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:
  - –NOx 7 %
  - –PM 25 %
  - –SOx >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

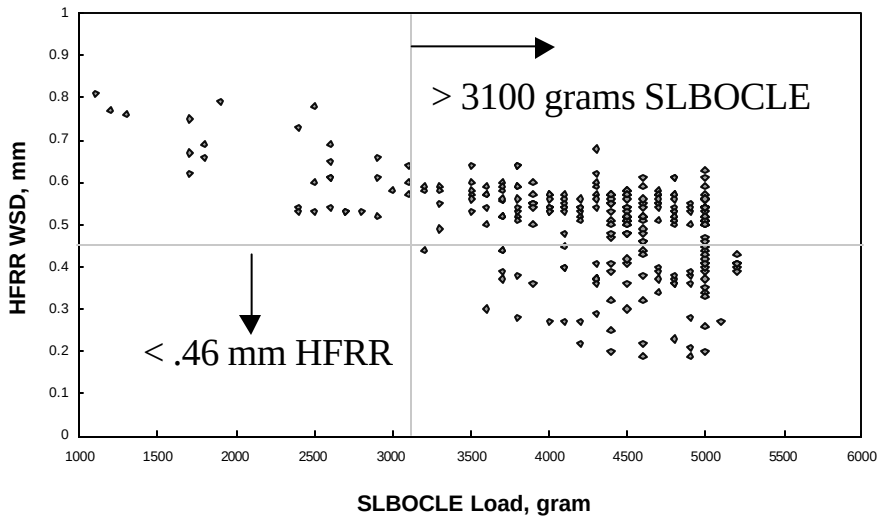
Current ASTM Ballot

- 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



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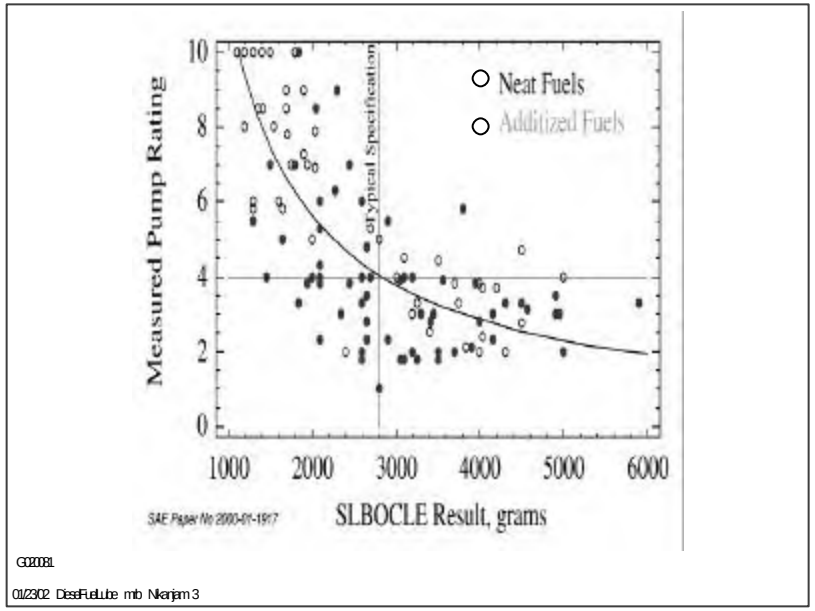
- SLBOCLE and HFRR measure different wear mechanisms
- Fuels with WSD less than 460 microns meet minimum 3100 gram SLBOCLE requirement
- Fuels meeting minimum 3100 gram SLBOCLE may have WSD > 460 microns

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