



Mid-Level Ethanol Blends Test Program

DOE, NREL, and ORNL Team

Presented by

Keith Knoll

Work supported by DOE/EERE

Shab Fardanesh and Joan Glickman

Office of the Biomass Program

Kevin Stork

Vehicle Technologies Program

**Vehicle Technologies Program Annual Merit Review and
Peer Evaluation meeting**

May 19, 2009

Project ID: ft_05_knoll



**This presentation does not contain any proprietary
or classified information**





Collaborators

Kevin Stork	DOE OVT
Shab Fardanesh	DOE OBP
Joan Glickman	DOE OBP
Wendy Clark	NREL
Ron Graves	ORNL
Keith Knoll	NREL
Doug Lawson	NREL
Robert McCormick	NREL
Steve Przesmitzki	NREL
Tim Theiss	ORNL
Brian West	ORNL

Many other NREL, ORNL
and subcontractor staff

Overview



Timeline

- Start: Summer 2007
- End: 2011?
- % complete: ~30%

Budget

- Total project funding
 - DOE ~\$40M through FY10
 - Industry and EPA: \$6M additional
 - Contractors (DOE funds): ~\$34M
- FY08: \$14.9M (OBP and VT)
- FY09: \$ 4M committed
 - \$10-\$15M add'l expected (ARRA + VT)

Barriers

- Non-petroleum based fuels infrastructure and end use
 - E15/E20 not legal fuels
 - Infrastructure to dispense into vehicles
 - Vehicle/engine safety and warranty issues (e.g., materials)
 - Vehicle/engine emissions

Major Partners

- EPA (government)
- CRC (autos and oils)
- OPEI (small nonroad engines)
- ISMA (snowmobiles)
- NMMA (marine)
- MIC (motorcycles and ATVs)

National Biofuels Targets

•New Renewable Fuel Standard

- Expand use of renewable fuels to 36 billion gallons annually by 2022 (vs. 7.5B gal/yr by 2012 in EPA Act 2005)
- Limits corn based RIN credits to 15 bgy
- Cellulosic biofuels component
 - 0.5 billion gallons by **2012**
 - 3 billion gallons by **2015**
 - 16 billion gallons by **2022**
- Includes Significant Safeguards
 - Ethanol production from corn is capped
 - EPA developing regulations to implement
 - EPA authorized to waive targets annually
 - Requires GHG reductions, which include land use impact
 - Requires studies on environmental impacts

•DOE Longer-Term Goal (30 X 30)

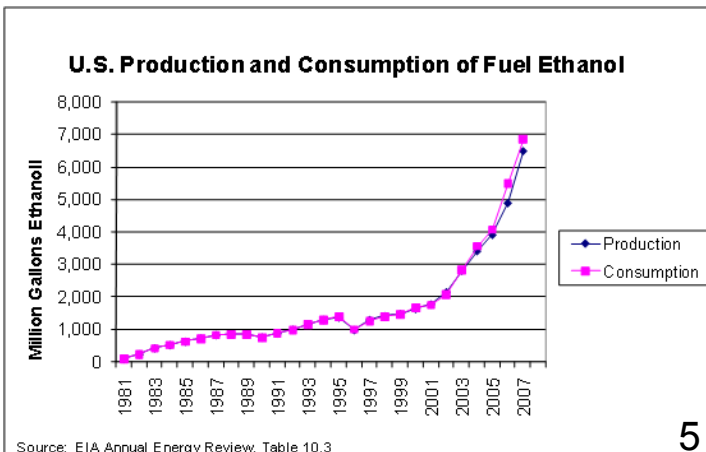
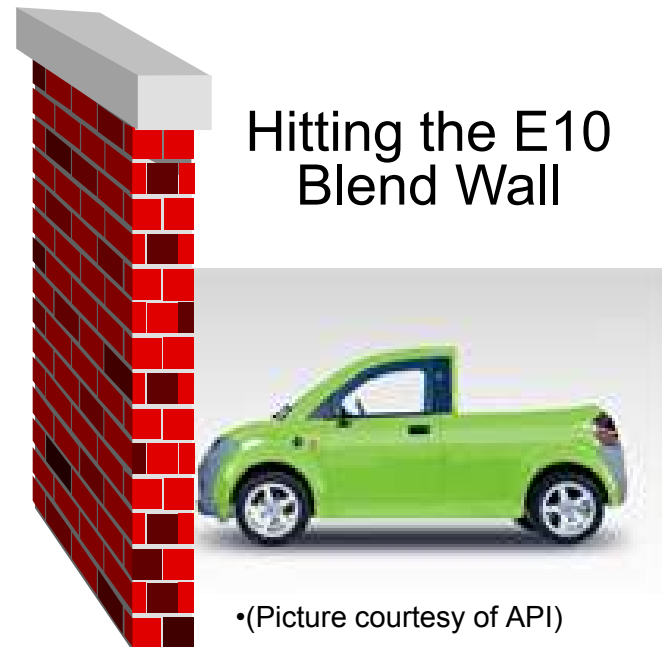
- Displace 30% of US gasoline consumption by 2030 with biofuels (60 billion gallons)



Best short-term option to displace gasoline - Ethanol

Developing A Ready End-Use Market for Ethanol

- An estimated 9+ billion gallons of ethanol were used in the U.S. in 2008
 - More than 99% is used in the form of E10
 - E10 market will be saturated at about 11+ billion gallons in CY09 (blend wall).
- DOE strategy for expanding ethanol use
 - **Evaluate feasibility of using mid-level ethanol blends (e.g., E15, E20) in conventional vehicles (non-flex fuel vehicles)**
 - Already involved in expanding E85 by targeting specific regions/cities to establish high concentration of FFVs and infrastructure
- EPA has authority to issue a “substantially similar” waiver to allow alternative fuels to be used in place of gasoline
 - Evaluate effects on durability, driveability, materials, and emissions

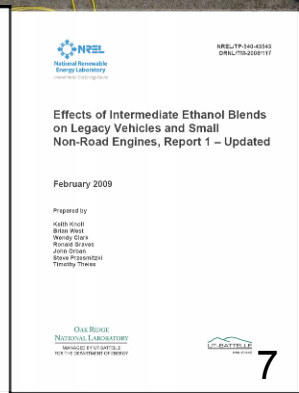
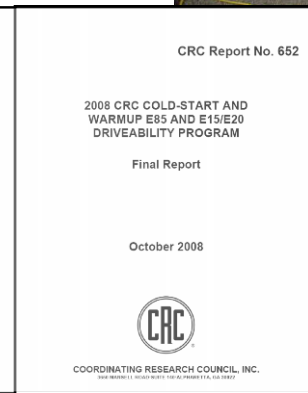
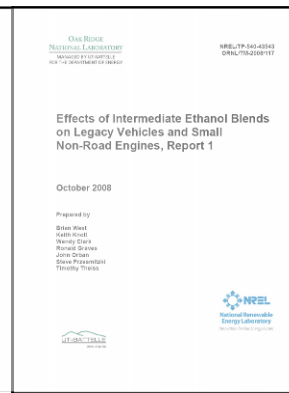


Goals and Objectives

- **Determine Effects of Mid-Level Ethanol Blends on Legacy Vehicles and Engines**
 - **Short-term Effects**
 - Emissions
 - Driveability
 - Equipment failure
 - **Long-term (full life) Effects**
 - Emissions
 - Driveability
 - Durability
 - Safety
- **Enable informed decision-making**

Approach

- Multiple parallel efforts
- Vehicle testing at national labs and subcontractors
 - ORNL, NREL
 - TRC
 - SwRI[®], DRI, Elemental Analysis, Inc
 - ETC
- Small engine testing at National Labs and subcontractors
 - ORNL, NREL
 - TRC
- Industry/Stakeholder partnerships (e.g., CRC, EPA)
 - Share cost
 - Valuable guidance
- Report Progress Periodically



Technical Accomplishments -1

- **Completed and published Literature Review to guide program**
- **Completed and published Driveability program with CRC**
- **Completed Small Nonroad Engine pilot study**
 - **Published report October 2008**
 - **Announced by Energy Secretary Bodman with release of Biomass Action Plan**
- **Completed Legacy Vehicle Emissions Study**
 - **16 vehicles (1999 to 2007) tested at 3 sites for short-term emissions and fuel economy, catalyst temperature**
 - **First published October 2008**
 - **Updated Report published February 2009**

Technical Accomplishments -2

- **Began Detailed Vehicle Emissions Study with EPA**
 - 22 vehicles to be tested with 31 match-blended fuels
- **Began Full Useful Life Vehicle Emissions Studies**
 - Up to 80 vehicles to be aged to full life to assess long term emissions impact of ethanol blends
 - 3 subcontracts, 3 test sites
- **Began Vehicle Evaporative Emissions Study with CRC**
 - 16 vehicle study with 6 fuels to assess evaporative emissions impacts of ethanol blends
- **Began Materials Compatibility Studies**
 - Examine wetted components or materials with ethanol blends

Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

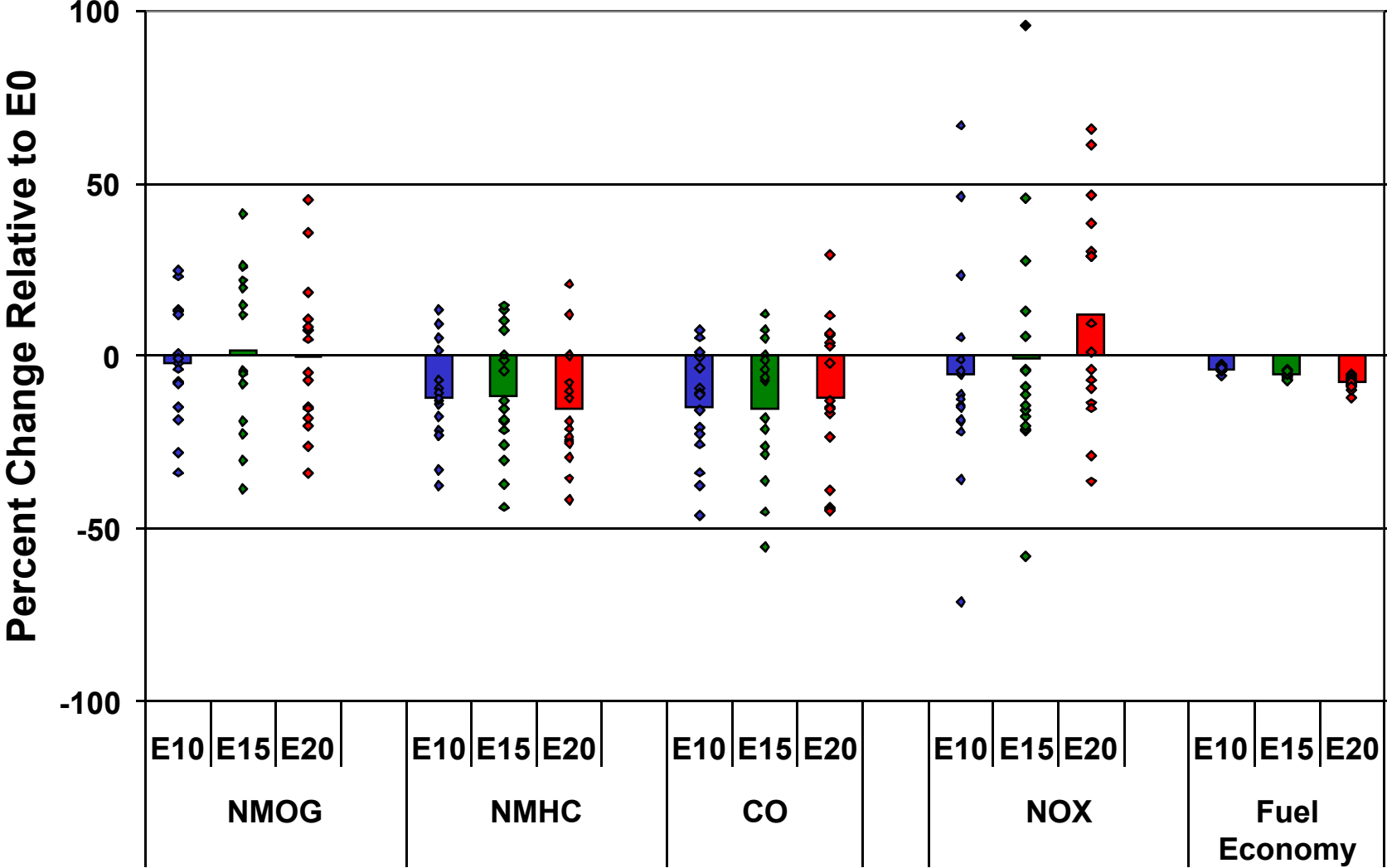
V1- Test Vehicles

OEM (make)	Model	Year	Engine	Initial odometer reading (miles)	Emission standard	Test site	LFT at WOT?
Chrysler	Town & Country	2007	3.3 L V6	35,000	Tier 2, Bin 5	NREL/CDPHE	N
Ford	F150	2007	5.4 L V8	28,600	Tier 2, Bin 8	TRC	Y
Ford	F150	2003	5.4 L V8	57,000	Tier 1 LEV	TRC	Y
Ford	Taurus	2003	3.0 L V6	89,600	Tier 2, Bin 8	TRC	N
GM (Buick)	Lucerne	2007	3.8 L V6	10,000	Tier 2, Bin 5 (CA LEV II)	NREL/CDPHE and ORNL*	Y
GM (Buick)	LeSabre	2003	3.8 L V6	78,000	Tier 2, Bin 8	NREL/CDPHE	Y
GM	Silverado	2007	4.8 L V8	12,800	Tier 2, Bin 8	TRC	Y
Honda	Accord	2007	2.4 L I4	11,400	Tier 2, Bin 5 (CA LEV II)	TRC	N
Nissan	Altima	2003	3.5 L V6	53,300	LEV	TRC	N
Toyota	Camry	2007	2.4 L I4	26,440	Tier 2, Bin 5	ORNL and NREL/CDPHE*	Y
Toyota	Camry	2003	2.4 L I4	72,800	ULEV	ORNL	N
Chrysler	PT Cruiser	2001	2.4 L I4	93,400	NLEV	NREL/CDPHE	Y
Ford	Crown Victoria	1999	4.6 L V8	50,900	ULEV	NREL/CDPHE	Y
Honda	Civic	1999	1.6 L I4	79,680	Tier 1	ORNL	N
Toyota	Corolla	1999	1.8 L I4	96,400	Tier 1	NREL/CDPHE	Y
VW	Golf GTI	2004	1.8 L I4 Turbo	32,900	Tier 2, Bin 8	ORNL	Y

*Round-robin vehicle tested at two sites

V1- Vehicle Emissions Results:

(16 Vehicle Fleet – each point represents a vehicle)



Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Task V2: EPA Act Program



V2 - Specific Objective/Overview of Tasks

- **Objective: Establish effects of RVP, T50, T90, aromatic content and EtOH levels on exhaust emissions from new Tier 2 and in-use vehicles**
- **Tasks include**
 - Testing 19 new Tier 2 vehicles and 3 high mileage/emitter vehicles
 - Test fuel matrix of 31 fuels (including 1 E85 fuel)
 - Species measured: Regulated emissions, CO₂, NO₂, VOCs, ethanol, carbonyl compounds
 - VOCs include gaseous and semi-volatile organic (SVOC) compounds
 - N₂O, NH₃ and HCN by FTIR
 - Some PM, PM number and size, and SVOC speciation

V2 Program Status

- Test program development has been completed with addition of E20 fuels in fuels matrix.
- EPA contract for Phases 1 and 2 in place with SwRI[®]; NREL subcontract for fuel blending in place; NREL Phase 1 and 2 subcontract in place; NREL issued RFP for Phase 3 on March 5, 2009.
- Fuel blending began in February 2008; significant challenges have been faced for blending; problems solved.
- 2008 model year vehicle recruitment completed; 3 high mileage/high emitter vehicles not recruited yet.
- Phase 1 testing (75°F) began in April 2008 and completed in August; Phase 2 testing (50°F) completed in January 2009.
- Phase 3 testing (all vehicles with 28 fuels at 75°F began in March 2009.

Task Summary

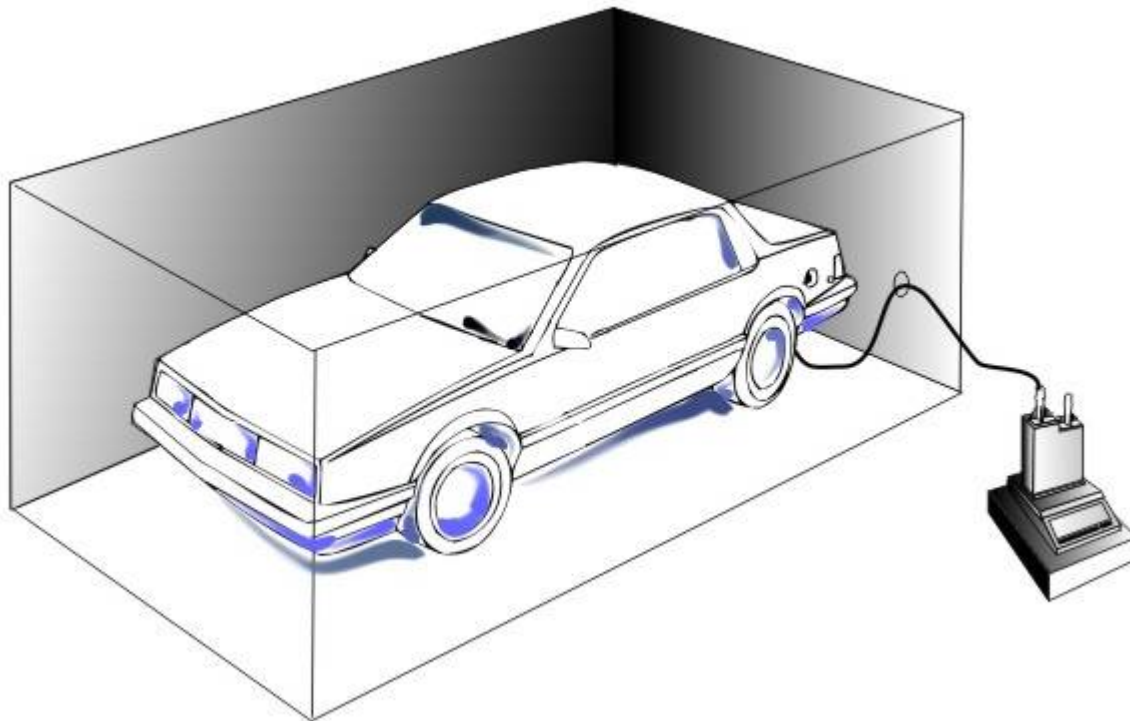
Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

Vehicle Evaporative Emissions

V3: Evaporative Emissions (DOE, EPA, CRC)

- 16 Vehicles / 6 Fuels (E0, E10, E20)
- Initial phase complete, report expected 1st Qtr 2009
- 2nd phase started Oct 2008, expect report March 2010
- **Static Permeation, Running Loss Permeation**



Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

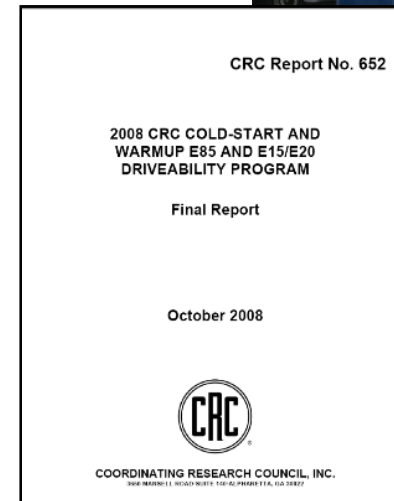
Vehicle Driveability / Operability

V5: Cold Start and Driveability (DOE and CRC) - 6 Vehicles

- Low Temp, Class 1 & 2 E0, E15, E20. Match Blends
- Report issued October 2008
 - No temperature effect noted on driveability with gasoline
 - Driveability with ethanol blends showed a marginally significant temperature effect
- High Temp / High Altitude testing (Class 1) planned for summer 2009
- “Official” driveability using trained raters

V11: RIT Vehicle Fleet Study

- 10 Vehicles / 2 Fuels (E0, E20), Splash Blends
- Larger fleet study in planning stages
- NREL analyzing data: driveability, maintenance costs, fuel economy



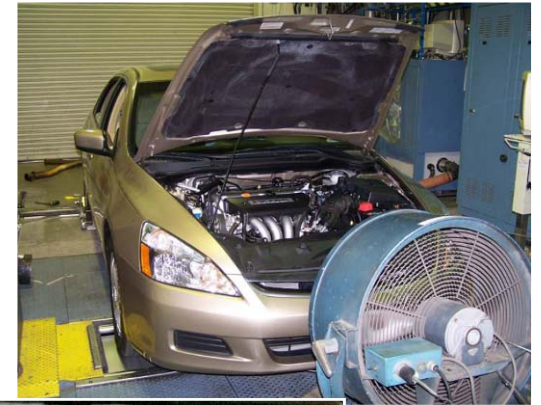
Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

V4 Project Status

- **Vehicle emissions testing and aging underway at SwRI® (with CRC)**
 - Aging on mileage accumulation dynamometers
 - 16 vehicles purchased and under test
 - 2006-2008 model year
 - Additional vehicles TBD
- **Parallel contracts starting**
 - TRC
 - Aging on track
 - 8 new 2009 vehicles
 - 8 additional vehicles TBD
 - ETC
 - Mileage accumulation dynamometers
 - 8 new 2009 vehicles
 - 8 additional vehicles TBD



Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

Fuel System Materials Compatibility

V6: Fuel System Materials Compatibility (DOE and CRC)

- 3 Fuels: E0, E10, and E20-aggressive
- Testing underway – full results expected by January 2010
- Fuel system component, sub-system and system evaluation



Photos courtesy of CRC

V7: Vehicle Materials Compatibility

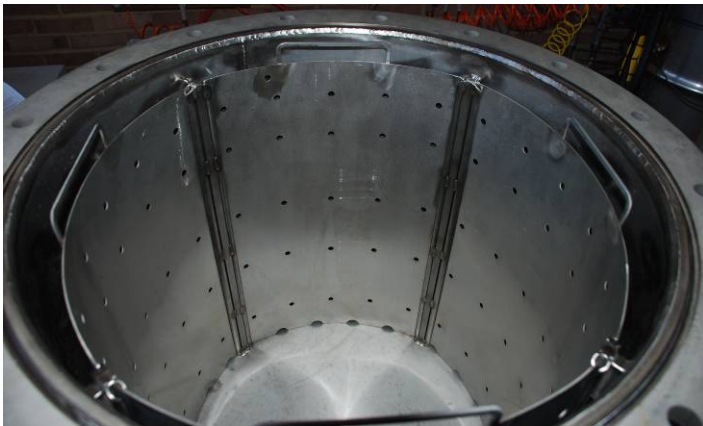
- Review of MN / RFA reports

V8: Fuel Dispenser Materials Compatibility

- Collaboration with UL
- More detail to follow

V8 - Materials Compatibility Studies

- **Dispenser component tests summer/fall 2007 with UL**
 - UL ready to take applications for E85 pump certification
- **Stir tank apparatus constructed for elastomer and metal-based coupon or component studies**
 - More fundamental materials studies
 - Dynamic test (stir tank)
 - Temperature control (up to 60°C)
 - Coupons periodically removed for analysis
 - Studies currently underway
 - Apparatus available for evaluation of automotive or SNRE materials



Metals and Elastomers under investigation:

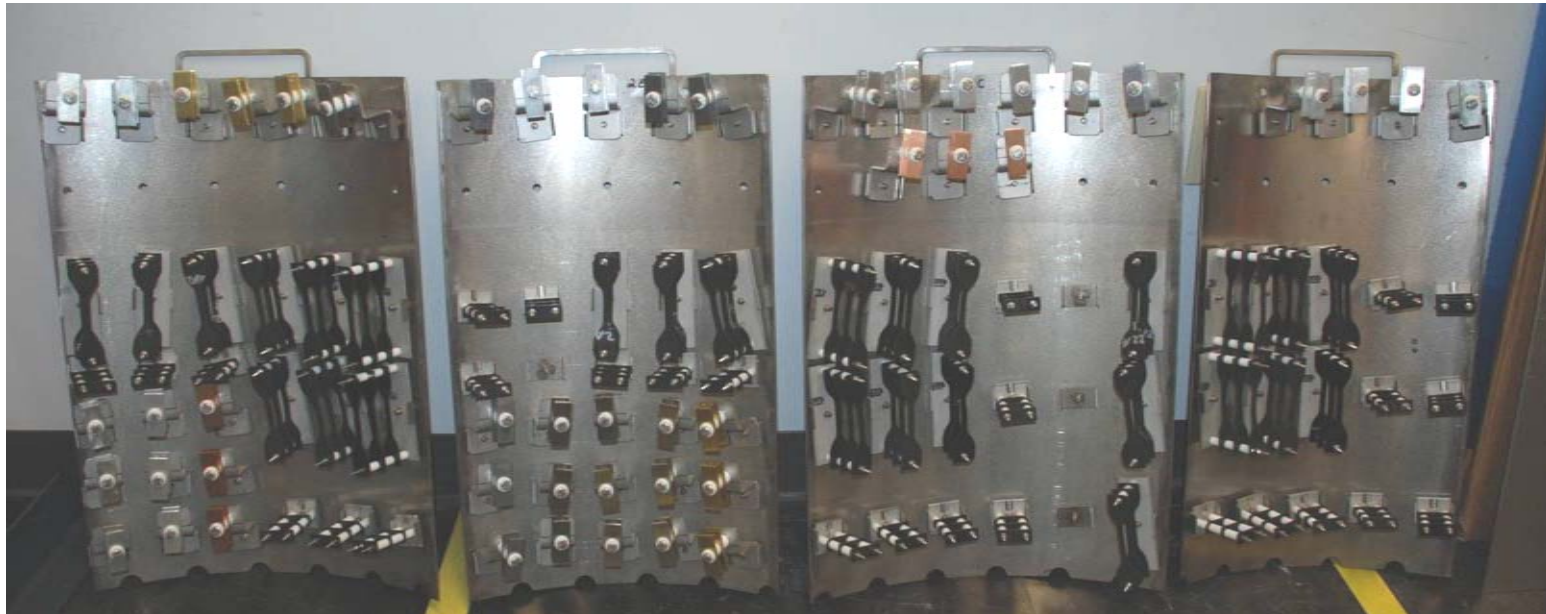
Metals and Alloys

Nickel	Stainless steel
Bronze	Brass
Terne metal	mild steel
Aluminum	mild steel (galvanized)

Elastomers

Viton A401C	Dyneon FE 5620
Viton B601C	Dyneon FE 5840
Viton GF-600S	Dyneon FPO 3741
Viton GFLT-S	Dyneon LFTE 6400
Goodyear NBR 559N (nitrile)	

Currently used on many standard gasoline dispenser hoses



Task Summary

Team Developed List of 15 projects in Summer 2007

Vehicle Tasks	Task Description	DOE Lead
V1	Short-term “quick-look” emissions study of 16 vehicles (4 fuels)	ORNL/NREL
V2	Detailed Exhaust emissions with EPA (22 vehicles, 31 fuels; E-89 with CRC, 2/31 fuels)	NREL
V3	Vehicle Evaporative Emissions with CRC (E-77)	NREL
V4	Full-life Vehicle Emissions Study (Catalyst Durability with CRC, E-87)	ORNL
V5	Vehicle Driveability with CRC (CM-138)	NREL
V6	Vehicle Fuel System Materials Compatibility with CRC (AVFL-15)	NREL
V7	Vehicle Materials Review (University of MN/RFA Studies)	ORNL
V8	Materials Compatibility with UL (E85 dispensers + materials studies)	ORNL
V9	Vehicle On-board Diagnostics and Operations Issues	NA
V10	Health Impacts	NA
V11	Fleet Performance and Emissions with RIT	NREL
Non-automotive Engines and small nonroad engines (SNREs)		
SE1	SNRE emissions and temperature (quick-look, in-house ORNL and NREL, 6 engines, 4 fuels)	ORNL/NREL
SE2	SNRE Full Useful Life Emissions and Durability (22 engines, 4 fuels, 17 engines to full life)	ORNL
SE3	SNRE Class II engine Full Useful Life Emissions and Durability	NA
SE4	Motorcycles, marine, ATVs, Snowmobiles	NA

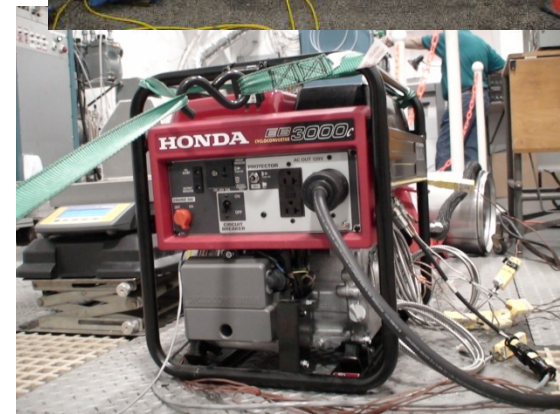
Small Non-Road Engines (SNRE) **(Lawn and garden equipment, Generator Sets)**

SE1: Emissions and Exhaust Temperature Pilot Study (6 engines)

- 6 Engine Families / 4 Fuels (E0, E10, E15, E20)
- Reported to EPA in October 2007
- Published results in Mid-Level Blends Report 1 (October 2008)

SE2: Full Useful Life Emissions and Durability

- 17 engines aged to full life / 4 Fuels (E0, E10, E15, E20)
- Reported in Mid-Level Blends Report 1 (October 2008)



SE1/SE2 Small Engine Test Results Summary:

- **Emissions changes with increasing ethanol**
 - NOx emissions increase
 - HC and CO emissions decrease
 - Results were expected due to leaner operation with open-loop engines
- **Temperatures**
 - Exhaust and component temperatures increased
 - No catastrophic failures due to ethanol
 - Multi-cylinder engines not tested to full life. May be more sensitive to higher levels of ethanol
- **Operability**
 - Increased ethanol caused clutch engagement at idle on tested commercial line trimmers (due to higher idle speed), a potential safety concern
 - Increased idle speed due to leaner operation
 - Carburetor adjustment was able to eliminate the problem on these engines

Near-term focus on partial waiver for newer vehicles has deferred additional SNRE and other non-automotive work

Milestones

August 2007

- ORNL issued Literature Review on Technical Issues of E20 Fueling on Legacy Engines

October 2008:

- ORNL/NREL issued Report 1 on Vehicle and Small Engine Results

October 2008:

- CRC Report #652 on driveability issued (co-funded by DOE). Report available to public on CRC website.

January 28, 2009:

- DOE, labs, and equipment manufacturers participated in second meeting of API-organized 'Coordination Committee on Intermediate Ethanol Blends R&D' (most recent of several such meetings)

February 2009:

- NREL/ORNL issued Update to Report 1 to include results from 3 additional vehicles (vehicles were still under test when October report published)

Future Work

- **Complete Full Useful Life Vehicle Durability Study (V4) on 48 vehicles by September 2010**
- **Complete Phase 3 of Vehicles emissions study (V2) with EPA (January 2010)**
- **Complete high-temperature, high-altitude driveability study by September 2009 (V5)**
- **Complete 16 Vehicle evaporative emissions study (V3) by March 2010**
- **Complete vehicle materials studies with CRC (V6) January 2010**
- **Continue to work with UL, EPA, CRC and other industry stakeholders to execute test programs underway and define additional studies**

Summary

- **Relevance**
 - DOE, NREL, and ORNL Team working to establish feasibility of Mid-level Ethanol Blends.
 - Mid-level blends seen as key to compliance with EISA
- **Approach**
 - Multiple resources utilized in parallel to conduct massive test program
 - Collaborating with government and industry stakeholders
- **Technical Accomplishments**
 - Published Lit. Review, results of vehicle and small engine tests, driveability study
 - Initiated multiple parallel projects at several test sites
- **Technical Challenges**
 - EPA will decide legality of E15/E20
 - Challenge is to produce adequate volume of quality data in appropriate time frame
 - DOE, EPA, and industry resources are being applied to meet this challenge
- **Technology transfer and future work**
 - Working closely with industry stakeholders and EPA to define and execute program