



Fuels for Advanced Combustion Engines (FACE)

*Josh Taylor, Scott Sluder, and Ken Wright
(And the entire FACE working group)*

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Members of the FACE WG

- Working group formed when DOE labs approached the CRC AVFL committee to collaborate on this project of mutual interest

Auto/Diesel Manufacturers

- General Motors
- Ford
- Cummins
- International Truck & Engine
- DDC

Government Agencies/National Labs

- U.S. Department of Energy
- National Renewable Energy Lab
- Oak Ridge National Lab
- Sandia National Lab
- Pacific Northwest Lab
- Lawrence Livermore National Lab

Energy Companies

- ConocoPhillips
- ExxonMobil
- Marathon Petroleum
- BP
- Chevron Energy Technology Co.

Other Organizations

- Battelle Memorial Institute
- West Virginia University
- NCUT
- Bill Leppard

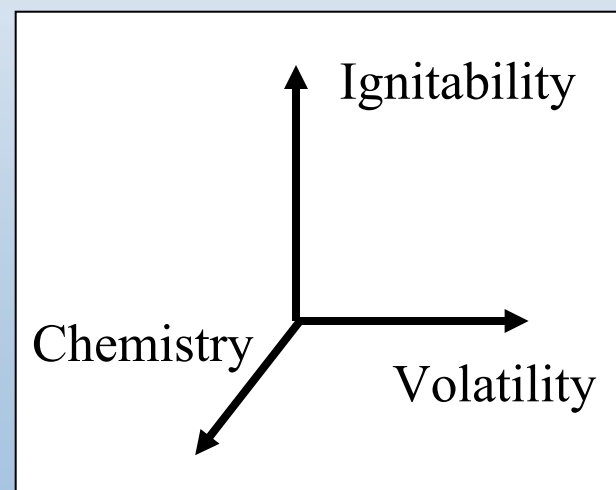
FACE Objectives

- Many competing engine technologies
 - Combustion
 - LTDC, PCCI, HCCI, MK, UNIBUS, etc.
 - Injection strategies
 - Early, late, split
 - Ignition control
 - Intake temperature, EGR, spark assist, variable compression ratio, etc.
- Difficult to cross-compare fuel effects
- **Objective:** Prepare a statistically designed set of research fuels that allow investigators to quantify fuel effects
 - Each technology may operate best with different fuels
 - We will not optimize “a fuel” for advanced combustion



Approach

- Gasoline and diesel sub-teams were formed
- Identify relevant physical properties for fuels
 - Downselect to focus on 3-4 most important
- Set ranges for relevant properties
- Define constraints for blending fuels
 - Fuels blended primarily from refinery streams
 - Additives should not be used and pure compound use should be minimal
- Contract a blender to prepare the fuels and make them available to research community
- Conduct extensive characterization of the fuels and make the results available publicly

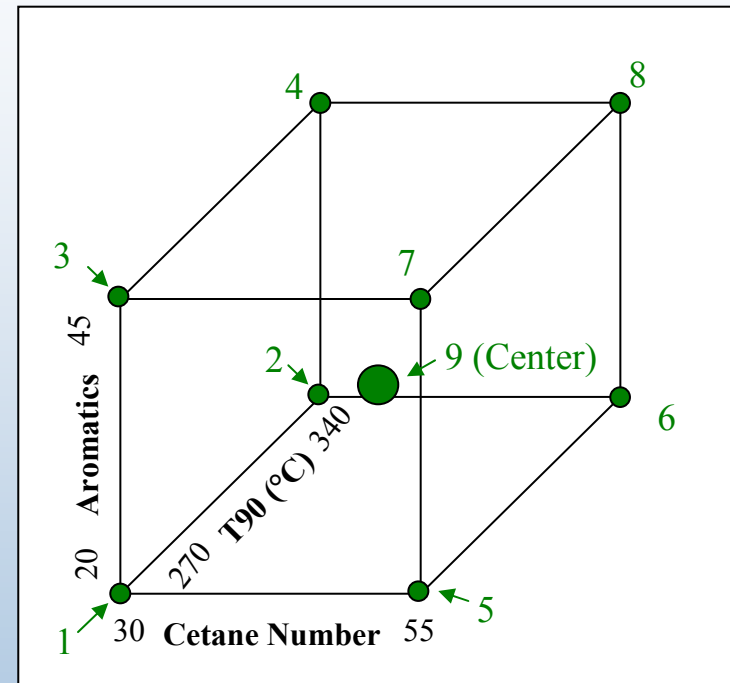


Gasoline FACE Fuels Matrix

- Properties defined:
 - RON (70-95)
 - Sensitivity (0-12)
 - n-Paraffins (5-25%)
 - Aromatics (0-50%)
- Constraints:
 - RVP = 7 psi
 - < 10% pure compounds
 - < 10% olefins
- Approach:
 - Hand blends of ~30 fuels will be prepared in small batches
 - Ability to match target properties and initial testing will help select final 10 fuel recommendation
- Status:
 - RFP issued and no responses were received
 - Possibly Chevron-Phillips may be interested in blending fuels

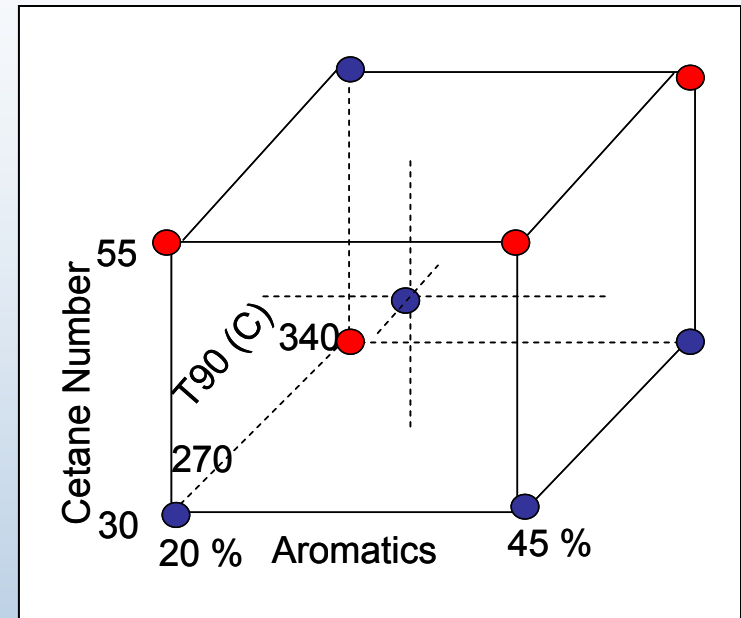
Diesel FACE Fuels Matrix

- Property Targets
 - Cetane Number (30-55)
 - Aromatics (20-45%)
 - T_{90} (270-340°C, or 518-644°F)
- Constraints
 - ULSD (< 15 ppm S)
 - < 4% olefins
 - Smooth distillation curve
- Center of cube shifted to mimic an average market fuel
 - CN = 43
 - Aromatics = 32%
 - $T_{90} = 320^{\circ}\text{C}$



Status of Diesel Fuel Blending

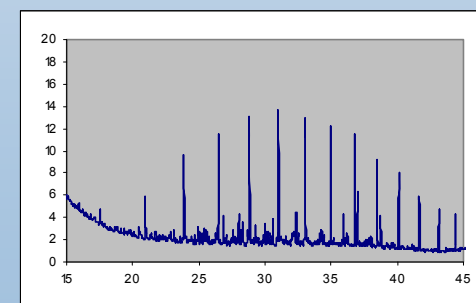
- Chevron-Phillips Chemical was selected as the blender for the diesel matrix of fuels
- 5 fuels have been blended and are available for purchase
- Decisions have been made to reach some of the challenging targets in remaining fuels
 - Remaining fuels are currently being blended and will be available soon



- Blue points in the cube are fuels blended as of 6/20/2007 and received for CN tests.
- Red points are fuels not yet blended.

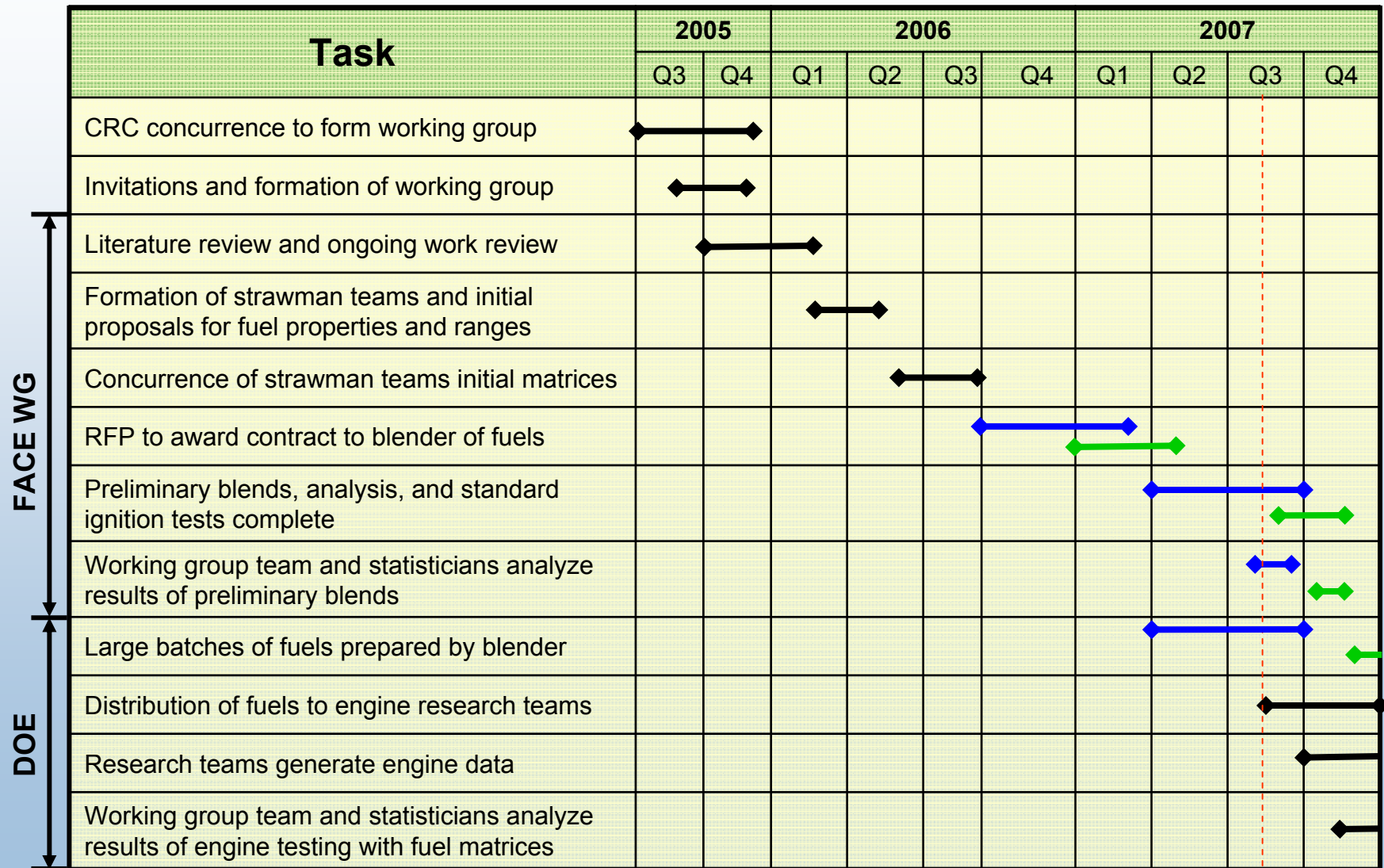
Characterization of Fuels

- Octane Number (RON & MON for gasoline range)
- Cetane Number and IQT Derived Cetane Number (for distillates)
- API Gravity
- RVP
- Sulfur
- Distillation (D86 – IBP, T5, T10,...T90, T95, EP)
- Oxygen
- H/C ratio
- Benzene
- Heat of Combustion (gross & net)
- Other D4814 properties for gasoline
- Other D975 properties for distillates
- **PIANO (n-paraffins, iso-paraffins, aromatics, naphthenes, olefins) (by FIA)**
- **Detailed Hydrocarbon Analyses (Possible techniques):**
 - **GC and GC/MS**
 - **2 Dimensional GC and 2D GC/MS**
 - **GC-FIMS**
 - **NMR**



FACE Timeline

 Diesel team
 Gasoline team



Future Direction of FACE

- Recasting mission statement
 - Allow working group to oversee project work
 - Fuel effects testing in advanced combustion engines
- Focus groups formed
 - Alternative fuels
 - Ethanol in gasoline blends
 - Biodiesel, oil sands diesel, and XTL/renewable diesel
 - Chemical kinetics
 - Fuels to span range of commercially available gasoline/diesel
 - Fuel safety issues
- Disseminate results of fuel characterization and testing