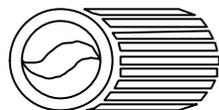


# Public Workshop on Regulatory and Non-Regulatory Fuels Activities for 2003

April 10, 2003

California Environmental Protection Agency

---



**Air Resources Board**

# Public Workshop on Regulatory and Non-Regulatory Fuels Activities

- Introductions
- Amendments to the California Diesel Fuel Regs.
  - 15-ppm Sulfur Limit
  - Procedures for Certifying Alternative Formulations
  - Flexibility Issues
  - Lubricity
- Diesel Engine Lubricating Oils
- Fuel Properties for Diesel Engine Certification
- Presentations by Others
- Open Discussion
- Closing Remarks

# Introductions

# California Diesel Fuel Program

## Background

# California Diesel Fuel Program

- Adopted in 1988
- Implemented October 1993
- Provides flexibility by allowing certification of equivalent formulations
- On-road and off-road motor vehicles
- Emission benefits:

|                  |       |
|------------------|-------|
| –NO <sub>x</sub> | 7 %   |
| –PM              | 25 %  |
| –SO <sub>x</sub> | >80 % |

# Low-Sulfur Diesel Fuel Programs

- U.S. EPA adopted 15-ppm sulfur rule in 2001 for on-road diesel motor vehicles, to be implemented in 2006
- U.S. EPA considering low-sulfur regulation for off-road motor vehicles.
- South Coast adopted Rule 431.2 in 2000,
  - 15-ppm sulfur limit for diesel fuel to be used in stationary engines, implementation is 2004
  - 15-ppm sulfur limit for motor vehicle, implementation in 2005 unless the ARB adopts for 2006.

Draft Proposed Amendments  
Under Development - California  
Diesel Fuel

15-ppm Sulfur Limit

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Lower CARB diesel sulfur limit to 15 ppm
- Applies to
  - On-road and off-road vehicle uses
  - Stationary sources (Air Toxic Control Measure)
- Necessary to:
  - implement diesel PM risk reduction plan
  - enable new diesel engine control technology
- Implementation in 2006

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Implementation concurrent with EPA's 2006 implementation date
  - No phase-in
  - At this time, no provisions for small refiners

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Replace ASTM D2622-94 (x-ray fluorescence) test method for determining sulfur content
  - Detection limit of 10 ppm
  - Repeatability of +/-9 ppm at 15 ppm S
- With ASTM D5453-93 (UV fluorescence)
  - Detection limit of 1 ppm
  - Repeatability of +/-2.8 ppm at 15 ppm S

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- No changes to aromatic hydrocarbon specifications

Draft Proposed Amendments  
Under Development - California  
Diesel Fuel (Continued)

Procedures for Certifying  
Alternative Diesel Fuel  
Formulations

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Update certified diesel fuel formulation procedures
  - Sulfur specification of candidate fuels
  - Sulfur specification of reference fuels
  - Eliminate unused sulfate credit provision

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Add provisions to ensure that commercial formulations and candidate fuels are equivalent
  - Candidate fuel subject to same required specifications and ranges as the reference fuel (e.g., API gravity, viscosity, distillation Ts)
  - Candidate fuel properties could differ from reference fuel properties by no more than half of the permitted fuel property ranges
  - Applicable to existing and new certifications

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Add provisions to ensure that commercial formulations and candidate fuels are equivalent (continued)
  - Exception: a candidate fuel outside of an allowable property range can still be the basis of a certified formulation if the applicant agrees that the certified formulation include additional specifications based on the candidate fuel properties

Draft Proposed Amendments  
Under Development - California  
Diesel Fuel (Continued)

Flexibility Issues

# Draft Proposed Amendments Under Development - California Diesel Fuel (Continued)

- Consider alternative set of flat limits, similar to flat limits used in the reformulated gasoline regulations.
  - Consider properties, such as total and poly-cyclic aromatics, density, cetane, sulfur, nitrogen, et al.
  - Allow importation of diesel fuel without having to use one of the existing alternative formulas.

# Average California Fuel Properties

|              | EPA/AAM LA    | EC-D Test LA  |
|--------------|---------------|---------------|
| Aromatics    | 21.9 % (vol.) | 20.4 % (vol.) |
| Poly- Aroms. | Not Meas'd    | 3.1 % (wt.)   |
| API Gravity  | 37.6          | 36.2          |
| Cetane No.   | 52.3          | 53.7          |
| Sulfur       | 130 ppmw      | 121 ppmw      |
| Nitrogen     | Not Meas'd    | 98 ppmw       |

AAM averages of 1995-2000 for LA area. EC-D test program averages of 1998 and 1999 LA-area fuels.

# Draft Proposed Amendments Being Considered for California Diesel Fuel

- Consider the development of a Predictive Model for diesel formulations.
  - A diesel Predictive Model would allow anyone to certify an alternative formulation without testing.
  - Allow importation of diesel fuel without having to use one of the existing alternative formulas.
  - Depending on adequacy of existing data

Draft Proposed Amendments  
Under Development - California  
Diesel Fuel

Lubricity

# Draft Diesel Fuel Lubricity Concept

# Lubricity Concerns Related to Low Sulfur Diesel Fuel

- Diesel fuel injection systems require adequate fuel lubricity to prevent excessive wear
- Hydrotreating process to lower sulfur can reduce level of trace components, which can reduce lubricity
- Sweden experienced fuel lubricity problems in 1991 with low sulfur diesel fuel

# California Experience

- Refineries voluntarily implemented and maintain recommended lubricity level
  - 3,000 gms Scuffing Load BOCLE
- CARB monitored California diesel fuel in 1993 through 1996 and concluded lubricity levels of diesel fuel were consistently at or near the recommended level

# Lubricity Concerns Related to Low Sulfur Diesel Fuel

- Current Concerns:
  - Equipment manufacturers believe lubricity standard necessary with 15 ppm diesel sulfur standard
- ASTM has attempted but not been successful to date in passing a lubricity standard

# Industry Standards

- European standard EN590
  - HFRR 460 micron maximum wear scar diameter (WSD) @ 60 deg C
- World Wide Fuels Charter lubricity specification
  - HFRR 400 microns maximum WSD @ 60 deg C
- SAE J2265: Diesel Fuel Performance Requirement and Test Method for Assessing Fuel Lubricity
  - HFRR 450 microns maximum WSD @ 60 deg C
  - Allows additive/fuel combinations with a greater WSD that give acceptable performance as agreed between fuel supplier and purchaser

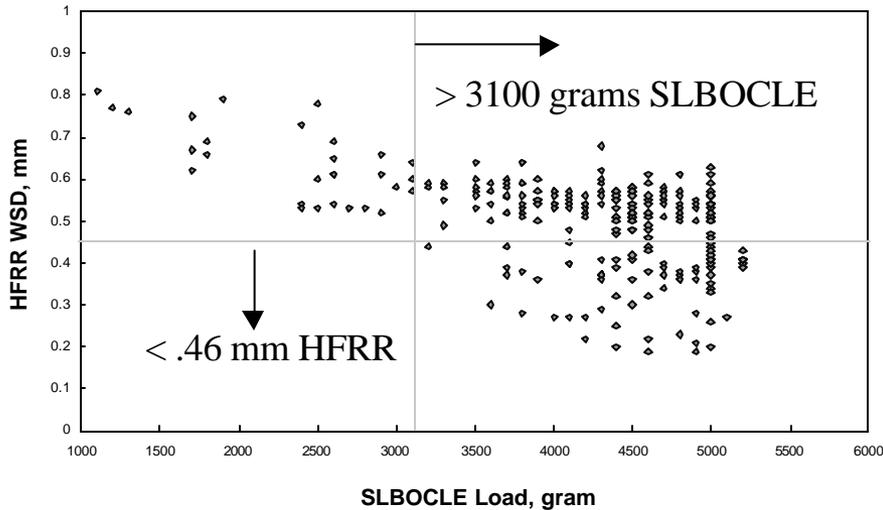
# Current ASTM Ballot

- Minimum lubricity limit being proposed as starting point
- 3,100 grams scuffing load BOCLE for all grades of diesel
- Planning work to determine if vehicles of 2007 and beyond require higher lubricity level
  - Specify more stringent lubricity requirement for ULSD (15 ppm sulfur) if necessary

# EMA Position on Minimum Lubricity for 15 ppm Sulfur Diesel

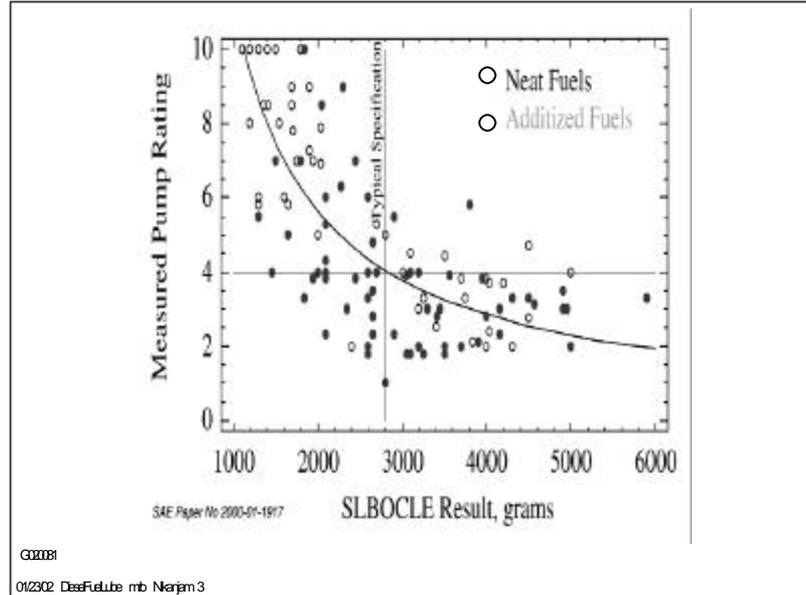
- Cites two non-equivalent standards
- HFRR maximum WSD 450 microns @ 60 deg C
- SLBOCLE minimum scuffing load of 3100 grams

# SLBOCLE and HFRR Lubricity Evaluation Tests Do Not Correlate



- SLBOCLE and HFRR measure different wear mechanisms
- Fuels with WSD less than 460 microns meet minimum 3100 gram SLBOCLE requirement
- Fuels meeting minimum 3100 gram SLBOCLE may have WSD > 460 microns

# 3100 SLBOCLE Protects Traditional Fuel System Technology



- California voluntary standard of 3000 SLBOCLE has protected equipment for last decade
- SLBOCLE results correlate well with existing pump data
- Existing pump data not representative of newer technology

# New Fuel System Technology Requires Higher Lubricity Levels

- Vastly increased injection pressures and tighter tolerances
  - Improved combustion efficiency
  - Reduced PM
- 20k - 30k psia pressures, tighter tolerances, plus life requirements present new design challenges
- HFRR wear mechanism more consistent with high pressure pump tribology
- No statistical data currently available for new pump technology

# European Experience

- In 2001 LD diesels ~33% of new car sales in Europe
- LD European diesels use advanced electronic high pressure direct fuel injection systems
- EN590 requirement of 460 micron maximum WSD shown to be protective of high pressure fuel injection systems

# New Fuel System Technology In U.S. Market

- Several engine manufacturers report vehicles with new fuel system technology in U.S. market since 2001/2002
- Vehicles primarily medium duty trucks
- Vehicle must be protected against premature wear to maintain emissions benefits

# ARB Draft Diesel Fuel Lubricity Concept: Two Tier Approach

- Protect existing equipment
  - 3,100 gram minimum based on Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE)
  - Codify current refinery voluntary practice: consistent with 1994 California Governor's Task Force recommendation
  - Time frame: ASAP
- Protect new low emissions high pressure fuel injection systems technology
  - 460 micron wear scar (WSD) diameter High Frequency Reciprocating Rig (HFRR)
  - Time frame: 2005/2006 (?)

# Issues

- Fuel testing requirements
  - Current practice
  - Consider innovative options
- Additive harm effects
  - Pipeline
  - Engine - oil contamination
    - Function of additive chemistry

# Issues

- Are there harm effects due to current lubricity level (minimum 3100 gms SLBOCLE) on new technology fuel systems in existing fleet?
- Can an SLBOCLE level be defined that is protective of new technology fuel systems?

# Diesel Engine Lubricating Oils

# Following Industry Efforts

- Awaiting test results:
  - Advanced Petroleum-Based Fuels - Diesel Emissions Control (APBF-DEC) Lubricants Work Group
  - Southwest Research Institute private consortium:
    - Diesel Aftertreatment Sensitivity to Lubricants (DASL) / Non-Thermal Catalyst Deactivation (N-TCD)
- ASTM Heavy Duty Engine Oil Classification Panel
  - Proposed Category 10 (PC-10)
- Industry efforts may preclude necessity for regulatory action

# Draft Proposed Amendments for Fuel Properties for Diesel Engine Certification Testing

# Proposed Amendments Under Development for California Certification Diesel Fuel

- Sulfur content of California certification fuel to be consistent with Title 40, Code of Federal Regulations, §86.1313-2007.
- (b)(2)...petroleum fuel for diesel engines...
- Total Sulfur, ppmw 7 - 15

# Presentations by Others

# Open Discussion

# Closing Remarks