

# **"Catalyst Compatible" Diesel Engine Oils**

## **DECSE Phase II**

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"Exploring Low Emission Diesel Engine Oils"

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January 31, 2000

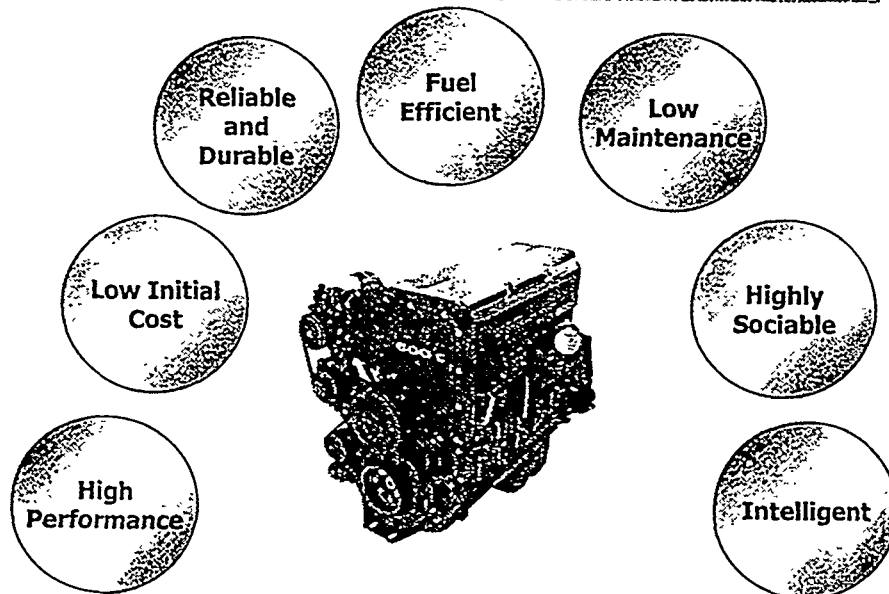
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## **Outline**

- **Background**
- **Recent trends in engines and oils**
- **DECSE program**
- **Technical hurdles**

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## Meeting the Needs of the Customer

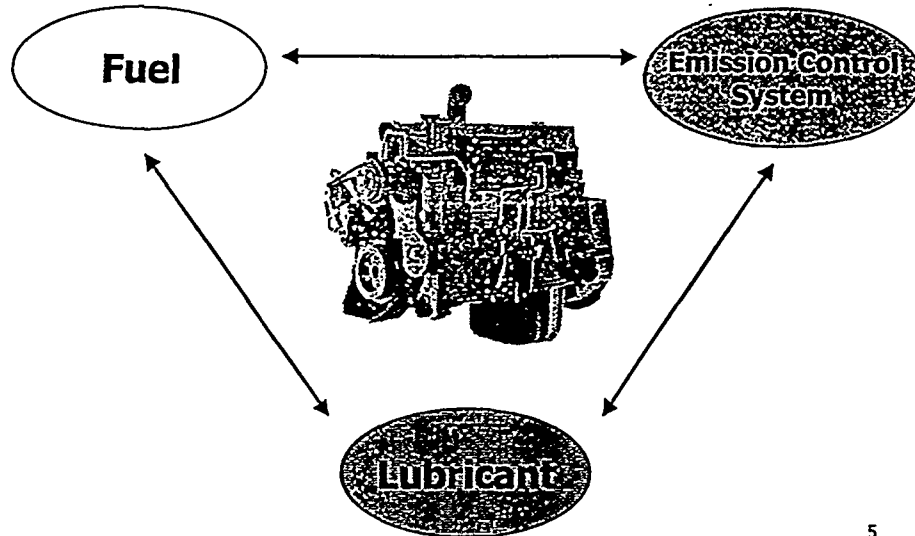


## Background

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- Final rule on Tier II
  - potential for diesel engine penetration
- EPA presently considering:
  - Future HD emissions standards for NO<sub>x</sub>, PM
    - Aftertreatment *forcing*
  - Diesel fuel sulfur reductions
    - Aftertreatment *enabling*

## Critical Sub-system Linkages



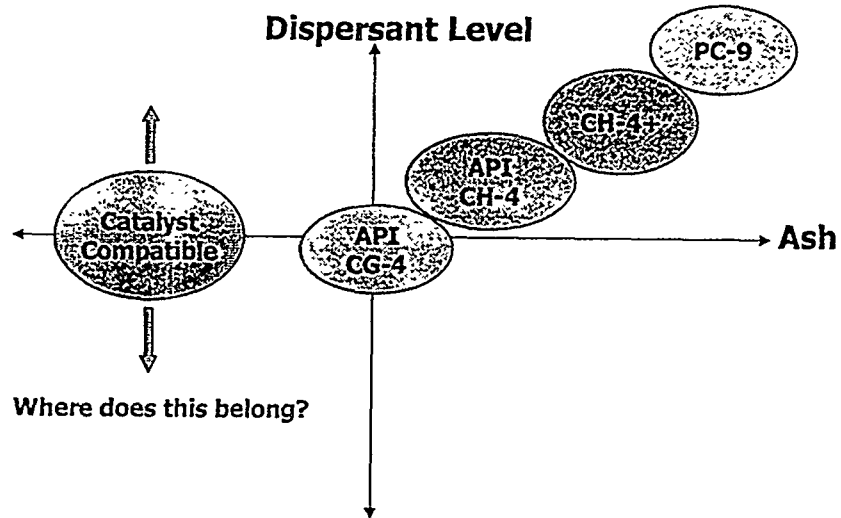
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## Trends Influencing Oil Formulation

- Demands for longer maintenance intervals
- Retarded injection timing
  - Need improved soot handling
- Exhaust Gas Recirculation (EGR)
  - Corrosion protection
  - Oxidation resistance at elevated temperatures
- Closed Crankcase Ventilation (CCV)
  - More oil in exhaust
  - Maintain turbocharger efficiency

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## Lubricant Development Trends



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## DECSE Program

- Diesel Emission Control - Sulfur Effects
  - Phase 1 investigated **fuel sulfur** effects on:
    - NOx adsorber catalysts
    - Diesel oxidation catalysts
    - Lean NOx catalysts
    - PM filters/traps
  - Lubricant used in testing contained 0.35% S
  - Summary: <http://www.ott.doe.gov/decse/>

➤ Phase 2 research to focus on lubricant effects

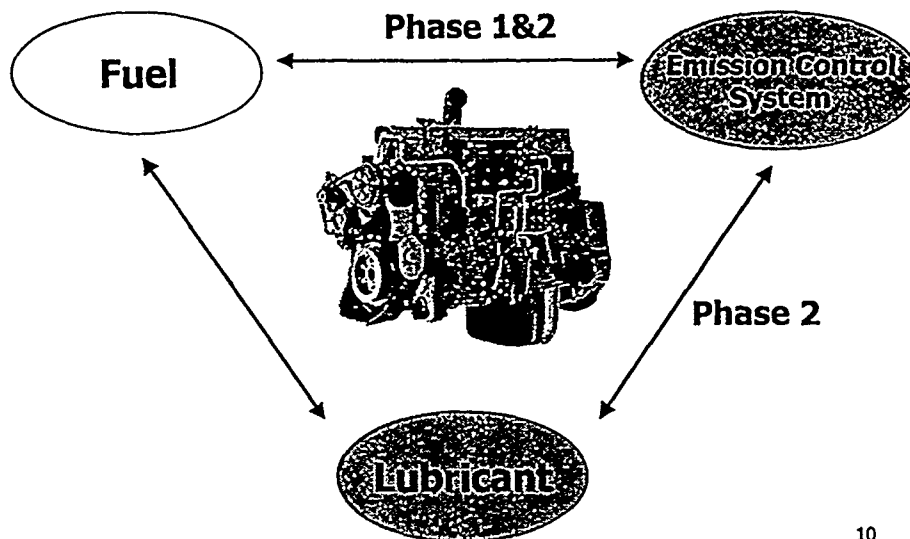
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## DECSE Phase 2 Research

- Government/industry participation:
  - DOE and National labs
  - EMA
  - API/NPRA
  - CMA
  - MECA
- Program initiation: January 2000
- Planned duration: 3 years

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## DECSE Research Focus



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## **Study Questions**

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- What are the effects of lubricant properties and composition on engine-out/catalyst-in emissions?
- How do these effects influence the performance and durability of diesel engine emission control systems (ECS)?
- What is the impact of oil age?

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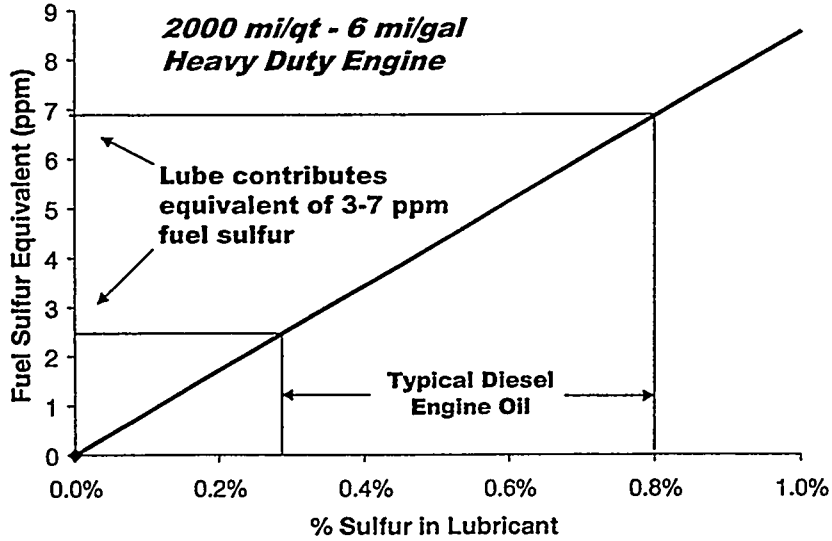
## **What Is Known....**

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- Emission control systems vary in sulfur sensitivity, but in general "the lower, the better"
- Lubricant contributes small, but potentially significant level of sulfur
- Automotive three-way catalysts have known incompatibilities

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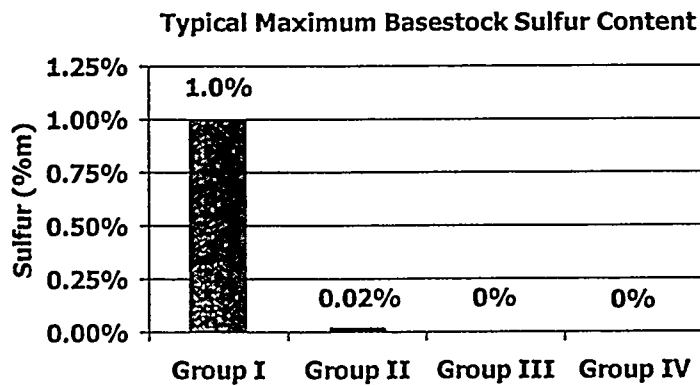
## Lube Oil Sulfur Contribution



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## Sources of Lube Oil Sulfur

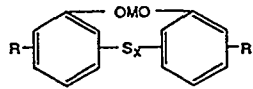
- Base oil



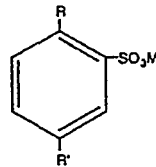
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## Sources of Lube Oil Sulfur

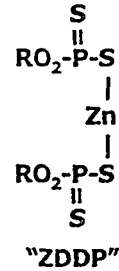
- Sulfur containing additives
  - Anti-wear agents (ZDDP, others)
  - Detergents (sulfonates, phenates)
  - Corrosion inhibitors
  - Friction modifiers
  - Anti-oxidants



Sulfur Coupled Phenate



Sulfonate



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## Other Characteristics of Interest....

- Sulfated ash
  - May plug PM traps
- Zinc and phosphorous
  - Known incompatibility with automotive three-way catalyst
- Volatility/distillation characteristics
- Aromatic level and type
- Viscosity
- Nitrogen
- Olefins

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## **Approach**

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- Task 1
  - Multi-cylinder engine tests to determine lubricant effects on engine-out emissions
  - Medium displacement engine equipped with EGR and CCV
- Task 2
  - Bench-scale analysis to determine if lube derived emissions impact performance of ECS
- Task 3
  - Confirm task 2 results on catalyst equipped engine
  - ECS durability

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## **Desired Outcome**

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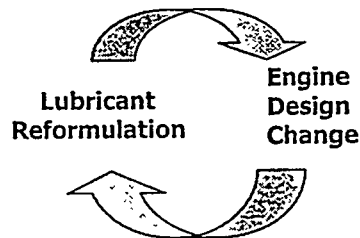
- To determine which (if any) lube derived emission components are detrimental to ECS performance/durability
- Guidelines for lubricant formulation:
  - Basestock
  - Additive
- Design guidelines:
  - Engine manufacturers
  - ECS suppliers

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## Technical Hurdles

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- Maintaining backward compatibility
  - Older engines still on the road
  - Implications of misapplication
- Conflicting demands
  - Compliance may necessitate EGR + aftertreatment which differ in appetite

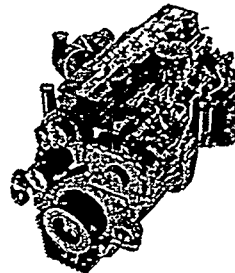


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## Outlook....

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- As we strive to produce high performance, low emissions products we must...
  - First establish an understanding of fundamentals
  - Be creative in development
  - Form partnerships in anticipation of challenges



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