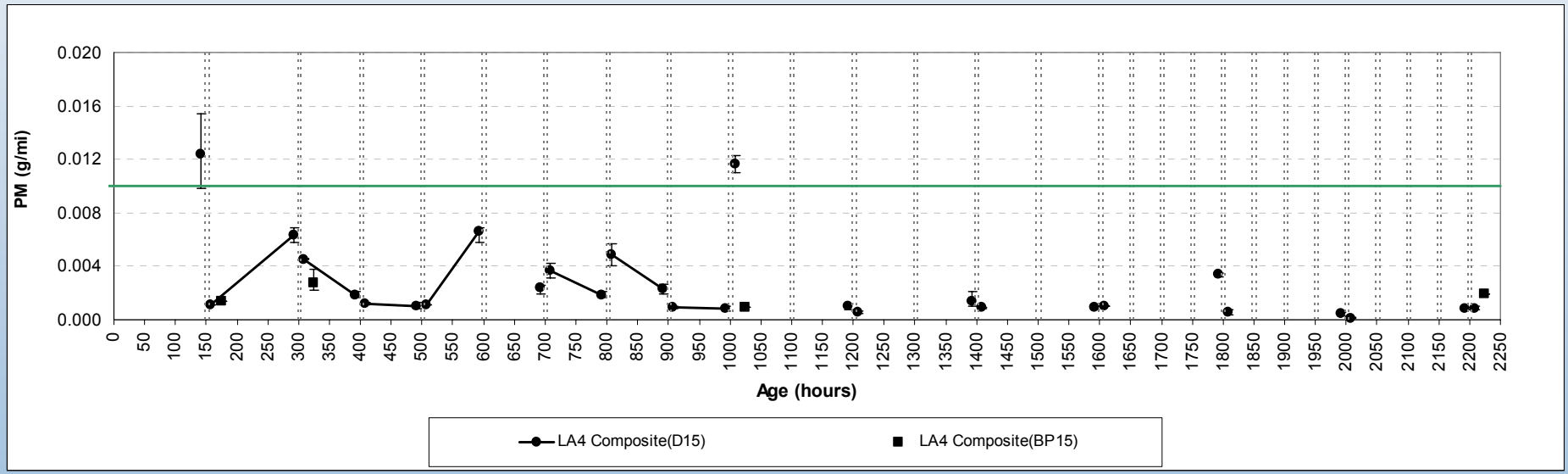
Passenger Car Project Test Results

Desulfation Effectiveness



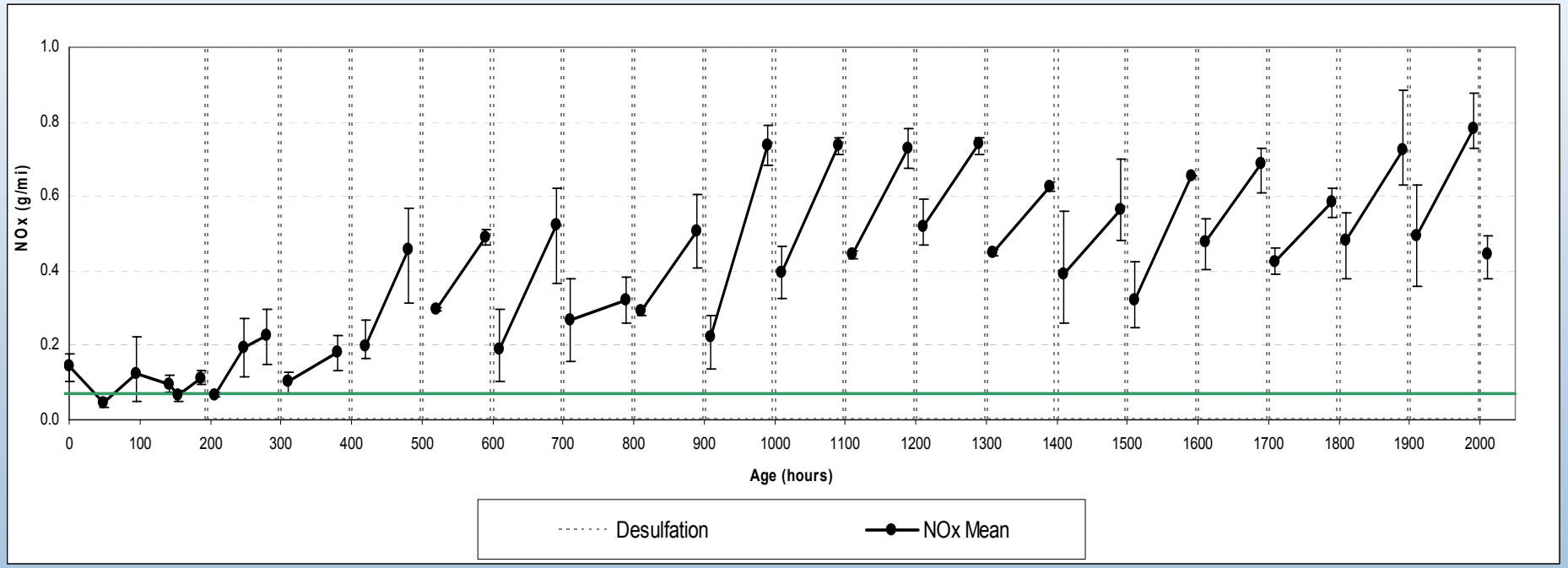
Passenger Car Project Test Results

PM Emission Trends



Medium-Duty Engine Project Test Results

NOx Emission Trends



Medium-Duty Engine Project Test Results

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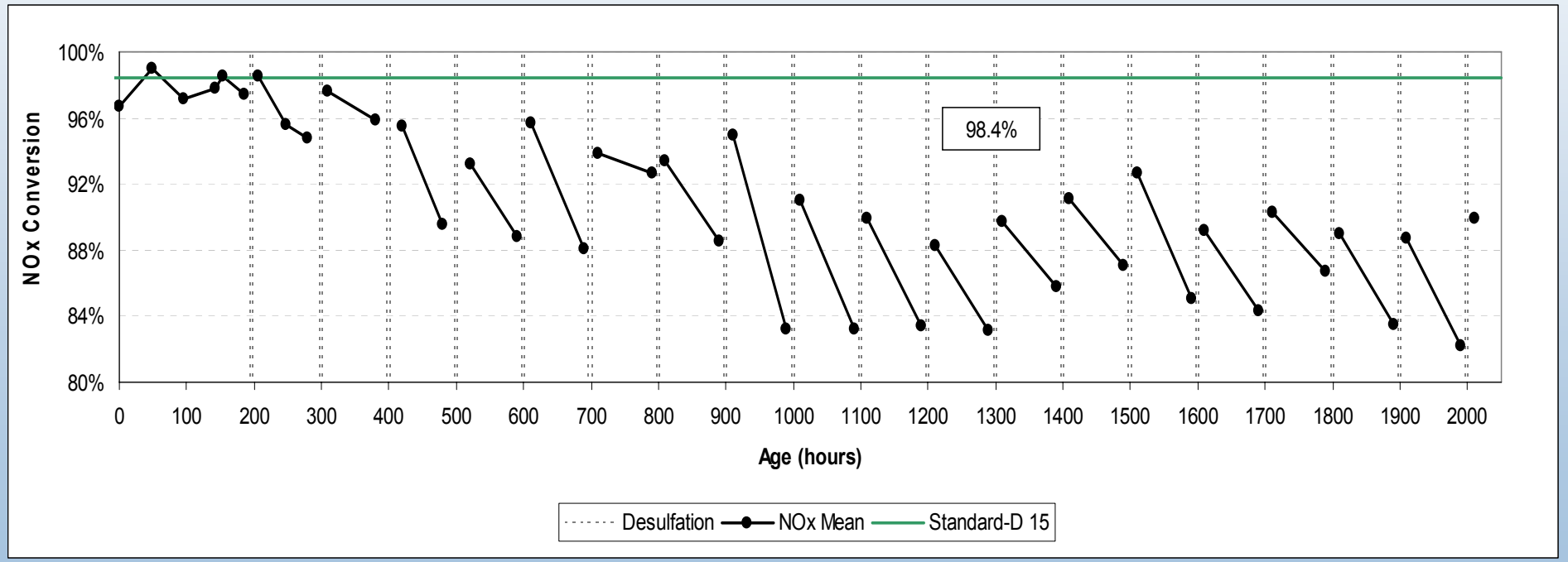

Medium-Duty Engine Project Test Results

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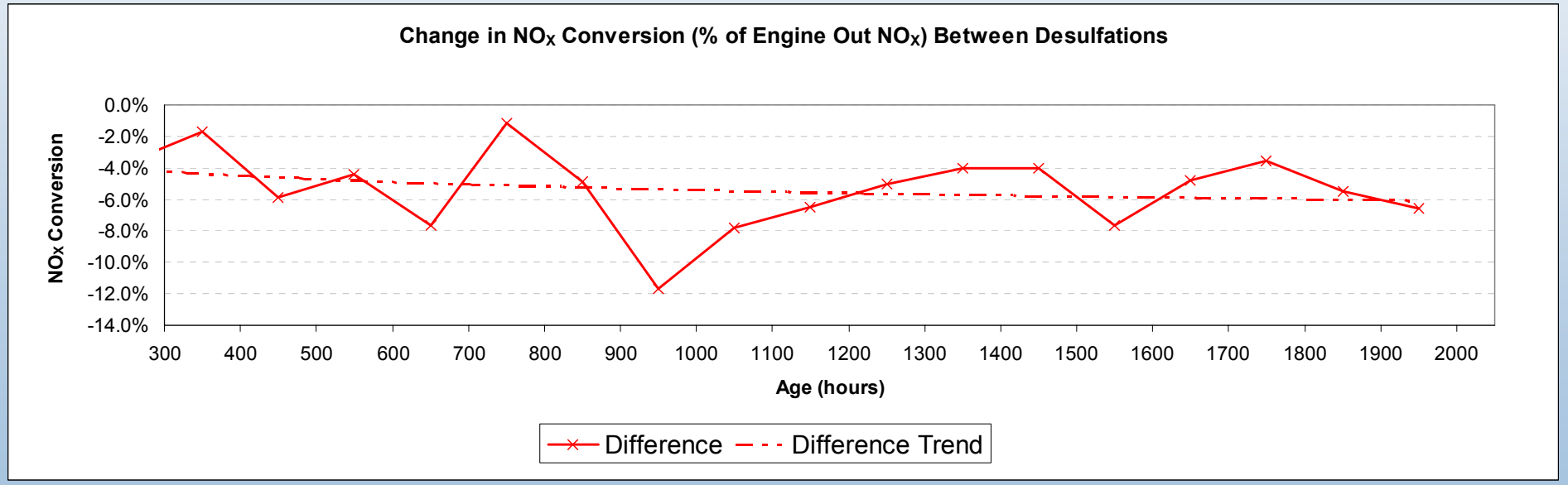

Medium-Duty Engine Project Test Results

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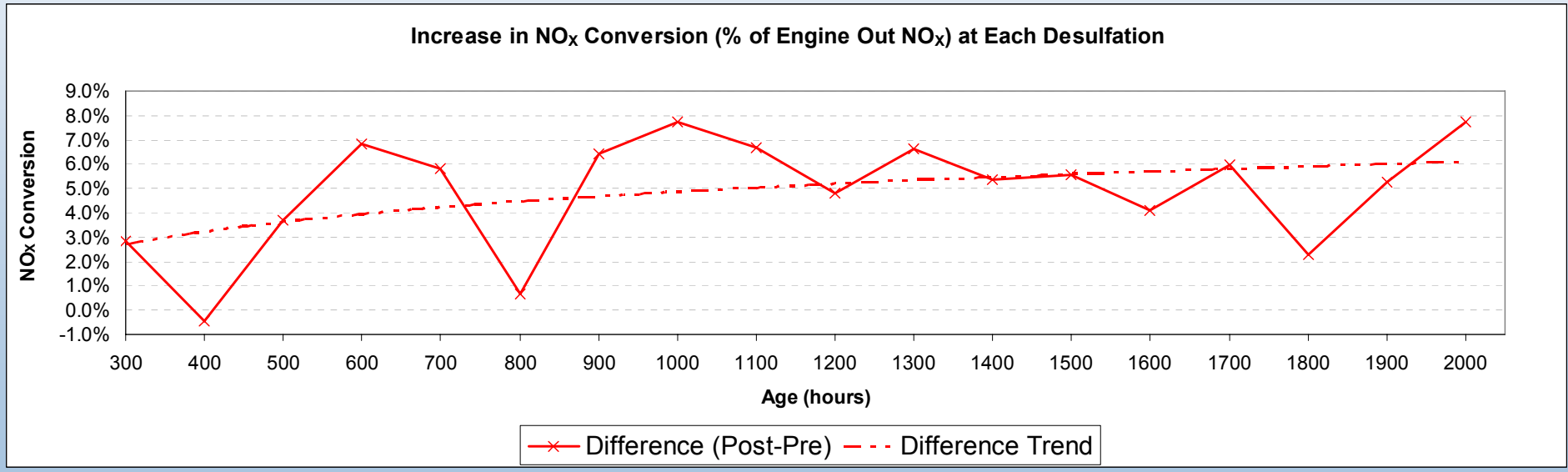
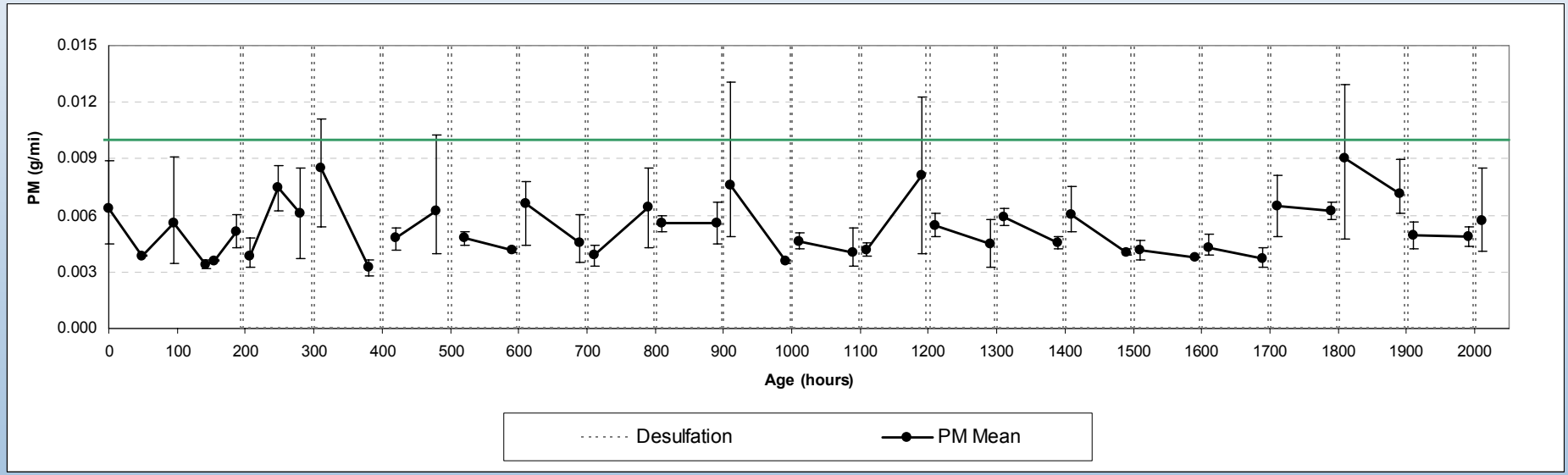


Medium-Duty Engine Project Test Results

PM Emission Trends



Summary

- Fresh NOx adsorber system in conjunction with 15ppm sulfur fuel can achieve Tier 2 Bin 5 NOx emission levels for both platforms
- Desulfation strategies are effective in recovering NOx adsorber performance with some deterioration through 2000 hours for both platforms
- Aged and desulfurized NOx adsorber system in conjunction with 15ppm sulfur fuel achieved Tier 2 Bin 5 NOx emission levels for the passenger car platform, achieved 85-90% NOx conversion for the MD Engine platform
- DPF in conjunction with 15ppm sulfur fuel can achieve Tier 2 Bin 5 PM emission levels throughout aging for both platforms
- Detailed emissions information (e.g. CO, HC, and Unregulated species) are included in final report

Program Participants

Automobile:
DaimlerChrysler
Ford
GM
Toyota

Government:
CARB/SCAQMD
DOE
EPA
NREL
ORNL

Engines:
Caterpillar
Cummins
Detroit Diesel
EMA
International Truck & Engine
John Deere
Mack Trucks

Technology:
Battelle

Emission Control:
Argillon
ArvinMeritor
Benteler
Clean Diesel Tech.
Corning
Delphi
Donaldson Co.
Engelhard
Johnson Matthey
MECA
NGK
Rhodia
Robert Bosch Corp.
STT Emtec AB
Tenneco Automotive
3M
Umicore

Energy/ Additives:
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API
BP
Castrol
Chevron Oronite
Chevron
Ciba
Conoco-Phillips
Crompton
Ergon
Ethyl
ExxonMobil
Infineum
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Marathon Ashland
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