

# **Diesel Fuel Comparison Study Workshop**

**January 8, 2009**

**California Environmental Protection Agency**

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

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

\* Determination will be made using ASTM 5186 for CARB ULSD and ASTM 1319 for Fall-Back Federal-A

**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 (90<sup>th</sup>, 95<sup>th</sup>) 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) Averages <sup>1</sup> , Summer 2007	“Alliance of Automobile Manufacturers” (CA & TX data removed) Averages <sup>2</sup> , 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

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

<sup>2</sup> 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 <sup>1</sup> Summer 2007 <sup>2</sup>	“Boundary” CARB Fuel Properties (Small Refinery Fuel) Summer 2007 <sup>2</sup>	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) <sup>3</sup>
Cetane Number (additized)	51.8	48.9	45 – 48
Sulfur (ppm)	4	5	4 - 8

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

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

<sup>3</sup> 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  
2007<sup>1</sup> Survey**

#2 Regular Diesel S15	avg	Percentiles			
		5 <sup>th</sup>	10 <sup>th</sup>	90 <sup>th</sup>	95 <sup>th</sup>
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 <sup>2</sup> (ppm)	6	3	4	8	9

<sup>1</sup> Samples taken in July 2007 from 16 U.S. cities, excludes Los Angeles & San Antonio data  
<sup>2</sup> 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 50<sup>th</sup> to 90<sup>th</sup> percentile
- Staff selected the results of the 85<sup>th</sup> 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 <sup>1</sup>		
	min <sup>2</sup>	avg <sup>2</sup>	max <sup>2</sup>
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

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

<sup>2</sup> Based on survey fuels with 85<sup>th</sup> 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 <sup>1</sup>		
	min <sup>2</sup>	avg <sup>2</sup>	max <sup>2</sup>
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

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

<sup>2</sup> Based on survey fuels with 85<sup>th</sup> 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>

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