

Biodiesel and Renewable Diesel Research Study

April 10, 2008

California Environmental Protection Agency



Air Resources Board

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

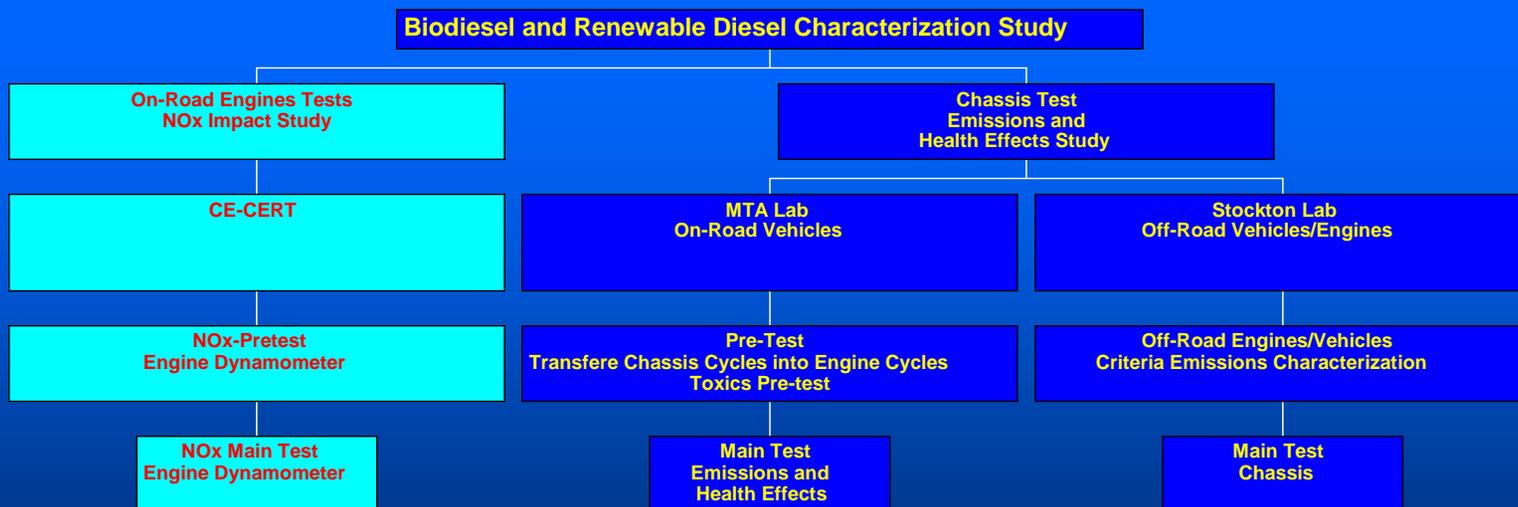
- Cleaire Longview
 - Significant market share for buses
 - Controls both NO_x and PM
- Johnson Matthey reformulated CRT
 - Expected to have significant market share
 - PM only

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

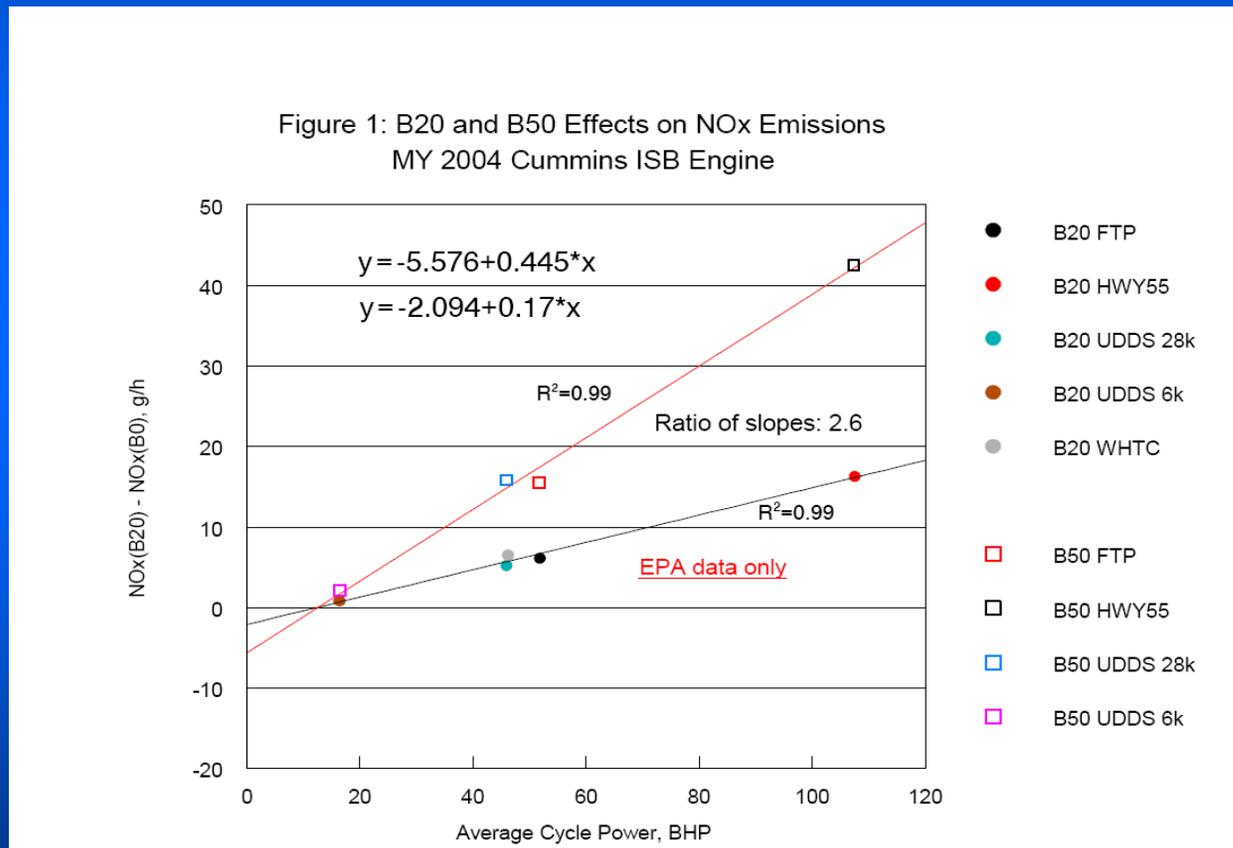
Biodiesel and Renewable Diesel NOx Impact Study



Possible Biodiesel NOx Impacts

- Evaluate test cycle load effects on NOx
- Evaluate biodiesel level effects on NOx

Biodiesel NOx Effect-Average Cycle Power



- EPA CBET Program

CE-CERT NOx Impact Study: Main Test

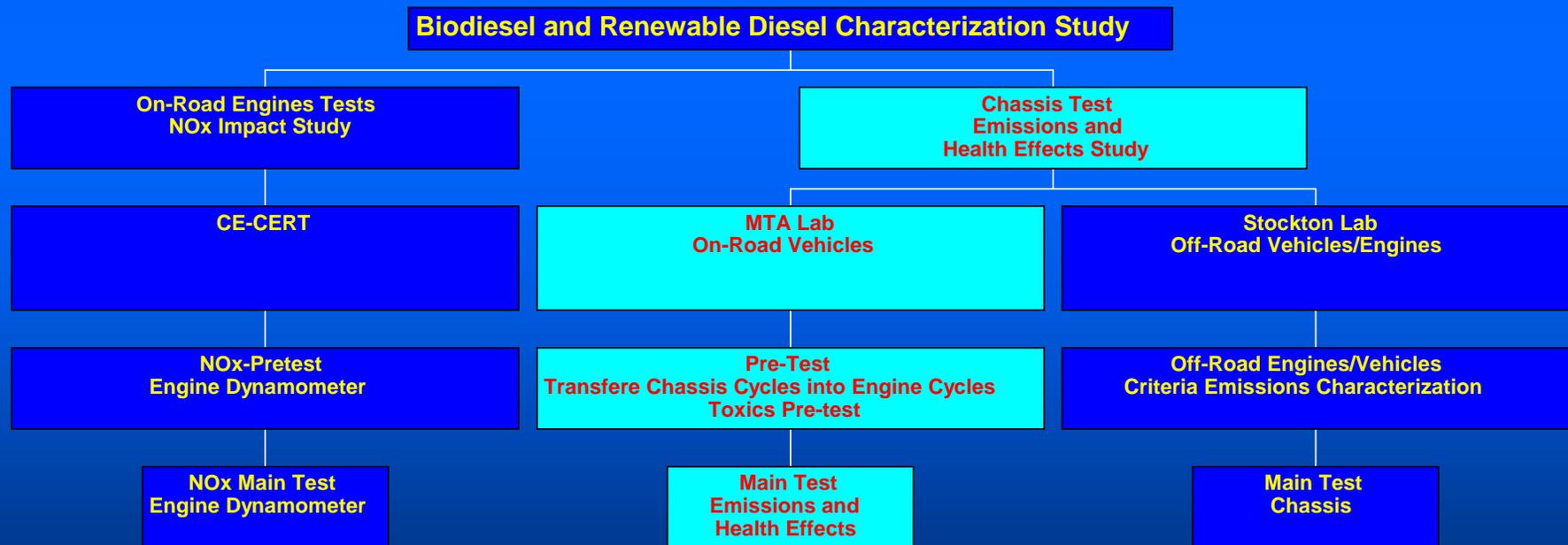
- Build upon USEPA and NREL studies
- Test conducted on an engine dynamometer
 - Engine dynamometer is suited to conduct the NOx impact study
 - Provides precision necessary to distinguish small differences in NOx i.e. 2% change at B20
- Engines
 - 2006 Cummins ISM and 2007 engine
- Test cycles
 - FTP,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

- 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

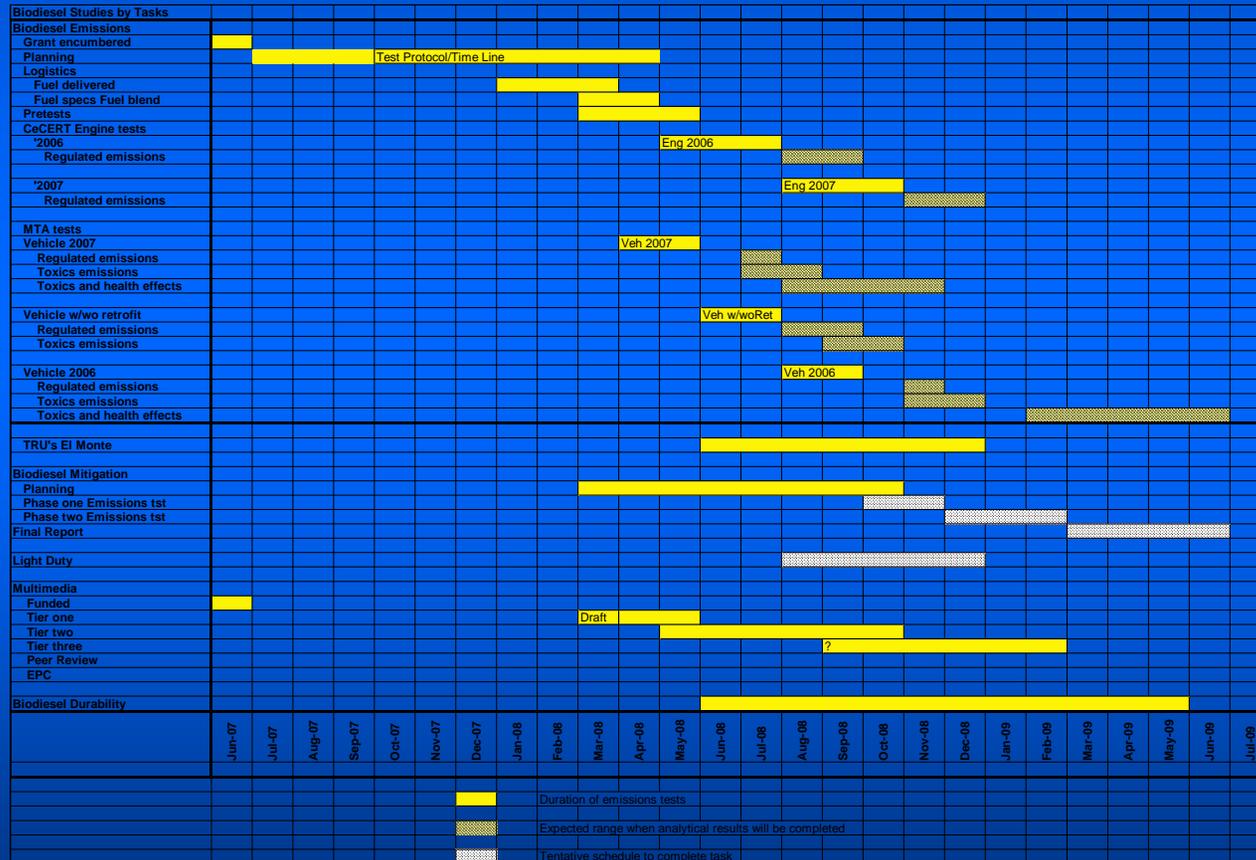
Biodiesel Multimedia Assessment

- 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



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