

Status of APBF-DEC NOx Adsorber/DPF Projects

Brian West

Oak Ridge National Laboratory

Matthew Thornton and Shawn Whitacre

National Renewable Energy Laboratory

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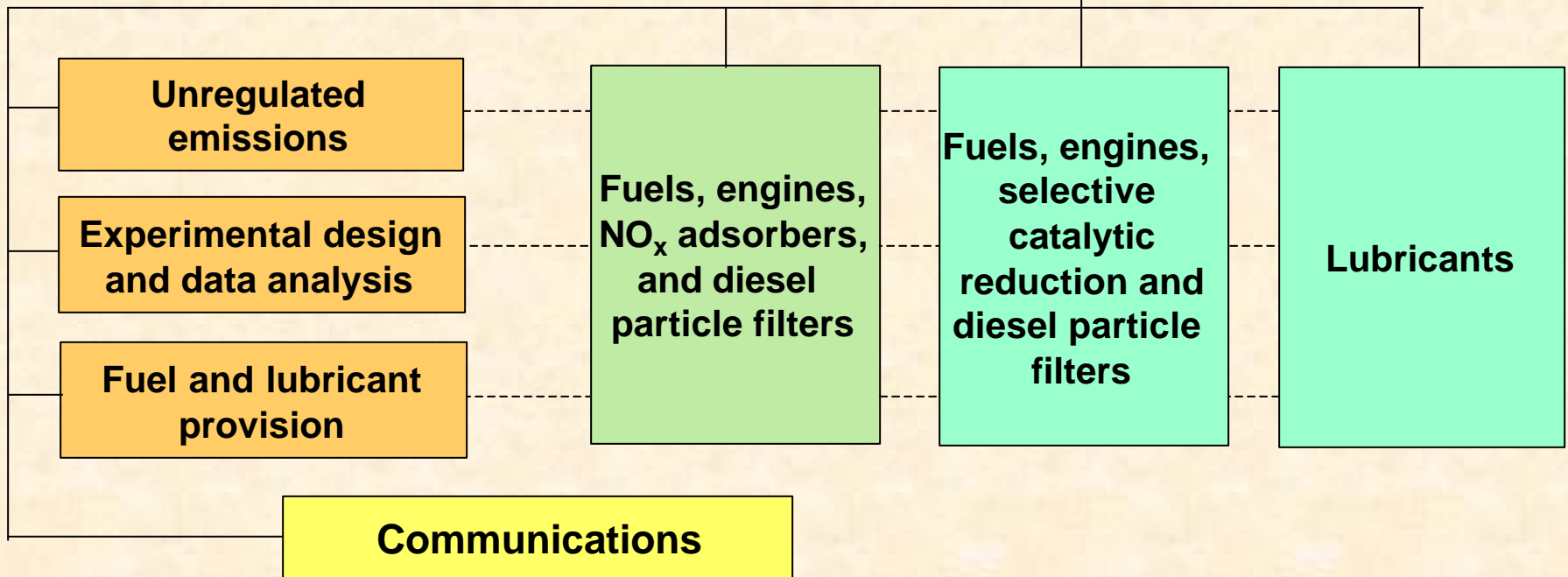
**OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY**



APBF-DEC* is Managed and Directed by Technical Committees

DOE, EPA, additive companies,
automobile manufacturers, engine
manufacturers, energy companies,
emission control mfrs., Calif. agencies

APBF-DEC Steering Committee



APBF-DEC Activity is Supported by Industry and Government Partners and Subcontractors

- **DOE**
 - NREL
 - ORNL
- **API - American Petroleum Institute**
- **EMA - Engine Manufacturers Association**
- **MECA - Manufacturers of Emission Controls Association**
- **ACC - American Chemistry Council**
- **NPRA - National Petrochemical and Refiners Association**
- **CARB - California Air Resources Board**
- **SCAQMD - South Coast Air Quality Management District**
- **EPA**
- **Battelle**
- **FEV**
- **SwRI**
- **Ricardo**
- **ATL**
- **DRI**

5 Fuels Testing Projects Being Conducted at Contract Laboratories

- **NOx Adsorber/DPF**

- Ricardo – Heavy-duty engine



- SwRI – “Heavy-light duty” pickup truck



- FEV – Light-duty passenger car



- **Urea SCR/DPF**

- SwRI – Heavy-duty engine

- **Lubes**

- ATL – Medium-duty engine

Objective: Examine fuel property effects on advanced diesel emission control systems.

Approach:

- **Demonstrate low emissions potential of diesel engines equipped with advanced fuel, NOx adsorbers, DPFs, double-wall exhaust, etc**
 - **Three engine and/or vehicle platforms, two different exhaust system architectures on each platform**
- **Age systems with DECSE 8 and 15 ppm S fuel for up to 1500 hrs**
 - **Periodic emissions evaluations during aging**
 - **Periodic unregulated emissions measurement with 15 ppm S refinery product**
- **Examine other fuel properties**

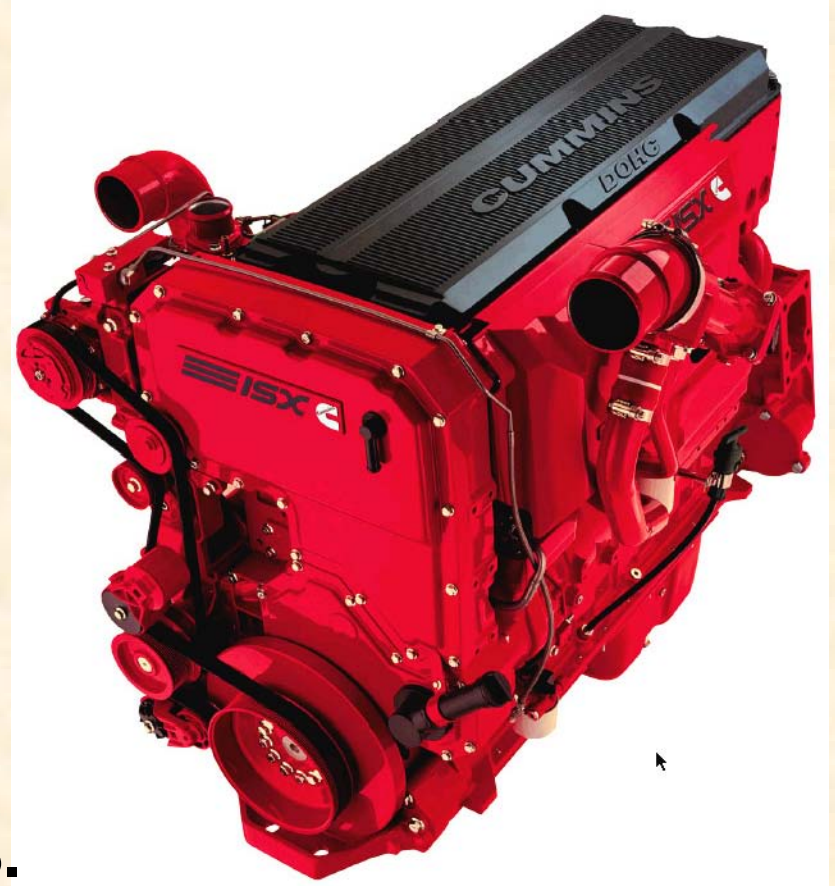
Each platform will determine effects of fuel properties on:

- NOx and PM reduction efficiency
- Fuel economy
- Other particle emissions
 - PM breakdown (SOF, sulfate, insolubles)
 - PAH and Nitro-PAH
 - Metals
- Other gas phase emissions
 - THC, NMHC, CO, CO₂
 - Gas phase PAH and nitro-PAH
 - Nitroxyalkanes
 - Benzene
 - 1,3 butadiene
 - Formaldehyde
 - Acetaldehyde
 - N₂O
 - SO₂
 - H₂S

Heavy-Duty Project Being Conducted at Ricardo



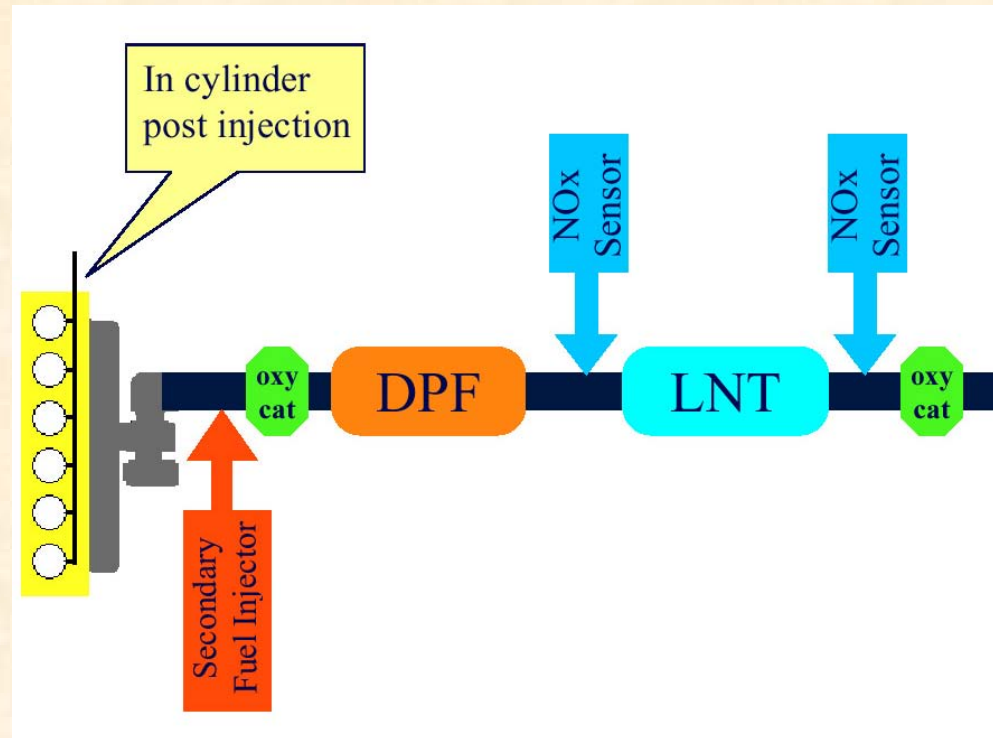
- 15 liter ISX engine supplied by Cummins
 - DOHC, 4 valves/cylinder, central unit injector
 - Rated at 475-500 hp, 1650 lb.ft torque
 - Fitted with EGR system, compliant with 2002/2004 standards
- Cummins is supporting control system interface
- HD FTP and 13-mode S.S.



Heavy-Duty Single Leg Adsorber System



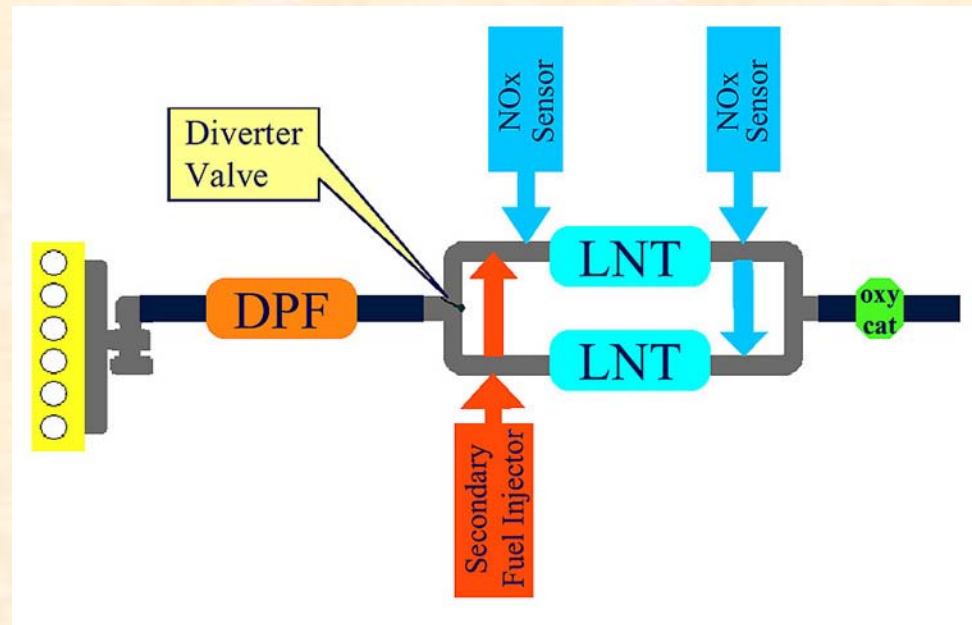
- Catalysts supplied by MECA member
- Single leg NOx Adsorber system delivered
- Increased EGR, in-cylinder post-injection, and in-pipe fuel injection will be used for regeneration



Heavy-Duty Dual Leg Adsorber System



- Catalysts supplied by MECA member
- Dual leg NOx Adsorber system expected 8/2002
- Rich exhaust conditions will be achieved by in-pipe fuel injection



Heavy-Duty Status/Plans



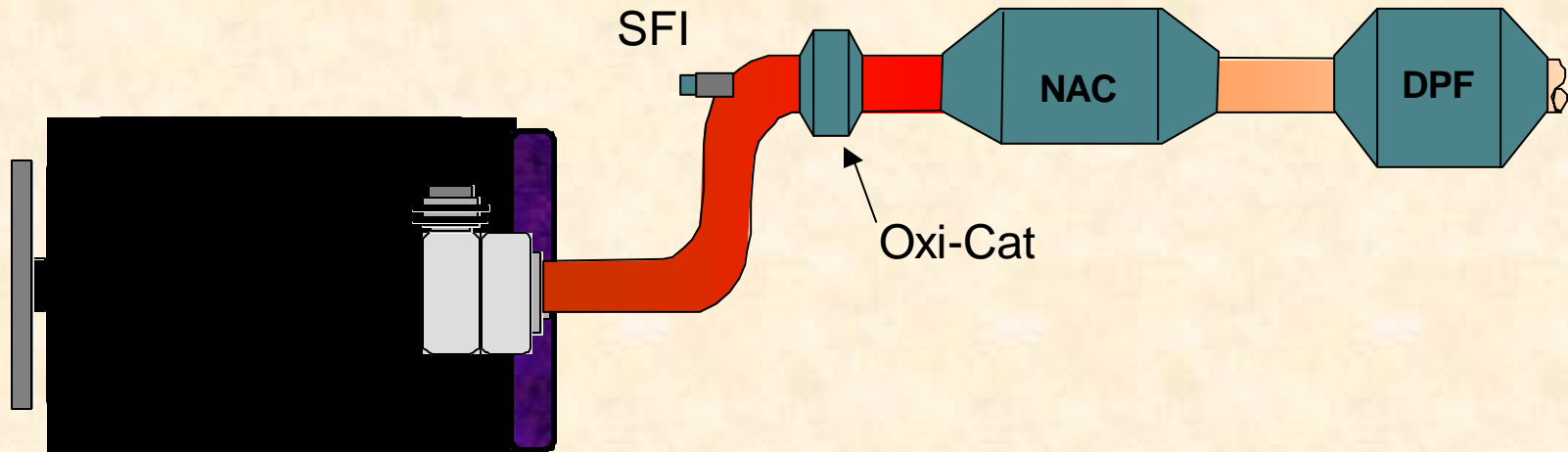
- **Currently tuning/optimizing ECS – A (single leg system). Continue through October '02**
- **Baseline engine-out testing: October 2002 (includes toxic/unregs with BP15)**
- **Delivery of ECS-B (dual leg system) expected this month. Will tune/optimize through December '02**
- **Aging and performance testing: Jan-Oct 2003**
- **Other fuel properties: Fall 2003**

Pickup/SUV project being conducted at Southwest Research Institute

- 2002 Chevrolet Silverado 2500 HD pickup
- 6.6 liter Duramax Diesel
 - 300 hp @ 3100 rpm
 - Center-mounted Turbocharger
 - Charge Air Cooled
 - Bosch Common Rail Fuel Injection
 - 4V Aluminum Heads
 - 2002 CA Calibration
- FTP, US06, and HFET cycles



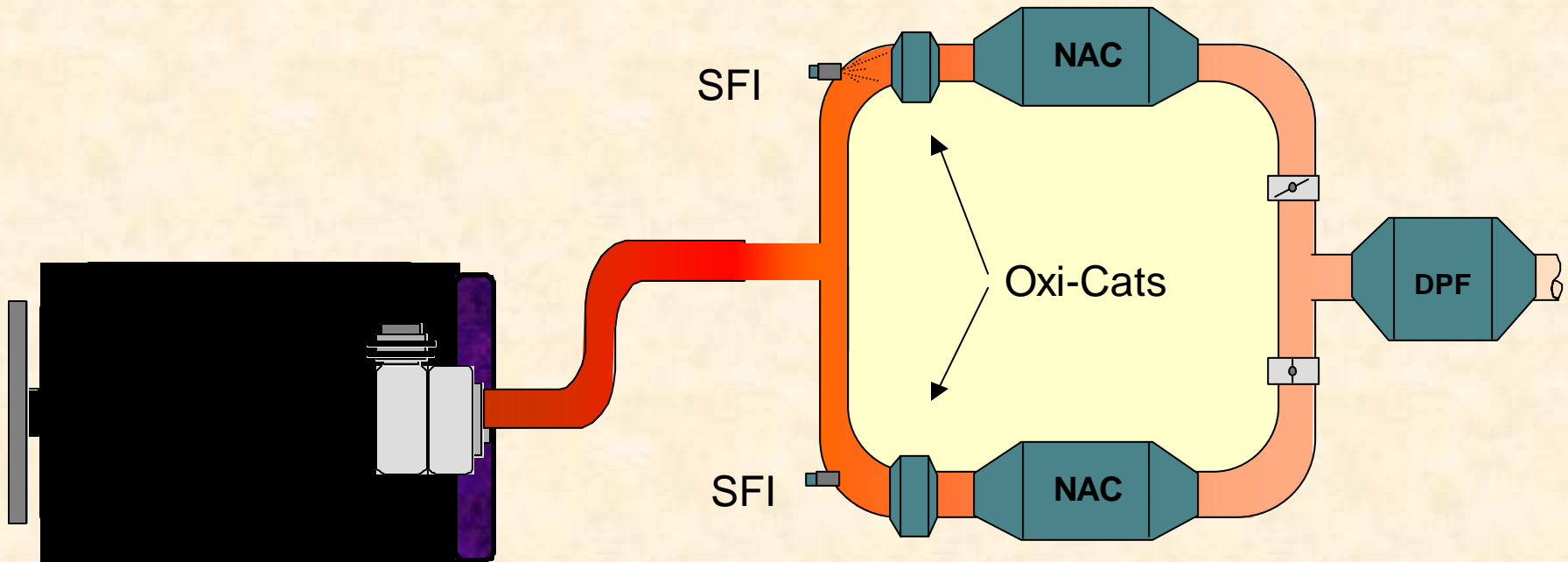
Pickup/SUV Project Single Leg Adsorber System (ECS-A)



Single In-Line
Emissions Control System



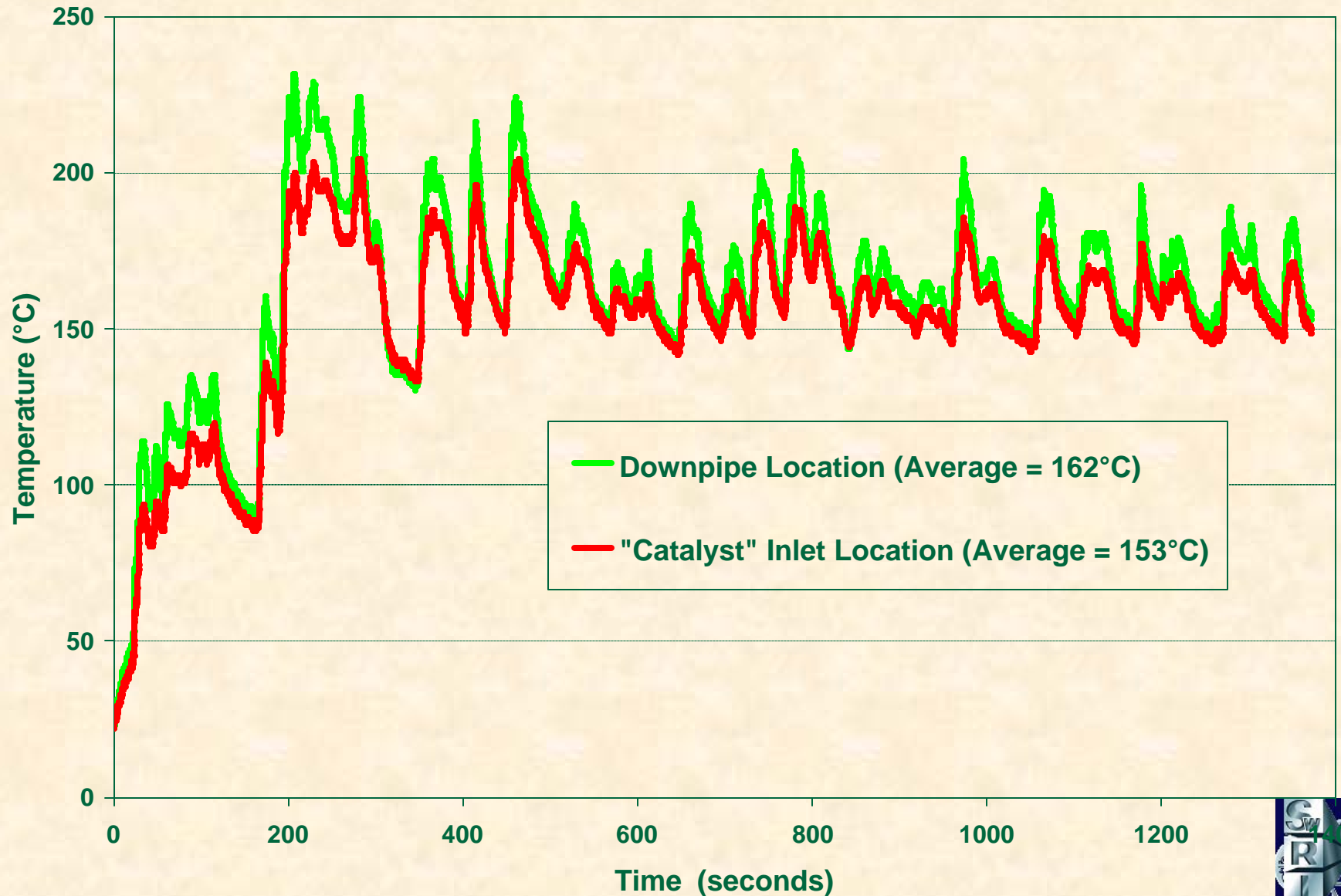
Pickup/SUV Project Dual Leg Adsorber System (ECS-B)



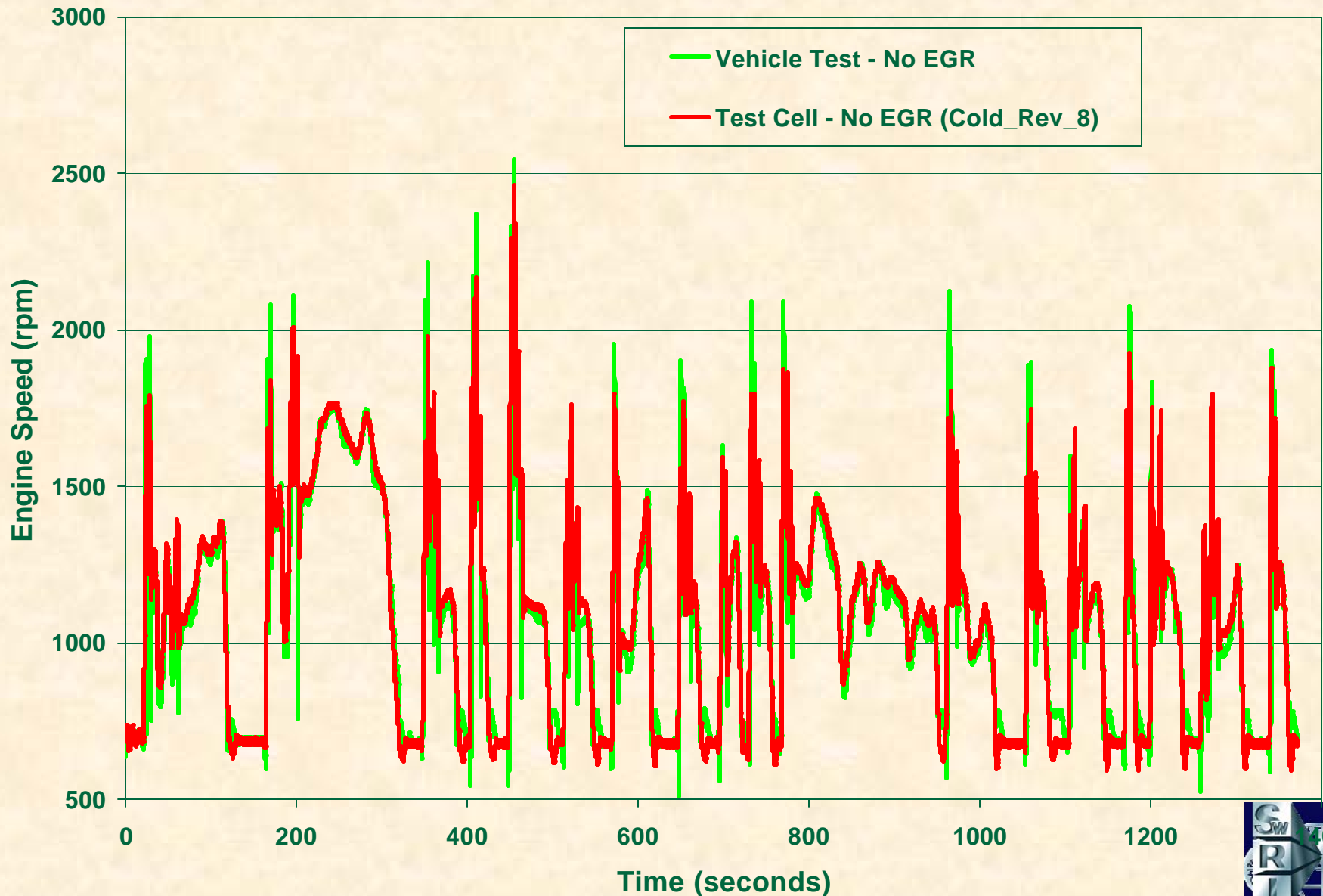
Dual-Branch
Emissions Control System



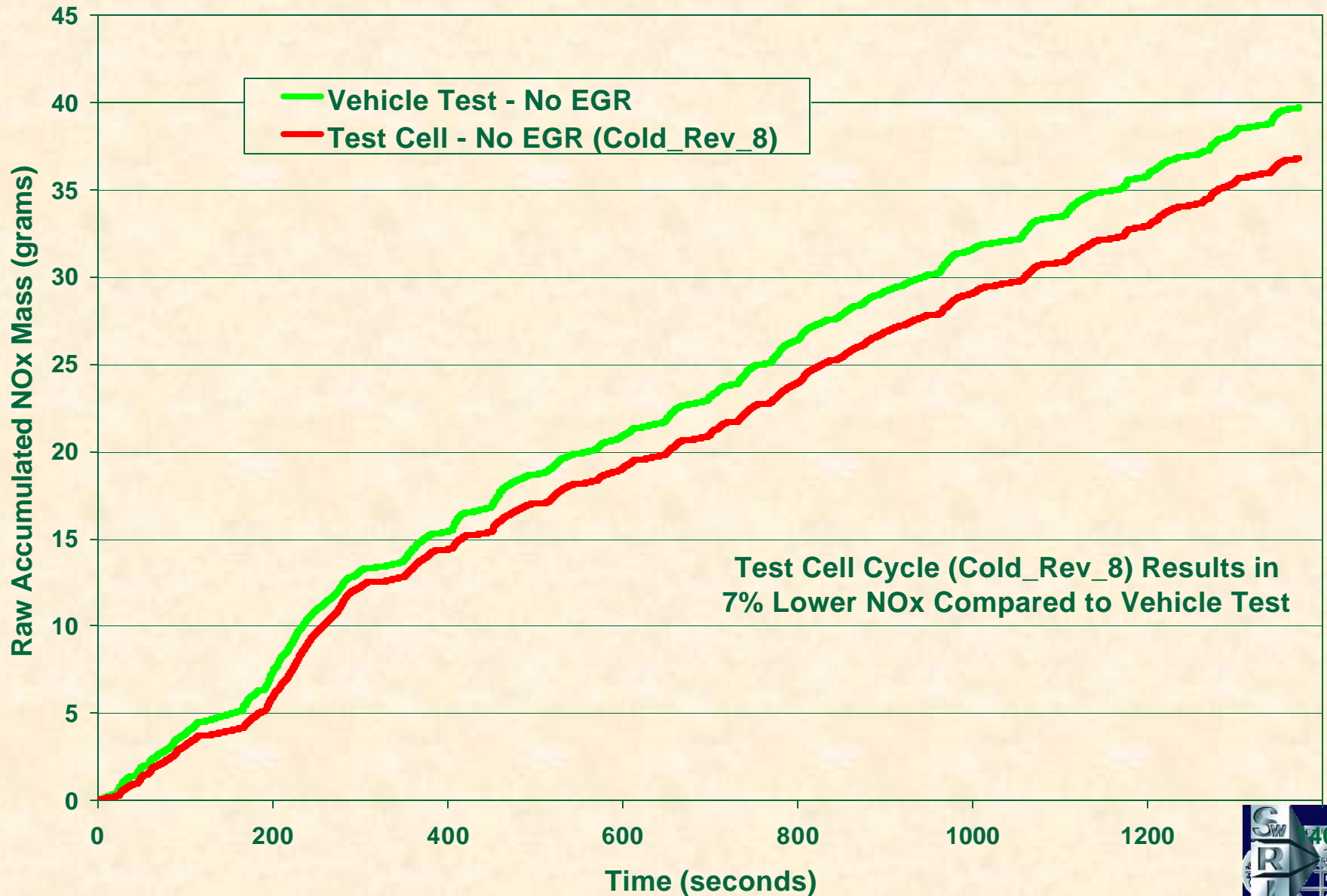
Exhaust Temperatures Over the Light-duty FTP present a significant challenge



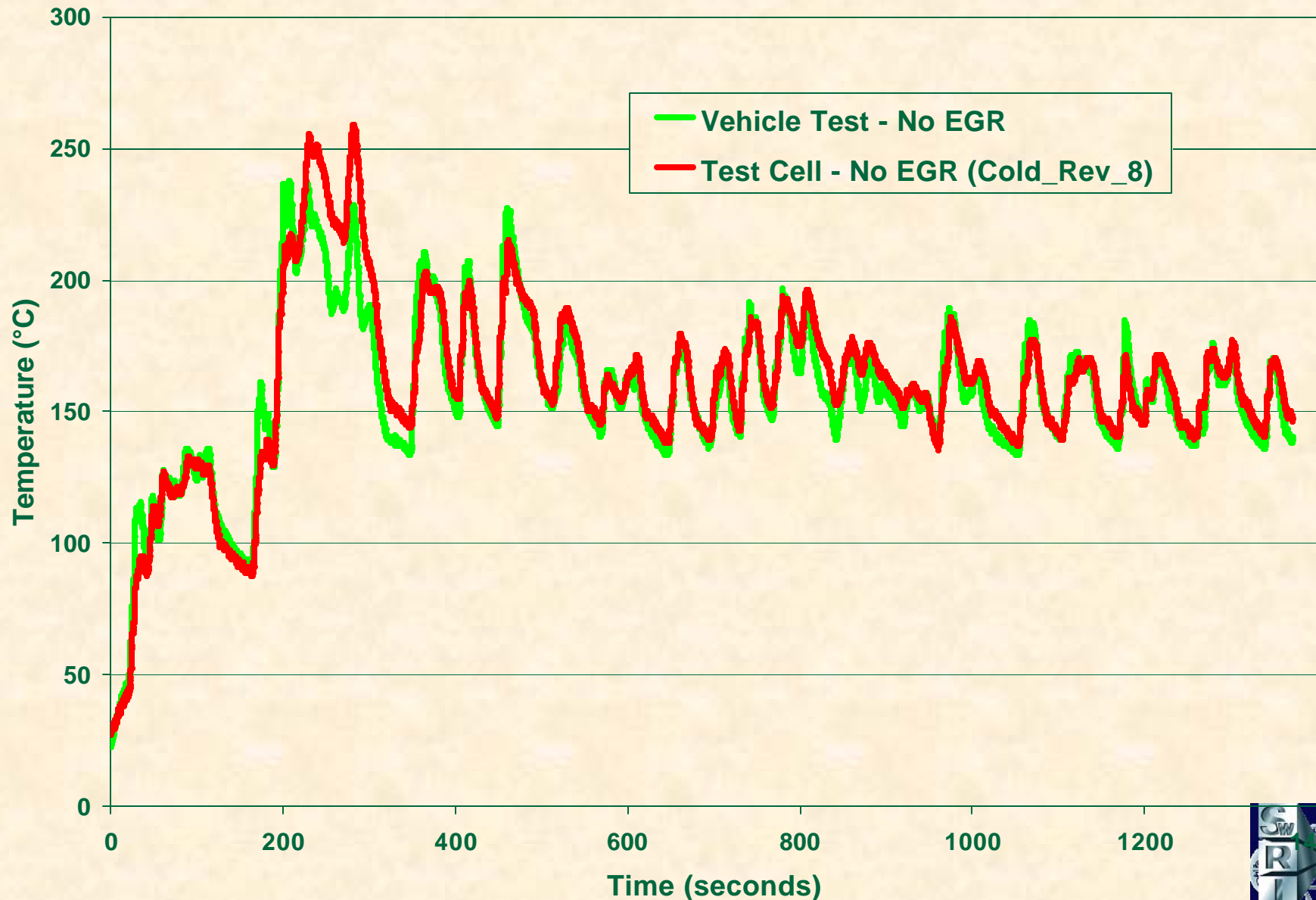
Transient engine dyno test emulates the light-duty chassis dynamometer FTP



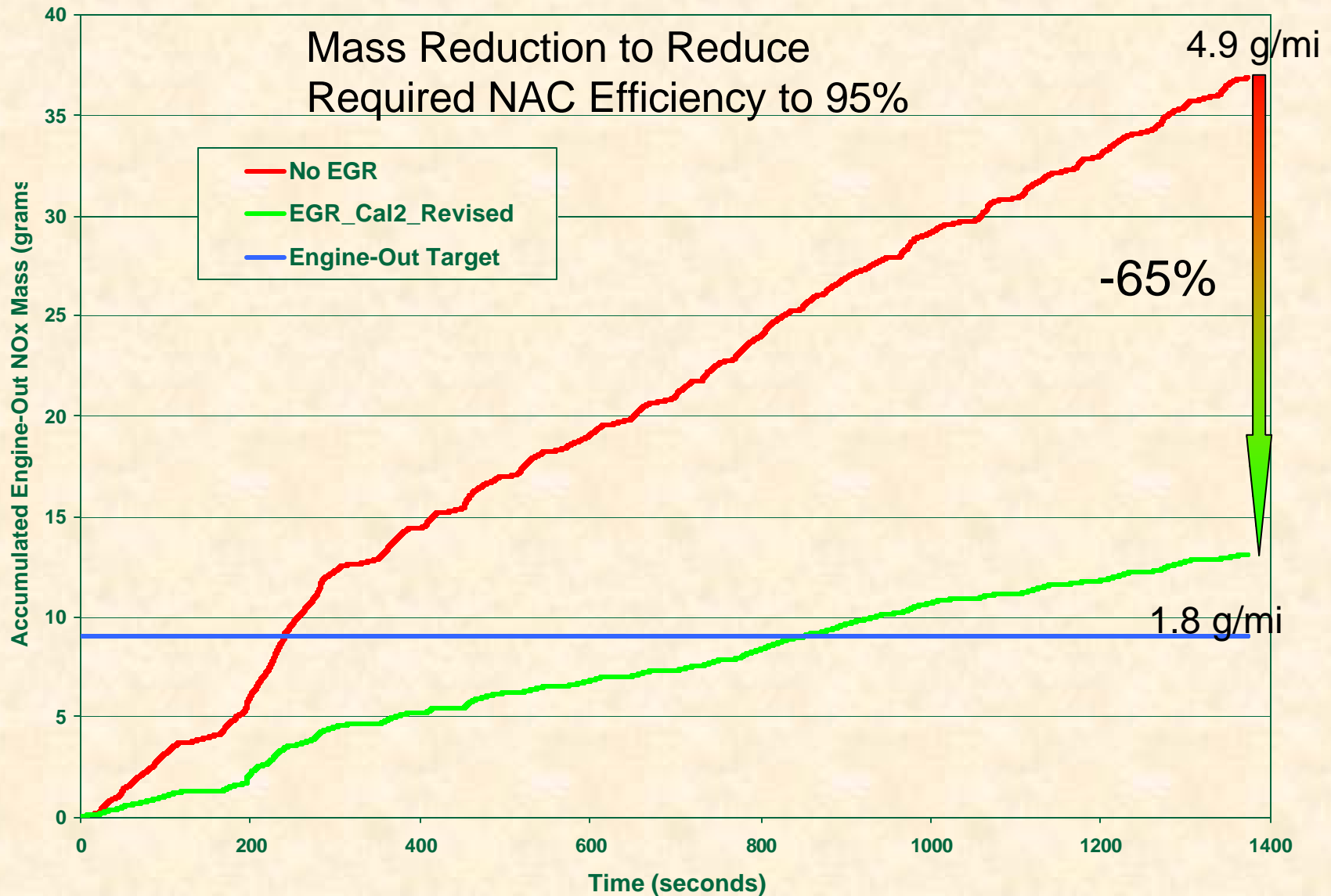
Engine dyno test produces nearly same NOx as chassis dynamometer test



Engine dyno exhaust temperature also agrees well with chassis test



More aggressive EGR has yielded significant engine-out NO_x reduction



Pickup/SUV Project Status and Plans

- All catalysts on hand
- Currently tuning/optimizing systems (both single and dual leg systems). Continue through November '02
- Baseline engine-out testing: October 2002 (includes toxic/unregs with BP15)
- Aging and performance testing: Jan-Dec 2003
- Other fuel properties: Fall 2003

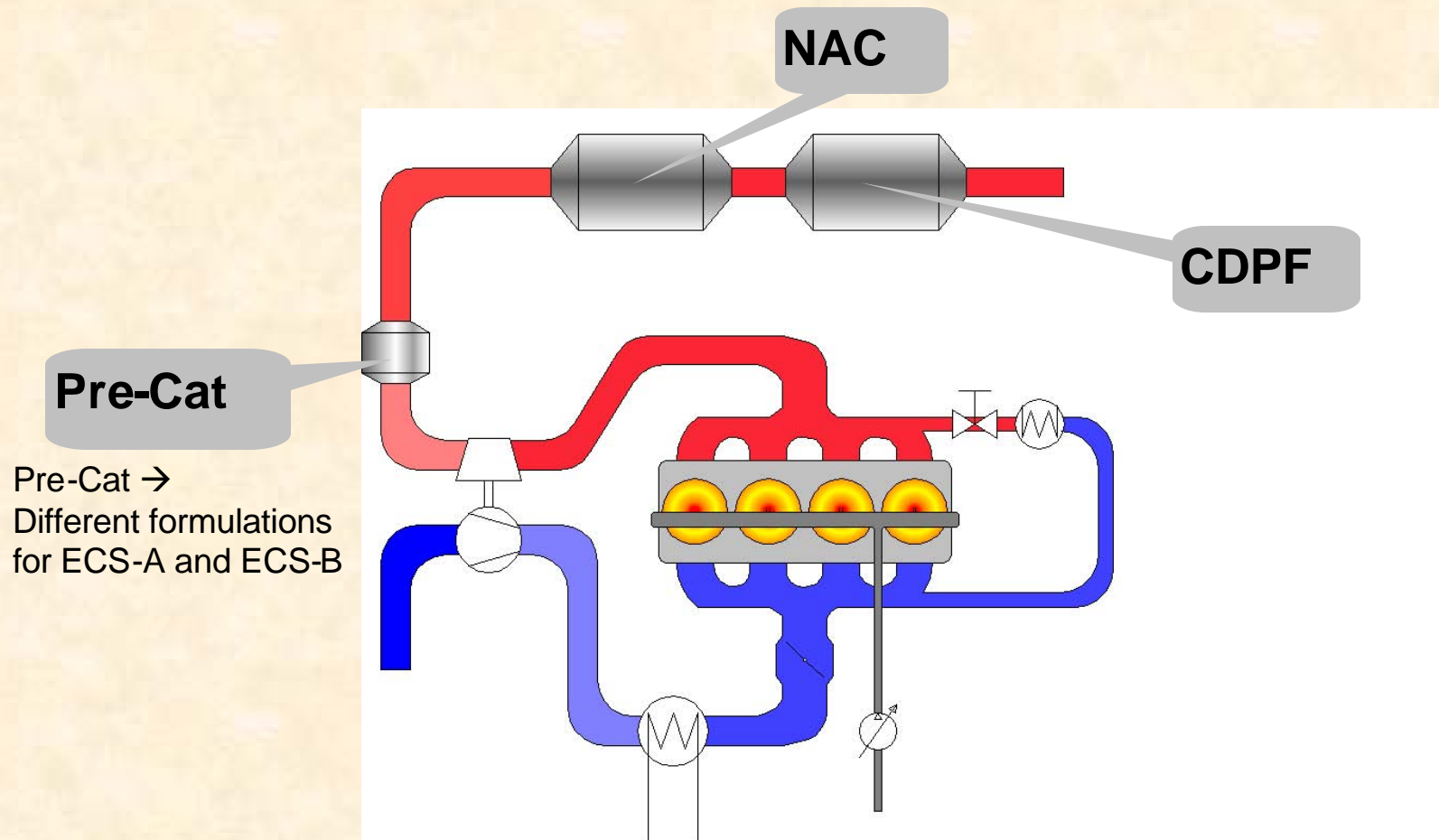


Passenger car project being conducted at FEV

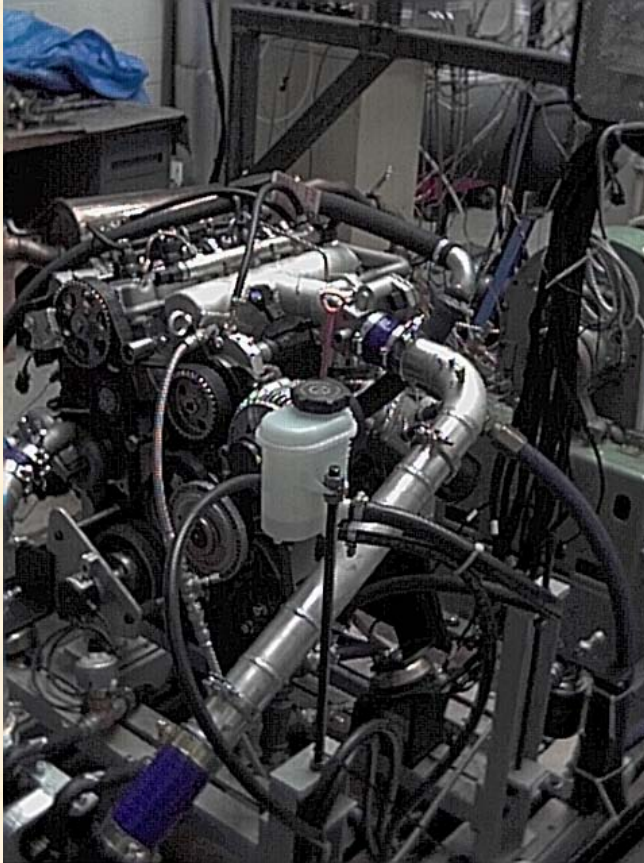
- Audi A4 Avant platform
- 1.9 liter engine
 - Bosch common-rail fuel injection
 - Central vertical injector
 - 4 valves/cyl
 - 100 kW @ 4000 rpm
 - ASCET-SD controls
- FTP, US06, and HFET cycles



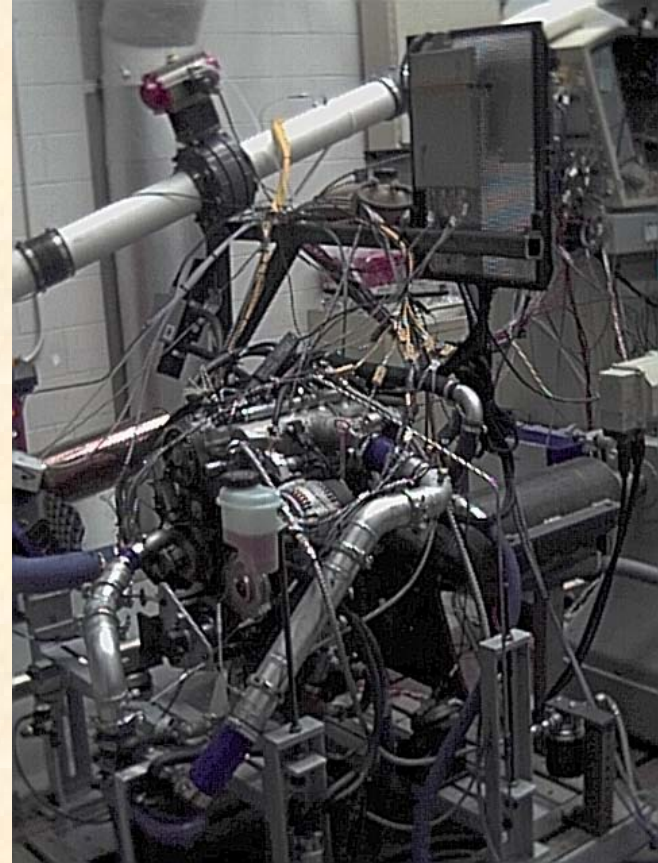
Both passenger car emission control systems are single leg configuration



In addition to vehicle, three additional engines and engine test cells dedicated to this project



Test Cell 4



Test Cell 5

Passenger Car Project Status and Plans

- **Completed prototype engine builds, vehicle set up**
- **First sets of catalysts on hand (both systems)**
- **Developing transient dynamometer test to emulate chassis tests**
- **Currently tuning/optimizing systems. Continue through December '02**
- **Baseline engine-out testing: October 2002 (includes toxic/unregs with BP15)**
- **Aging and performance testing: Jan-Nov 2003**
- **Other fuel properties: Spring 2004**

Acknowledgements

- **Department of Energy, FreedomCar and Vehicle Technologies Office, for financial support of contracts and ORNL/NREL**
- **APBF-DEC partners for financial and in-kind support**
- **Ricardo, SwRI, and FEV for their hard work and commitment to the program**
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Questions?

APBF-DEC Contacts:

- **Brian West,** **865-946-1231**
– westbh@ornl.gov
- **Matthew Thornton,** **303-275-4273**
– matthew_thornton@nrel.gov
- **Shawn Whitacre,** **303-275-4267**
– shawn_whitacre@nrel.gov