

# **Advanced Petroleum-Based Fuels - Diesel Emissions Control (APBF-DEC) Program**



**Program Summary  
August 2001**



# DEC Mission

- Identify optimal combinations of fuels, lubricants, diesel engines, and emission control systems to:
  - Meet projected emission standards during the period 2000 to 2010 while maintaining continuous improvement in engine efficiency and durability
  - Maintain customer satisfaction with vehicle performance
  - Provide the basis for economical transport of people and goods
  - Meet additional potential constraints (e.g., emissions of unregulated substances, including ultra-fine particulate matter and greenhouse gases)
- Explore the potential to achieve even lower emissions of criteria and unregulated pollutants beyond 2010



# APBF-DEC Products

- Light and heavy-duty platforms for measurement of effects of fuel and lubricant composition on emissions under transient operation
- Comprehensive data on status of fuel-engine-emission control technologies reducing criteria emissions for U.S. EPA's biennial technology assessments
- Comprehensive data on effects of fuel & lubricant properties on emissions of unregulated substances

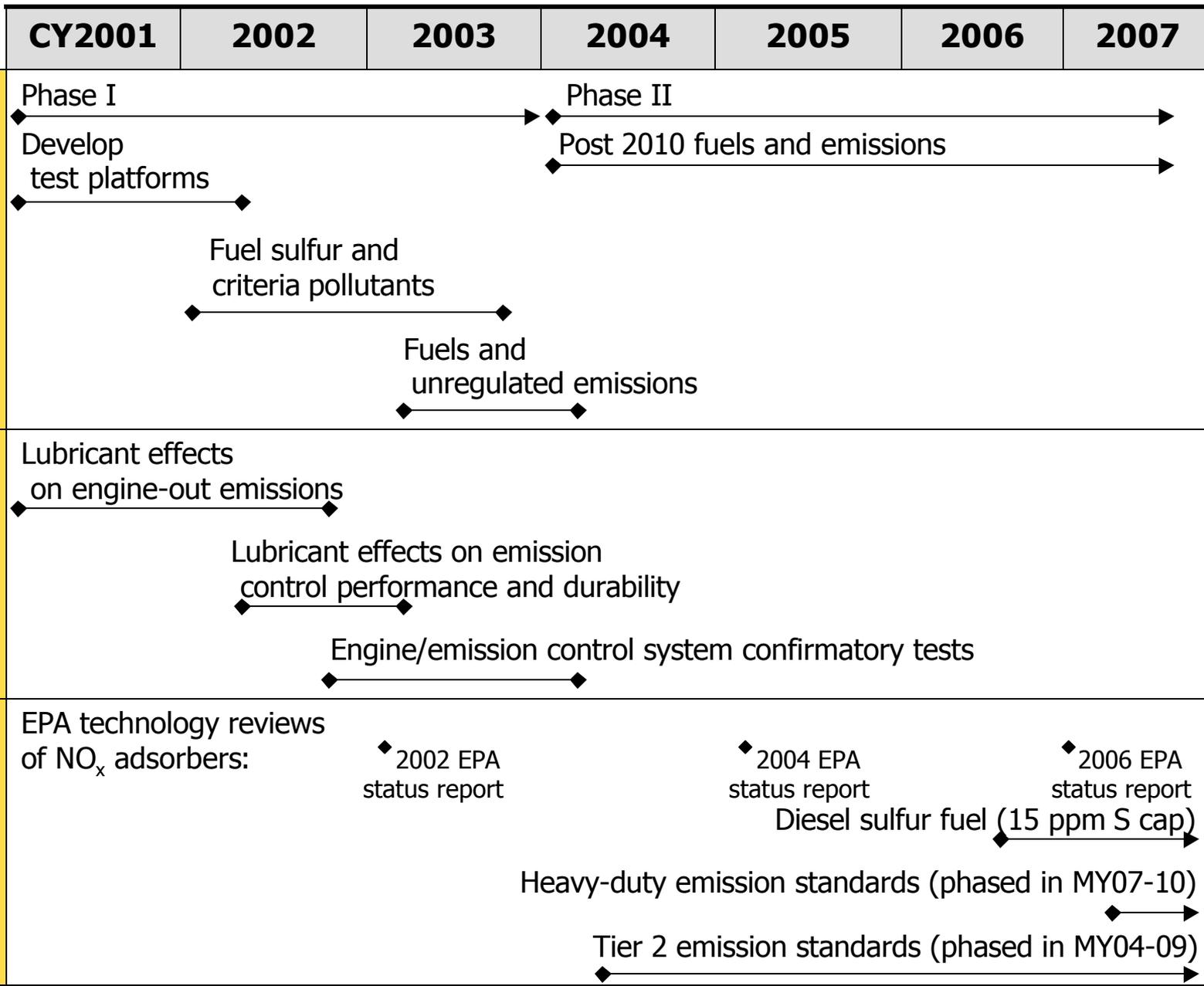


# DEC Summary

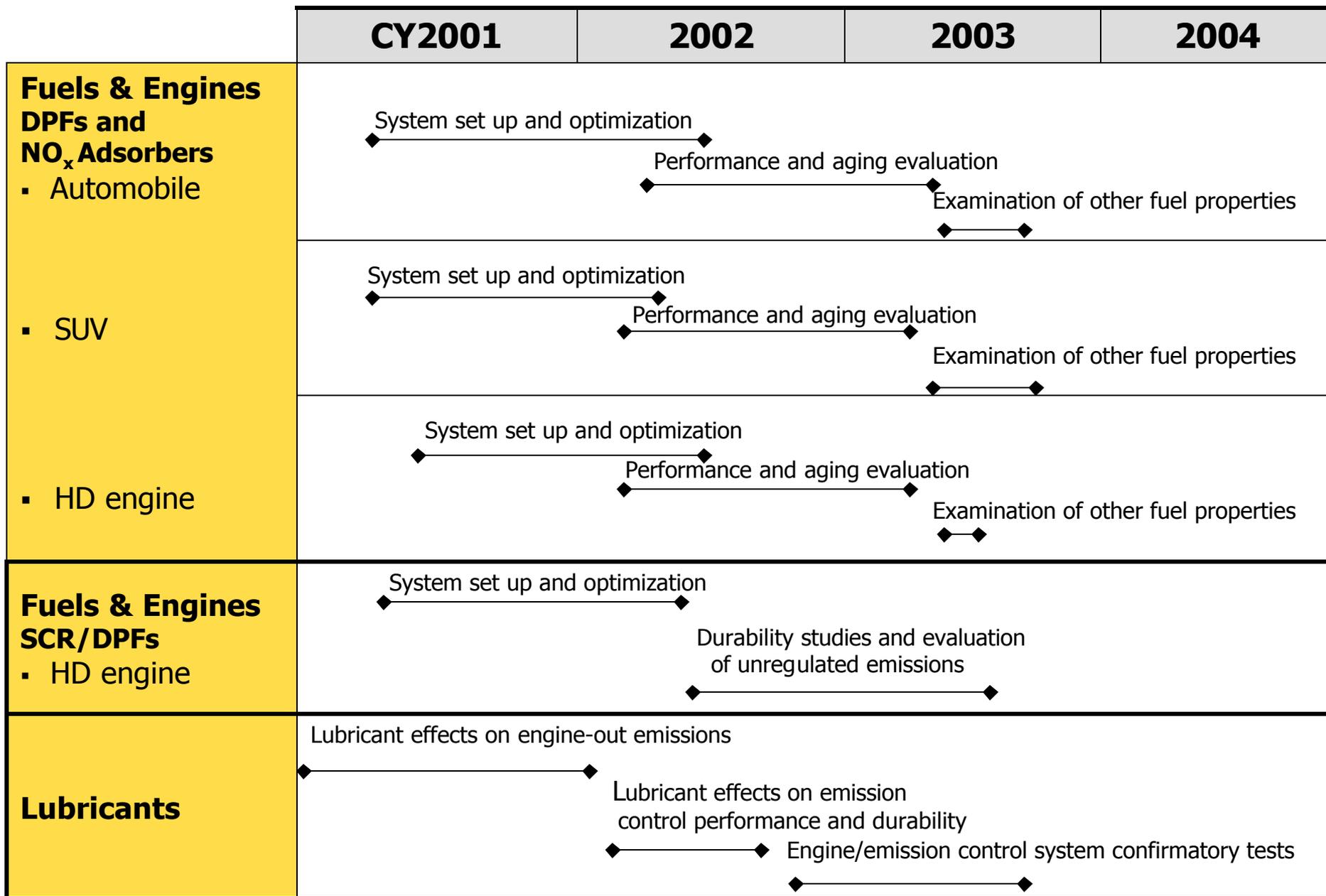
- Includes vehicles from automobiles to heavy-duty trucks
- Systems approach investigating fuels, lubricants, engines, emission control systems
- Initial timeframe 2000 to 2003 to provide information to industry and government within regulatory environment
- Resource needs of \$36 million, including \$22 million in cash and \$14 million in in-kind contributions
- Government planning for \$16 million of the \$22 million cash contribution
- Government/industry Steering Committee and Work Groups guiding the DEC Program



# APBF-DEC Program Schedule



# APBF-DEC Phase I Project Schedule



# Studies of Fuel Composition Effects



	<b>Phase I 2001-2003</b>	<b>Phase II 2004-2007</b>
<b>Fuel Effect Studied</b>	Sulfur	Sulfur, other substances & properties (e.g., aromatics, oxygen, cetane)
<b>Test Fuels</b>	<b>DECSE</b> <ul style="list-style-type: none"><li>• 3 ppm sulfur (set-up)</li><li>• 8 &amp; 15 ppm sulfur</li><li>• 30 ppm sulfur</li></ul> Refinery process fuel A	Refinery Process Fuels <ul style="list-style-type: none"><li>• Fuel B</li><li>• Fuel C</li><li>• Fuel D</li></ul> Fischer-Tropsch Fuels <ul style="list-style-type: none"><li>• Fuel E</li><li>• Fuel F</li></ul>
<b>Emission Measurements</b>	NO <sub>x</sub> Particulate matter <ul style="list-style-type: none"><li>• Soluble organic fraction</li><li>• Sulfate</li></ul> Hydrocarbons (HC) Carbon monoxide (CO)	NO <sub>x</sub> HC, CO, N <sub>2</sub> O Particulate matter <ul style="list-style-type: none"><li>• Soluble organic fraction</li><li>• Sulfate</li><li>• PAH , Nitro-PAH</li></ul> Speciated non-methane organic gases Formaldehyde Other unregulated substances



# DEC Participants

- U.S. DOE
- U.S. Environmental Protection Agency
- American Petroleum Institute
- National Petrochemical and Refiners Association
- Engine Manufacturers Association
- Manufacturers of Emission Controls Association
- American Chemistry Council
- California Air Resources Board/South Coast Air Quality Management District

# DEC Participating Companies/Organizations



## Automobile:

Ford  
GM  
DaimlerChrysler

## Heavy - Duty

### Engine:

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

## Emission Control:

MECA  
Johnson Matthey  
ASEC  
DeGussa Metals  
Catalysts Cerdec

Engelhard

Siemens

## Government:

DOE  
NREL  
ORNL  
EPA  
CARB/SCAQMD

## Technology:

Battelle

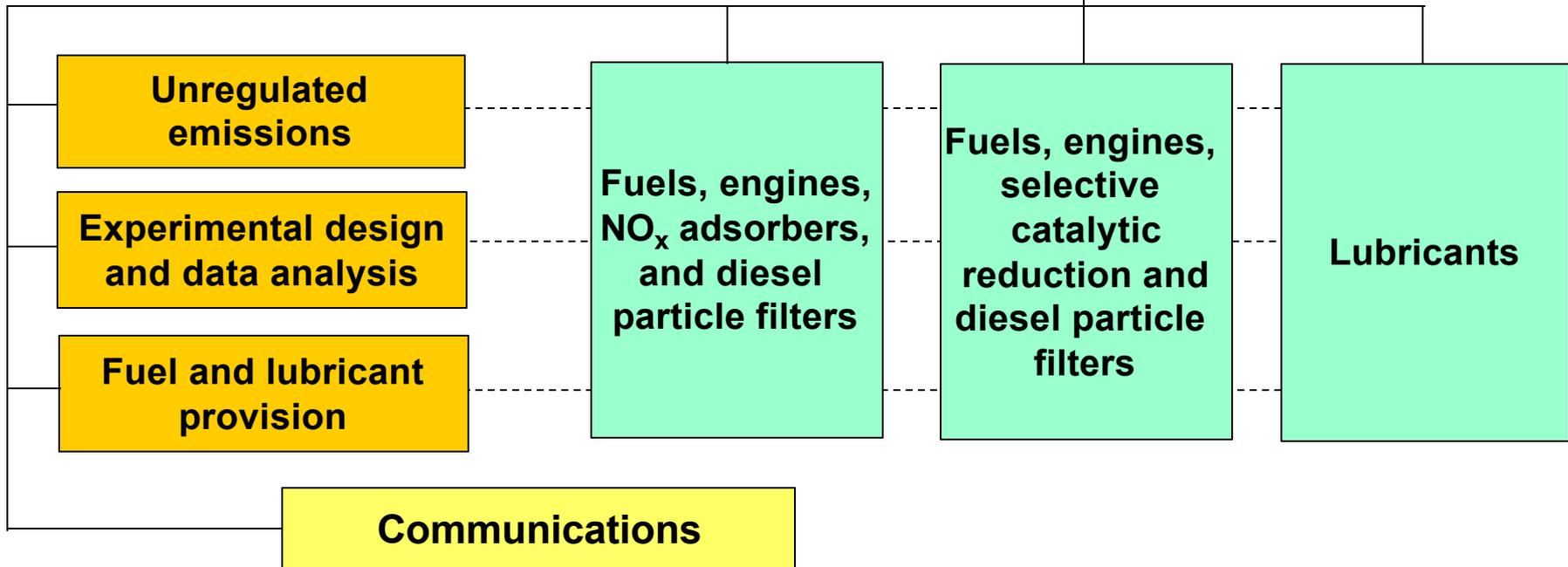
## Energy/Additives:

API  
American Chemistry Council  
NPRA  
BP  
Ethyl  
ExxonMobil  
Marathon Ashland  
Pennzoil  
Lubrizol  
Equilon  
Texaco  
Chevron Oronite  
Ciba  
Chevron Products  
Ergon  
Valvoline  
Motiva  
Infineum

# Integrated Systems Approach



DOE, EPA, additive companies,  
Ford, DaimlerChrysler, General Motors,  
engine manufacturers, energy companies,  
emission control mfrs., Calif. agencies



# Fuels, Engines, SCR/DPF Technologies

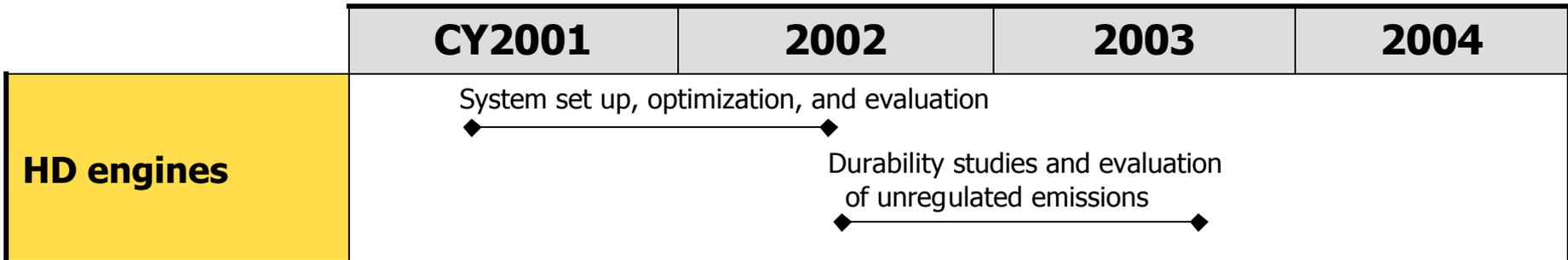


- Goal - Demonstrate low emissions performance attainable with SCR and diesel particle filter technologies (SCR/DPF). Evaluate sensitivities to fuel variables.
- Deliverables:
  - Optimized SCR/DPF systems for testing heavy-duty engines
  - SCR/DPF emissions performance
  - Effects of fuel variables including sulfur and aromatics
  - Durability data, emissions performance with aging
  - Assessment of urea infrastructure barriers
- Contractors:
  - Southwest Research Institute - testing
  - A.D. Little - urea infrastructure assessment

# Fuels, Engines, SCR/DPF Technologies



- Scope:
  - Two heavy-duty engines (Caterpillar C12, 12-liter, MY2000)
  - SCR catalysts (vanadium, zeolite, base metal) with DPFs
  - Fuels matrix - DECSE fuels (3, 8, 15, 30 ppm sulfur), Fischer-Tropsch, variable aromatics
  - Durability data out to 6,000 hours
  - Emissions - regulated, PM fractions (soluble organic fraction, sulfate),  $N_2O$ ,  $NH_3$ ,  $C_6H_6$ , HCHO,  $CH_3CHO$ , 1,3-butadiene
- Schedule



# Fuels, Engines, NO<sub>x</sub> Adsorber, DPF Technologies



- Goal - Demonstrate low diesel emissions performance with system of engine, controls, fuel, NO<sub>x</sub> adsorber, diesel particle filter, thermal management technologies
- Deliverables:
  - Optimized NO<sub>x</sub> adsorber/DPF systems for testing heavy- and light-duty engines utilizing late-cycle injection
  - NO<sub>x</sub> adsorber/DPF emissions performance
  - System durability
- Contractors:
  - FEV Engine Technology - passenger car
  - Southwest Research Institute – pick-up truck
  - Ricardo - heavy-duty engine

# Fuels, Engines, NO<sub>x</sub> Adsorber, DPF Technologies



- Scope:
  - One heavy-duty engine (15-liter Cummins ISX) and two light-duty engines (1.9-liter TDI in Audi A4 passenger car and 6.6-liter GM Duramax in a pickup)
  - Two emission control systems in each project, including NO<sub>x</sub> adsorbers and DPFs, and thermal management technologies
  - Initial demonstration on DECSE fuel - other fuel properties examined after demonstrating ultra-low emissions

# Fuels, Engines, NO<sub>x</sub> Adsorber, DPF Technologies



- Schedule - May 2001 - October 2003

	CY2001	2002	2003	2004
Automobile	<p>System set up and optimization</p> <p>Performance and aging evaluation</p> <p>Examination of other fuel properties</p>			
SUV	<p>System set up and optimization</p> <p>Performance and aging evaluation</p> <p>Examination of other fuel properties</p>			
HD engine	<p>System set up and optimization</p> <p>Performance and aging evaluation</p> <p>Examination of other fuel properties</p>			



# Lubricants

- Goal - To determine which (if any) lube-derived emission components are detrimental to performance/durability of emission control systems
- Deliverables:
  - Documentation of effects of lubricant composition on emissions and performance of advanced emission control technologies
  - Guidelines for formulation of lubricants
    - Basestock selection
    - Additive development
- Contractor – Automotive Testing Laboratories



# Lubricants

- Scope:
  - Engine and bench scale testing will determine the impact of lubricant formulation on the performance and durability of diesel emission control devices.
  - International T444E (7.3-liter, V8) engine equipped with CCV and cooled exhaust gas recirculation
- Schedule - April 2001 - December 2003

