

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

Background

- 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

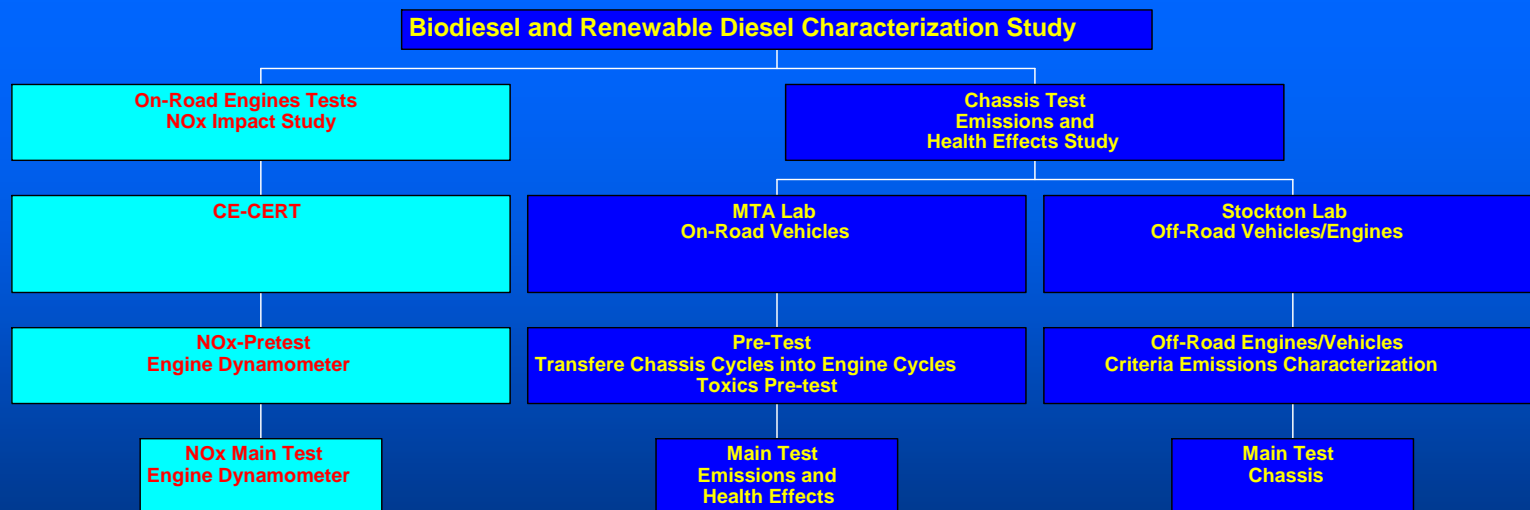
- Cleaire Longview
 - Significant market share for buses
 - Controls both NO_x and PM
- Johnson Matthey reformulated CRT
 - Expected to have significant market share
 - PM only

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

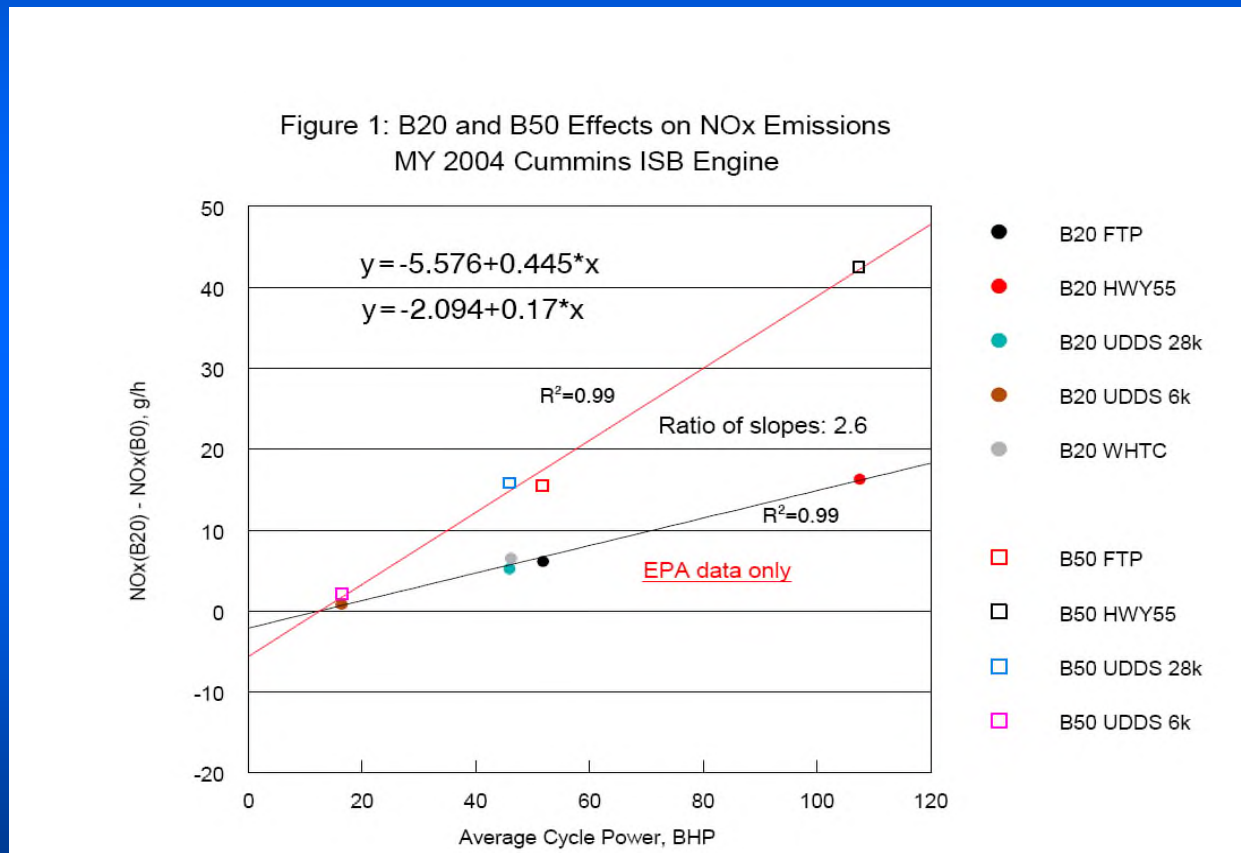
Biodiesel and Renewable Diesel NOx Impact Study



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

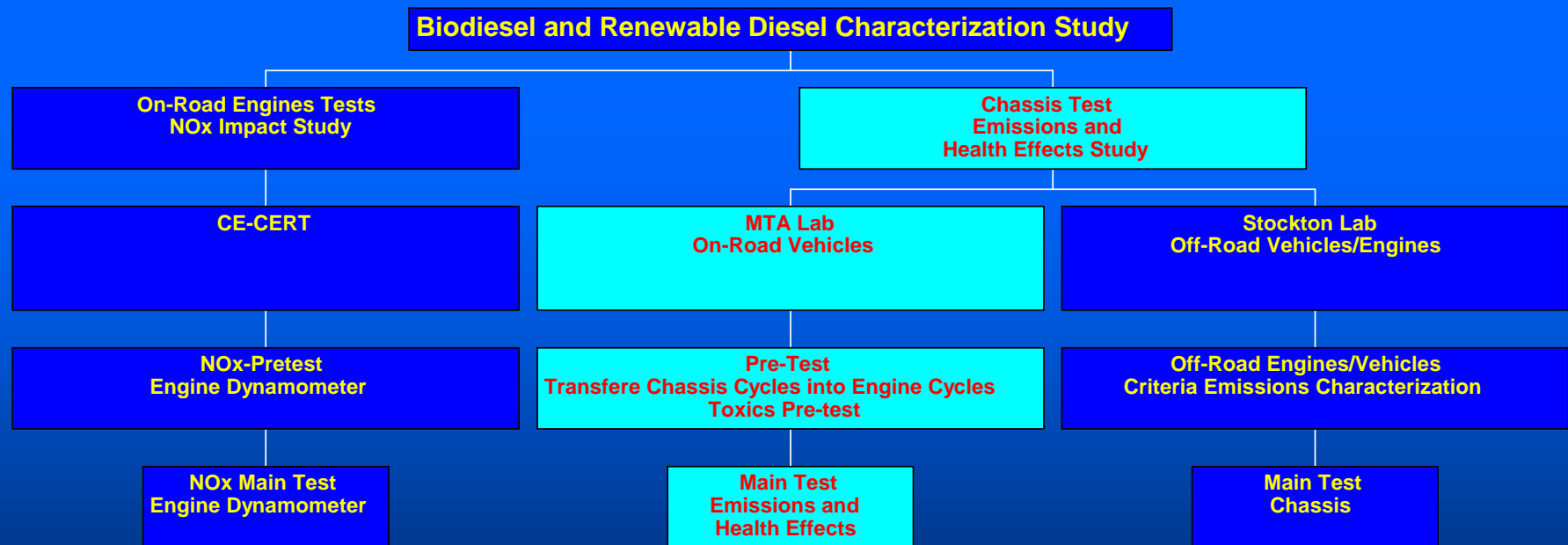
- Build upon USEPA and NREL studies
- Test conducted on an engine dynamometer
 - Engine dynamometer is suited to conduct the NOx impact study
 - Provides precision necessary to distinguish small differences in NOx i.e. 2% change at B20
- Engines
 - 2006 Cummins ISM and 2007 engine
- Test cycles
 - FTP,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

		Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09		
Biodiesel Emissions																							
Logistics																							
	Fuel delivered		Yellow bar																				
	Fuel specs Fuel blend				Yellow bar																		
Pretests				Yellow bar																			
CeCERT Engine tests																							
	'2006					Eng 2006																	
	Regulated emissions									Grey bar													
'2007																							
	Regulated emissions									Eng 2007			Grey bar										
MTA tests																							
	Vehicle 2007				Veh 2007																		
	Regulated emissions							Grey bar															
	Toxics emissions							Grey bar															
	Toxics and health effects								Grey bar														
	Vehicle w/wo retrofit							Veh w/woRet															
	Regulated emissions								Grey bar														
	Toxics emissions								Grey bar														
Vehicle 2006										Veh 2006													
	Regulated emissions											Grey bar											
	Toxics emissions											Grey bar											
	Toxics and health effects												Grey bar										
		Yellow bar		Duration of emissions tests																			
		Grey bar		Expected range when analytical results will be completed																			

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

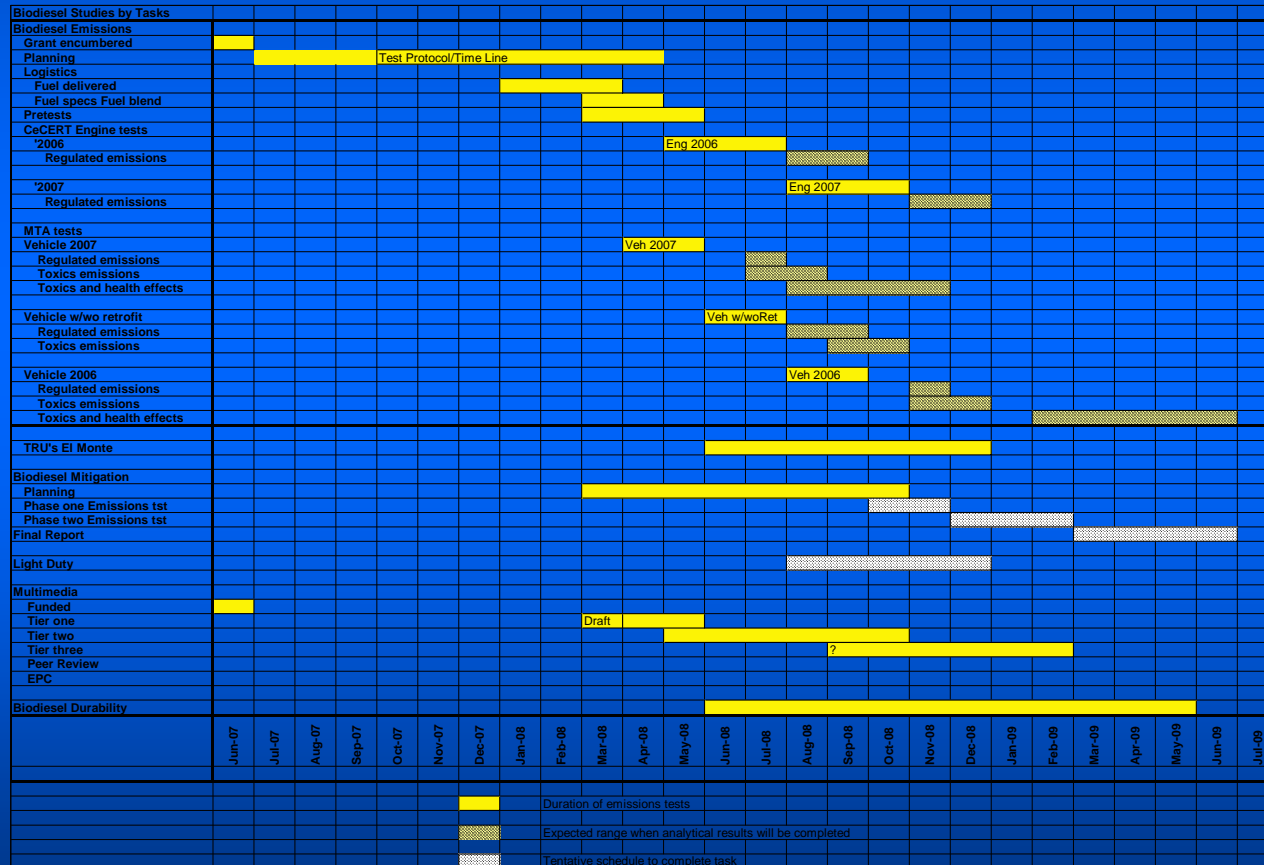
Biodiesel Multimedia Assessment

- 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