Diesel Fuel Comparison Study Workshop

October 14, 2008

California Environmental Protection Agency

Air Resources Board

Agenda

Background
- AB679 (Calderon)
- Legislative Intent

- Project Schedule
- Revisions to the draft Test Plan
  - Objective & Scope
  - Proposed Test Engine/Cycle Selection
  - Proposed Test Vehicle/Cycle Selection
- Diesel Fuel Properties
  - CARB ULSD
  - Federal ULSD
- Future Discussion Topics
- Next Meeting

Background

- Assembly Bill 679 (Calderon)
  - Requires ARB to convene a panel of interested parties to develop a test protocol
  - Test program shall measure the emissions benefits of CARB diesel fuel
  - Conduct test program
  - Report the results to the Senate Committee on Environmental Quality, the Senate Committee on Transportation and Housing, and the Assembly Committee on Transportation

Background

- Legislative Intent
  - Federal ultralow diesel may produce emissions benefits close to those of CARB diesel
  - Thought to be especially significant for HD diesel engines employing new technology (e.g. EGR)
  - Higher cost of CARB diesel is a competitive disadvantage for CA trucking industry
  - Develop and implement test plan to measure differences in NOx & PM emissions between CARB diesel and Federal ultralow diesel

Project Schedule

- Contract suspended due to budget issues
- Revised draft test plan available for review and comment
  http://www.arb.ca.gov/fuels/diesel/dieselcomp/dieselcomp.htm
- Continuing to review fuel properties, soliciting comments
- Emissions Testing – scheduled to begin in late 2008
  - Coordinating schedules with Biodiesel Research Program

Revised Draft Test Plan

- *Assessment of the Emissions from the Use of California Air Resources Board Qualified Diesel Fuel in Comparison with Federal Diesel Fuels – Overview*

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Objective & Scope

- Design & implement test program to define the emissions benefits of CARB diesel fuel versus several different Federal diesel fuel blends
  - Proposed scope:
    - Engine dyno – Test 3 (4 if 2010 engine is available) engines, two test cycles
    - Chassis dyno – 9 test vehicles, 1 test cycle, ARB HHDDT cruise, multiple test repetitions per fuel
    - Fuels – 1 ‘representative’ CARB diesel, 2 Federal diesel ‘blends’
    - Emissions measurements – THC, CO, CO2, NOx, NO, PM

Test Engine Selection - Engine Dynamometer Testing

- Test Engine 1 – Selection Confirmed
  - 2006 Cummins ISM 370, 10.8 liter, EGR
  - EFN: 6CEXH0661MAT
- Test Engine 2 – Selection Confirmed
  - 2007 DDC MBE4000, 12.8 liter
  - EFN: 7DDXH12.8DJA
  - EGR+OC+PTOX
- Test Engine 3 – Selection Confirmed
  - 1991 DDC Series 60, 11.1 liter
  - EFN: MDD11.1FZAZ

Test Engine Selection - 2010 Compliant Engine

- Currently working with the Engine Manufacturers Association
  - Seeking a 2010 compliant engine for inclusion in the engine dynamometer test matrix
  - Would include NOx after treatment
  - We would likely test a pre-production or prototype engine

Test Cycle Selection – Engine Dynamometer

- Two test cycles selected
  - First Cycle: Heavy Duty Federal Test Procedure (FTP) Transient Cycle
    - Currently used for emission testing of HDD on-road engines
  - Second Cycle: ARB Heavy Heavy-Duty Diesel Truck (HHDDT) cruise cycle
    - 2083 second cycle with 40 mph average speed
    - Translated cycle, can be used on engine or chassis dynamometers
    - Engine dyno results could be confirmed by chassis testing of in-use HDD fleet

Engine Dynamometer Test Matrix

- 6 test replicates per test day, 3 morning & 3 afternoon
- 2 fuels per test day
- 2 test cycles, 36 tests per engine

Test Day	Morning Schedule (3 replicates)	Afternoon Schedule (3 replicates)
Day 1	CCC	AAA
Day 2	AAA	BBB
Day 3	BBB	CCC
Repeat		

C CARB diesel fuel, A Federal A diesel fuel, B Federal B diesel fuel

Proposed Test Vehicle Selection - Chassis Dynamometer Testing

- Propose testing a matrix of 9 vehicles
  - Matrix should be based on CA's in-use HD on-road fleet
  - Should incorporate a range of technologies if possible
  - Engine dynamometer test results will help shape final matrix
- Vehicle acquisition
  - Advertisement
  - Rental / lease
  - Private owners
- Resources available for vehicle recruitment

Test Cycle Selection – Chassis Dynamometer

- ARB HHDDT cruise cycle selected
  - One test cycle selected to increase the number of test replicates per fuel type
  - Test cycle directly tied to engine dynamometer test results
  - 12 test replicates per fuel type

Chassis Dynamometer Test Matrix

- 6 test days per vehicle
- 12 tests per fuel, 36 tests per vehicle

Test Day	Morning Schedule (3 test replicates)	Afternoon Schedule (3 test replicates)
ARB HHDDT Cruise Test Cycle		
Day 1	CCC	AAA
Day 2	AAA	BBB
Day 3	BBB	CCC
Repeat once		

C=CARB diesel fuel, A=Federal A diesel fuel, B=Federal B diesel fuel

Diesel Fuel Selection

- Propose using three test fuels:
  - Representative or ‘Average’ CARB ULSD
  - Representative or ‘Average’ Federal ULSD
  - Federal ULSD with fuel properties that represent the upper/lower boundaries, affecting emissions characteristics

CARB Diesel Fuel Properties

Average Pool Properties[1]: Summer 2006[2]

Property	CARB ULSD
API Gravity	38.5
Rel Density (60/60°F)	0.8324
T50 (°F)	479.3
Aromatics (v/v)	17.6
Cetane Number (additized)	51.3
Cetane Number (clear)	49.1
Sulfur (ppm)	4.4

[1] All data represent volume weighted averages.

[2] Summer 2006: Refers to the period from June 1 through September 20, 2006.

CARB Diesel Fuel Properties

Average Properties[1]: Summer 2007[2]

Property	CARB ULSD
API Gravity	37.0
Rel Density (60/60°F)	0.8398
T50 (°F)	490.5
Aromatics (v/v)	15.9
Cetane Number (additized)	51.6
Cetane Number (clear)	-
Sulfur (ppm)	3.1

[1] Data average of 12 - 50 samples taken from CA refineries, not volume weighted.

[2] Summer 2007: Refers to the period from May 21 through August 16, 2007.

‘Average’ CARB ULSD Properties

Proposed Ranges for Test Fuel Selection

Revised October 2008

Property	Range
API Gravity	38 - 39
T50 (℉)	470 – 490
Aromatics (v/v)	16 - 20
Cetane Number (additized)	50 - 54
Sulfur (ppm)	~~(<8)~~ <5

‘Average’ Federal ULSD Properties
Proposed Ranges for Test Fuel Selection (Federal – A)

Property	Range
API Gravity	35 - 37
T50 (℉)	490 – 510
Aromatics (v/v)	27 - 33
Cetane Number	44 - 46
Sulfur (ppm)	<15

‘Boundary’ Federal ULSD Properties
Proposed Ranges for Test Fuel Selection (Federal – B)

Property	Range
API Gravity	33 - 34
T50 (℉)	-
Aromatics (v/v)	35 - 40
Cetane Number	40 - 42
Sulfur (ppm)	<15

Future Discussion Topics

- Soliciting comments regarding range of fuel properties for study test fuels
- Continuing to seek a 2010 compliant engine for inclusion in the fuel comparison study
- Continued schedule coordination with Biodiesel research project

Next Meeting

- Tentatively scheduled for December 2008
- Visit our web site
  - http://www.arb.ca.gov/fuels/diesel/dieselcomp/dieselcomp.htm

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