

Diesel Fuel Comparison Study Workshop

January 8, 2009

California Environmental Protection Agency



Air Resources Board

Agenda

- Project Overview
 - Aromatics Data Issue
 - Advisory Panel Actions
 - Action Items
 - Proposed Federal – B ULSD
 - Test Fuel Procurement Issues
 - Future Discussion Topics
- Next Meeting

Aromatics Data and Associated Test Methods

- ARB required test method for the determination of aromatic hydrocarbon content of diesel fuel is ASTM D5186, Supercritical Fluid Chromatography (SFC)
- All CARB ULSD data presented regarding aromatics has been based on ASTM D5186
- The “Alliance of Automobile Manufacturers” North American Fuel Survey aromatic hydrocarbon data previously presented has been based on ASTM D1319, Fluorescent Indicator Adsorption
- The Northrop Grumman 2007 Fuel Survey aromatic hydrocarbon data previously presented is also based on ASTM D1319, so direct comparison with the “Alliance of Automobile Manufacturers” survey data is appropriate
- The “Alliance of Automobile Manufacturers” survey includes aromatics data based on ASTM D5186 as well as ASTM D1319

Federal Diesel Fuel Properties

“Alliance of Automobile Manufacturers” North American Fuel Survey

Summary Statistics for Selected Properties from the Summer 2007 Survey

Note: Statistics based on data from 16 U.S. cities, Los Angeles & San Antonio data has been removed, data includes aromatics based on both ASTM D1319 & ASTM D5186

#2 Regular Diesel S15	2007 Summer ¹		
	min	avg	max
Gravity, °API	33.0	35.4	38.9
T50 (°F)	493	506	521
T90 (°F)	595	608	623
Aromatics (V %) <small>ASTM D1319</small>	19.9	28.6	40.0
Aromatics (V %) <small>ASTM D5186</small>	18.2	25.7	33.6
Cetane Number	40.2	46.3	55.0
Sulfur ² (ppm)	2	6	17

¹ Samples taken in July 2007
² Using ASTM D5453

Ranges for Average ULSD Test Fuel Selection

Revised December 2008

Property	“Average” Federal ULSD Ranges (Federal – A)	“Average” CARB ULSD Ranges (CARB ULSD)
API Gravity	34.5 – 36.5	37.5 – 39.5
T50 (°F)	490 – 510	470 – 490
T90 (°F)	595 – 615	595 – 615
Aromatics (v%) D5186		16 – 19
Aromatics (v%) D1319	27 – 30	
Cetane Number	45 – 48	50- 53
Sulfur (ppm)	4 - 8	2 - 6

Advisory Panel Approvals

- At the December 3, 2008 meeting the Advisory panel approved the following:
 - CARB ULSD test fuel properties
 - Federal – A test fuel properties
 - “Fall-Back” Federal – A test fuel properties
 - Revised Draft Test Plan with continuing updates and future revisions

Approved Property Ranges for “Average” CARB ULSD Test Fuel Selection (CARB ULSD)

Revised and Approved December 2008

Property	“Average” CARB ULSD Test Fuel Property Ranges (CARB ULSD)
API Gravity	37.5 – 39.5
T50 (°F)	470 – 490
T90 (°F)	595 – 615
Aromatics (v%) Based on ASTM D5186	16 – 19
Cetane Number	50 – 53
Sulfur (ppm)	2 - 6
Note: Test fuel must contain zero biodiesel	

Approved Property Ranges for “Average” Federal ULSD Test Fuel Selection (Federal - A) Revised and Approved December 2008

Property	“Average” Federal ULSD Test Fuel Property Ranges (Federal - A)
API Gravity	34.5 – 36.5
T50 (°F)	490 – 510
T90 (°F)	595 – 615
Aromatics (v%) Based on ASTM D1319	27 – 30
Cetane Number	45 – 48
Sulfur (ppm)	4 - 8
Note: Test fuel must contain zero biodiesel	

Approved Property Ranges for “Fall-Back” Federal ULSD Test Fuel Selection (“Fall-Back” Federal - A) Defined and Approved December 2008

Property	“Fall-Back” Federal ULSD Test Fuel Property Ranges (Fall-Back Federal - A)
API Gravity	2 – 4 points lower than the “Average” CARB ULSD test fuel
Aromatics (v%) *	10 – 12 Volume % higher than the “Average” CARB ULSD test fuel
Cetane Number	4 – 6 points lower than the “Average” CARB ULSD test fuel
Sulfur (ppm)	0 – 4 ppm higher than the “Average” CARB ULSD test fuel
<p>Note: Fall-Back Federal-A test fuel to be used in the event that staff cannot locate Federal – A test fuel based on approved property ranges, must contain zero biodiesel</p> <p>* Determination will be made using ASTM 5186 for CARB ULSD and ASTM 1319 for Fall-Back Federal-A</p>	

Revised Draft Test Plan approved with continuing updates and future revisions

Approved December 2008

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

Dr. Thomas D. Durbin

University of California, Riverside

CE-CERT

Action Items from December 2008 Advisory Panel Meeting:

- Do the properties proposed for the Federal – B test fuel actually exist in one or more of the survey fuels?
- Does the Auto Alliance survey data include samples from Texas and if so, what would the data look like with Texas removed?
- Provide information on the range of properties for CARB ULSD from the survey data to determine what a “boundary” CARB ULSD test fuel looks like.
- Does the Northrop Grumman fuel survey contain any volume data for Federal fuels?
- Look at some different percentiles in the survey data (90th, 95th) to determine the prevalence of the various properties
- Revise the definition of the “boundary” test fuel (Federal – B) and present those proposed properties to the Panel

Action Item

Availability of Federal – B Test Fuel

- A review of the “Alliance of Automobile Manufacturers” Summer 2007 North American Fuel Survey showed no fuel samples within the target property ranges
- 4 fuels met all the target properties except for Cetane:
 - Target Cetane range: 40 – 42
 - Survey values: 42.7, 43.4, 43.6, 46.5
- An additional 5 had 2-3 properties slightly higher than the required ranges
- Without CA & TX data, 125 individual fuel samples reviewed

Action Item

Comparison of Federal Diesel Fuel Survey Data without Los Angeles and San Antonio samples

Averages Properties of Samples Collected Summer 2007

Properties	“Alliance of Automobile Manufacturers” (CA data removed) Averages¹, Summer 2007	“Alliance of Automobile Manufacturers” (CA & TX data removed) Averages², Summer 2007
Gravity, °API	35.5	35.4
T50 (°F)	506	506
T90 (°F)	607	608
Aromatics (v%) ASTM D1319	28.2	28.6
Cetane Number	46.4	47.1
Sulfur (ppm)	6	6

¹ Statistics are based on data from 17 U.S cities, data from Los Angeles, California has been removed from the sample

² Statistics are based on data from 16 U.S. cities, data from Los Angeles, California and San Antonio, Texas has been removed from the sample.

Action Item

Comparison of CARB Diesel Fuel Properties Summer 2007 “Average” and “Boundary” fuel properties

Property	Average CARB Fuel Properties ¹ Summer 2007 ²	“Boundary” CARB Fuel Properties (Small Refinery Fuel) Summer 2007 ²	Approved Ranges for “Average” Federal ULSD Test Fuel
API Gravity	37.6	34.9	34.5 – 36.5
T50 (°F)	480	508	490 – 510
T90 (°F)	602	619	595 – 615
Aromatics (V %) ASTM D5186	16.7	27.3	(24.5 – 27.5) ³
Cetane Number (additized)	51.8	48.9	45 – 48
Sulfur (ppm)	4	5	4 - 8

¹ Data average of 12 - 50 samples taken from CA refineries, volume weighted.

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

³ Range not approved, approximation based on ASTM D5186 aromatics content.

Action Item

2007 Northrop Grumman Diesel Fuel Oil Survey Data

- The Northrop Grumman survey does include some fuel volume data listed by district
- Unfortunately, only about half of the data include information regarding the volume of fuel sold in each district
- Therefore, volume weighting of the survey data is not possible
- Additionally, while the data also lists the fifth and ninety-fifth percentiles for the various fuel properties, because of the small sample size most of these data are represented by the minimum and maximum values, respectively

Action Item - Federal Diesel Fuel Properties

“Alliance of Automobile Manufacturers” North American Fuel Survey
 Summary and Descriptive Statistics for Selected Properties from the Summer
 2007¹ Survey

#2 Regular Diesel S15	avg	Percentiles			
		5 th	10 th	90 th	95 th
Relative Density, (60/60 °F)	0.8478	0.8358	0.8382	0.8544	0.8572
°API Gravity	35.4	33.6	34.1	37.3	37.8
T50 (°F)	506	482	487	526	531
T90 (°F)	608	580	583	629	630
Aromatics (V %) ASTM D1319	28.6	22.1	23.0	33.3	36.1
Aromatics (V %) ASTM D5186	25.7	20.7	21.5	29.5	30.3
Cetane Number	46.3	41.8	42.6	49.3	50.9
Sulfur ² (ppm)	6	3	4	8	9

¹ Samples taken in July 2007 from 16 U.S. cities, excludes Los Angeles & San Antonio data

² Using ASTM D5453

Action Item

Federal – B Diesel Test Fuel Selection

- Staff Recommendation – New proposal for the selection of a commercially available Federal ULSD with fuel properties that would lead to higher exhaust emissions

New Selection Criteria Based on Potential Exhaust Emissions

- Using the EPA's Unified Model, staff calculated the potential NOx and PM emissions using the data from the "Alliance of Automobile Manufacturers" Summer 2007 North American Fuel Survey.
- The analysis was performed using 125 fuel samples, the CA and TX fuel samples were removed
- Results were ranked by potential NOx emissions from 50th to 90th percentile
- Staff selected the results of the 85th percentile and greater and reviewed these individual fuel properties
- 19 individual fuels were used to determine the range of properties for staff's recommendation

Summer 2007 Federal ULSD Fuel Properties of Highest NOx Emitting Fuels

Results based on EPA's Unified Model using ASTM D1319 for aromatics content

#2 Regular Diesel S15	Survey Fuel Properties Based on Highest Potential NOx Emissions ¹		
	min ²	avg ²	max ²
Gravity, °API	33.0	33.9	35.2
T50 (°F)	478	505	526
T90 (°F)	576	607	632
Aromatics (V %) ASTM D1319	31.2	34.9	40.0
Aromatics (V %) ASTM D5186	28.4	30.2	33.6
Cetane Number	40.2	43.1	46.5
Sulfur (ppm)	5	7	9

¹ Analysis based on "Alliance of Automobile Manufacturers" North American Fuel Survey, Summer 2007

² Based on survey fuels with 85th percentile and higher NOx emissions as determined from EPA's Unified Model using ASTM D1319 for aromatics content

Summer 2007 Federal ULSD Fuel Properties of Highest NOx Emitting Fuels

Results based on EPA's Unified Model using ASTM D5186 for aromatics content

#2 Regular Diesel S15	Survey Fuel Properties Based on Highest Potential NOx Emissions ¹		
	min ²	avg ²	max ²
Gravity, °API	33.0	33.9	35.2
T50 (°F)	478	499	517
T90 (°F)	576	600	629
Aromatics (V %) ASTM D5186	28.4	30.1	33.6
Aromatics (V %) ASTM D1319	30.7	33.9	40.0
Cetane Number	40.2	42.4	44.9
Sulfur (ppm)	5	7	9

¹ Analysis based on "Alliance of Automobile Manufacturers" North American Fuel Survey, Summer 2007

² Based on survey fuels with 85th percentile and higher NOx emissions as determined from EPA's Unified Model using ASTM D5186 for aromatics content

Proposed Ranges for Federal - B ULSD Test Fuel Selection

(using ASTM D1319 for aromatic content)

Revised January 2009

Property	Proposed “Boundary” Federal ULSD Property Ranges (Federal – B)	Previously Proposed Federal-B ULSD Property Ranges
API Gravity	33.0 – 35.2	33 – 34
T50 (°F)	478 - 526	≥500
T90 (°F)	576 - 632	>620
Aromatics (v%) ASTM D1319	31.2 – 40.0	35 – 40
Aromatics (v%) ASTM D5186	28.4 – 33.6	
Cetane Number	40.2 – 46.4	40 – 42
Sulfur (ppm)	5 - 9	<15

Fuel Procurement Issues

- Availability of CARB ULSD
- Availability of Federal – A ULSD

Availability of “Average” CARB ULSD Test Fuel

- Staff has not been able to locate a refinery that is currently producing a CARB ULSD that meets the proposed property ranges
- Staff is waiting for additional data from refinery COA's
- Should the Panel discuss the possibility of blending fuels?
- Should the Panel consider changes to the property ranges?

Availability of Federal – A Test Fuel

- A review of the “Alliance of Automobile Manufacturers” Summer 2007 North American Fuel Survey shows 9 fuel samples within the target property ranges
- Samples were from: Atlanta, Denver, Kansas City, Miami, Philadelphia, St, Louis
- An additional 9 had only one property slightly higher than the target property ranges (example: Aromatics 30.3 V%, T90 618 °F)
- 9 others had 2 – 3 properties slightly higher than the required ranges
- Without CA & TX data, 125 individual fuel samples reviewed

Future Discussion Topics

- 2010 compliant engine for inclusion in the fuel comparison study
- Locate & purchase Comparison Study test fuels
- Shipping & storage of test fuels
- Continued coordination with the Biodiesel research project

Next Meeting

- Tentatively scheduled for March 2009
- Visit our web site
 - <http://www.arb.ca.gov/fuels/diesel/dieselcomp/dieselcomp.htm>

Contact Information

- Floyd Vergara, Manager
 - (916) 327-5986
 - fvergara@arb.ca.gov

- Jim Guthrie
 - (916) 327-1508
 - jguthrie@arb.ca.gov

