Introductions
Agenda

- Introduction
- Summary of previous workgroup discussions
  - Fuels
  - Engine selection
  - Vehicle Selection
  - Test Matrix
- Test Protocol
- Test schedule
- NOx Migration Update
- Biodiesel Multimedia Tier Evaluation
- Open discussion

- Comparison of Emission Benefits of CARB Diesel vs. Federal Diesel
  - Open discussion
• Executive Order S-1-07 Low Carbon Fuel Standard (LCFS)
  – Reduce at least 10 percent of the carbon intensity of California's transportation fuels by 2020.
  – Early action item with a regulation to be adopted and implemented by 2010.

• Executive Order S-06-06, establishing targets for the use and production of biofuels and biopower
  – Includes biodiesel and ethanol.
  – California shall produce a minimum of 20 percent of its biofuels within California by 2010, 40 percent by 2020, and 75 percent by 2050.
• Low Carbon Fuels Standard
  – Biofuels Specifications adopted by the first quarter of 2009
  – Biodiesel and renewable diesel research study is needed
Biodiesel and Renewable Diesel Research Study

- Biodiesel and renewable diesel emissions evaluation
- NOx formation and mitigation evaluation
- Transportation Refrigeration Units (TRUs)
- Light duty vehicles
- Durability study
- Multi-Media evaluation
Funded Research Update

• Biodiesel and Renewable Diesel Research Study
  – Biodiesel and renewable diesel characterization and NOx mitigation study-$1,689,000
  – Biodiesel and renewable diesel multimedia study-$400,000
  – Total cost $2,189,000

• Other contributors
  – South Coast Air Quality Management District-$150,000
  – National Biodiesel Board-$50,000
  – WSPA provided the CARB diesel
  – Innerstate Oil is providing transportation, short term storage of fuels, and the facility to blend fuels
  – Neste has provided the renewable diesel and funding
  – Discussions on-going with other contributors
Biodiesel and Renewable Diesel Emissions Characterization and NOx Mitigation Research

“Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California- Biodiesel Characterization and NOx Formation and Mitigation Study”

Principal Investigators: Thomas D. Durbin (UCR) and J. Wayne Miller (UCR)
University California Riverside-CE-CERT
University California Davis
Scope of Work

Task 1: Biodiesel and Renewable Diesel Emissions Evaluation Study
   - Evaluate emissions and health effects
   - Evaluate NOx impact

Task 2: NOx Formation and Mitigation Study
   - Investigate the mechanism of NOx formation and evaluate possible NOx mitigation options
     • Changes in fuel specifications-match blending
     • Refinery process
     • Additives
Summary of previous workgroup discussions
**Fuels Update-Specifications**

Initial base fuel specifications analysis

- CARB diesel fuel-ASTM D975
- Renewable diesel fuel ASTM D975
- Biodiesel feedstocks-D6751
- Samples from multiple drums were pooled
- All analyses conducted in triplicate
  - Where available, the certificate of analysis will count as one replicate.
Fuels Update - Biodiesel Additive

- Bioextend 30 (Tenox) treat rate
  - Based on oxidative stability and duration of storage
  - Recommended 600-700 ppm
  - Added directly to biodiesel feedstock not to finished fuel blend
Fuels Update-Blending

• Initial blend: 300 gallons of animal feedstock B20
• Blend level check by ASTM D7371-07
  – Samples were collected at various depths in the tote to check for uniform mixing
  – Samples will be sent to Magellan Laboratories for analysis
• Main blending of all blend levels and feedstocks to be conducted in mid-April
Fuels Update-Blending

- Main blending conducted in totes
- Gravimetric blending
- Add biodiesel last
- Biodiesel blend will be stirred for one hour
- Four totes needed per biodiesel blend
  - Mixing between totes will be done by electric pumps
  - Blend level will be measured
Fuel Storage Update

• On-going search for suitable long term storage facility
  – Located a non-temperature controlled storage facility on the coast where there is smaller temperature swings
Test Engine Update

• Engine secured for testing
  – 2006 11 L Cummins ISM purchased

• Other engines under consideration
  – 2007 15 L Detroit Diesel 15 (DD15)
    • Smallest DD15 engine at maximum horse power rating of the dynamometer (1550 ft-lb limitation)
  – 2007 11 L Detroit Diesel series 60 engine
  – 2007 International
Test Vehicle Update

• Vehicle one secured for testing
  – Purchased a heavy-Duty Truck equipped with a 2006 11 L Cummins ISM

• Rent/lease second vehicle
  – Heavy-duty diesel truck equipped with a 2007 Caterpillar C15 engine

• Vehicle three
  – Medium duty truck or bus
Test Vehicle Update-Aftertreatment Selection for Vehicle Three

• Cleaire Longview
  – Significant market share for buses
  – Controls both NOx and PM

• Johnson Matthey reformulated CRT
  – Expected to have significant market share
  – PM only
Discussion
Test Design

• Task 1: Biodiesel and Renewable Diesel Characterization Study
  – NOx Impact
  – Unregulated emissions and health effects

• Task 2: NOx Mitigation Study
  – Phase one
  – Phase two
Biodiesel and Renewable Diesel
NOx Impact Study
Possible Biodiesel NOx Impacts

- Evaluate test cycle load effects on NOx
- Evaluate biodiesel level effects on NOx
Biodiesel NOx Effect-Average Cycle Power

Figure 1: B20 and B50 Effects on NOx Emissions
MY 2004 Cummins ISB Engine

y = -5.576 + 0.445x
y = -2.094 + 0.17x

Ratio of slopes: 2.6

EPA data only

- EPA CBET Program
CE-CERT NOx Impact Study: Main Test

- Build upon USEPA and NREL studies
- Test conducted on an engine dynamometer
  - Engine dynamometer is suited to conduct the NOx impact study study
  - Provides precision necessary to distinguish small differences in NOx i.e. 2% change at B20
- Engines
  - 2006 Cummins ISM and 2007 engine
- Test cycles
  - FTP, UDDS light, HHDDT cruise
CE-CERT Main Test Protocol

• Received no comments
Discussion
On-Road Biodiesel and Renewable Diesel Characterization Study Conducted at ARB’s Heavy Duty Dynamometer Facility’s (MTA) Chassis Dynamometer Test Laboratory in Los Angeles
On-Road Biodiesel and Renewable Diesel Characterization Study

- Objective:
  - Test on-road vehicles
  - Emissions and health effects characterization
    - In-depth toxics characterization
    - Greenhouse gas emissions
    - Ultrafines and other species

- Conducted at MTA
Test Protocol

• Revised Draft test protocol posted
  – Table 2: revised some of the estimated target detection limits

• Issues to be resolved
  – Regeneration events
    • Record regeneration events
    • Include as part of data
  – Crankcase emissions
Discussion
Off-Road
Vehicle Test Conducted At Stockton’s Emission Test Facility

– Obtained engine dynamometer
NOx Mitigation Study

– No updates at this time
## Test Schedule-Emissions Characterization and NOx Mitigation Tests

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<th>Logistics</th>
<th>Fuel delivered</th>
<th>Pretests</th>
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### Duration of Emissions Tests
- Yellow: Duration of emissions tests

### Expected Range when Analytical Results will be Completed
- Dotted: Expected range when analytical results will be completed

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Test Schedule

• Goal is to adopt the low carbon fuel standard in December of 2008
  – Requires “critical mass” of biodiesel and renewable research be completed before December 2008
  – Options
    • Increase number of emissions tests per day
      – Require revision to test protocol
      – Pretest will determine if this is a suitable option
    • Completely characterize one engine before starting second engine
Discussion
Light-Duty Diesel Vehicle Testing

- To be conducted in collaboration with ARB’s Research Division Light-Duty Test Program
- Two vehicles
  - One passenger car
  - One pick-up truck/SUV/minivan
- Start date delayed to late 2008
Durability Study

- Request for proposal
  - Literature search
  - Survey
- CRC advisory role
TRU Research

• TRUs
  – Test B100 on TRU engines
  – Proposed test will be conducted be at the small engine dynamometer facility in El Monte
  – Estimated to be conducted in the Summer 2008
Biodiesel Multimedia Assessment

• Principle Investigators
  – Dr. Tom McKone, University CA Berkeley
  – Dr. Tim Ginn University CA Davis

• Biodiesel and renewable diesel
  – Assesses impacts on water, soil, air, human health, and the environment
  – Compared to CARB diesel
  – Evaluation includes a range of feedstocks, blend levels, and additives
Biodiesel Multimedia Assessment Protocol

• Draft Multimedia Guidance Document
  – Tier one: Establishes the risk assessment elements and issues (scope of work)
  – Tier two: Development of the experimental design
  – Tier three: Multimedia risk assessment submittal, review, and recommendation

• Goal to present Draft Tier one at the next advisory group meeting
### Test Schedule

#### Biodiesel/Renewable Diesel Research Study

**Biodiesel Studies by Tasks**

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**Biodiesel Mitigation**

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**MultiModal**

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**Summary of Milestones**

- Tier one milestones are to be met by March 2008.
- Tier two milestones are to be met by June 2008.
- Tier three milestones are to be met by September 2008.
- Tier four milestones are to be met by December 2008.

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This schedule is subject to change based on the progress of the research study.
Future Discussion Topics

- UL certification of biodiesel pumps
- Guidelines for converting a diesel engine to biodiesel
Biodiesel and Renewable Diesel Advisory Group

• Next meeting in June 2008