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 Migation 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.

Background

- 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

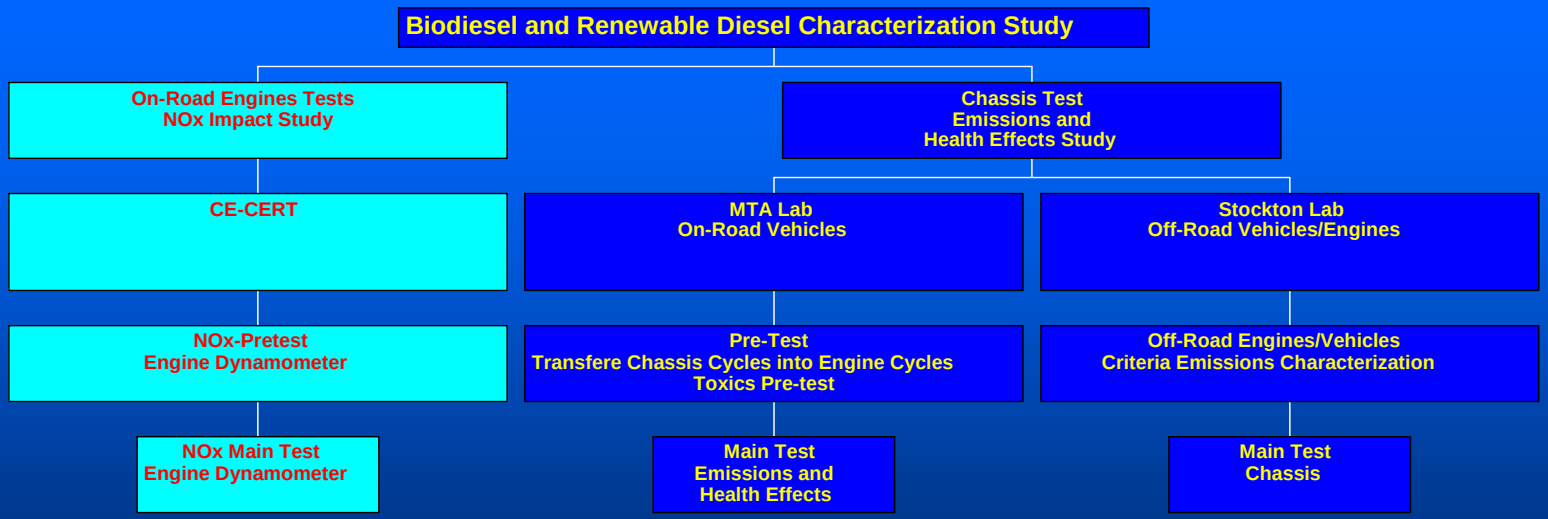
- Cleaire Longview
  - Significant market share for buses
  - Controls both NOx and PM
- Johnson Matthey reformulated CRT
  - Expected to have significant market share
  - PM only

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

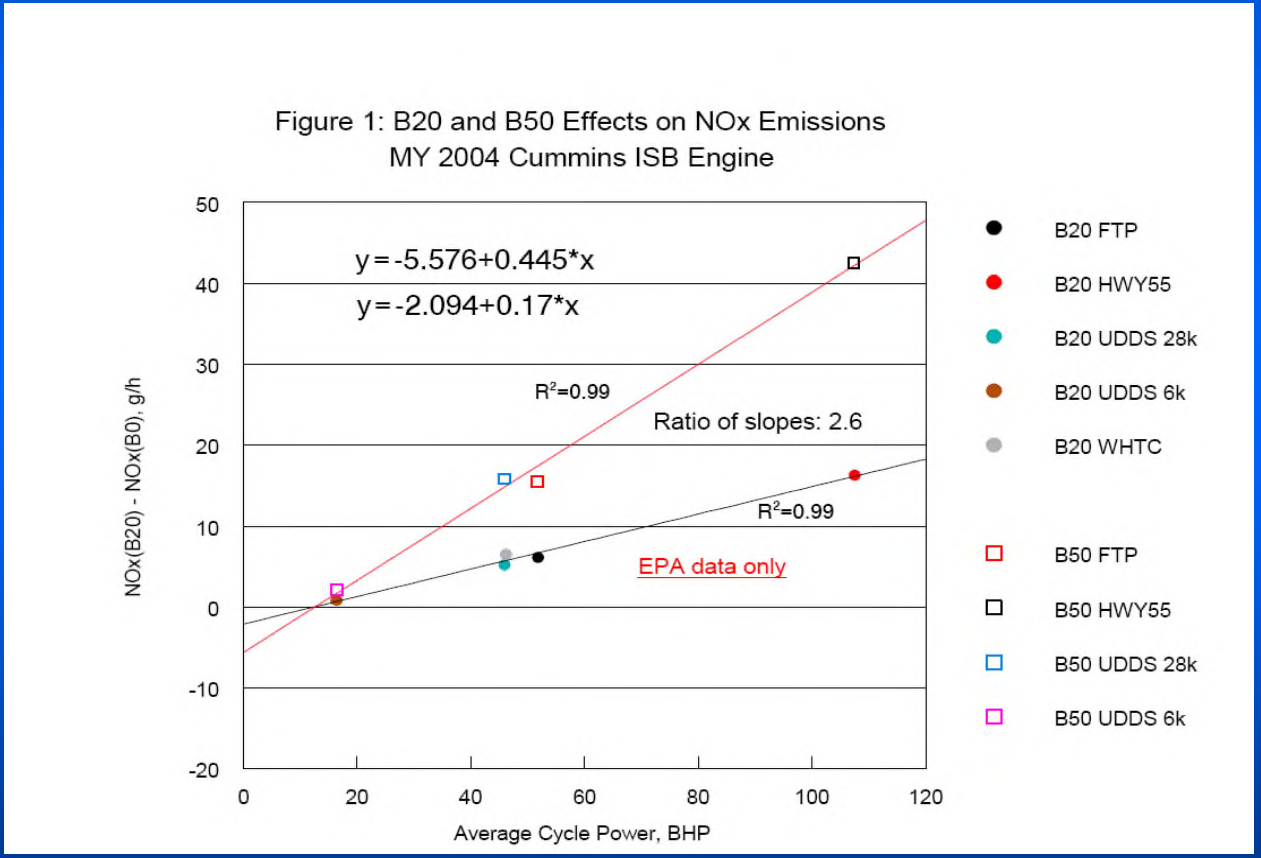
Biodiesel and Renewable Diesel NOx Impact Study



Possible Biodiesel NOx Impacts

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

Biodiesel NOx Effect-Average Cycle Power



- EPA CBET Program

CE-CERT NOx Impact Study: Main Test

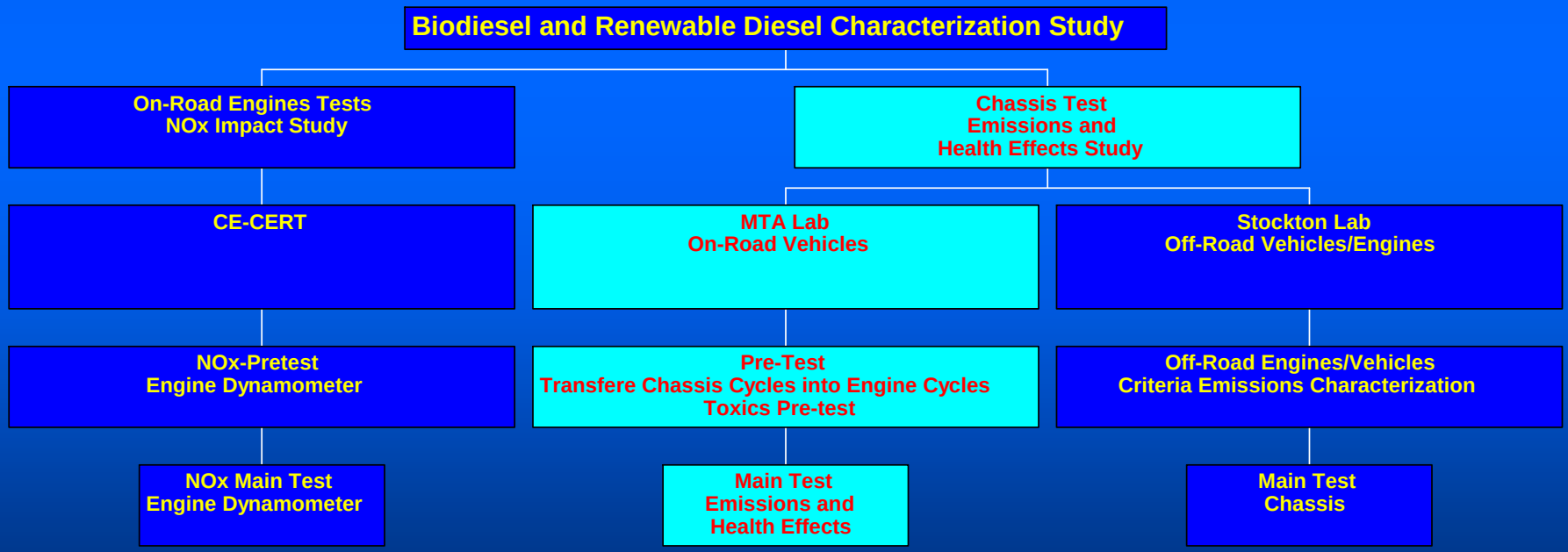
- Build upon USEPA and NREL studies
- Test conducted on an engine dynamometer
  - Engine dynamometer is suited to conduct the NOx impact study study
  - Provides precision necessary to distinguish small differences in NOx i.e. 2% change at B20
- Engines
  - 2006 Cummins ISM and 2007 engine
- Test cycles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

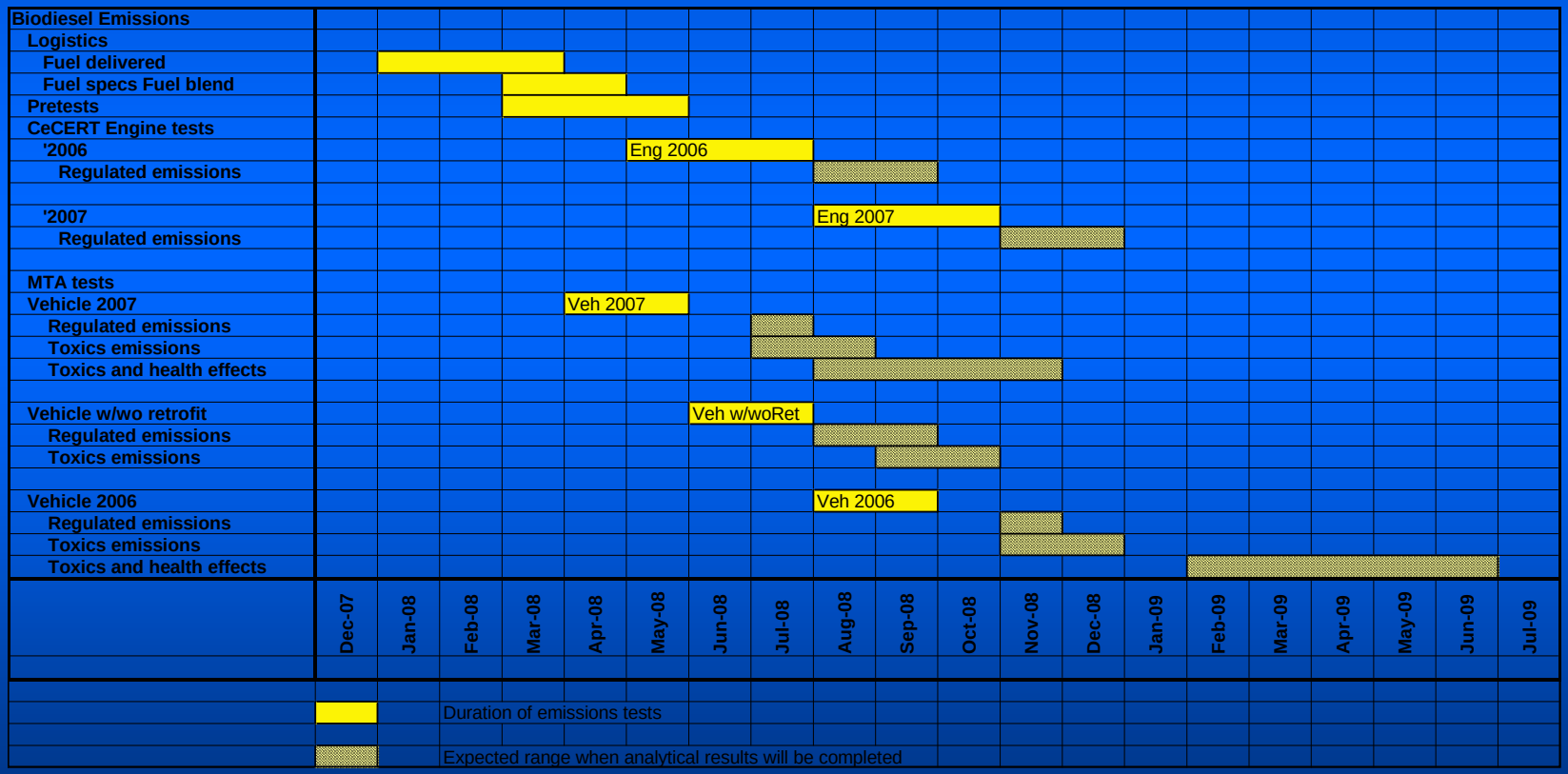
Off-Road Vehicle Test Conducted At Stockton's Emission Test Facility

– Obtained engine dynamometer

NOx Mitigation Study

– No updates at this time

Test Schedule-Emissions Characterization and NOx Mitigation Tests



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

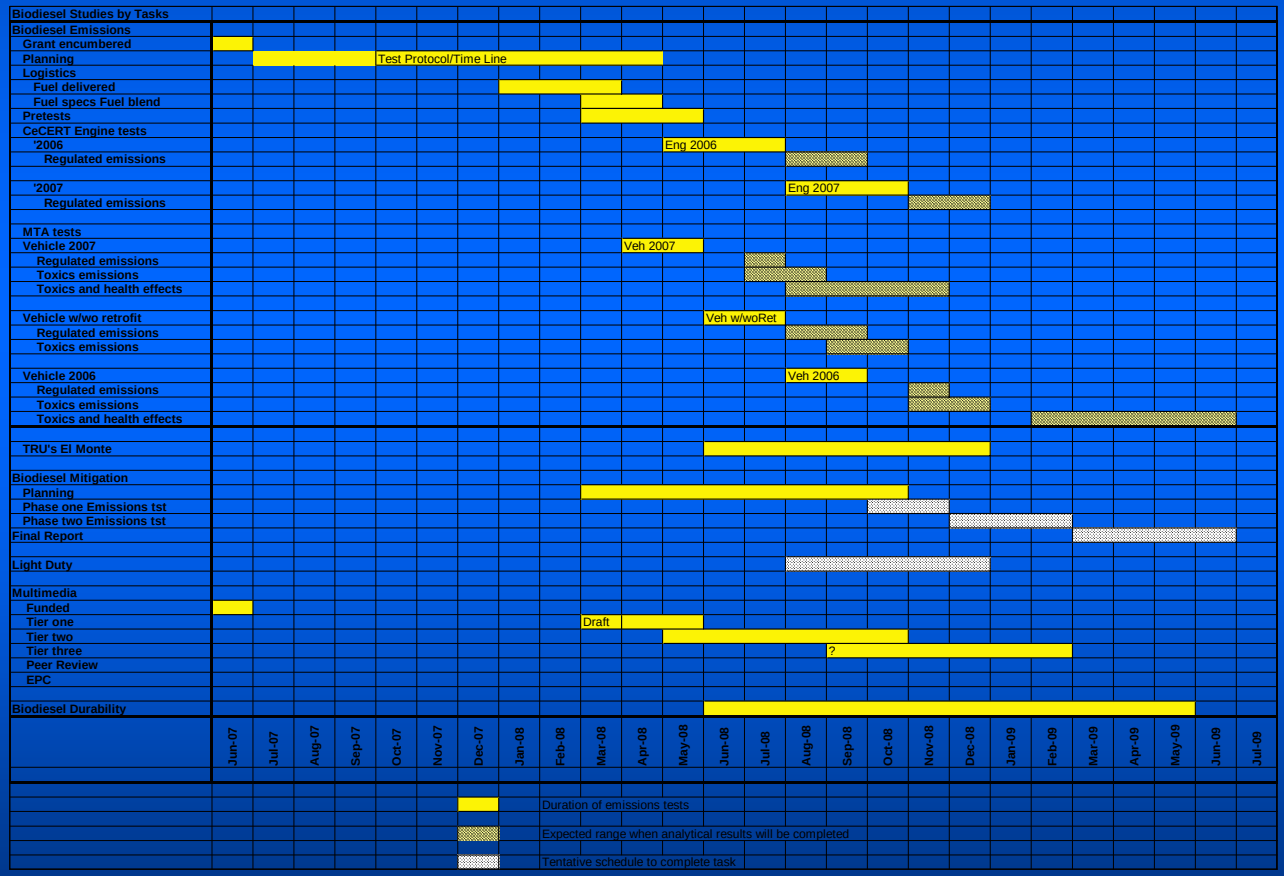
Biodiesel Multimedia Assessment

- 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