A State-of-the-Art CIDI Aftertreatment System for U. S. Tier-2 Emissions

R. Aneja, B. Bolton, N. Hakim, S. Li, Z. Pavlova-MacKinnon

Detroit Diesel Corporation

The modern CIDI (diesel) engine will require advanced aftertreatment systems in order meet Tier-2 emissions regulations. This puts the CIDI at the forefront as a viable power plant for personal transportation needs. With its high efficiency advantage, the CIDI would also contribute to CO_2 reduction and energy savings.

A prototype integrated engine-aftertreatment system has been developed and tested. The system consists of selective catalytic reduction (SCR) and catalyzed soot filter (CSF) components. It was bench tested and vehicle mounted. Preliminary bench and vehicle chassis dynamometer test results will be presented. Substantial NOx and PM reductions were attained. Future plans and refinements of the SCR, CSF and integrated system will be briefly described.

DAIMLERCHRYSLER

DaimlerChrysler Powersystems

State of the Art Diesel Aftertreatment Systems

R. Aneja, B. Bolton,

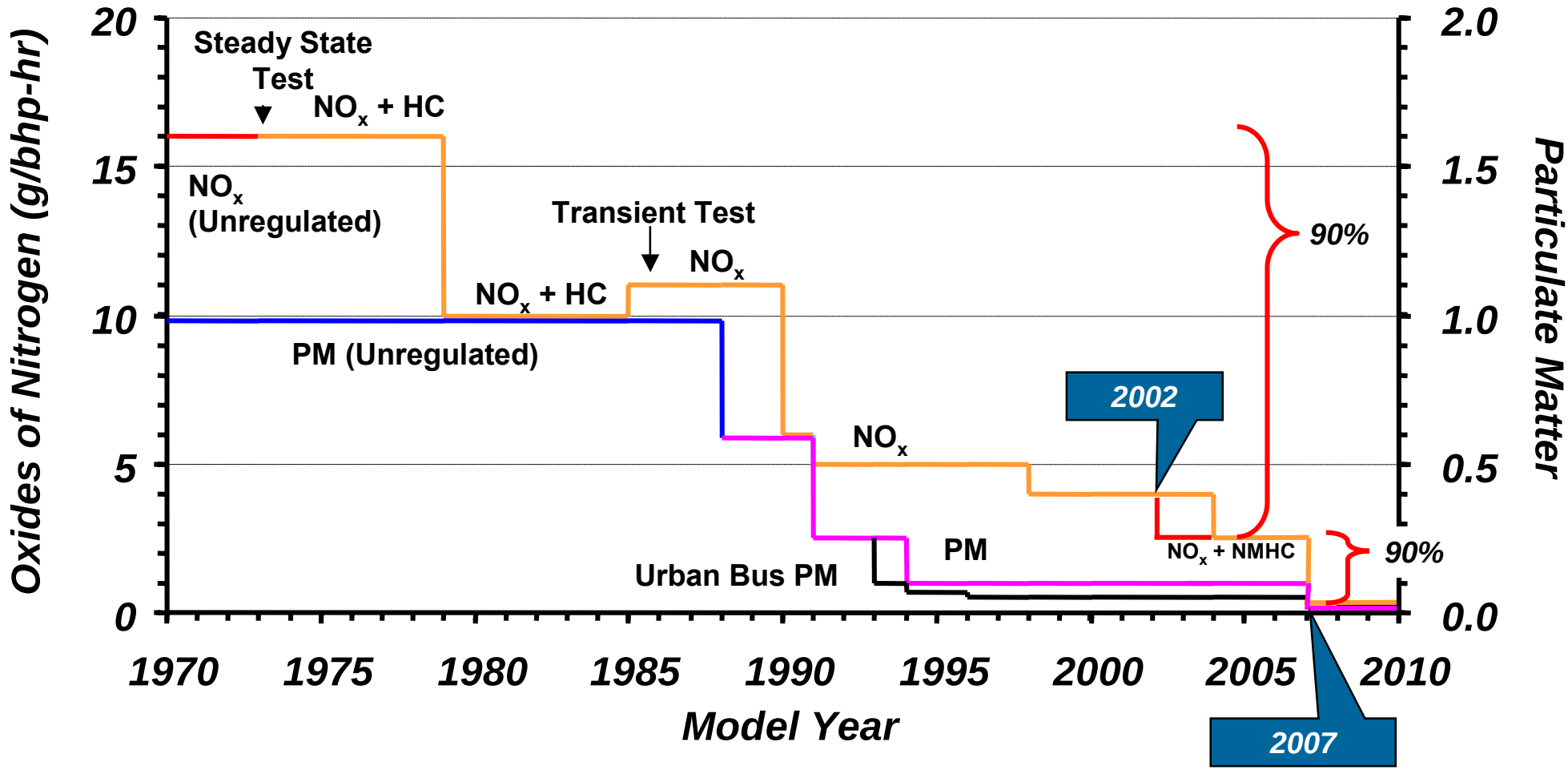
N. Hakim, Z. Pavlova-McKinnon

Acknowledgements

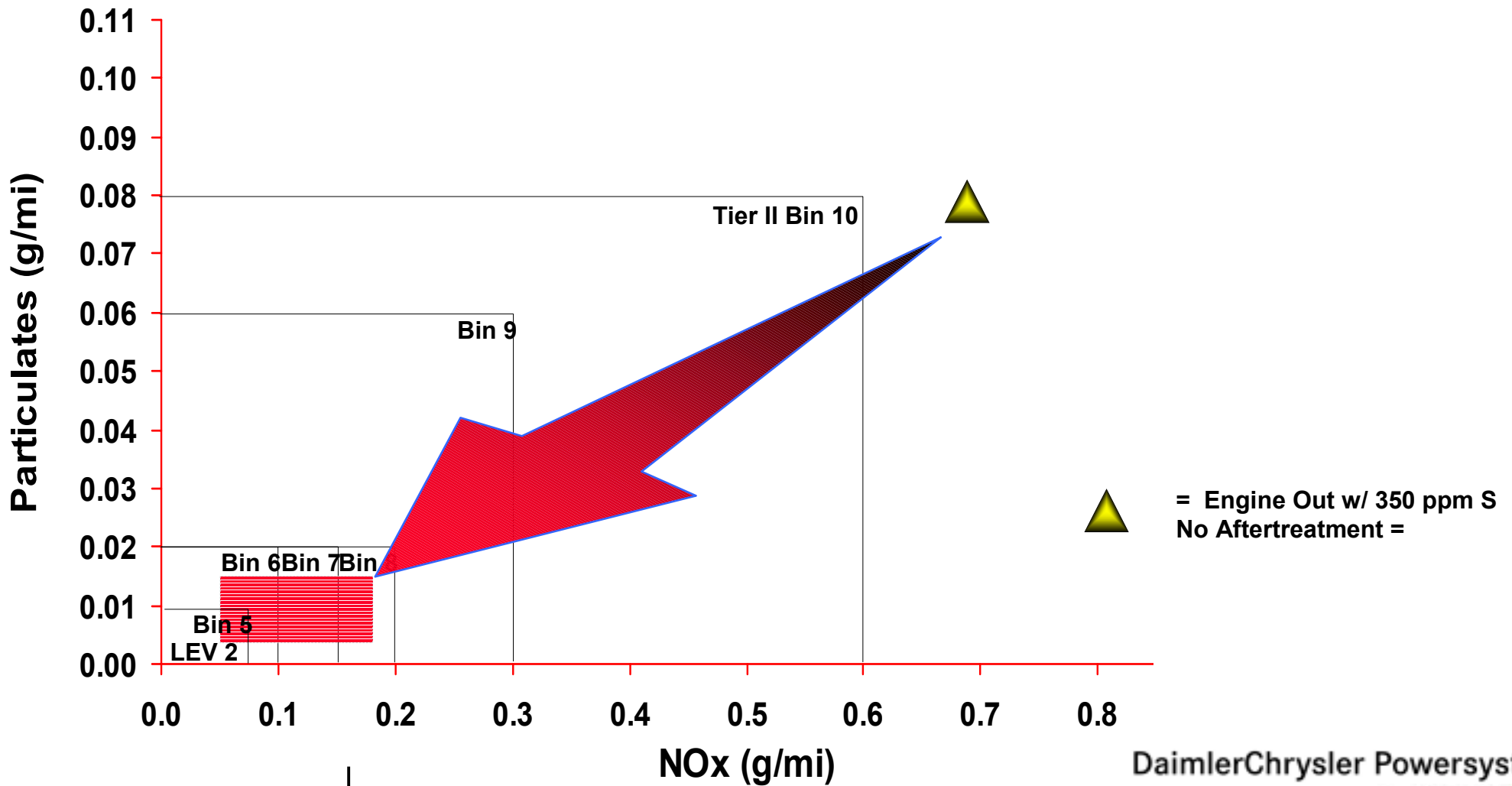
- DOE-OTT
- The DDC Engineering Technologies Team
- Engelhard

Emissions Regulations

Heavy Duty Emissions



Light Duty Emissions



HD and LD 2007+ Standards

Significant AT is Inevitable

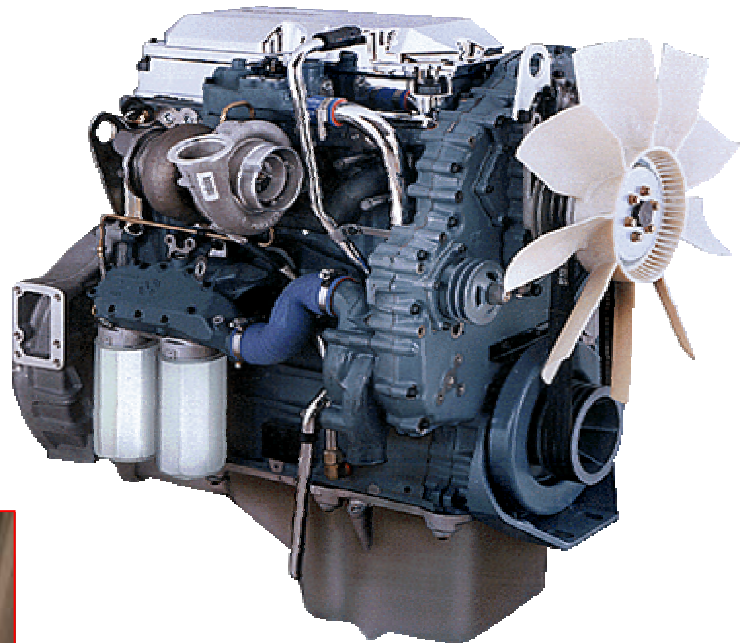
HD & LD 2007+ Standards

- Technically Daunting, Leap Frog Technologies Required

- Integrated Controls
  (AT - Engine - Powertrain - Vehicle)

Implementation Efforts

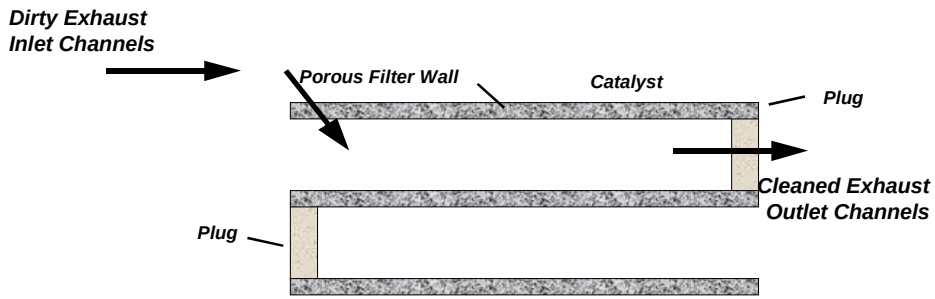
Recent Product Release - Emitless™



Particulate Filter For Series 50 Retrofit

DaimlerChrysler Powersystems

Recent Product Release - Emitless™



- Engelhard Partnership
- Electronically Integrated Pressure and Temperature Sensing

Recent Product Release - Emitless™

Current Engine, with Oxidation Catalyst
High Sulfur Fuel (DF# 1)

PM	0.04	g/hp-hr
CO	0.8	g/hp-hr
HC	0.05	

Emitless CSF Replacing Oxidation Catalyst (Development Tests)

High Sulfur Fuel*

PM	< 0.01	g/hp-hr
CO	0.02	g/hp-hr
HC	< 0.5	g/hp-hr
NOx	3.8	g/hp-hr

Low Sulfur ~ 10 ppm

PM	< 0.01	g/hp-hr
CO	< 0.1	g/hp-hr
HC	< 0.01	g/hp-hr
NOx	3.4	g/hp-hr

*: SS PM Exceeds 0.04g/hp-hr

Demonstration Program - SCR

Test Vehicle

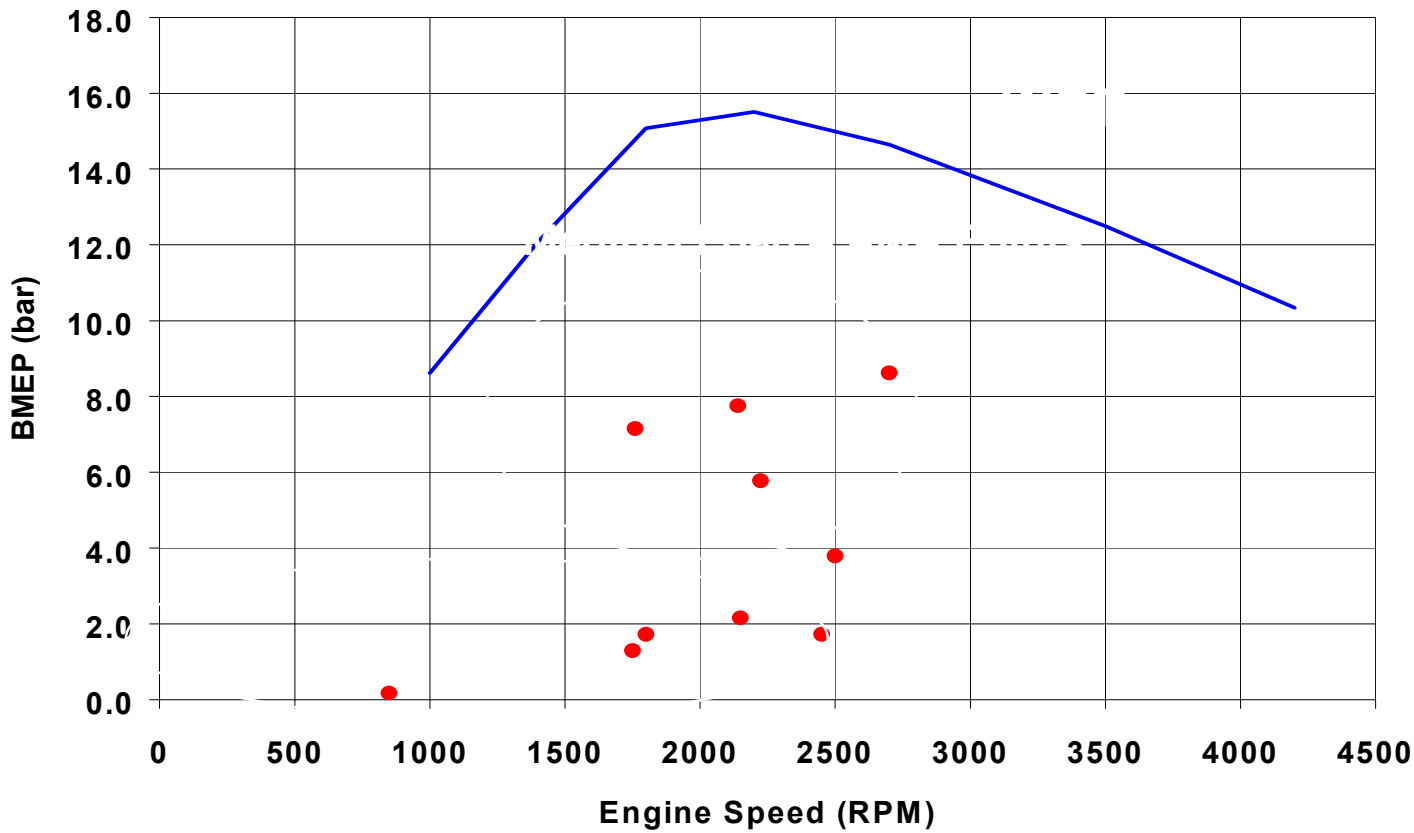
Century Class Argosy, 248" Wheelbase, Two 100 gal Fuel Tanks, Single Flatbed Trailer

Passenger Car Focus

Steady State Development

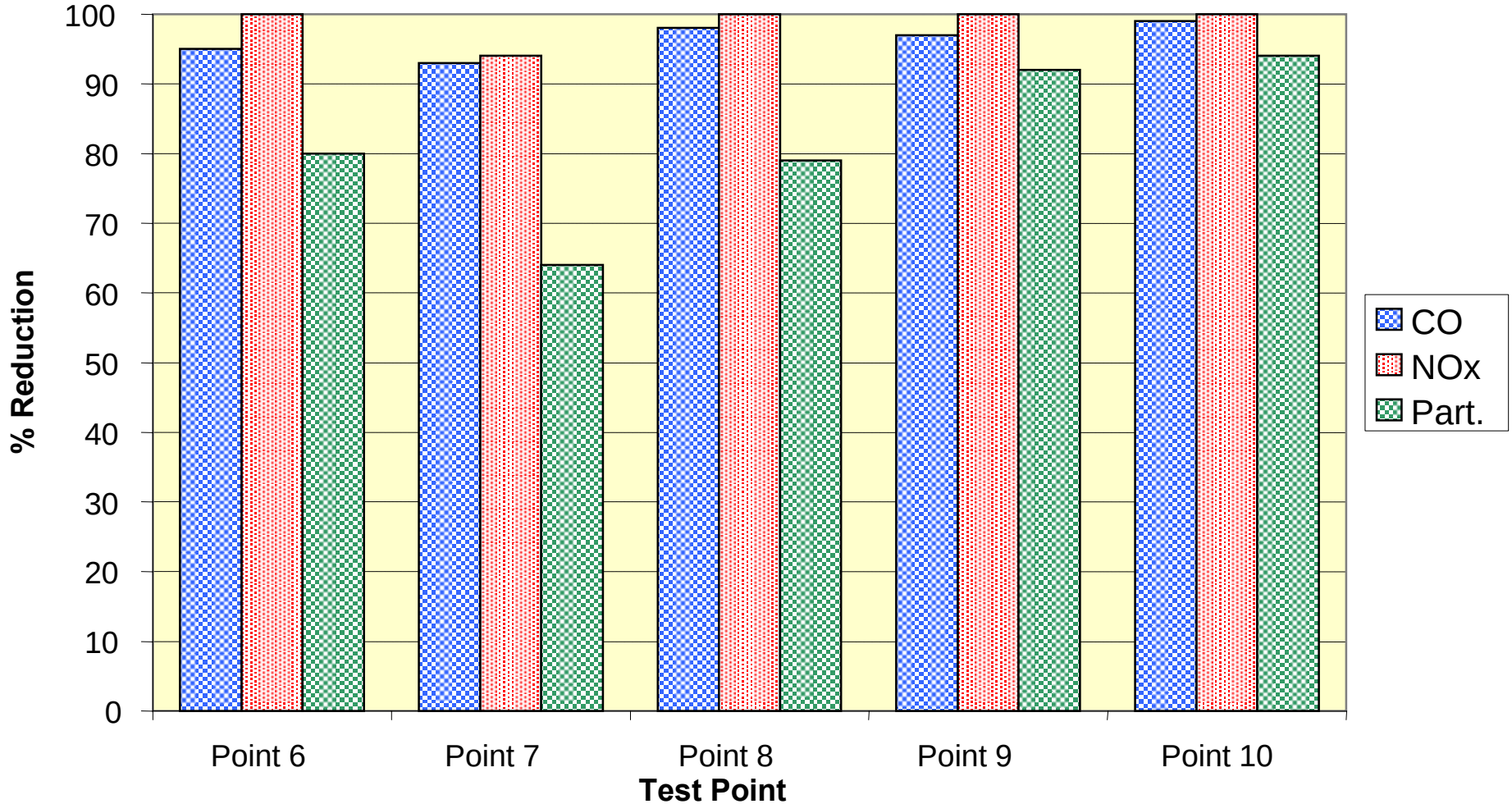
0.5L/cyl Modal Characterization

Use Multiple Points to Tune SCR and Engine Calibrations Points Based on FTP75 & AMA Drive Cycle



Gas Phase and Particulate Reductions

In Cooperation with Engelhard



Steady State Modal Points

DaimlerChrysler Powersystems

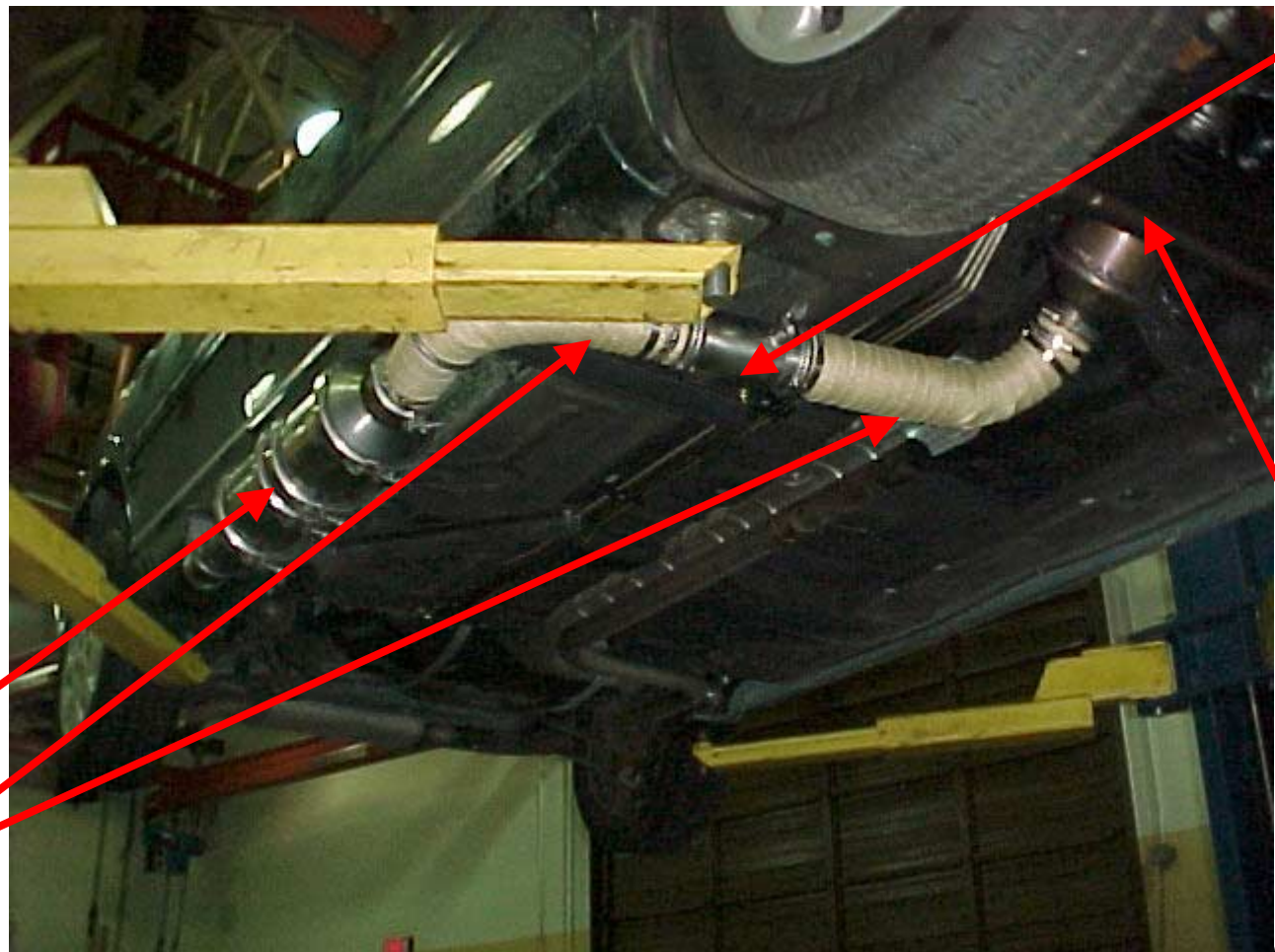
Steady State Modal Points Temperature,Emission and NH_3 & N_2O Effects

	Point 6	Point 7	Point 8	Point 9	Point 10
Speed/load, rpm/Nm	2225/75	1759/90	2143/100	2700/110	2700/44
Filter Inlet, °C	310	323	355	370	270/280
SCR Inlet, °C	280	280	312	335	244/255
CO Engine Out, ppm	95	55	90	165	255/275
CO SCR Out	5	4	2	4	4
NOx SCR inlet, ppm	438	960	900	780	160/260
NO2/NOx	0.8	0.75	0.69		0.86/0.80
Max. NOx Conversion, %	100	94	100	100	100
NH3 @ Max NOx Conv., ppm	0	0	0	25	13
N2O @ Max NOx Conv., ppm	50	90	70	40	25

In Cooperation with Engelhard

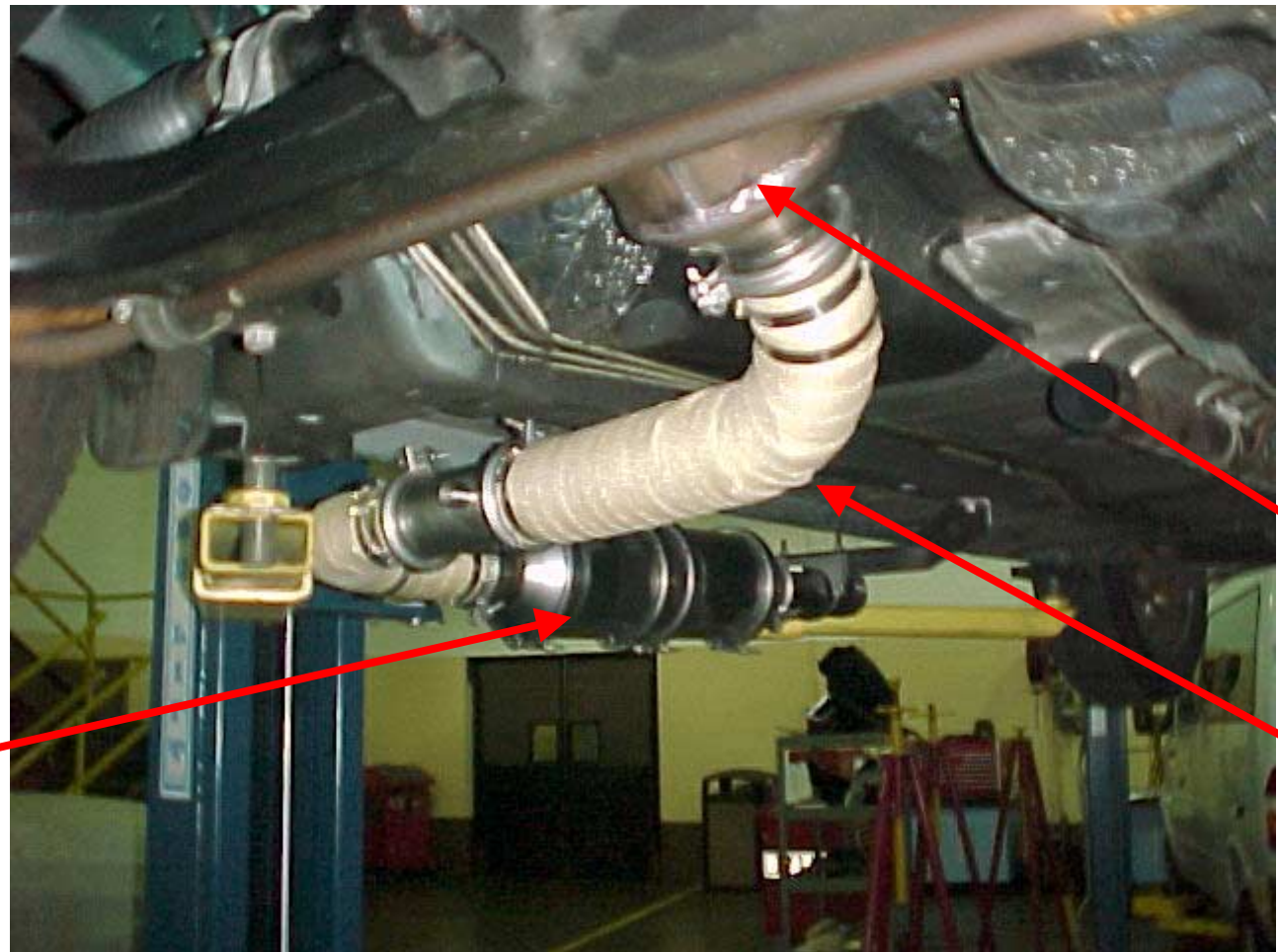
Vehicle Integration

Chrysler Neon Vehicle with DDC 1.5L HSDI and CSF-SCR Exhaust Aftertreatment System



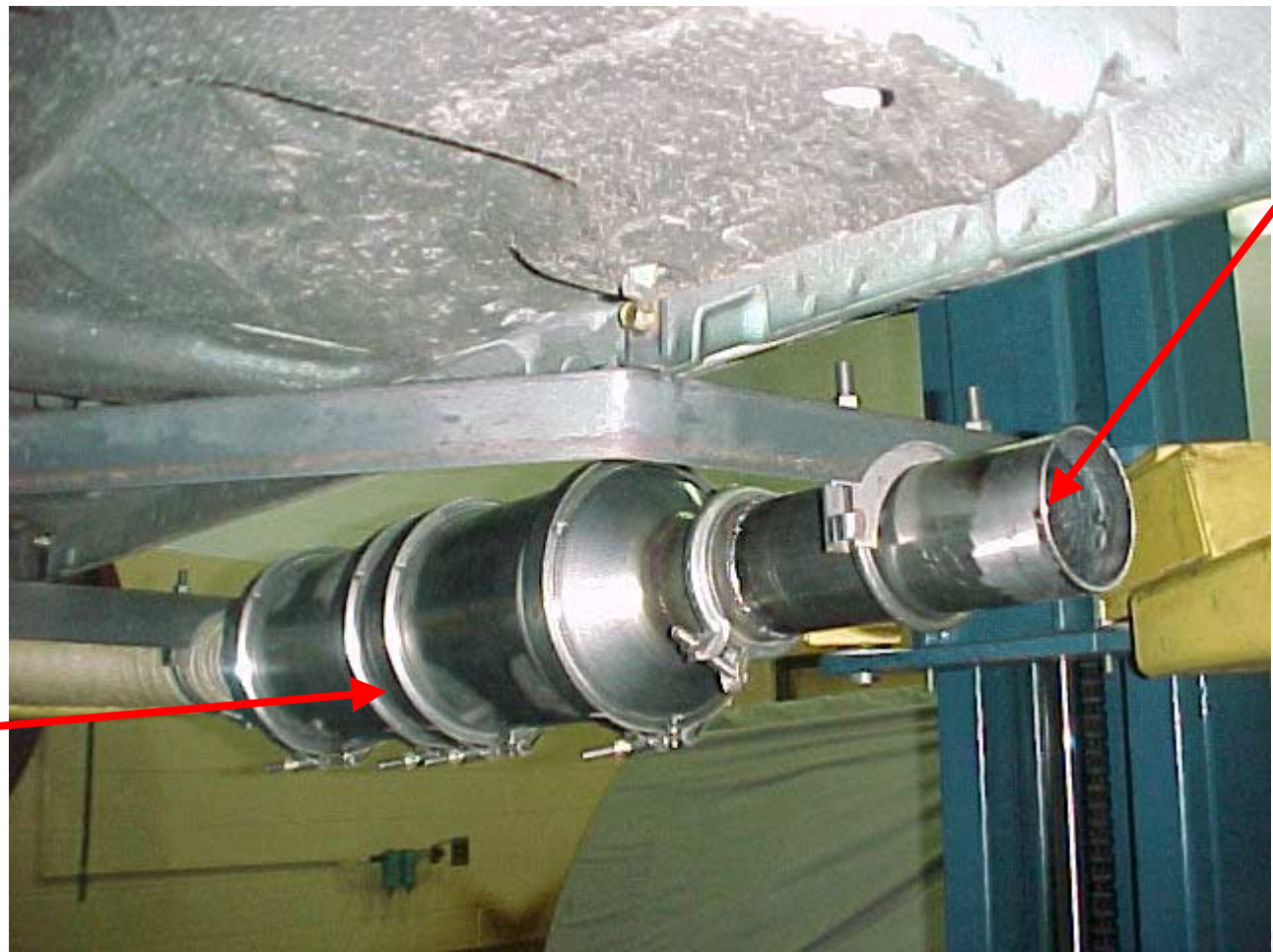
PNGV Mule Vehicle

Chrysler Neon Vehicle with DDC 1.5L HSDI and CSF-SCR Exhaust Aftertreatment System



DaimlerChrysler Powersystems

Chrysler Neon Vehicle with DDC 1.5L HSDI and CSF-SCR Exhaust Aftertreatment System

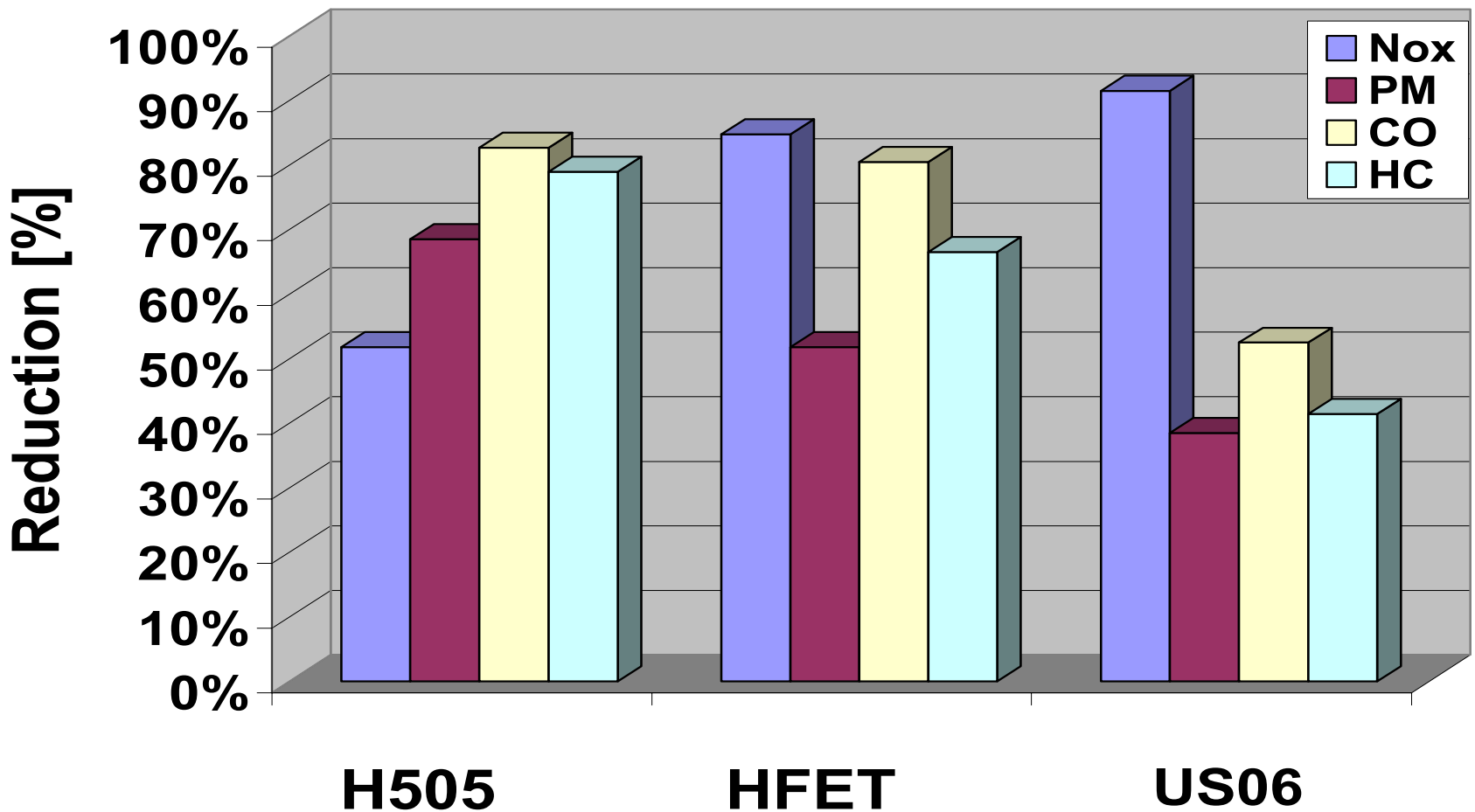


Vehicle Test Results

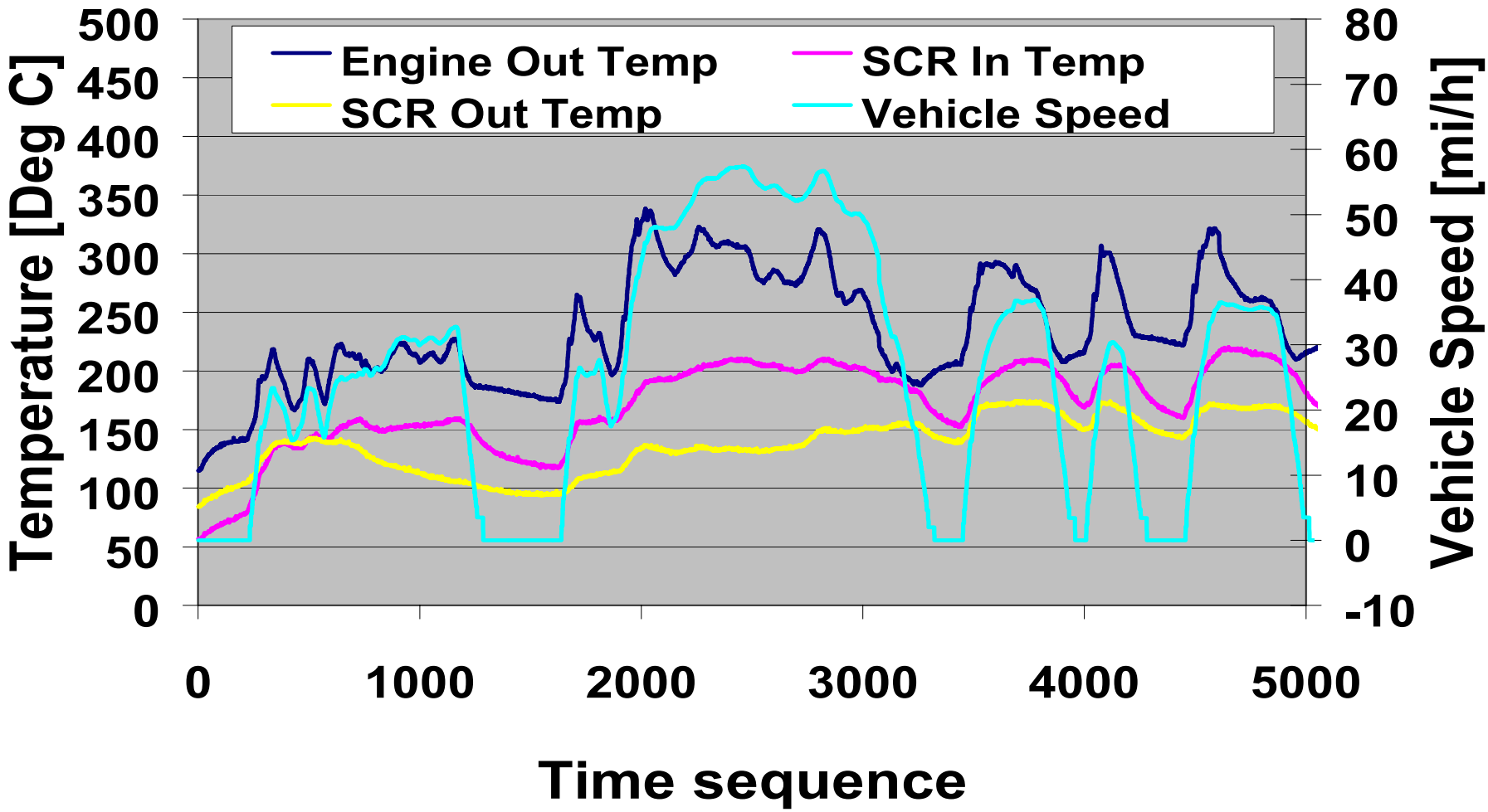
Vehicle Test Results

- Vehicle Results Are Complimentary to Engine Test Stand Results
- These Results Are Considered Preliminary Data for Initial Integrated System Check Out.
- Testing Did Not Include Ammonia Slip Measurement

Vehicle Test Data



Vehicle H505 – Speed and Temperature Contours



Concluding Remarks

R&D Efforts Continue. Meeting Future Emissions for Both HD and LD Is a Realistic Target for CIDI (Diesel) Engines