CRC

ANNUAL REPORT

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COORDINATING RESEARCH COUNCIL, INC.

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COORDINATING RESEARCH COUNCIL ANNUAL REPORT

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PART ONE

STATE OF THE COUNCIL

STATE OF THE COUNCIL - 2020

In 1919, a technical committee was formed for the purpose of cooperative research between the automotive and energy industries, government scientists, and academia. That Committee became the Coordinating Research Council in 1942. CRC continues to provide a forum and process for industries to work together on joint research of mutual interest, and encourages cooperation and communication on research between industries, governments, and the scientific community at large. The operation of the Council has evolved to meet the needs of this community, and currently includes four Automotive-focused Committees, an Aviation Committee, and a multitude of active Working Groups and Technical/Advisory Panels.

CRC technical work during the 2020 research program year, as in years past, includes broad cooperation on research projects and in technical workshops. Research partners in 2020 span the stakeholder community, including: the U.S. Environmental Protection Agency (EPA), the California Air Resources Board (CARB), the Health Effects Institute (HEI), the South Coast Air Quality Management District (SCAQMD), the Truck and Engine Manufacturers Association (EMA), the U.S. Department of Agriculture (USDA), many of the U.S. Department of Energy (DOE) National Laboratories, Trade Organizations, individual equipment manufacturers, and representatives of alternative/emerging fuels and technologies.

CRC technical reports are approved by the committees and research partners that oversee the research, and are then made available on the CRC website, www.crcao.org. Select research projects conducted by CRC are also reported in the peer-reviewed literature. Workshop summaries and, if available, proceedings are also made available.

Details on these completed studies and ongoing CRC committee projects appear in Part Two of this Annual Report. Final Reports issued since the last CRC Annual Report are listed in Part Three. Organization and Memberships are presented in Part Four.

In 2020, the COVID-19 Global Pandemic had a tremendous impact on the world, and continues to do so at the time of this report. The work of the Council continues unabated, bringing together all of our Members and Partners using virtual meeting technology to continue the vital collaborative research that is our mission.

PART TWO

DETAILED REPORTS OF CRC PROJECTS

CRC WORKSHOP ON LIFE CYCLE ANALYSIS OF TRANSPORTATION FUELS

CRC Project No. E-93-6

Leaders: R. De Kleine
J. Han
A. Levy

Scope and Objective

CRC has hosted six biennial, invitation-only Life Cycle Analysis (LCA) workshops, starting in 2009 at Argonne National Laboratory (ANL) near Chicago. Each were attended by more than 100 LCA experts from government, industry, academia, and non-governmental organizations (NGOs). Workshop summaries are posted on the CRC website. The sixth workshop was held October 15-17, 2019 at ANL.

Current Status and Future Program

The 2019 workshop organizing committee includes representatives from American Petroleum Institute (API), Argonne National Laboratory (ANL), CARB, Conservation of Clean Air and Water in Europe (Concawe), U.S. DOE, U.S. EPA, National Biodiesel Board (NBB), Natural Resources Canada, USDA, Ford Motor Company, Chevron Global Downstream, Phillips 66, Oak Ridge National Laboratory, Renewable Fuels Association (RFA), Marathon Petroleum Company LP, Neste, ExxonMobil Research & Engineering, the European Joint Research Center's Institute for Environment and Sustainability, the Union of Concerned Scientists, and the International Council on Clean Transportation (ICCT). The 2017 workshop sponsors included API, ANL, CARB, Canadian Fuels Association, Concawe, NBB, RFA, USDA, University of Michigan Energy Institute, and the Union of Concerned Scientists. Neste and the DOE were welcomed as new sponsors in 2019.

The workshop goals were to:

- Outline technical needs arising out of policy actions and ability of LCA to meet those needs.

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- Identify research results and activities that have come to light in the past two years that have helped to close data gaps previously outlined as outstanding issues.
- Identify data gaps, areas of uncertainties, validation and verification, model transparency, and data quality issues.
- Establish priorities for directed research to narrow knowledge gaps and gather experts' opinions on where scarce research dollars would best be spent.
- Past workshop proceedings and summary articles can be found on the CRC website.

Sessions at the 6th workshop in October 2019 included technical presentations on Transportation Fuel Policy, Liquid Petroleum Fuels, Recent Modeling of Crop-Based Biofuels, Examining Counterfactual Scenarios, Advanced Liquid Fuel Pathways, and Electrical Pathways. A summary article is available on the CRC website. Future workshops are under consideration.

REAL WORLD VEHICLE EMISSIONS WORKSHOP

CRC Project No. E-110

Leaders: D.M. DiCicco
S.A. Mason

Scope and Objective

For three decades, CRC has held an annual vehicle emissions workshop, gathering international experts in the field of vehicle/engine emissions to discuss the latest activities in modeling, measurement, and analysis.

The inaugural CRC Emissions Workshop convened as the "CRC-APRAC Vehicle Emissions Modeling Workshop" on October 30 and 31,1990. It was the first time that representatives from government agencies, universities, automotive and oil industries, and consulting and testing firms active in examining vehicle emissions inventories were assembled in one location with 117 participants engaging in discussions and twenty speakers presenting in four technical sessions including EMFAC7 and MOBILE4 Models, Model Evaluations, Laboratory Vehicle Emissions Studies, and On-Road Emissions Studies.

In three decades of annual events, the Real World Emissions Workshop has grown into an international event, hosting over 250 participants representing more than a dozen countries. Its 30-year history has spanned an era where the public has benefited from large reductions in vehicle tailpipe emissions, brought about by improvements in emissions control technologies and fuels, leading to demonstrable improvements in air quality. Program topics areas include novel and new research in:

- Air Quality
- Emissions Modeling
- Off-Road / Non-Road Emissions
- Emissions Measurement Methods
- Fuel Effects on Exhaust Emissions
- Improving the Emissions Inventory

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- Particulate Emissions and Measurement
- Emissions Control Measures (I/M) and OBD
- In-Use Emissions for Light- and Heavy-Duty Vehicles
- Non-Tailpipe Emissions
- Sensors and New Technology

Current Status and Future Program

For the first time in its history, the 2020 Real World Workshop was cancelled as a result of the COVID-19 pandemic. The 2021 Workshop is scheduled to convene as the 30th event at the Renaissance in Long Beach, CA, March 7-10, 2021.

EVALUATION AND STATISTICAL ANALYSIS OF REMOTE SENSING DEVICES AND TECHNOLOGY

CRC Project No. E-119-3/ E-119-3a

Leaders: D.M. DiCicco
S.A. Mason
M. Maricq

Scope and Objective

Since the early 1970's, many heavily populated U.S. cities have violated the National Air Quality Standards (NAAQS) established by the EPA pursuant to the requirements of the federal Clean Air Act. The NAAQS regulate emissions of six criteria pollutants: carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), lead, ground-level ozone (O3), and sulfur dioxide (SO2). Carbon monoxide (CO) levels are elevated primarily due to direct emission of the gas; and ground-level ozone, a major component of urban smog, is produced by the photochemical reaction of NOx and hydrocarbons (HC). Ambient levels of particulate emissions can result either from direct emissions of particles or semi-volatile species, or from secondary reactions between gaseous species, such as ammonia (NH3) and nitrogen dioxide. On-road vehicles continue to serve as one of the sources for atmospheric criteria pollutant emissions, contributing CO, volatile organic compounds (VOCs), NH3 and NOx to the national emission inventory. Ambient air measurements taken over the last three decades illustrate the dramatic emissions reductions from on-road sources achieved by the automotive and petroleum industries.

Alternate remote sensing device (RSD) measurement systems may provide an opportunity for future data collection campaigns. The objective of Project E-119-3 is to evaluate other RSD systems' ability to measure on-road emissions (CO, CO2, and HC, NO and NO_2, SO_2 and NH_3 and PM) over a five-day period, making real time comparisons to the Fuel Efficiency Automobile Test (FEAT) device, responsible for the historical CRC record of on-road emissions data for over three decades. Measurements will also capture evaporative emission and PM emissions when available to complement emissions measurements from the FEAT device. Under Project E-119-3a, statistical comparisons of the three RSD datasets are be done to compare and contrast each system's consistency or variability to measure and record data across a range of operating conditions.

Current Status and Future Program

Two contractors have been selected to co-locate alternate RSD technologies alongside the Denver University FEAT system during a test campaign in Phoenix, AZ. Charles Blanchard has been contracted under Project E-119-3a to conduct statistical analysis of the three data sets.

LIGHT-DUTY PORTABLE EMISSIONS MEASUREMENT SYSTEM (PEMS) PURCHASE AND STATISTICAL ANALYSIS PROJECT DEVELOPMENT

CRC Project No. E-122-2/ E-122-2a/ E-122-2b/ E-122-2c

Leaders: M.B. Viola
P. Loeper

Scope and Objective

With Europe adopting the use of portable emissions measurement systems (PEMS) to determine light-duty emissions, there is a greater interest in the functionality and use of these systems.

The objective of Project E-122-2 is to understand PEMS performance in measuring changes during on-road and chassis-roll tests. The on-road cycle developed in CRC Project E-122, which incorporates city, urban, and highway driving, will be used. Several engine technologies are represented in the test fleet, which will be tested with different fuel properties to investigate how well PEMS can detect fuel property impacts on emissions. Summer and Winter fuels, each having a low and high Particulate Matter Index (PMI), as described by the Honda method, will be used for testing. A total of four fuels will be run on each of four vehicles multiple times to understand the variation in emissions that occur and how they change on the same route on a daily basis. A PEMS will be used to measure the tailpipe emissions. Repeat testing will be conducted on a chassis-dynamometer for comparison to the PEMS unit, which will also measure emissions at the same time on the chassis roll for direct comparison. Specific goals of this project include determination of the following:

- Repeatability of the chassis roll testing to compare to the PEMS unit;
- Repeatability and accuracy of PEMS unit under real on-road driving conditions and changing ambient temperatures;
- Ability of the PEMS to measure differences in gaseous and PM emissions with respect to changes in PMI and/or Vapor Pressure (VP) of the fuel; and,

- The correlation of exhaust flow measurement of CO2 from the individual PEMS system with direct vehicle exhaust flow meter from the test cell and with constant volume sampling (CVS) bags.

To make certain the testing data collected would be suitable for statistical analysis, a statistician (CRC Project E-122-2a) developed the test matrix for this project, defining:

- Number and sequence of testing on each fuel and vehicle;
- Vehicles of each technology to test, (one hybrid or two of the same type, etc.); and,
- Market fuels to test and what fuel properties to investigate.

The statistician will be involved throughout the project on regular project calls to help guide decisions and conduct all the statistical analysis on the project data at the end of testing and will provide all of the analysis for the Final Report.

Current Status and Future Program

The contract for E-122-2 was awarded to Southwest Research Institute (SwRI) in April 2019. Experimental testing will continue at their facilities in San Antonio, Texas into 2020. High- and low-PMI summer market fuels have been obtained, and vehicle testing will continue through 2020 and into early 2021.

CONTINUED MONITORING OF E-23/E-106 SITE EMISSIONS

CRC Project No. E-123

Leaders: D.M. DiCicco
S.A. Mason

Scope and Objective

Project E-23 achieved historically significant on-road emission measurements from six cities, Chicago, Denver, Los Angeles, Phoenix, Omaha, and Tulsa using consistent equipment and calibration methods between 1997 and 2006. Project E-106 and a companion California Air Resources Board contract extended those measurements beginning in 2013 in Chicago, Denver, Los Angeles, and Tulsa. The longer the historical record is, the more that can be learned, because the effect of age on fleet emissions can be observed without the confusion caused by the effect of changing model years.

Current Status and Future Program

Project E-123 repeats the E-106 schedule to return to Tulsa, Denver, and Chicago on an alternating two-year schedule for one measurement campaign (one five-day week) in each location every other year. The project returns to the E-106 Tulsa site in the early fall of both 2017 and 2019, to Denver in the winters of 2018 and 2020, and the Chicago site in the early fall of 2018 and 2020. The equipment used is the same equipment used in E-23 and E-106; it can monitor CO, HC's, NO, NH_3 and NO_2 in real time from each passing vehicle. Typically, each test campaign yields 20,000 to 25,000 valid emissions readings. Project E-123 is therefore expected to provide between 120,000 and 140,000 vehicle emissions readings.

As a continuation of earlier research, this project was awarded to Denver University (DU). The Final Reports for Tulsa (Fall, 2017, Fall 2019); Denver (Winter, 2017; Winter 2020), and Chicago (Fall 2018) are available on the CRC website. Testing will be completed in 2021, following a return campaign in both Chicago and Denver.

EMISSIONS COMMITTEE

REMOTE SENSING DEVICE DATA MINING FOR I/M PROGRAM EFFECTIVENESS

CRC Project No. E-123-4

Leaders: D.M. DiCicco
S.A. Mason

Scope and Objective

As on-road vehicle emissions in the U.S. have decreased dramatically over the past 30 years, the distribution itself has become increasingly skewed. This is reflected in the fact that a smaller percentage of the fleet is responsible for a larger percentage of the emissions. This should provide opportunities for current Inspection and Maintenance (I/M) programs to produce large percentage reductions in fleet emissions as they are positioned to successfully find and fix a small number of high emitting vehicles. However, computer model estimates of percentage fleet emission reductions for I/M programs have been going in the opposite direction during this period with published estimates of 15% or less benefits depending on the emission species.

The University of Denver (DU) began collecting on-road fuel specific vehicle emissions in 1989 for CO with HC and nitric oxide added during the 1990's. To date, there are 92 databases collected in the U.S that contain more than 1.5 million records. The large majority of these have been collected in areas with I/M programs, and at least 20 databases with more than 200,000 records have been collected in areas that do not have a program.

Project E-123-4 will explore how the worst-performing vehicles' emissions have changed in I/M versus non-I/M areas by comparing differences in emissions species, quantification, and shape of the emissions distribution seen during this extended period of time.

Current Status and Future Program

This project was conducted by DU. An Executive Summary of the report is available on the CRC website, and a journal article is in preparation.

DETAILED HYDROCARBON ANALYSIS (DHA) AND PARTICULATE MATTER (PM) EMISSIONS DATA MINING

CRC Project No. E-127-1

Leaders: D.M. DiCicco
P. Loeper

Scope and Objective

Several CRC projects have investigated oxygenated gasoline fuels and the resultant effects on emissions. In CRC Project E-94-2, exhaust emissions data (with a focus on particulates) was collected from 12 vehicles utilizing gasoline direct injection (GDI) engines over the LA92 drive cycle. Six test fuels were "match" blended so that targets for ethanol content, octane number (AKI), and particulate matter index (PMI) could be reached. CRC Project E-94-3 was created to utilized "splash" blended fuels to provide a comprehensive picture of how varying fuel properties affect vehicle emissions. CRC Project E-129 investigated emission effects of additional fuel oxygenates including iso-butanol and MTBE.

Detailed hydrocarbon analysis (DHA) was performed on each test fuel to determine the PMI. This index, developed by Honda, provides a means to assess particulate formation "potential" of a given fuel. In considering the spectrum of these programs with respect to oxygenate type and fuel blending strategies, Project E-127-1 seeks to perform a meta-analysis of the DHA methods used in these studies. The DHA results and particulate emissions data from these vehicle emissions projects are analyzed and compared to identify hydrocarbon (HC) species groups that positively correlate with increased particulate emissions

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Current Status and Future Program

The contractor, Southwest Statistical Consultants, evaluated each vehicle's PM emissions, determining HCs that correlate with the vehicles PM emissions. The HCs that correlate to PM emissions for multiple vehicles were noted. The Final Report for this project is posted on the CRC website.

ALTERNATIVE OXYGENATES EFFECTS ON EMISSIONS PHASE II

CRC Project No. E-129-2

Leaders: E. Barrientos
J. Jetter

Scope and Objective

CRC E-94 Projects were conducted to better understand the fuel effects on tailpipe emissions for gasoline direct injection (GDI). These studies observed an increase in particulate mass (PM) emission rate in GDI engines trending with an increasing ethanol content. However, the mechanism for increased PM formation remains unclear as ethanol itself is not thought to be a PM precursor. It has been theorized that the presence of ethanol contributes to a charge cooling effect in GDI engines, increasing PM formation from other fuel components. Other potential explanations include shifts in distillation characteristics, changes in volatility, and decreasing energy content. CRC project E-129 was developed to determine whether the observed trend held for higher ethanol concentrations and to investigate potential mechanisms for PM formation with other oxygenates.

The purpose of this work is to extend the analysis of project E-129 to additional oxygenates of interest and to add key information to explain the ethanol effects on SI PM emissions. The project will evaluate these fuels in a single cylinder engine (SCE), which offers more controllability of key parameters that are known to affect vehicle emissions and extend the analysis deeper into trends for NOx and THC related to fuel composition.

Current Status and Future Program

NREL has been contracted to perform this work in their single-cylinder test set-up. Twelve different oxygenated blends in high- and low- particulate matter index (PMI) base fuels will be evaluated. The report is expected to be completed by mid-2021.

EMISSIONS COMMITTEE

PUBLICATION OF THE STORY OF THE (NEAR) ELIMINATION OF GASOLINE VEHICLE EMISSIONS

CRC Project No. E-130

Leaders: D.H. Lax
C.J. Tennant

Scope and Objective

Since the 1970's and earlier, the dramatic reductions of automotive pollution have contributed to significant improvements in air quality. This project seeks to produce a lay level, easily understood story of how automotive emissions have been reduced to present-day levels to educate a broad audience of the achievement of near-zero gasoline vehicle emissions accomplished over many years. Existing literature and accounts from industry and government agency participants directly involved in the research, investigations, and regulatory development that enabled this achievement will be included. The project is divided into three phases:

- Phase 1: Identify and acquire literature and conduct and document interviews of expert individuals working on emissions reductions technology during the period of focus.
- Phase 2: A technical publication writer will compile and distill all the information collected by the contractor in Phase 1. The deliverable will be a pamphlet or publication that presents the story to a broad, non-technical audience.
- Phase 3: Additional publications or reporting avenues will be explored.

Current Status and Future Program

Steve Welstand, and Dr. Kent Hoekman, consultants, have been contracted for Phases 1 and 2 of this project, which is expected to continue throughout 2020.

STUDYING CAPABILITIES AND LIMITATIONS OF VEHICLE TELEMATICS DATA

CRC Project No. E-131

Leaders: P. Loeper
M.B. Viola

Scope and Objective

Due to increasingly stringent ambient air quality standards in the U.S., both the EPA and CARB work to improve the fidelity and predictive capabilities of their emissions inventory models (e.g., MOVES and EMFAC, respectively). One example of these efforts is recent presentations by the EPA using vehicle telematics data (e.g., auto insurance driving behavior programs managed by Verizon) to improve understanding of vehicle usage patterns. Data from these programs can include key-on/off sequences, vehicle speed, vehicle acceleration, idle time, and vehicle soak times. In turn, this type of information could prove invaluable to improving model inputs/assumptions in MOVES, for example.

While these vehicle telematics databases can undoubtedly serve as an important component for future model development, CRC is interested in learning more about the capabilities and limitations of these systems.

Current Status and Future Program

Eastern Research Group (ERG) has examined three different telematics datasets, performing case studies with each to highlight various capabilities and limitations. The Final Report is available on the CRC website.

EMISSIONS COMMITTEE

IMPACTS OF E15 ON NOX EMISSIONS

CRC Project No. E-133

Leaders: M.B. Viola
P. Loeper

Scope and Objective

The current fleet is using gasoline-ethanol blends of 90% gasoline and 10% ethanol in gasoline internal combustion engines. There are many vehicles that now accept E15 blends. However, E15 is still not the prevalent fuel in the market and there is much discussion on how the additional ethanol may impact NOx emissions.

The objective of this project is to conduct chassis dynamometer vehicle testing as well as PEMS emissions testing with E15 fuels to determine the impact additional ethanol may have on NOx emissions. Additional gaseous and PM emissions will also be measured to understand all criteria and particulate impacts. This testing would use newer Tier 3 certified vehicle(s) for testing, the same vehicles used in Project E-122-2.

This work would be conducted using vehicles from Project E-122-2 as well as the PEMS units currently owned by CRC. There are two winter market E10 fuels: one low- and one high-PMI fuel. These same fuels will be splash blended to E15. Additionally, two summer market E10 fuels, one low- and one high-PMI fuel will also be splash blended to create E15 fuels. Testing will be conducted after E-122-2 Tier 3 Certification fuel at the end of Winter and Summer testing using the same on-road and chassis-dynamometer drive cycle as from CRC project E-122 and E-122-2.

Current Status and Future Program

The contract for this work has been awarded to SwRI as an add-on project to CRC Project E-122-2. Project E-133 work is expected to follow the timeline of the E-122-2 work.

LIQUID LEAKER TEST VEHICLE DETECTION IN E-119-3 RSD TEST CAMPAIGNS

CRC Project No. RW-105

Leaders: M.M. Maricq
R. Sager
S. Mason

Scope and Objective

The objective of this project is to understand the capabilities of RSD systems to measure and interpret high evaporative emitters as well as PM emissions. Roadside measurements of PM will include installation of an on-board PEMS unit on test vehicles to serve as a reference measurement.

Under this project, the contractor will co-locate and coordinate with three RSD systems at a single test site under contract E-119-3. During the test campaign, the contractor will operate test vehicles to drive through the RSD roadside location. The vehicles will be set up as liquid leakers to identify each system's capability of detecting evaporative emissions. Additionally, a vehicle with zero emissions is expected to drive through the test site several times per day releasing known levels of pollutants to serve as calibration points.

To detect PM emissions, a PEMS that has robust capability to measure particle mass will be installed on both of the test vehicles. Installation can be completed at the same time as the evaporative measurements if PEMS does not interfere with these test cases. PM and criteria pollutants will be measured during each test run.

Current Status and Future Program

Revecorp was selected as the contractor for RW-105. The three RSD systems for E-119-3 are separately contracted by CRC. Co-location of all four vendors in Phoenix, AZ will be scheduled in 2021.

EMISSIONS COMMITTEE

ASSESSMENT OF ALTERNATE FORUMLATIONS FOR THE PM INDEX

CRC Project No. RW-107-2

Leaders: J.J. Jetter
R.P. Lewis

Scope and Objective

The EPA, Honda, and others have confirmed that the PM Index can reasonably predict the relative particulate-forming tendency of a gasoline. CRC Project RW-107 examined the performance of PMI and a number of other PM-indices for their ability to predict particle emissions from gasoline fuels using datasets representing a variety of technologies and fuel formulations. A chief issue was that none of the available PM indices were able to accurately predict PM emissions for fuel groups that contain both neat (E0) and E10 gasolines. In the CRC Projects E-94-2 and E-94-3 and the EPAct studies, E10 and higher fuels were found to have consistently higher PM emissions than E0 gasolines of the same PMI values. PM emissions of E10 to E20 fuel blends were higher than indicated by PMI values while E0 emissions were lower. Improving the indices to remove the emissions bias with respect to ethanol was identified as a priority.

Project RW-107-2 will seek to:

- Optimize the mathematical form of the original PMI equation.
- Investigate potential adjustments for other fuel properties, such as net heating value, density, and various distillation parameters. If an ethanol bias remains after these steps, determine an appropriate adjustment factor.

Current Status and Future Program

Rincon Ranch Consulting was selected as the project contractor for this work, which is expected to continue through 2020.

VALIDATION OF THE NEW PM INDEX FORMULA

CRC Project No. RW-107-3

Leaders: J.J. Jetter
R.P. Lewis

Scope and Objective

RW-107 revealed that the original PM Index exhibited an ethanol bias. A more robust PMI formulation is being developed in RW-107-2, in which correlation with measured PM will be improved, and the ethanol bias eliminated. The new formulation will incorporate multiple enhancements. The third phase of the project will produce a fresh dataset, which is required to validate this new form of the PM Index equation, preferably including a range of PMI values, vehicle technologies, and fuel formulations.

The data required for the PMI validation consist of PM emission measurements from the first phase of a cold-start LA92 cycle, and analyses of the test fuels. Vehicle testing will be conducted to collect PM filter samples from the dilution tunnel during the LA92, and measure gaseous emissions (NOx / CO / HC / etc.) The LA92 cycle will be repeated as necessary to meet the validation requirements. The test fleet will include PFI vehicles and GDI vehicles. (The mathematical form of the vapor pressure term in the new equation is dependent upon engine technology, specifically GDI vs. PFI.) Test fuels will include E0, E15, and E20 blends, all based on winter and summer market fuels. The E0 fuels are required to confirm that the ethanol bias has been removed in the new PMI formula.

Current Status and Future Program

SwRI was awarded this contract, which will be integrated into the E-122-2 and E-133 combined test matrix.

EMISSIONS COMMITTEE

E-15 FUEL SURVEY

CRC Project No. RW-115

Leaders: M. Moore
P. Loeper

Scope and Objective

Through two separate actions in 2010 and 2011, the EPA approved the use of E15 fuel in model year 2001 and newer light duty vehicles. In March 2019, the EPA issued a final rule to extend the summertime 1 psi RVP waiver to gasoline-ethanol blends up to 15% ethanol. This action facilitates the year-round sale of E15 in conventional gasoline areas. E15 is available today at more than 1,800 refueling stations in 30 states, and federal programs have offered funding designed to expand the infrastructure for renewable fuels via the installation of blender pumps.

Fuel properties, quality, dispenser configuration, and labeling are all important factors and are not well understood for E15. The objective of this project is to analyze fuel properties of E15 fuel samples from a wide array of retail stations and document their labeling, naming, dispenser style, and configuration. This project seeks to improve the understanding of E15 fuel quality and how E15 is being marketed and dispensed.

Current Status and Future Program

This project leveraged the Summer 2019 Alliance of Automobile Manufacturers North American Fuel Survey to collect and analyze 38 market fuel samples from around the U.S. A summary report and data from the Summer Survey are available on the CRC website as CRC Report No. 674. A Winter 2020 Fuel Survey is active.

REMOTE SENSING MEASUREMENTS IN CENTRAL FRESNO, CALIFORNIA

CRC Project No. RW-117

Leaders: D.M. DiCicco
S.A. Mason

Scope and Objective

Fresno, CA is a community of approximately 500,000 people located in California's central San Joaquin Valley. The Central Valley is an area in California that regularly exceeds National Ambient Air Quality Standards for PM and ozone. Mobile sources are one of many factors that contribute either with direct particulate emissions or indirectly with ozone pre-cursor emissions of carbon monoxide (CO), volatile organic compounds and oxides of nitrogen emissions to these air quality problems. Characterizing the Fresno area's light and medium-duty vehicle fleets emission distribution, and their changes over time, can be an important source of information in the community's efforts to improve the local air quality.

The University of Denver (DU) visited Fresno, CA in March of 2008 and collected seven days of measurements using DUs FEAT optical remote sensing unit. FEAT collects fuel specific gaseous emissions of CO, hydrocarbons (HC), nitric oxide (NO), nitrogen dioxide (NO_2, $NO_x \equiv NO + NO_2$), ammonia and opacity. In this project, DU will return to the 2008 location to collect emissions measurements following the standard E-23 protocols that have been used in other CRC projects

Current Status and Future Program

This project is expected to support a larger effort by CARB to collect emissions measurements from at least ten disadvantaged communities throughout the State of California. Data collected by DI will be shared with CARB to support planning for their project. The Central Fresno field campaign is expected to occur in Spring, 2021.

AVFL COMMITTEE

IMPROVED DIESEL SURROGATE FUELS FOR ENGINE TESTING AND KINETIC MODELING

CRC Project Nos. AVFL-18 and AVFL-18a

Leaders: S. McConnell
W.J. Pitz

Scope and Objective

The objective of these projects is to establish and evaluate a methodology for formulating surrogate fuels with compositional, ignition-quality, volatility, and density characteristics that are representative of diesel fuels produced from real-world refinery streams. Such fuels will enable more valuable study of combustion in both experimental engines and computer simulations, which will help in the development of better fuels and engines.

Current Status and Future Program

A surrogate fuel is a mixture of generally less than a dozen pure compounds that matches certain selected characteristics of a target fuel composed of many hundreds to thousands of compounds. Surrogate fuels are of interest because they can enable a better understanding of fundamental fuel composition and property effects on combustion and emissions formation processes in internal combustion engines. Ultimately, their application in numerical simulations with accurate vaporization, mixing, and combustion models could revolutionize future engine designs by enabling computational optimization for evolving real fuels. Dependable computational design could enable improved engine function at significant cost savings relative to current optimization strategies, which rely on physical testing of hardware prototypes. A literature review was performed in support of this research, and was published on the CRC website in December 2009.

The project team identified compounds representing the major hydrocarbon classes found in real diesel fuels to be included in surrogate fuel formulations. First-generation surrogates were formulated for two ultra-low-sulfur #2 diesel reference fuels.

Analyses have been conducted to quantify the extent to which the surrogate fuels match the ignition quality, volatility, and density characteristics of their corresponding target fuels.

Project AVFL-18 is being performed in collaboration with researchers at several DOE national laboratories: Sandia National Laboratory (SNL), National Renewable Energy Laboratory (NREL), Lawrence Livermore National Laboratory (LLNL), Pacific Northwest National Laboratory (PNNL), and Oak Ridge National Laboratory (ORNL); as well as a Canadian federal laboratory (CanmetENERGY) and the Army Research Laboratory. The National Institute of Standards and Technology (NIST) assisted with fuel property measurements and regression optimization techniques to support surrogate formulation.

Final evaluation of the first-generation surrogates was completed. A project report was reviewed and approved by the project panel and committee for journal publication. The journal article describing the surrogate fuel formulation process was published in May 2012 in *Energy & Fuels* and is currently available on their website, as well as on the CRC website, as the Final Report for the first phase of AVFL-18.

Research was extended under AVFL-18a to facilitate the development of second-generation surrogates with improved capabilities for matching market diesel fuels, blending engine research test quantities of surrogates, as well as single-cylinder engine and combustion vessel testing of selected surrogate fuels. Panel members worked to identify and obtain compounds of sufficient purity and sulfur content for blending surrogate fuels, using a variety of synthesis approaches. All four surrogates have been blended by Chevron for the selected surrogate formulations.

Researchers at the Army Research Laboratory, SNL, and National Research Council Canada performed single-cylinder engine and combustion vessel testing of the surrogate fuels. Combustion modeling of engine performance is being conducted in an independent fashion to predict the performance of the surrogate fuels in the selected engine test platforms. Publications are in development by the individual participating laboratories to document the testing and evaluation of the surrogate diesel fuels, and links will be posted to the CRC website when they are available.

The second article under AVFL-18a was published in *Energy & Fuels* (January 2016) covering creation of the surrogate fuels in sufficient quantities for engine and combustion-vessel testing, as well as subsequent physical and chemical property measurements.

CanmetENERGY provided CRC with a report describing work conducted under AVFL-18a on GCxGC analysis of surrogate component purity, titled: "GC×GC Studies of Palette Compounds Used in the Next Generation of Diesel Fuel Surrogate Blends." This report is available on the CRC website (June 2016.)

Freezing point evaluations at elevated pressures have been conducted at Pacific Northwest National Laboratory on the surrogate test fuels to determine phase change conditions that may impact laboratory combustor and engine operations. A journal paper on the experimental apparatus designed to make these measurements was accepted for publication in Review of Scientific Instruments (2020). NIST supported the project with additional surrogate fuel property analyses. NIST published their most recent work in January 2017, "Preliminary Models for Viscosity, Thermal Conductivity, and Surface Tension of Pure Fluid Constituents of Selected Diesel Surrogate Fuels" as a NIST report.

The Panel directed the research conducted under CRC Contract No. AVFL-18a-1, "Autoignition Study of CRC Diesel Surrogates in a Rapid Compression Machine (RCM)," at the University of Connecticut. The Final Report was published on the CRC website in October, 2018. A journal article on the experimental RCM data and its simulation using a chemical kinetic model from Lawrence Livermore National Laboratory was published in Combustion and

Flame (September, 2020). Sandia National Laboratory has performed Optical Engine measurements on the surrogate fuels; results from this research will be reported in 2020. The Panel continues to meet regularly to review data and progress. Five journal articles from researchers working on the diesel fuel surrogates are in development.

AVFL COMMITTEE

OCTANE NUMBER, ENGINE EFFICIENCY, AND CO2: FILLING LITERATURE GAPS

CRC Project No. AVFL-20 and AVFL-20a

Leaders: J. E. Anderson
A. Iqbal
C. S. Sluder

Scope and Objective

This study investigates efficiency advantages for increased octane number fuels that may be available from ethanol or other blend components in modern light-duty vehicles.

Current Status and Future Program

The project consists of dynamometer testing on engines to evaluate the effects of fuel octane rating, sensitivity, and ethanol content on engine efficiency.

CRC and ORNL worked together to conduct both phases of engine testing and performance modeling for this study. The first phase was conducted on a Ford 1.6L turbocharged direct injection (DI) EcoBoost engine. Flint Hills Resources was a co-sponsor of both phases of this project. Gage Products prepared test fuels according to the matrix of 19 test fuels approved by the project panel members and the committee. Detailed Hydrocarbon Analysis (DHA) of the test fuels was performed by Chevron.

The test fuel matrix allowed exploration of a wide range of ethanol content (10 to 30 vol%), research octane number (91 to 102), and sensitivity (S=RON-MON) (6 to 7 and 10 to 12). ORNL completed the first stage of engine testing of all 19 fuels for knock resistance at a single compression ratio in the Ford EcoBoost engine. Subsequently, six of the test fuels were chosen for more detailed engine performance characterization at appropriately matched compression ratios. Using these data, vehicle-level modeling was used to estimate efficiency, fuel economy, and tailpipe CO2 emissions for these fuels in two vehicles. The Final Report for

AVFL COMMITTEE

AVFL-20, "Effects of Octane Number, Sensitivity, Ethanol Content, and Engine Compression Ratio on GTDI Engine Efficiency, Fuel Economy, and CO2 Emissions," was published on the CRC website in November 2017.

A naturally aspirated 1.4L test engine with port fuel injection (PFI) was provided by FCA for the companion Project AVFL-20a. Testing on the PFI engine has been conducted by ORNL/DOE. The final report will be published as an Open Access SAE Paper.

AVFL COMMITTEE

GASOLINE FUEL PROPERTIES IMPACT ON FUTURE ENGINE DESIGN

CRC Project No. AVFL-26

Leaders: M. B. Viola
S. McConnell
C.S. Sluder

Scope and Objective

The objective of AVFL-26 is to evaluate the effects of a range of combinations of gasoline properties and compositions on a next-generation advanced engine platform aimed at maximizing fuel efficiency.

Current Status and Future Program

The fuel matrix in this study includes E0, E10, E30; high and low Research Octane Number (RON); and high and low distillation end point to represent possible impacts on particulate matter (PM) emissions. The test engine is a GM 2.0L I4 turbocharged LTG engine modified to create a possible next generation advanced technology configuration, reaching for a 25% reduction in crude oil consumption with a 2-stage turbo, 25% EGR, high energy ignition, and a higher compression ratio.

Gage Products Company prepared the fuels. The engine was provided and set up by GM. Testing and analysis of the results were performed by IAV. ORNL performed modeling to support the analysis of the results. The Final Report was released on the CRC website.

HEAT OF VAPORIZATION MEASUREMENTS OF GASOLINE AND ETHANOL BLENDS

CRC Project No. AVFL-27 and AVFL-27-2

Leader: M. B. Viola

Scope and Objective

These projects are evaluating methods for measurement of the heat of vaporization (HOV) for gasoline and ethanol/gasoline blends and are exploring alternate methods of determining the HOV as a function of boiling point and composition.

Current Status and Future Program

The University of Delaware (UDEL) and the National Renewable Energy Laboratory (NREL) were involved to examine the selected test fuels in the first phase of the project. Three fuels from the FACE gasoline fuel set (Fuels A, D, and H) were selected by the project panel. Fuels A and H were tested at three ethanol blend levels (10%, 15%, and 30%). Iso-octane served as a reference compound for which the HOV is well known. Thermogravimetry with Differential Scanning Calorimetry (TGA/DSC) methods were used by both laboratories. In addition, a method based on Detailed Hydrocarbon Analysis (DHA) compositional data was explored at NREL.

The Final Report for Phase 1 of the project, "Heat of Vaporization Measurements of Gasoline and Ethanol Blends" was published on the CRC website in August 2016 and consists of a single document with both contractor reports (Parts A and B) and an Executive Summary prepared by the committee.

NREL is performing Phase Two of the project: "Full and Partial Heat of Vaporization Measurements of Gasoline and Ethanol/Gasoline Blends." The final report will be in the form of an SAE Publication in 2020; an abstract for this research will be posted to the CRC web site.

AVFL COMMITTEE

GASOLINE TURBOCHARGED DIRECT INJECTION (GTDI) ENGINE WEAR TEST DEVELOPMENT

CRC Project No. AVFL-28, AVFL-28-2 and AVFL-28-3

Leaders: G. C. Gunter
T. Kowalski

Scope and Objective

Gasoline turbocharged direct injection (GTDI) engines often produce more severe operating conditions than port fuel injection (PFI) engines. GTDI engines operate at higher temperature, higher cylinder pressure, and higher specific torque. GTDI engines are often downsized, causing them to operate at higher load for a larger fraction of operating time. Some modern engines also use alternative combustion cycles (Miller/Atkinson, for example) or stop/start technology which subjects the engine and lubricant to new types of stress compared to conventional PFI engines. Some GTDI engines use certain lubricated components not represented in current wear tests based on PFI engines; for example, turbocharger bearings, polymer-coated bearings, and aluminum alloy bearings. For these reasons, a new test for GTDI engines is needed to represent current and future engine technologies.

The objective of this research is to develop a procedure for testing wear performance of engine lubricant (motor oil) for use in GTDI engines operating in high-fuel-economy duty cycles. Elements of this test protocol include:

- Test engine candidates
- Test engine configuration and component selection
- Test engine operating conditions
- Test methods and criteria to measure engine wear
- Criteria to rate lubricant performance

CRC does not establish lubricant specifications or define certification procedures. Data generated from CRC research can be used by lubricant standards-setting organizations that may develop lubricant specifications and engine wear tests as they see fit.

The research is expected to determine general sensitivities of GTDI engine technology and to develop appropriate operating conditions to test those sensitivities. The purpose is not to point out the sensitivities or weaknesses of any particular engine model.

Current Status and Future Program

In AVFL-28, a series of in-field operating conditions were selected, and the engine operated at these conditions using both a SAE 5W-30 oil and a SAE 0W-16 oil with the same additive package. The Final Report for AVFL-28, "Gasoline Direct Injection (GDI) Engine Wear Test Development" was published on the CRC website in January 2018.

In AVFL-28-2, SwRI evaluated GTDI engine wear performance using the same GTDI engine model, operating procedures, and test matrix as in AVFL-28, with a focus on different engine components to extend the work of the prior project. The Final Report for AVFL-28-2 was published on the CRC website in October 2019.

A third phase, AVFL-28-3 is underway, with reporting expected in late 2020.

AVFL COMMITTEE

ENHANCED SPECIATION OF GASOLINE / ENHANCED DHA AND PMI REPRODUCIBILITY

CRC Project No. AVFL-29 and AVFL-29-2

Leaders: J.J. Jetter
G.C. Gunter

Scope and Objective

Most Detailed Hydrocarbon Analyses (DHAs) are performed with ASTM Methods D6729, D6730, or variations thereof. These are gas chromatography methods in which many species are left unidentified. Labs can leave ≥5% of the species listed as unidentified, typically for species eluting late in the chromatogram which have comparatively strong effect on the particulate matter index (PMI). Unidentified or misidentified peaks in this region can result in an inaccurate PMI determination and can misrepresent the composition of a given sample.

The objective of AVFL-29 was to develop an enhanced method for the speciation of gasoline. Desired attributes of the method:

- Capable of being used on a routine basis by a typical chemical analysis laboratory.
- Easy to perform qualitative and quantitative calibration. A detector with a linear response to pure hydrocarbons is preferred to minimize the number of species in the calibrant.
- Provides accurate quantification of oxygenated species.
- Resolves, identifies, and quantifies species to the greatest reasonable extent. Identifies specific isomers whenever possible; compound class and carbon number are the minimum identification requirements for species > C9.
- Capable of quantifying species with a boiling point up to 280°C at a minimum; 350°C is the preferred target.

The objective of AVFL-29-2 is to determine the magnitude of variability of DHA and PMI results as measured by various test labs in practice for a set of gasoline samples covering a wide range of PMI. A secondary objective is to determine which components contribute most to PMI variability. The approach includes analysis of several gasoline samples covering a range of PMI at various commercial and industry laboratories, using enhanced and standard DHA methods, and analysis of results.

Current Status and Future Program

AVFL-29 was performed by Separation Systems, Inc. The Final Report, "Enhanced Speciation of Gasoline," and Master Database were published on the CRC website in June 2018.

AVFL-29-2, "Enhanced DHA and PMI Reproducibility," has been awarded to DRI, and is underway. Reporting is expected in early 2021.

AVFL COMMITTEE

AUTOIGNITION CHARACTERIZATION OF AVFL-20 TEST FUELS

CRC Project No. AVFL-31a, AVFL-31b, and AVFL-31c

Leaders: J. Anderson
A. Iqbal
S. McConnell

Scope and Objective

The objectives of Projects AVFL-31a, AVFL-31b, and AVFL-31c are to evaluate combustion properties of the AVFL-20 test fuel set using laboratory autoignition characterization methods to develop correlations between fuel properties, composition, and autoignition characteristics.

Current Status and Future Program

Rapid Compression Machine (RCM) testing of AVFL-20 fuels has been performed by the Massachusetts Institute of Technology (MIT) [AVFL-31a], and additional testing is being conducted at Argonne National Laboratory (ANL) [AVFL-31b]. Different approaches for evaluating the RCM ignition delay data in conjunction with the engine test data are being considered. Modeling results to support the comparison research are being performed under AVFL-31c by Ford. Reporting is anticipated in late 2020.

EFFECTS OF BOOST PRESSURE AND FUEL COMPOSITION ON COMBUSTION KNOCK CHARACTERISTICS

CRC Project No. AVFL-32

Leaders: S. McConnell
A. Iqbal

Scope and Objective

The main objective of Project AVFL-32 is to learn how boosting affects the knock characteristics of fuels with varied levels of important hydrocarbon classes found in modern commercial gasolines. A secondary objective is to investigate how boosting affects the operation of the standard RON Cooperative Fuel Research (CFR) test engine and what further information would be required to propose modifications to the octane test method to improve the correlation between octane number and knock propensity in modern SI engines.

During Phase 1 of this research, several fuels of similar RON rating, but varied chemical composition, were analyzed under standard RON conditions on the instrumented CFR F1/F2 engine at Argonne National Laboratory. Important parameters affected by fuel composition during RON testing, despite constant RON level, include indicated mean effective pressure (IMEP), lambda, onset of auto-ignition, peak rate of heat release during auto-ignition, and knock over-pressure (mean amplitude of pressure oscillations), and more.

Phase 2 is exploring how increased boost pressure on the CFR engine affects the knocking characteristics of several fuels with similar RON and varied chemical composition.

AVFL COMMITTEE

Current Status and Future Program

Project AVFL-32 is being conducted by Argonne National Laboratory. An Open Access SAE Paper will be published in late 2020 documenting initial progress in this research. Additional publications are expected in 2021.

FUNDAMENTAL STOCHASTIC PRE-IGNITION (SPI) STUDY

CRC Project No. AVFL-33

Leaders: E. Chapman
G. C. Gunter

Scope and Objective

The goal of Project AVFL-33 is to characterize the impact of fuel properties on wall wetting and how this affects SPI frequency and severity in a Gasoline Turbocharged Direct Injection (GTDI) engine. Fuel properties of interest include alcohols, aromatics, isoparaffins, olefins, and heavy-end volatility.

The approach will be to perform dynamometer testing of a GTDI engine at SPI-prone conditions to determine fuel effects on SPI and influence of wall wetting.

Current Status and Future Program

The project is being performed by Oak Ridge National Laboratory. Reporting is expected in 2021.

AVFL COMMITTEE

ADVANCED CHARACTERIZATION OF E-117 DIESEL FUELS

CRC Project No. AVFL-34

Leaders: M. B. Viola

Scope and Objective

The goal of Project AVFL-34 is to use advanced characterization techniques to better understand differences in fuel composition that could help explain emissions differences observed in CRC Project E-117, "Combustion and Emissions Characteristics of a Medium-Duty Vehicle Operating on a Hydrogenated Vegetable Oil Renewable Diesel."

Current Status and Future Program

The Pacific Northwest National Laboratory (PNNL) and CanmetENERGY performed detailed fuel composition analyses on fuel samples provided from Project E-117. Final reporting on Project AVFL-34 is anticipated in late 2020, in the form of an Open Access publication.

ADVANCED COMBUSTION LITERATURE SURVEY

CRC Project No. AVFL-35

Leaders: J. Jetter
A. Ickes

Scope and Objective

The goal of Project AVFL-35 is to obtain an understanding of (1) current, state-of-the-art advanced combustion concepts – approaches, limitations, and performance, (2) how fuel properties affect operation of the different concepts, and (3) the key supporting literature references.

This project consists of a literature search along with a summary of findings and analysis of the specific combustion techniques. With the breadth of different concepts (and acronyms) falling into the advanced combustion area, concepts will be curated and grouped as appropriate to highlight key trends.

Current Status and Future Program

This project was awarded to SwRI. Final reporting is expected in late 2020.

AVFL COMMITTEE

IMPACT OF MON ON ENGINE PERFORMANCE

CRC Project No. AVFL-36 / CM-137-19-1

Leaders: A. Iqbal
V. Costanzo
S. McConnell

Scope and Objective

The primary objective of this study is to investigate the impact of fuel MON on engine anti-knock performance under a wider range of operating conditions, including those where the sensitivity weighting factor between RON and MON (K) may be positive (and potentially greater than 0.5). Testing under a wider range of operating conditions will help establish the relevance of fuel MON for modern engines, including from the perspective of durability and safe operation. To this end, the study will evaluate the impact of MON at multiple operating conditions including but not limited to:

- High speed high load (high power) operation with elevated air charge temperatures. This engine operation regime is representative of real-world driving conditions such as towing a trailer up a steep grade on a hot day. For future powertrains, this operating regime is expected to become even more challenging as criteria emissions regulations are driving elimination of enriched engine operation as a strategy for managing exhaust gas temperatures.
- Knock-limited part load operation which is relevant for drive cycle fuel economy. This operating regime is of interest for downsized boosted SI engines.

Current Status and Future Program

This Project has been awarded to FEV, and is underway. This work is being planned in cooperation between the AVFL and Performance Committees. Reporting is expected in 2021.

CRC "STOCHASTIC PRE-IGNITION" (SPI) WORKSHOP – 2020 & CRC "FUELS AND ENGINES: THE ROAD AHEAD" (FETRA) WORKSHOP – 2020 *FORMERLY TITLED: "ADVANCED FUEL & ENGINE EFFICIENCY" (AFEE) WORKSHOP*

CRC Project No. AFEE-2020

Leaders: V. Costanzo
R. McCormick
E. Chapman

Scope and Objective

In planning the third AFEE Workshop, the Organizing Committee decided to divide the content into two events, under new names, to best match the research topics with specialists in these fields.

The goal of the FETRA Workshop is to foster an open dialogue on the technical merits and challenges for engines and fuels for transportation, with a particular emphasis on practical pathways to reducing greenhouse gas and criteria pollutant emissions from transportation over the next thirty years.

The SPI Workshop has a particular emphasis on current status of stochastic preignition, and discussion of next steps that the industry might take to improve the design threshold for downsized boosted engines through formulation and design changes in oils, fuels and engines.

Current Status and Future Program

The SPI Workshop is being planned for September, 2020. The FETRA Workshop is being planned for October, 2020. An Organizing Committee drawn from the AVFL Committee, NREL, and ORNL meets regularly to define the session topics and identify invited speakers. These Workshops will be held online / virtually, and attendance is by invitation of the Organizing Committee.

AVFL COMMITTEE

THERMAL AND ELECTRICAL PROPERTIES OF LUBRICANTS FOR HEV/EV APPLICATIONS

CRC Project No. AVFL-37

Leaders: G. C. Gunter
A. Gangopadhyay

Scope and Objective

The objective of Project AVFL-37 is to develop a database of thermal and electrical properties of base oils from Group I to Group V. These data will enable better understanding of base oil chemistry to help meet the performance requirements of next generation automatic transmission fluid for future hybrid and all-electric vehicles.

The plan is to select several different base oils from Group I to Group V. The base oils will be selected upon recommendation from oil/additives companies based on their knowledge and experience in formulation and availability. The project will emphasize Group V oils including monoesters, diesters, polyol esters, aromatic esters, phosphate esters, polyalkylene glycols, silicones, synthetics and variants thereof, etc. Group V oils are emphasized because it includes a wide variety of chemical types, producing greater differences in properties, and they are not as well characterized as other Groups.

Current Status and Future Program

The Project Panel is considering a submitted proposal for this project, which is expected to start in 2020.

FUELS FOR ADVANCED COMBUSTION ENGINES (FACE) WORKING GROUP

Leaders: J. E. Anderson
S. McConnell

The AVFL Committee formed the FACE Working Group to foster collaboration with other industry and government research laboratory experts. The mission statement for this group was developed in 2005 and updated in 2015. The original mission of the FACE group was to recommend sets of test fuels well-suited for research so that researchers evaluating advanced combustion systems can compare results from different laboratories using the same set (or sets) of fuels.

The FACE group is composed of volunteers from industry, government, and academia. Its membership includes researchers from the fuel industry, as well as members representing the engine, automobile and emission control technology manufacturers, academia, and U.S. DOE and Canadian national laboratories. The collaboration includes scientists and engineers from ANL, LLNL, NREL, ORNL, PNNL, SNL, and NRCAN/CanmetENERGY.

An initial key activity of this group was developing two sets of fuels for research in advanced combustion in the diesel and gasoline ranges. The diesel fuel set, defined in 2007, became commercially available for purchase from Chevron Phillips Chemical Company, LLC (CPChem). Extensive characterization work has been performed by laboratories participating in the FACE Working Group; a summary of standard analyses of these fuels is available from the CRC website.

The Final Report, "FACE-1 Chemical and Physical Properties of the Fuels for Advanced Combustion Engines (FACE) Research Diesel Fuels" was published on the CRC website in 2010, after an accompanying conference paper was given at the 2009 SAE Fall Powertrains, Fuels, and Lubricants Meeting.

AVFL COMMITTEE

A gasoline-range fuel set design was also developed by the FACE Working Group. All ten fuels were blended in large batches and became commercially available for sale from CPChem. Detailed characterization of the gasoline fuel set is available on the CRC website in tabular form and further documented in CRC Final Report AVFL-24, "FACE Gasolines and Blends with Ethanol: Detailed Characterization of Physical and Chemical Properties." (2014)

Current and future activities may include publishing a review of available data using the FACE fuels from combustion studies, along with recommendations for parameters to measure in the studies, outreach to the technical community to raise awareness of the availability of the test fuels, and ongoing discussions of how best to approach alternative fuels research when also working with the FACE fuel sets.

The FACE Working Group has created a number of sub-teams to address various technical aspects of their work plan. Spin-off projects generated by ideas from this group include: AVFL-16, AVFL-18, AVFL-19, AVFL-23, AVFL-24, AVFL-26, AVFL-31, and AVFL-32.

AVFL LUBRICANTS ADVISORY PANEL

Leaders: G. C. Gunter
T. Kowalski

The AVFL Committee technical scope includes evaluation of impacts of current lubricants on advanced vehicles and future lubricants on current or advanced vehicles. The AVFL Committee organized a panel of engine lubrication experts from industry that serves as a resource for CRC Committees and Project Panels to consult on matters involving lubricants. The AVFL Lubricants Panel is also developing studies focused primarily on lubricant impacts for consideration by the full Committee.

The Panel meets periodically to develop project ideas for consideration by the AVFL Committee. The recently completed Projects AVFL-28 and AVFL-28-2, and ongoing Projects AVFL-28-3 and AVFL-37 were developed by this Panel.

ATMOSPHERIC IMPACTS COMMITTEE

DEVELOPMENT AND EVALUATION OF DATABASES AND ESTIMATION METHODS FOR PREDICTING AIR QUALITY IMPACTS OF EMITTED ORGANIC COMPOUNDS

CRC Project No. A-108

Leaders: C.G. Rabideau
T.J. Wallington

Scope and Objective

This project brings together an expert panel to evaluate the structure-reactivity and other estimation methods needed to develop complete detailed mechanisms and make recommendations for approaches judged to be the most consistent with available knowledge. This is analogous to the work of the International Union of Pure and Applied Chemistry (IUPAC) or NASA kinetic data panels, or the books on atmospheric mechanisms by Calvert and co-workers, but it is focused on compiling and evaluating estimation methods rather than the underlying experimental data themselves. As with these other efforts, this project has significant in-kind and ongoing support with periodic updates as new data and methods become available.

The expert panel consists of "full active participants" as well as "observers" who occasionally weigh in with their expertise. The panel members assembled into various working groups to organize the efforts, objectives, tasks, and current status of the work of each group.

The working groups include the following:

- Project Coordination and Leadership
- Preparation of a Perspective Article
- MAGNIFY/EUROCHAMP-2020/MCM Coordination
- Experimental Data Collection
- Quantum Calculation Data Collection
- Organic SAR Group/ Estimates for Reactions of Organic Compounds

- Radical SAR Group/ Estimates for Reactions of Organic Radicals
- Estimates for Photolysis
- Chemical Mechanism Working Group
- Thermochemistry Working Group
- Mechanism Generation Working Group

Current Status and Future Programs

A multi-year contract was awarded to UC Riverside in April 2017 and continues through 2020.

A perspective article that provides a general overview of gaps for improving atmospheric kinetic modeling was published in the *International Journal of Chemical Kinetics.* A second journal article on the experimental database has been published in *Earth System Science Data.*

ATMOSPHERIC IMPACTS COMMITTEE

THE INFLUENCE OF NO_X ON SECONDARY ORGANIC AEROSOLS AND O_3 FORMATION: CHAMBER STUDY

CRC Project No. A-113

Leaders: T.J. Wallington
S. Gao

Scope and Objective

The complex interplay of VOCs and NOx on atmospheric ozone formation (e.g., the ozone isopleth) requires a detailed, mechanistic understanding of the underlying chemical processes leading to its formation. Similarly, it has become readily apparent that condensable species formed in peroxide rich (low-NO) environments and organic nitrate formation in higher NOx environments both contribute significantly to enhanced aerosol formation. Classic environmental chamber experiments using VOC and NO/NO_2 mixtures may miss important SOA formation pathways leading to errors in atmospheric predictive models. As stringent NOx controls continue to reduce ambient NOx levels, it is critical that secondary pollutant formation be evaluated under such peroxide rich (low NOx) environments to greatly improve prediction of secondary pollutants under future environmental situations.

Within this project, specifically designed novel environmental chamber experiments will elucidate the key roles of NO_x on SOA formation and investigate the role of peroxide chemistry. These large chambers are designed to study atmospheric chemistry at low NOx concentrations (atmospherically relevant NOx loadings).

Primary objectives of Project A-113 are to:

- Design new experimental methods using environmental chambers to elucidate the interplay of NOx with select anthropogenic and biogenic precursors at atmospherically relevant (current and projected) oxidant levels;
- Identify SOA formation potential of select VOC precursors within these well-controlled environments;

- Evaluate ozone prediction under these scenarios; and,
- Provide guidance to regional air quality models on how to implement improvements to SOA predictive models.

Current Status and Future Programs

This study directly addresses one of the Research Needs (Influence of NOx on SOA Formation and Ozone) from the CRC Air Quality Modeling Research Needs (AQMRN) Workshop held in February 2016.

The multi-year project began in January 2018 with UC Riverside and continues into 2021.

ATMOSPHERIC IMPACTS COMMITTEE

CHARACTERIZING PRIMARY ORGANIC AEROSOL EMISSIONS FROM IN-USE MOTOR VEHICLES

CRC Project No. A-114/ RW-111

Leader: M.E. Moore

Scope and Objective

It has been shown that primary organic aerosol (POA) mass from combustion emissions evaporates as it is diluted to ambient conditions. The semi-volatile partitioning of a large fleet of gasoline vehicles has been demonstrated on a chassis dynamometer and the volatility profiles have been quantified using a combination of thermodenuder and mass spectrometer analysis. Large scale model studies have also shown that treating POA compounds as semi-volatile has a significant impact on the average magnitude of emissions from combustion sources as well as on the spatiotemporal variability of organic aerosol (OA) concentrations, particularly in urban areas and close to sources. Although many chemical transport models (CTMs) now include POA semi-volatile partitioning, standard emissions measurements procedures do not collect the information needed to inform gas/particle partitioning calculations.

Current vehicle emissions measurements report total hydrocarbons, non-methane organic compounds, and particulate mass. However, in order to calculate OA partitioning, one needs to know how the emissions themselves respond to swings in the pollutant particle concentrations, for example. Without this information, many CTMs have relied on ambient OA measurements to constrain the total OA mass emitted from combustion sources like vehicles, and parameters vary widely depending on the model and application. While there has been extensive recent work on the detailed measurement of POA volatility and composition, these scientific findings need to be connected to standard measurements and methods that are the most common source of data for emissions inventories and models like CMAQ.

Current Status and Future Program

The goal of this project is to quantify the volatility profile and particle concentration in exhaust emissions. Measurements focus on physical properties of exhaust, both particulate and gas-phase concentrations.

Results from this study will be used to:

- Confirm that varying dilution leads to organic evaporation behavior that is consistent with published volatility profiles and partitioning theory,
- Better understand the interpretation of existing emissions datasets where particle concentration and volatility information does not exist,
- Determine the accuracy and limitation of using dilution factor to quantify the volatility profile of individual vehicles during standard emissions measurement efforts, and
- Add to the growing body of data documenting the volatility profiles of individual vehicles by tier, model, and model year, etc.

West Virginia University was awarded the contract for this project in February 2019, which continues through 2020.

ATMOSPHERIC IMPACTS COMMITTEE

ROLE OF METEOROLOGY, EMISSIONS AND SMOKE ON O_3 IN THE SOUTH COAST AIR BASIN

CRC Project No. A-118

Leaders: G. Myers
S. Winkler

Scope and Objective

The greater Los Angeles air basin is home to approximately 18 million people and has the highest O_3 design value in the country. Despite great progress on reducing O_3 in the region, levels are still well above the NAAQS. In addition, recent O_3 concentrations have risen with little understanding why. This project seeks to examine complex relationships between O_3, emissions, meteorology, and wildfire impacts to improve knowledge on O_3 processes in this region through three objectives:

- Develop statistical models using meteorology and satellite observations over a 13-year period from 2006-2018 that can characterize the maximum daily 8-hour average O_3 for four sites in the greater LA air basin to examine impacts of daily variations in meteorology on O_3 in the region.
- Evaluate wildfire impacts on O_3 for the greater LA air basin using statistical models along with indicators for wildfire smoke, such as surface $PM_{2.5}$ and satellite data.
- Examine short and long-term changes in O_3 due to emissions, meteorology and smoke in the greater LA air basin to understand the causes for the recent lack of improvement in O_3 levels.

Current Status and Future Programs

This project addresses one of the top priority research needs for additional meteorology research identified at the 2018 SCORES workshop. The contract for this project was awarded to University of Washington, and the Final Report was completed and posted on the CRC website January, 2020.

ATMOSPHERIC IMPACTS COMMITTEE

IMPROVING MODELNG TECHNIQUES AND DATA AVAILABILITY FOR SOURCE CHARACTERIZATION

CRC Project No. A-119

Leaders: S. Collet
M. Janssen

Scope and Objective

Emerging data in Chemical Transport Modeling (CTM) and related measurements are improving our understanding of the relationships of different sources of emissions. Changes in emissions over the past 10 years are making us re-think traditional ideas about the most significant source. For example, images from Geotaso data showing the concentration of emissions on a high ozone day in Metropolitan Chicago indicate that interstates where light duty vehicles dominate the fleet are less important; and interstates with high heavy-duty truck and rail yards and intermodal trucking facilities are showing higher than expected NOx concentrations.

There are two activities in need of upgrades to improve understanding of this shift in source contributions including changes to the newest CTM source apportionment tools, and improved reporting tools that extract critical high-resolution inventory data which can be compared to terrestrial and remote sensing measurement data.

Current Status and Future Programs

University of North Carolina (UNC) was awarded this contract in June 2019 to develop a tool to read existing sectors as grouped source apportionment output files from SMOKE. This tool allows users to review existing values and make simple changes to group numbers and generates a gridded map of before- and after-classifications with state and county boundaries.

The Final Report and data for the modeling tool were posted to the CRC website in March, 2020. The tool has since been updated to improve its capabilities in response to modeling needs. This update was available as of June, 2020.

ATMOSPHERIC IMPACTS COMMITTEE

EMPIRICAL ANALYSIS OF HISTORICAL AIR QUALITY AND EMISSIONS INFORMATION TO DEVELOP OBSERVATIONALLY-BASED MODELS OF OZONE-VOC-NO_X RELATIONSHIPS IN SOUTHERN CALIFORNIA AND THE COMPARISON TO AIR QUALITY MODELS

CRC Project No. A-120

Leaders: S. Gao
S. Winkler
T. French

Scope and Objective

The South Coast Air Basin (SoCAB) of California has the highest peak ozone levels in the U.S. in spite of stringent controls. While significant ozone reductions have been realized, the recent trend has found a leveling off in the ozone design value (ODV), and the last two years have seen an increase. Multiple questions arise, including: How will ozone respond to proposed emissions changes? What is the most effective approach forward? How effective have past controls been in relationship to the advantages of NOx vs. VOC controls? What is the ultimate background ozone level? How well do chemical transport models, which are used to develop control strategies, capture ozone trends and, importantly, sensitivities to emissions?

The objective of this study is to conduct extensive and detailed modeling of SoCAB for a number of historical and future years, with extensive uncertainty analysis, to understand how well the current CTMs capture ozone dynamics. While the focus is on ozone, the modeling will provide similar results for particulate matter. There will be three specific approaches to go beyond typical studies:

- Extensive sensitivity analysis (with uncertainty analysis of sensitivities),
- Use of isopleths to provide a more direct, visual analysis tool (that can also be quantitative), and

- Direct comparison of modeled sensitivities with empirically-derived sensitivities (including the use of isopleths).

Current Status and Future Programs

Project A-120 is being conducted by Georgia Tech, and meets several of the top research priority needs resulting from the 2018 CRC SCORES workshop, including addressing data gaps in the observational response of ozone to changes in NO_x and VOC. The contract was awarded in May 2019, and will continue through 2020.

ATMOSPHERIC IMPACTS COMMITTEE

DIRECT MEASUREMENT OF OZONE SENSITIVITY TO NO_X AND VOC IN THE SOUTH COAST AIR BASIN

CRC Project No. A-121

Leaders: T. Wallington
T. Kuwayama

Scope and Objective

The combined results from past studies using photochemical grid models and indicator species suggest that NO_x emission controls provide an efficient method to reduce surface ozone concentrations in California, but recent increases in ambient ozone concentrations in Los Angeles highlight the need for additional air pollution mitigation strategies. Direct measurements of the change in ozone per unit change in precursor species in the atmosphere would build confidence in the model prediction. In 2014, the SCAQMD funded a pilot project to measure the sensitivity of ozone formation to NOx and VOC using smog chambers deployed at sites across the SoCAB.

This project will use the methods previously developed in the SCAQMD pilot project to measure ozone sensitivity to precursor NO_x and VOC concentrations at a number of locations over an entire summer period in the SoCAB. The results will provide direct measurements to compare against model predictions for optimal ozone control strategies.

Current Status and Future Programs

Project A-121 meets the top research priority needs resulting from the 2018 CRC SCORES workshop to observe response of ozone to changes in NO_x and VOCs. The project is co-funded by California Air Resources Board. The contract for this project was awarded to UC-Davis in May 2019. The multi-year effort will continue through 2020.

MOBILE SOURCE AIR TOXICS WORKSHOP 2021

CRC Project No. A-122

Leaders: S. Winkler
S. Yoon

Scope and Objective

The objective of this Workshop is to bring together key individuals and organizations working on current issues of mobile source air toxics for in-depth technical discussions in a workshop format. The Atmospheric Impacts Committee, in conjunction with CARB, hosted the 2010, 2013, 2015, 2017, and 2019 CRC Mobile Source Air Toxics (MSAT) Workshops in Sacramento following the previous workshops held in Houston in 2002, Scottsdale in 2004, and Phoenix in 2006 and 2008. Each of these events brought together key government, academic, and industry researchers, and stakeholders working in this area.

Current Status and Future Programs

The 9th MSAT Workshop was held in Sacramento, CA on February 4-6, 2019, with co-sponsors including CARB, API, HEI and SCAQMD. There were 30 technical presentations and over 120 attendees of the Workshop, which was hosted by CARB at their headquarters. Dr. Kent Hoekman was selected again to support organization of the 2019 MSAT Workshop with the aid of organizing committee participants. A Summary article was published in July 2019 edition of *EM Magazine.*

A 10th workshop is being planned for 2021. It is expected that this workshop will relocate to Riverside, CA in Fall 2021 to coincide with the opening of the new CARB facilities.

ATMOSPHERIC IMPACTS COMMITTEE

UNCERTAINTY IN OZONE CHANGES FROM CONTROL STRATEGY IMPLEMENTATION

CRC Project No. A-123

Leaders: C. Rabideau
S. Winkler
M. Janssen

Scope and Objective

Three-dimensional (3-D) chemical transport models (CTMs) are used to predict pollutant concentrations in future years and thus have an important role in developing State Implementation Plans (SIPs) for ozone (O_3) and particulate matter. CTMs require numerous inputs and parameters that are uncertain to various degrees. For example, current chemical mechanisms for O_3 formation have hundreds of rate constants and product stoichiometric coefficients, each with an associated uncertainty. Consequently, CTM predictions have uncertainty, and understanding this uncertainty is important to determining the significance of comparisons between predicted and observed O_3 concentrations, O_3 changes predicted in attainment demonstrations (SIPs) and modeled O_3 trends (dynamic evaluation).

A global uncertainty analysis of model predictions is a challenge due to the large number of inputs and parameters, the possibility of interactions among them, and the relatively long computer runtimes for 3-D models. In a recently completed project for the Texas Air Quality Research Program (AQRP), the uncertainty in O_3 concentrations in eastern Texas predicted by the Comprehensive Air Quality Model with Extensions due to uncertainties in the chemistry, emissions, deposition velocities, and O_3 boundary concentrations was estimated. A new approach to estimating the O_3 uncertainty due to uncertainty in the chemical mechanism was introduced.

The goal of this project is to extend the prior work to estimate the uncertainty in the O_3 change in eastern Texas in response to emission controls. The uncertainty in the O_3 change from a base to future year could be smaller than the uncertainty in the O_3 concentration itself because errors for model inputs in the future year may be similar to those in the base year (correlation). Consequently, when taking the difference in the O_3 concentration between the base and future years, some of the errors in the O_3 concentrations for the two years may cancel, i.e., the O_3 concentration may tend to be greater than the correct value or less than the correct value in both years because some model input errors are in the same direction and have about the same magnitude in both years.

Current Status and Future Programs

Project A-123 meets the top research priority needs resulting from the 2018 CRC SCORES workshop. The contract for this project was awarded to Ramboll for completion in late 2020.

ATMOSPHERIC IMPACTS COMMITTEE

EVALUATION OF OZONE PATTERNS AND TRENDS IN EIGHT MAJOR METROPOLITAN AREAS IN THE U.S.

CRC Project No. A-124

Leaders: G. Myers
S. Winkler

Scope and Objective

Ozone in the U.S. remains a persistent problem with more than 120 million people living in areas that do not meet the 2015 standard. While much progress in meeting the standard has been made over the past few decades, it has slowed since 2013 and even some "back-sliding" has been observed, as the mean and 90th percentile of all sites has actually increased. Regionally, the trends largely track the national pattern and show little change over the past 5 years.

In this project, possible causes for these trends at sites in eight core based statistical areas (CBSAs) across the U.S. will be investigated. For each site, the complex relationships between O_3, emissions and meteorology will be examined and possible smoke impacts on O_3 at each site will be identified. This will improve our knowledge on O_3 processes in these regions and provide guidance to policy makers on future attainment strategies.

One or more monitoring sites at each location have been selected based on design value (DV). This project builds on CRC project A-118, which focused on the impact from smoke, NOx and climate change on O_3 in the South Coast Air Basin. For that project, Generalized Additive Models were developed to explain trends in the MDA8 for 6 sites in the South Coast region. The results show that NOx emissions are the largest drivers on long-term trends in MDA8 O_3 and that neither smoke nor climate change have had a significant influence on the long-term O_3 trends in this region, to date.

Specific goals of this project are:

- Evaluate the relationship between daily MDA8 O3, temperature, NOx, and the presence or absence of smoke for 8 large metropolitan areas in the US with high O_3 DVs.
- Develop Generalized Additive Models (GAM) to understand the relationship between daily MDA8 values and key meteorological predictors for 8 large metropolitan areas in the U.S. with high O_3 DVs.
- Examine patterns and trends in the GAM results to evaluate the causes for trends or lack of trends at each of the 8 regions considered.

Current Status and Future Programs

University of Washington has been contracted for Project A-124, which will continue through 2020. Additional monitoring sites at two locations are being supported through co-sponsorship.

PERFORMANCE COMMITTEE

GASOLINE ENGINE DEPOSITS

CRC Project No. CM-136

Leader: M. Sheehan
J. Cruz

Scope and Objectives

The current objectives of this group are to:

- Develop test procedures for the objective evaluation of spark-ignition (SI) engine fuel and fuel additive contributions to combustion chamber deposits (CCD), intake valve deposits, and injector deposits in Port Fuel Injection (PFI) and Direct Injected (DI) vehicles.
- Determine the extent of SI fuel injector fouling and intake valve deposits and assess the adequacy of current deposit control additive dosages to prevent deposit formation.

Current Status and Future Program

Gasoline Engine Intake Valve Deposit Testing

ASTM D5500 is the test recognized by EPA for certifying additives to protect against Intake Valve Deposits. CARB has a separate test, and there is also a private program Top Tier certification test. The CRC Gasoline Deposit Group is considering a re-evaluation of the test procedures to possibly update the vehicles/engine and the fuels used to assess deposit levels and the impact of fuels. The ASTM standard was implemented in 1994. Since that time there have been changes in fuel properties, engine technologies, ethanol usage rates, and new performance requirements. The composition of the fuel sold at retail today has changed, with Tier III regulations reducing sulfur content. Since 1994, refining changes have been made and crude oil type has shifted with changing crude slates. Changes in engine technology include hybrids, FFVs (Flex Fuel Vehicle), DISI (Direct Injection Spark Ignition), turbo boost, downsizing, and VVT (Variable Valve Timing). The extent of ethanol use has also dramatically changed. The current engine test platforms, which include dated BMW 318i and Ford 2.3L (ASTM D6201), do not represent the majority of the current vehicle population. The certification fuel requirements are also quite different from today's fuel composition.

Additive companies of the American Chemistry Council (ACC) are working to develop a new PFI-based intake valve test. The primary goal is to replace the existing tests, in particular the BMW test required by EPA and the Ford 2.3L required by CARB, with a more modern test. A project panel has been formed to plan CRC research on this topic.

The role of CRC is to provide data on performance but does not recommend what limits or variables should be set for standards or regulatory performance.

Port Fuel Injection (PFI) Intake Valve Deposit (IVD) Test Development (CM-136-18-1)

This project will develop a new engine-based test method suitable to replace existing ASTM D5500 test method for demonstrating effectiveness of gasoline detergent additives. It will conduct an engine test program to develop a final test fuel specification, test parameters, operating conditions, engine hardware requirements, and recommendations for pass / fail criteria. The work will result in an ASTM test methodology for IVD measurement and be acceptable to the EPA and potentially CARB for use in their Lowest Additive Concentration (LAC) certification test programs. This work will be completed in the Prove-out Phase of the CRC test development project. There will be a follow up Precision Phase of the project to define the repeatability and reproducibility of the test method once the Prove-out Phase is complete. The overall development project is expected to consist of three Prove-Out phases and one Precision phase.

• Phase 1 – Prove-Out Test Cycle

• Phase 2 – Prove-Out Test Fuel

• Phase 3 – Prove-Out Detergent

• Phase 4 – Precision

The project team has formed around five workstreams: Engine Test Development, Data Analysis, Test Fuel, Additives, and EPA / CARB Engagement.

A request for proposals for this project was released on the CRC website, and review of the proposals is in progress, anticipating the start of work in late 2020.

Investigation into Filter Plugging Due to Sulfate Salt Contamination of Ethanol, Gasoline, and Gasoline-Ethanol Blends (CM-136-15-1 / CM-136-18-2)

The objective of the first project was to develop a thorough understanding of the formation of particulate sulfate salts in ethanol, gasoline, and fuels containing ethanol, including the impacts of water and ethanol concentration, the level of sulfates and cations, and the influence of temperature, gasoline aromatic content and detergent additives on fuel-borne particulate formation and filterability. Based on filterability experiments, the goal was to determine the relative maximum levels of cations and sulfate anions in ethanol and in fuel blends containing ethanol with current levels of detergent additives that will result in filter plugging and vehicle performance problems.

The first project consisted of two phases:

Phase One was a literature search of the published information on the possible sources of the cations and sulfate anions, the solubility of various sulfate salts in alcohols, hydrocarbons, and their blends, filter plugging due to sulfate salts, potential interactions between fuel additives and sulfate salts and automotive performance problems associated with sulfate salts in gasoline and gasoline-ethanol blends. This information was categorized and summarized to guide the next phase.

Phase Two consisted of laboratory work to determine the solubility and filterability of sulfate/sulfite salts in ethanol, gasoline and gasoline-ethanol blends, and higher amounts of gasoline detergent additives. This is the foundation for understanding the chemistry of the formation of sulfate salts and their ability to plug filters and vehicle fuel handling equipment.

In the laboratory experimental phase, the variables were determined based on the literature search. The first set of lab experiments looked at the solubility of sulfate salts in denatured fuel ethanol. The variables included temperature, water content, cation (ammonium, sodium), and sulfate anion level. The second set of lab experiments studied the solubility of sulfate salts in gasoline. The variables considered include temperature, water content, cation (ammonium or sodium), aromatic content, detergent level, and sulfate anion level. The third set of experiments studied the solubility of sulfate salts in gasoline-ethanol blends and focused on the variables that were determined to be important in sets 1 and 2.

Testing involved preparing the required solutions and heating/cooling them to test temperature. The solutions were then filtered using an appropriate ASTM test procedure. The amount and composition of precipitate were determined and compared with the initial dosage.

RFA and Flint Hills Resources co-sponsored this project. The Final Report, "Investigation into Filter Plugging Due to Sulfate Salt Contamination of Ethanol, Gasoline, and Gasoline-Ethanol Blends" was published on the CRC website in January 2018.

The objectives of the follow-on work are to address a narrower range of solubility issue, and the researchers are focused on investigations of sodium sulfate, sodium bisulfite and sodium metabisulfite in ethanol. "Investigation of Sulfate Salt Solubilities in Ethanol and Gasoline-Ethanol Fuel Blends" is being conducted by DRI. A problem with the measurement method was detected and some of the work is being redone at no cost to CRC. Reporting is anticipated in 2021.

PERFORMANCE COMMITTEE

VOLATILITY

CRC Project No. CM-138

Leader: R. Lewis
M. Valentine

Scope and Objective

The objective of the CRC Volatility Group is to investigate the relationship between vehicle driveability performance and fuel volatility characteristics.

Current Status and Future Program

Development of an Engine Based Test for Determining the Effect of Spark-Ignition Engine Fuel Properties on Combustion and Vehicle Driveability (CM-138-15-2 / CM-138-19)

The objective of Project CM-138 is to take a more fundamental approach toward measuring the in-cylinder combustion instability that is the root cause of poor vehicle operability. CRC would like to determine whether fuels of differing compositions and physical characteristics (e.g., Driveability Index) can be distinguished from vehicle performance differences using an instrumented engine in a vehicle on an all-weather chassis dynamometer. In addition, CRC would like to identify the measurements that are most effective at differentiating the physical and compositional characteristics between fuels. Finally, CRC would like to establish the resolution and repeatability of the measurements.

The test program consists of testing instrumented whole vehicles on a chassis dynamometer. The vehicles are being tested one at a time with time between each vehicle for the evaluation of the data and potential test program adjustment to apply the learnings from the last test to the next test. The engines in these vehicles are instrumented with cylinder pressure indication on each cylinder, Engine Control Unit (ECU) taps of the primary engine controls parameters, as well as temperature and pressure instrumentation of all major intake and exhaust components. All data are being captured using various measurement equipment (crank angle resolved and time based) and will be merged into one combined dataset which will be used for assessment. The driving pattern applied in CRC Report No. 666, “2013 CRC Intermediate-Temperature E15 Cold-Start and Warm-Up Vehicle Driveability Program” is being replicated with the instrumented vehicle on a chassis dynamometer. Test fuels are a series of hydrocarbon and hydrocarbon-ethanol blends of differing compositional and physical properties with the goal of determining discrimination sensitivity. FEV performed the testing. RFA co-sponsored this research. The Final Report has been released (2014).

A follow-on project has been developed to test an additional vehicle equipped with in-cylinder and spark-plug transducer pressure sensors, to assess the ability of the latter sensor type to be used for this type of research. The project is ongoing, and is expected to report results in 2021.

Comparison of Ambient Temperatures from ‘Doner Report’ to Modern Day Ambient Temperatures for the Same Geographic Areas (CM-138-16-2)

Table 4 Schedule of U. S. Seasonal and Geographical Volatility Classes in ASTM D4814 Standard Specification for Automotive Spark-Ignition Engine Fuel was generated from state ambient temperatures obtained by the U.S. Army during the 1970s, known as the “Doner Report”. Concerns were expressed in the industry that the original “Doner Report” information may be outdated. The objective of this project was to conduct a review of modern-day ambient temperatures for the geographic regions in ASTM D4814 Table 4 with the new data then compared to that in the “Doner Report.” The report and data review were done in a manner similar to that of the original “Doner Report” but with computer-generated isothermal maps. The new study included data covering 1996 through 2016 (twenty-one years, which is similar to that from the “Doner Report”), and Hawaii (left out of the original study). State temperature data (excluding Panama Canal which was part of the original report) were analyzed in multi-geographic regions when appropriate as was done for the prior study.

DRI performed this project. The Final Report was published on the CRC website in December 2018. In late 2019, it was discovered that updates to a table in the report were needed, and the proposed revision (addendum) to the Final Report was posted to the CRC website in March 2020.

<u>"Driveability Workshop to Train and Calibrate Raters Using the CRC Trick Car" – CM-138-18-1</u>

CRC has used trained raters for many years to assess the driveability vehicle performance for test programs. The existing driveability rater pool consist of retirees or from testing facilities. Therefore, CRC sees the need to establish new trained raters for future volatility projects. CRC has not conducted a rater workshop to train and calibrate driveability raters since 2002, where a 'trick car' (Driveability on Demand Training Vehicle) was used to train and calibrate driveability raters by subjecting them on demand to various driveability malfunctions at different intensities. Calibrating raters will improve test result precision. CRC has a new 'trick car' which was developed under CRC Project CM-138-17-1. The objective of this project is to meet at a common test site to train novice and inexperienced personnel to be driveability raters and to calibrate experienced driveability raters using the CRC Driveability on Demand Training Vehicle.

This Workshop was conducted by SwRI in September 2019. The Final Report has been released on the CRC website.

GASOLINE COMBUSTION GROUP

CRC Project No. CM-137

Leader: V. Costanzo
E. Chapman

Scope and Objective

In 2020, the name of this Working Group was changed from the Octane Group to the Gasoline Combustion Group. The objectives of this group are to conduct surveys of the combustion-related requirements of current production automotive vehicles, to develop methods for quantifying combustion-related fuel requirements of vehicles, and to determine effects of variables such as mileage accumulation and altitude on combustion-related fuel requirements.

Current Status and Future Program

CRC "Stochastic Pre-Ignition" (SPI) Workshop & CRC "Fuels and Engines: The Road Ahead" (FETRA) Workshop – 2020 ***Formerly Titled: "Advanced Fuel and Engine Efficiency" (AFEE) Workshop***

These Workshops are supported equally by the Performance Committee Gasoline Combustion Group and AVFL, and are described in the AVFL Committee section under the project number AFEE-2020.

"Impact Of MON On Engine Performance"- CRC Project No. AVFL-36 / CM-137-19-1

This Project is supported equally by the Performance Committee Gasoline Combustion Group and AVFL, and is described in the AVFL Committee section.

PERFORMANCE COMMITTEE

DIESEL PERFORMANCE GROUP

CRC Project No. DP

Leader: G. Gunter
S. Lopes

Scope and Objective

The objective of the Diesel Performance Group is to help to define the minimum diesel fuel requirements for light-duty diesel vehicles in North America. This will be achieved by providing supporting technical data for diesel performance issues that are needed by the fuel, engine, equipment, and additive industries and can be used by technical groups such as ASTM International, the International Organization for Standardization (ISO), and the National Conference on Weights and Measures (NCWM). Much of the knowledge gained is common to other diesel applications such as heavy-duty diesel (HDD). This Group works closely with industry stakeholders and benefits from their contributions.

The Diesel Performance Group currently has the following active and inactive panels and will adjust and add new ones as needed:

Active Panels:

- Cleanliness
- Corrosion
- Deposit
- Low Temperature Operability
- Stability

Inactive Panels:

- Biodiesel & Renewable Diesel
- Cetane Number
- Lubricity

Current Status and Future Program

Cleanliness

The objective of the Cleanliness Panel is to address, to investigate, and to provide information for general housekeeping and other issues for diesel fuel. The focus is fuel cleanliness and fuel properties that are outside the defined fuel properties in existing CRC DPG panels. These fuel cleanliness properties should have relevance from the point of diesel production to the point of customer use (refinery to vehicle fuel tank). Modern high-pressure common-rail injection systems require much cleaner diesel fuel.

The Panel generated a CRC guide to compile best available current knowledge and practice regarding cleanliness of diesel fuel. CRC Report No. 667, "Diesel Fuel Storage and Handling Guide," was published on the CRC website in September 2014. ASTM periodically holds workshops on this topic and distributes the guide to participants.

The Panel developed a summary one-sheet guide targeted to benefit fuel station operators. CRC Report No. 672, “Preventive Maintenance Guide for Diesel Storage and Dispensing Systems,” was published on the CRC website in July 2016.

The Panel meets periodically. Data have been generated by panel members and is under review for potential publication.

Corrosion

Accelerated corrosion has been observed in some retail underground tanks storing and dispensing ultra-low sulfur diesel (ULSD) since 2007. In addition, corrosion is affecting metallic equipment in both the wetted and un-wetted portions of some ULSD underground storage tanks (USTs). To identify the root cause of accelerated corrosion, multiple stakeholders in the diesel, vehicle, regulatory, and truck stop industries, through the Clean Diesel Fuel Alliance, sponsored a field research study by Battelle Memorial Institute in 2012.

PERFORMANCE COMMITTEE

The CRC Panel developed a protocol for selecting sites with diesel fuel systems that had severe corrosion. This was posted to the CRC website with the goal of informing the EPA and others in their current and future research on this topic (2014). Using the CRC protocol, the EPA, in consultation with the CRC Panel, conducted a survey of USTs in the field.

To identify possible root causes of the excessive corrosion, the CRC Panel developed a laboratory test program titled:

Identification of Potential Parameters Causing Corrosion of Metallic Components in Diesel Underground Storage Tanks (DP-07-16-1)

The project objective is to identify parameters that directly contribute to accelerated corrosion of metal parts and tank equipment in USTs that are in ULSD service, including retail sales, fleet suppliers, and fuel storage for emergency power generation. The parameters being evaluated were generated by identifying all major changes that took place related or independent of the introduction of ULSD.

Battelle performed the testing in this project, with significant interaction and support from CRC Panel Members. Fred Passman was contracted as a consultant to complete the Final Report. The release of the report is anticipated in late 2020.

Deposit

The objective of the Deposit Panel is to identify or develop a laboratory bench top or test rig for evaluating diesel fuel's tendency to cause internal injector deposits in diesel engines and to use a tool to evaluate possible effects by fuels, impurities, and additives.

Experts on the Deposit Panel wrote a review of potential causes of internal diesel injector deposits which was published as CRC Report #665, "Internal Diesel Injector Deposits," October 2013.

An initial scoping study of limited screening used three in-house tests to determine if fuels which are expected to cause internal injector deposits can be differentiated from those that are not expected to form such deposits. The Delphi rig was identified as one that had the potential for this application. Results of these studies are in two CRC reports on the CRC website:

- CRC Project DP-04, “Scoping Study to Evaluate Two Rig Tests for Internal Injector Sticking,” July 2012.
- CRC Project DP-04-13b, “Internal Injector Deposits: A Scoping Study to Evaluate the Delphi Test Rig,” August 2013.

A comprehensive rig/engine test program was conducted to verify correlation between the Delphi rig and actual engines. Results were positive and have been documented in CRC Report DP-04-10, “Internal Injector Deposits; Correlation of the Delphi Test Rig with Production Engines,” published March 2016 on the CRC website.

The Deposit Panel designed a program to set up and use the test rig at a U.S. research facility to begin evaluation of fuels, additives, and impurities. The project, titled “Fuel Research Using the Internal Diesel Injector Deposit (IDID) Rig” (CRC DP-04-17), was performed by SwRI. The Final Report was released on the CRC website in September 2019.

The Deposit Panel is planning additional research to build upon the recent publications.

Low Temperature Operability

The Panel conducted a study in which various test methods used to characterize fuel low temperature operability were evaluated for their ability to predict whether test vehicles experienced fuel-related operability problems in low temperature test conditions. Results were documented in CRC Report #649, “Evaluation of Low Temperature Operability Performance of Light-Duty Diesel Vehicles for North America,” November 2007.

The Panel conducted a study of the effect of biodiesel blendstock properties on cold flow properties of biodiesel blends. Results were documented in two reports: CRC Report #650, “Biodiesel Blend Low-Temperature Performance Validation”, June 2008 and CRC

Report #656, "Biodiesel Blend Low-Temperature Performance Validation," June 2010.

The panel has utilized members' expertise to generate CRC Report No. 671, "Diesel Fuel Low Temperature Operability Guide." The guide was written for general use by end users, fuel producers/distributers, and OEMs in providing guidance on the best ways to keep diesel vehicles operating under most low temperature conditions. The guide was released on the CRC website in September 2016.

The Panel is conducting a project titled, "Low Temperature Filterability of Diesel Fuel at Retail Pumps," using resources provided by Panel members. A test rig is being used to determine limitations in dispenser filters in operation in cold temperature. This test rig may be able to evaluate any relationship between filter pore size and operational issues at low temperatures. Reporting on this research is expected in late 2020.

Stability

This is a new Panel formed in 2020 to address issues related to diesel fuel stability. The Panel is currently considering potential project ideas related to 1) improving viability of engine-based stability tests which are based on dated technology and 2) investigating whether current ASTM fuel stability specification limits (Rancimat) are sufficient to protect modern fuel injection systems.

THERMAL STABILITY PANEL

CRC Project No. AV-24-16

Leaders: R. Juan
A. Carico

Scope and Objectives

There has been an increased number of incidences of jet fuels that do not meet the ASTM D1655 requirements for D3241 ("JFTOT") thermal stability at pre-airfield terminals or airport depots. The product in question does meet certification at the production point, but fails after moving through the fungible distribution system. The number and severity of these failures have caused supply chain and end user issues. The Project Panel will be investigating a number of failure mechanisms and the factors possibly involved in causing those failures.

Current Status and Future Program

The panel has been meeting periodically since its formation, with the frequency varied according to the occurrences of observed issues with fuel stability. Samples have been procured and testing performed to inform potential future research in this area.

AVIATION COMMITTEE

WATER-SOLUBLE CONTAMINANTS IN JET FUEL

CRC Project AV-25-16

Leader: J.P. Belieres

Scope and Objectives

The source and mechanism of water-soluble deposits on engine hardware remains elusive. It is hoped that a systematic yearlong sampling program along with an array of analytical tests will provide sufficient information to correlate engine deposits with fuel component variations. This project is testing monthly samples from a maximum of ten selected airport locations for a period of one year. The results of these tests can be used to determine correlations between properties, fuel component deposits and combustion events. A total of 95 regularly scheduled samples will be analyzed with provision for 5 additional "ad hoc" samples.

Measurements:

Fuel phase Analysis – "Organics"

- Measure total sulfur, nitrogen and oxygen content
- Perform speciation and measure concentration of nitrogen, sulfur, and oxygen containing species.

Aqueous phase analysis:

- Sample pH
- Total Nitrogen concentration
- IC Analyses
- Measure concentration of Cu, Mg, Fe, S, Si, and P, in the sample's water phase by ICP-OES.
- ESI-TOFMS

Current Status and Future Program

This project was awarded to the University of Dayton Research Institute. Testing is complete, and reporting is in progress, with publication expected in late 2020.

DEVELOPMENT OF INDUSTRY REFERENCE FLUIDS FOR ASTM D3241 TESTING

CRC Project No. AV-26-17

Leaders: J. Stolis
E.A. Lodrigueza

Scope and Objectives

The objective of Project AV-26-17 is to develop a reference fluid for standardization of ASTM D3241 testing - Standard Test Method for Thermal Oxidation Stability of Aviation Turbine Fuels. The impact of project success would be immediate, due to significant variations in ASTM D3241 testing experienced across labs using different equipment and test consumables currently available in the field. Benefits would extend to the long-term by improving D3241 calibration and provide future standardization of new D3241 testing equipment and consumables.

A first reference fluid will be designed to generate consistent D3241 tube deposit. This fluid shall undergo a known thermal oxidative chemistry pathway leading to consistent deposit thickness and profile on a D3241 heater tube at a test temperature falling within 250 to 300 °C. A second reference fluid is being designed to generate consistent D3241 differential pressure response. This reference fluid shall undergo a known thermal oxidative chemistry pathway leading to consistent particulates and a differential pressure of 100 mm Hg within a 60 to 90 minutes time frame in a similar test temperature range as the deposit reference fluid.

Visual tube ratings and metrology (ellipsometry/interferometry) shall be used to evaluate the consistency of deposits produced by the fluids on a single JFTOT instrument (designated as the project standard instrument) using batch equivalent consumables (single production batch of tubes). The consistent performance of the fluid(s) over time on the project standard instrument is an important requirement that needs to be demonstrated.

AVIATION COMMITTEE

Current Status and Future Program

Project AV-26-17 is being performed by the University of Dayton Research Institute. The Draft Final Report is in review, with publication expected in late 2020.

DEVELOPMENT OF FUEL V/L RATIOS FOR APPLICATION TO SYSTEM 'SUCTION' CAPABILITY DETERMINATION

CRC Project No. AV-27-18

Leaders: J. P. Belieres
R. Kamin

Scope and Objectives

The objective of Project AV-27-18 is to generate the appropriate data needed to update the SAE documents dealing with V/L and gases solubility, as well as updating CRC and ASTM publications. These publications determine the ability of a fuel pump to operate when presented with a fuel and gas (V/L, vapor-to-liquid fuel ratio), or minimum required inlet pressure (fuel only): with testing performed for stabilized operating conditions and idealized test conditions, and with practices stating that testing should not be used to establish transient performance for the aircraft installation since they are not intended to establish altitude, climb rate or other transient performance of the system.

In addition, under failure conditions, there is a need for the integrated aircraft and engine fuel system to operate, when the aircraft pumps are non-operational, in a "suction" or "gravity" feed mode. Under these conditions it is critical that air evolution from the fuel does not result in a "vapor lock" condition. This project is investigating:

- Air solubility (and other critical properties) of various fuel types, including biofuels, to support determination of test conditions for contemporary fuels.
- Capability to estimate influence of aircraft rate of climb, and the corresponding reduction in ambient pressure experienced by the fuel, on the derived V/L ratio, enabling a more accurate mechanism to determine two phase flow conditions within the aircraft and engine fuel system during transient aircraft operation.

AVIATION COMMITTEE

Current Status and Future Program

Project AV-27-18 is being performed by the University of Dayton Research Institute. Final reporting is expected in mid-2021.

PART THREE

RELEASED REPORTS

AIR POLLUTION AND ADVANCED TECHNOLOGY*

CRC Project No.	Title	Publication/NTIS Accession No.
A-107	Atmospheric Impacts of VOC Emissions: Formation Yields of Organic Nitrates in Reactions of Organic Peroxy Radicals with NO	PENDING
A-108	Database for the kinetics of the gas-phase atmospheric reactions of organic compounds	Earth Syst. Sci. Data, 12, 1203–1216, https://doi.org/10.5194/essd-12-1203-2020
A-118	Role of Meteorology, Emissions and Smoke on O3 in the South Coast Air Basins	PENDING
A-119	High-Resolution Inventory Data Extractor and Source Apportionments Regrouping Tool Developments	PENDING
AVFL-18a	Autoignition Of CRC Diesel Surrogates At Low Temperature Combustion Conditions: Rapid Compression Machine Experiments And Modeling	Comb.& Flame. 219 (2020) 178-197. https://doi.org/10.1016/j.combustflame.2020.05.017
AVFL-26	Future Gasoline Engine Technologies and High Octane Fuels for Reducing Fuel Consumption and GHG Emissions, Parts A & B	PENDING
AVFL-27-2	Full and Partial Heat of Vaporization Measurements of Gasoline and Ethanol/Gasoline Blends Executive Summary	PENDING

RELEASED REPORTS – 2020

CRC Project No.	Title	Publication/NTIS Accession No.
E-123	On-Road Remote Sensing Of Automobile Emissions In The Tulsa Area: Fall 2019	PENDING
E-123	On-Road Remote Sensing Of Automobile Emissions In The Denver Area: Winter 2020	PENDING
E-123-4	Revisit Inspection and Maintenance Evaluation using Historical U.S. Remote Sensing Measurements	PENDING
E-127-1	Detailed Hydrocarbon Analysis (DHA) And Particulate Matter (PM) Emissions Data Mining	PENDING
E-131	Studying Capabilities And Limitations Of Vehicle Telematics Data	PENDING
CRC Report No. 674	E15 Fuel Survey: July 2019	PENDING

RELEASED REPORTS – 2020

AVIATION AND PERFORMANCE*

CRC Project No.	Title	Publication/NTIS Accession No.
DP-04-17	CRC Internal Diesel Injector Deposit (IDID) Test: Hardware, Fuel, and Additive Evaluations	PB2020-100109
CM-138-15-2	Development of an Engine Based Test for Determining the Effect of Spark Ignition Fuel Properties on Combustion and Vehicle Driveability	PENDING
DP-04-17	CRC Internal Diesel Injector Deposit (IDID) Test: Hardware, Fuel, and Additive Evaluations	PB2020-100109
CM-138-18-1	CRC Driveability Workshop	PENDING

The primary source for CRC reports is:
National Technical Information Service, U.S. Department of Commerce
5285 Port Royal Road, Springfield, VA 22161; www.ntis.gov Phone: 800-553-6847; when ordering a report, be certain to include the NTIS Accession Number.

*"PENDING" reports are available now on CRC website, www.crcao.org.

PART FOUR

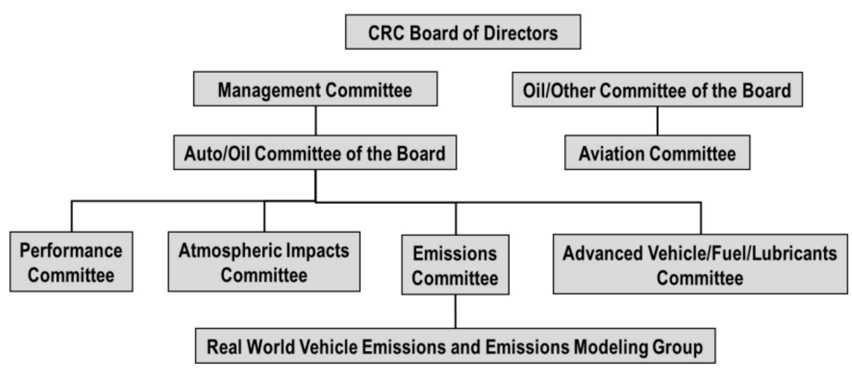
ORGANIZATION AND MEMBERSHIP

ORGANIZATION – 2020

The sustaining members of the CRC are the American Petroleum Institute (API) and a consortium of automobile manufacturers [Fiat Chrysler Automobiles (FCA), Daimler, Ford, General Motors, Honda, Mitsubishi, Nissan, Toyota, and Volkswagen]. For over 77 years, CRC has provided the means for the automotive and petroleum industries to study problems of mutual interest. The objective of CRC, as stated in our charter, is:

> To encourage and promote the arts and sciences by directing scientific cooperative research in developing the best possible combinations of fuels, lubricants, and the equipment in which they are used, and to afford means of cooperation with the Government on matters of national interest within this field.

CRC manages a range of technical projects designed to keep pace with today's rapidly-changing technology. Industry sponsors support approved projects by equal contributions from the industries directly concerned. Industry and the Government develop projects through committees comprised of their engineers and scientists.



Technical direction in each subject area is handled by an appropriate committee that closely supervises the progress of groups under its jurisdiction. The CRC Board of Directors is responsible for general policy and operation, including providing financial support, manpower, and laboratory facilities.

The diversity of the organizations participating in the various CRC committee activities can be seen in the remainder of this section. Committees and their working groups are made up of professionals of the highest technical competence in their areas.

CRC is not involved in regulation, hardware or fuel development, nor in setting standards. CRC has only one real mandate, and that is to add to the scientific base that may be useful in technology coordination and appropriate regulation. CRC final reports are made publicly available and are used by industry to help ensure optimum compatibility and customer satisfaction with its products and by industry, government, and the public to enhance joint achievement of clean air.

CRC has two basic types of research programs:

Cooperative research programs – where scientists from various organizations come together to conduct cooperative research. This method utilizes the expertise from industry, government, and academia to develop and conduct experimental research programs. The results of these programs are made publicly available through written technical publications.

Contract research programs – where CRC conducts research by contract with independent research laboratories. Requests for proposal are issued to leading research organizations and universities to carry out specific research programs. Committees composed of industry and government representatives design these programs. The committees evaluate the proposals, and the research is carried out under the monitorship of the committees. Reports that document the results of the study are made publicly available through written technical publications on the CRC website.

CRC's Auto/Oil Committee of the Board of Directors oversees the cooperative research summarized in this report. Board membership is comprised of seven representatives from the petroleum industry and nine representatives from the automobile companies. Each industry has one vote on this committee, and each side must agree on matters concerning research priorities and funding before a project goes forward.

This organizational structure ensures research programs that are relevant to both industries as they change their products to comply with the provisions in the U.S. Clean Air Act Amendments or other regulations that affect the industries. Industry believes that making improvements in air quality can best be achieved through a sound understanding of the scientific issues. Industry working together with involvement from appropriate Government agencies is an effective approach to obtain technical information needed to achieve environmental and other vehicle performance goals.

MEMBERSHIP

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R. A. Bougher	Administrative Research Assistant
B. L. Carter	Project Coordinator
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MEMBERSHIP

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J. E. Anderson, Co-Chair	Ford Motor Co.
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A. Ickes	Chevron Energy Techn.
A. Iqbal	FCA USA LLC.
J. J. Jetter	Honda R&D Am.
D. H. Lax	API
R. P. Lewis	Marathon Petroleum Corp.
G. K. Lilik	ExxonMobil
A. S. Mabutol	Mitsubishi Mtrs R&D Am.
J. Mengwasser	Shell Global Solutions
B. Reed	Mitsubishi Mtrs. R&D Am.
J. Y. Sigelko	Volkswagen of America
C. S. Sluder	ORNL
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M. Valentine	Toyota
M. B. Viola	General Motors
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D. M. DiCicco	Ford Motor Co.
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S. Goldsborough	ANL
G. C. Gunter	Phillips 66
X. He	Amarco Services
E. Hillawi	Nissan Tech. Ctr. N.A.
A. Ickes	Chevron Energy Techn.
A. Iqbal	FCA USA LLC.
N. Killingsworth	LLNL
D. H. Lax	API
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G. K. Lilik	ExxonMobil
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C. J. Mueller	SNL
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M. Ratcliff	NREL
J. Y. Sigelko	Volkswagen of America
C. S. Sluder	ORNL
M. Valentine	Toyota
M. B. Viola	General Motors

MEMBERSHIP

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T. Cushing	General Motors
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A. K. Gangopadhyay	Ford Motor Co.
D. Ganss	Nissan Tech. Ctr. NA
A. Gauer	General Motors
M. Herr	Ford Motor Co.
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J. S. Vilardo	Phillips 66

AVFL-18a PANEL

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R. Gieleciak	CanmetENERGY
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A. Ickes	Chevron Energy Techn.
C. J. Mueller	SNL
S. Neill	NRC Canada
M. Ratcliff	NREL
J. E. Temme	U.S. Army Research Lab
M. B. Viola	General Motors

MEMBERSHIP

AVFL-20/20a PANEL

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A. Iqbal, Co-Leader	FCA USA LLC.
C. S. Sluder, Co-Leader	ORNL

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V. S. Costanzo	Aramco Services	G. K. Lilik	ExxonMobil
J. Cruz	Daimler	S. McConnell	Marathon Petroleum Corp.
D. M. DiCicco	Ford Motor Co.	J. Mengwasser	Shell Global Solutions
M. Foster	BP	C. Pritchard	Flint Hills Resources
G. C. Gunter	Phillips 66	J. Y. Sigelko	Volkswagen of America
R. Hardy	Flint Hill Resources	J. J. Simnick	BP
D. H. Lax	API	M. Valentine	Toyota
T. Leone	Ford Motor Co.	M. B. Viola	General Motors

AVFL-26 PANEL

S. McConnell, Co-Leader	Marathon Petroleum Corp.
C. S. Sluder, Co-Leader	ORNL
M. B. Viola, Co-Leader	General Motors

R. Adams	Mitsubishi Mtrs. R&D Am.	D. H. Lax	API
		T. Leone	Ford Motor Co.
E. M. Chapman	General Motors	G. K. Lilik	ExxonMobil
V. S. Costanzo	Aramco Services	A. S. Mabutol	Mitsubishi Mtrs. R&D Am.
J. Cruz	Daimler		
D. M. DiCicco	Ford Motor Co.	J. Mengwasser	Shell Global Solutions
M. Foster	BP	B. Reed	Mitsubishi Mtrs. R&D Am.
D. Ganss	Nissan Tech. Ctr. NA		
G. C. Gunter	Phillips 66	J. Y. Sigelko	Volkswagen of America
A. Ickes	Chevron Energy Techn.	R. Sutschek	Volkwagen of America
A. Iqbal	FCA USA LLC.	M. Valentine	Toyota
J. J. Jetter	Honda R&D Am.		

MEMBERSHIP

AVFL-27-2 PANEL

S. McConnell, Co-Leader	Marathon Petroleum Corp.
M. B. Viola, Co-Leader	General Motors

J. E. Anderson	Ford Motor Co.	R. P. Lewis	Marathon Petroleum Corp.
E. M. Chapman	General Motors	G. K. Lilik	ExxonMobil
G. C. Gunter	Phillips 66	J. Y. Sigelko	Volkswagen of America
A. Ickes	Chevron Energy Techn.	M. Valentine	Toyota
J. J. Jetter	Honda R&D Am.		

AVFL-28-3 QUICK RESPONSE PANEL

G. C. Gunter, Leader	Phillips 66

B. Anderson	Afton Chemical	S. McConnell	Marathon Petroleum Corp.
D. H. Blossfeld	General Motors	J. Y. Sigelko	Volkswagen of America
A. K. Gangopadhyay	Ford Motor Co.	R. Stockwell	Chevron

AVFL-29-2 PANEL

G. C. Gunter, Co-Leader	Phillips 66
J. J. Jetter, Co-Leader	Honda R&D Am.

J. E. Anderson	Ford Motor Co.
E. M. Chapman	General Motors
A. Ickes	Chevron Energy Techn.
D. H. Lax	API
R. P. Lewis	Marathon Petroleum Corp.
G. K. Lilik	ExxonMobil
S. McConnell	Marathon Petroleum Corp.
J. Mengwasser	Shell Global Solutions
M. E. Moore	FCA USA LLC.
J. Y. Sigelko	Volkswagen of America
M. Valentine	Toyota
A. K. Voice	Aramco Service

MEMBERSHIP

AVFL-32 PANEL

A. Iqbal, Co-Leader	FCA USA LLC.
S. McConnell, Co-Leader	Marathon Petroleum Corp.

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E. M. Chapman	General Motors	R. P. Lewis	Marathon Petroleum Corp.
V. S. Costanzo	Aramco Services	G. K. Lilik	ExxonMobil
J. Cruz	Daimler	A. S. Mabutol	Mitsubishi Mtrs. R&D Am.
D. M. DiCicco	Ford Motor Co.	J. Mengwasser	Shell Global Solutions
M. Foster	BP	B. Reed	Mitsubishi Mtrs. R&D Am.
D. Ganss	Nissan Tech. Ctr. NA	C. S. Sluder	ORNL
G. C. Gunter	Phillips 66	R. Sutschek	Volkwagen of America
E. Hillawi	Nissan Tech. Ctr. N.A	M. Valentine	Toyota
		M. B. Viola	General Motors
J. Holland	Phillips 66	J. Wellhousen	Phillips 66
M. Hussain	Phillips 66		
A. Ickes	Chevron Energy Techn.		
J. J. Jetter	Honda R&D Am.		

AVFL-33 PANEL

E. M. Chapman, Co-Leader	General Motors
G. C. Gunter, Co-Leader	Phillips 66

R. Adams	Mitsubishi Mtrs. R&D Am.	K. R. Kress	Phillips 66
		G. K. Lilik	ExxonMobil
J. E. Anderson	Ford Motor Co.	M. McCarthy	Toyota
S. Bartley	Lubrizol	S. McConnell	Marathon Petroleum Corp.
D. Boese	Infineum	J. Mengwasser	Shell Global Solutions
B. Chinta	General Motors	M. E. Moore	FCA USA LLC.
V. S. Costanzo	Aramco Services	G. Parker	Lubrizol
J. Cruz	Daimler	J. Y. Sigelko	Volkswagen of America
A. Ickes	Chevron Energy Techn.	M. Valentine	Toyota
		M. B. Viola	General Motors
A. Iqbal	FCA USA LLC.		

MEMBERSHIP

AVFL-35 PANEL

J. J. Jetter, Co-Leader	Honda R&D Am.
A. Ickes, Co-Leader	Chevron Energy Techn.

V. S. Costanzo	Aramco Services	G. K. Lilik	ExxonMobil
G. C. Gunter	Phillips 66	S. McConnell	Marathon Petroleum Corp.
A. Iqbal	FCA USA LLC.	J. Y. Sigelko	Volkswagen of America
D. H. Lax	API	M. Valentine	Toyota
R. P. Lewis	Marathon Petroleum Corp		

AVFL-36/ CM-137-19-1 PANEL

V. S. Costanzo, Co-Leader	Aramco Services
A. Iqbal, Co-Leader	FCA USA LLC.
S. McConnell, Co-Leader	Marathon Petroleum Corp.

B. Alexander	BP	T. Leone	Ford Motor Co.
J. E. Anderson	Ford Motor Co.	G. K. Lilik	ExxonMobil
A. Aradi	Shell	S. McConnell	Marathon Petroleum Corp.
E. M. Chapman	General Motors	L. McQuinn	Ford
S. R. Golisz	ExxonMobil	P. M.Najt	General Motors
G. C. Gunter	Phillips 66	B. Raney-Pablo	Ford Motor Co.
J. Holland	Phillips 66	J. Y. Sigelko	Volkswagen of America
M. Hussain	Phillips 66	J. J. Simnick	BP
A. Ickes	Chevron Energy Techn.	M. Valentine	Toyota
C. Jones	General Motors		
D. H. Lax	API		

MEMBERSHIP

AVFL-37 PANEL

G. C. Gunter, Co-Leader	Phillips 66
A. K. Gangopadhyay, Co-Leader	Ford Motor Co.

J. E. Anderson	Ford Motor Co.	D. H. Lax	API
A. Aradi	Shell	G. K. Lilik	ExxonMobil
J. Barstad	Infineum	S. McConnell	Marathon Petroleum Corp.
C. Cao	Phillips 66	J. Y. Sigelko	Volkswagen of America
E. Hillawi	Nissan Tech. Ctr. N.A	R. Stockwell	Chevron
T. D. Kowalski	Toyota	M. B. Viola	General Motors

MEMBERSHIP

EMISSIONS COMMITTEE

P. Loeper, Co-Chair	Chevron Global Downstream
M. B. Viola, Co-Chair	General Motors

B. Alexander	BP
T. Bera	Shell Global Solutions
E. Barrientos	ExxonMobil
M. Block	Mitsubishi Mtrs R&D Am.
H. Cheng	BP
V. Costanzo	Aramco Services
J. Cruz	Daimler
D. M. DiCicco	Ford Motor Co.
J. J. Jetter	Honda R&D Am.
F. Khan	Nissan Tech. Ctr. NA
A. Mabutol	Mitsubishi Mtrs R&D Am.
S. A. Mason	Phillips 66
M. Moore	FCA USA LLC.
J. Y. Sigelko	Volkswagen of America
M. Valentine	Toyota
D. Vu	Marathon Petroleum Corp.

E-122-2 PANEL

P. Loeper, Co-Leader	Chevron Global Dnstrm.
M. B. Viola, Co-Leader	General Motors

B. Alexander	BP
E. Barrientos	ExxonMobil
T. Bera	Shell Global Solutions
M. Block	Mitsubishi Mtrs R&D Am.
J. Cruz	Daimler
D. M. DiCicco	Ford Motor Co.
S. Decarteret	General Motors
O. Garcia	Volkswagen of America
J. J. Jetter	Honda R&D Am.
C. Jones	General Motors
F. Khan	Nissan Tech. Ctr. NA
A. S. Mabutol	Mitsubishi Mtrs R&D Am.
S. A. Mason	Phillips 66
M. Moore	FCA USA LLC.
M. Olson	Mitsubishi Mtrs R&D Am.
M. Rosenbaeck	Volkswagen of Amercia
J. Y. Sigelko	Volkswagen of America
J. Unsworth	FCA USA LLC.
M. Valentine	Toyota
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Y. Xu	ExxonMobil
M. Yassine	FCA USA LLC.

E-127-1 PANEL

D. M. DiCicco, Co-Leader	Ford Motor Co.
P. Loeper, Co-Leader	Chevron Global Dnstrm.

J. E. Anderson	Ford Motor Co.
B. Alexander	BP
T. Bera	Shell Global Solutions
E. Barrientos	ExxonMobil
M. Block	Mitsubishi Mtrs R&D Am.
E. Chapman	General Motors
J. Cruz	Daimler
D. M. DiCicco	Ford Motor Co.
J. J. Jetter	Honda R&D Am.
C. Jones	General Motors
F. Khan	Nissan Tech. Ctr. NA
F. Krich	FCA USA LLC.
D. Lax	API
R. Lewis	Marathon Petroleum Corp.
S. A. Mason	Phillips 66
J. Mengwasser	Shell Global Solutions
M. Moore	FCA USA LLC.
M. Rosenbaeck	Volkswagen of America
J. Y. Sigelko	Volkswagen of America
R. Sutschek	Volkswagen of America
M. Valentine	Toyota
M. Viola	General Motors
D. Vu	Marathon Petroleum Corp.

MEMBERSHIP

E-129-2 PANEL

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D. Lax	API	M. Valentine	Toyota
R. P. Lewis	Marathon Petroleum Corp.	M. B. Viola	General Motors
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S. A. Mason	Phillips 66		

E-130 PANEL

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C. Tennant, Co-Leader	Coordinating Research Council

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S. A. Mason	Phillips 66	D. Vu	Marathon Petroleum Corp.

MEMBERSHIP

E-132 PANEL

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M. B. Viola, Co-Chair	General Motors

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J. Andrzewski	General Motors	J. J. Jetter	Honda R&D Am.
T. Bera	Shell Global Solutions	F. Khan	Nissan Tech. Ctr. NA
E. Barrientos	ExxonMobil	A. Mabutol	Mitsubishi Mtrs R&D Am.
M. Block	Mitsubishi Mtrs R&D Am.	S. A. Mason	Phillips 66
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H. Cheng	BP	R. Sager	FCA USA LLC.
V. Costanzo	Aramco Services	J. Y. Sigelko	Volkswagen of America
J. Cruz	Daimler	E. Strzelecki	General Motors
D. M. DiCicco	Ford Motor Co.	M. Valentine	Toyota
M. Grote	FCA USA LLC.	D. Vu	Marathon Petroleum Corp.

MEMBERSHIP

REAL WORLD VEHICLE EMISSIONS & EMISSIONS MODELING GROUP

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S. A. Mason, Co-Chair	Phillips 66

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R. Baldauf	US EPA	P. Loeper	Chevron Global Dnstrm.
N. J. Barsic	John Deere	J. E. Long	CARB
M. Beardsley	US EPA	A. S. Mabutol	Mitsubishi Mtrs R&D Am.
T. Bera	Shell Global Solutions	M. M. Maricq	Ford Motor Co.
E. Barrientos	ExxonMobil	M. E. Moore	FCA USA LLC.
K. Borgert	US EPA	J. Mengwasser	Shell Global Solutions
E. Chapman	General Motors	R. Nankee	FCA USA LLC.
V. Costanzo	Aramco Services	R. Nine	DOE/NETL
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A. Cullen	US EPA	R. Purushothaman	Caterpillar
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R. Giannelli	US EPA	D. Sonntag	US EPA
C. Hart	US EPA	R. Sutschek	Volkswagen of America
J. J. Jetter	Honda R&D Am.	M. Thornton	NREL
F. Khan	Nissan Tech. Ctr. NA	M. Valentine	Toyota
Y. Khan	Cummins	M. B. Viola	General Motors
F. A. Krich	FCA USA LLC.	D. Vu	Marathon Petroleum Corp.
C. Laroo	EPA	M. K. Yassine	FCA USA LLC.
D. H. Lax	API	S. Yoon	CARB

MEMBERSHIP

30TH REAL WORLD EMISSIONS WORKSHOP ORGANIZING COMMITTEE

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S. A. Mason, Co-Chair	Phillips 66

R. Baldauf	US EPA	Y. Khan	Cummins
N. Berry	SCAQMD	R. Purushothaman	Caterpillar
D. Choi	US EPA	M. Thornton	NREL
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T. Huai	CARB	S. Yoon	CARB
J. Impullitti	SCAQMD		

RW-105 PANEL

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J. Andrzewski	General Motors	P. Loeper	Chevron Global Dnstrm.
N. J. Barsic	John Deere	J. E. Long	CARB
S. Bohr	Ford Motor Co.	S. Mason	Phillips 66
J. Cruz	Daimler	M. E. Moore	FCA USA LLC.
A. Cullen	US EPA	J. Y. Sigelko	Volkswagen of America
D. M. DiCicco	Ford Motor Co.	M. Valentine	Toyota
C. R. Fulper	US EPA	M. B. Viola	General Motors
M. Grote	FCA USA LLC.	D. Vu	Marathon Petroleum Corp.
C. Hart	US EPA	S. Yoon	CARB

MEMBERSHIP

RW-107-2 PANEL

J. J. Jetter, Co-Leader	Honda R&D Am.
R. P. Lewis Co-Leader	Marathon Petroleum Co.

J. E. Anderson	Ford Motor Co.	M. M. Maricq	Ford Motor Co.
R. Baldauf	US EPA	S. A. Mason	Phillips 66
N. J. Barsic	John Deere	J. Mengwasser	Shell Global Solutions
M. Beardsley	US EPA	M. Moore	FCA USA LLC.
E. Barrientos	ExxonMobil	R. Nankee	FCA USA LLC.
E. Chapman	General Motors	R. Nine	DOE/NETL
J. Cruz	Daimler	M. Olechiw	US EPA
A. Cullen	US EPA	F. Parsinejad	Chevron Oronite
D. M. DiCicco	Ford Motor Co.	R. Purushothaman	Caterpillar
T. A. French	EMA	C. Ruehl	CARB
C. R. Fulper	US EPA	S. A. Shimpi	Cummins
B. Alexander	BP	J. Y. Sigelko	Volkswagen of America
R. Giannelli	US EPA	M. R. Smith	Navistar
C. Hart	US EPA	R. Sobotowski	US EPA
F. Khan	Nissan Tech. Ctr. NA	D. Sonntag	US EPA
F. A. Krich	FCA USA LLC.	M. Thornton	NREL
D. H. Lax	API	M. Valentine	Toyota
P. Loeper	Chevron Global Dnstrm.	M. B. Viola	General Motors
J. E. Long	CARB	D. Vu	Marathon Petroluem Corp.
A. S. Mabutol	Mitsubishi Mtrs. R&D	M. K. Yassine	FCA USA LLC.

MEMBERSHIP

ATMOSPHERIC IMPACTS COMMITTEE

S. Gao, Co-Chair	Phillips 66
S. Winkler, Co-Chair	Ford Motor Co.

E. Hillawi	Nissan Tech. Ctr. N.A.	G. F. Myers	Marathon Petroleum Corp.
D. Johnson	BP	C. Rabideau	Chevron
C. Jones	General Motors	J. Y. Sigelko	Volkswagen of America
T. Kidokoro	Toyota	R. Sutschek	Volkswagen of America
A. S. Mabutol	Mitsubishi Mtrs. R&D Am.	F. Turatti	Toyota
		T. J. Wallington	Ford Motor Co.
M. E. Moore	FCA USA LLC.	T. Yamada	Toyota
J. I. Moutinho	ExxonMobil		

ATMOSPHERIC IMPACTS WORKING GROUP

S. Gao, Co-Chair	Phillips 66
S. Winkler, Co-Chair	Ford Motor Co.

Z. Adelman	LADCO	M. Koerber	US EPA
D. C. Baker	API Consultant	T. Kuwayama	CARB
M. Beardsley	US EPA	C. Lawson	Shell
D. Choi	US EPA	D. H. Lax	API
D. M. DiCicco	Ford Motor Co.	S. M. Lee	SCAQMD
H. J. Feldman	API	M. M. Maricq	Ford Motor Co.
T. A. French	EMA	R. Mathur	US EPA
J. Geidosch	US EPA	K. Sargeant	US EPA
M. L. Gupta	FAA	S. Tanrikulu	BAAQMD
M. Janssen	LADCO	B. Timin	US EPA
C. Kalisz	API	C. Yanca	US EPA
D. M. Kenski	LADCO	J. Zietsman	TX A&M Trans. Inst.

MEMBERSHIP

A-114/RW-111 PANEL

M. E. Moore, Co-Leader	FCA USA LLC.
J. Geidosch, Co-Leader	US EPA

D. C. Baker	API Consultant
S. Berkhous	ExxonMobil
K. N. Black	FHWA
S. Collet	Toyota
T. Kuwayama	CARB
P. Loeper	Chevron
M. M. Maricq	Ford Motor Co.
S. A. Mason	Phillips 66
M. Hays	US EPA
G. F. Myers	Marathon Petroleum Corp.
R. Purushothaman	Caterpillar
B. Murphy	US EPA
J. Y. Sigelko	Volkswagen of America
D. Z. Short	Marathon Petroleum Corp.
M. R. Smith	Navistar

A-120 PANEL

T. A. French, Co-Chair	EMA
S. Gao, Co-Chair	Phillips 66

D. C. Baker	API Consultant
T. Kuwayama	CARB
C. Rabideau	Chevron
J. Y. Sigelko	Volkswagen of America
T. J. Wallington	Ford Motor Co.
S. Winkler	Ford Motor Co.

A-121 PANEL

T. Kuwayama, Co-Leader	CARB
T. J. Wallington, Co-Leader	Ford Motor Co.

S. Collet	Toyota
T. A. French	EMA
S. Gao	Phillips 66
M. Janssen	LADCO
C. Jones	General Motors
S. M. Lee	SCAQMD
J. I. Moutinho	ExxonMobil
C. Rabideau	Chevron
J. Y. Sigelko	Volkswagen of America

MEMBERSHIP

A-123 PANEL

C. Rabideau, Co-Leader	Chevron
M. Janssen, Co-Leader	LADCO
S.Winkler, Co-Leader	Ford Motor Co.

T. A. French	EMA	S. Reid	BAAQMD
B. Koo	BAAQMD	J. Y. Sigelko	Volkswagen of America
S. M. Lee	SCAQMD	S. Tanrikulu	BAAQMD
R. Mathur	US EPA	T. J. Wallington	Ford Motor Co.
M. E. Moore	FCA USA LLC.		
J. I. Moutinho	ExxonMobil		

A-124 PANEL

G. F. Myers, Co-Chair	Marathon Petroleum Corp.
S.Winkler, Co-Chair	Ford Motor Co.

Z. Adelman	LADCO	J. I. Moutinho	ExxonMobil
R. Agnew	Chevron	C. Rabideau	Chevron
J. W. Beasley	Marathon Petroleum Corp.	J. Y. Sigelko	Volkswagen of America
M. D.Bujdoso	Marathon Petroleum Corp.	R. Streight	Ford Motor Co.
R. H Browning	Utah Petroleum Org.	M. L. Textor	Marathon Petroleum Corp.
J. Esker	Utah Mining Association	T. J. Wallington	Ford Motor Co.
D. Greco	Michigan Manufacturers Assoc.		
B. Koo	BAAQMD		
S. M. Lee	SCAQMD		

MEMBERSHIP

PERFORMANCE COMMITTEE

A. Iqbal, Co-Chair	FCA USA LLC.
J. J. Simnick, Co-Chair	BP

J. Axelrod	ExxonMobil
V. Constanzo	Aramco Services
J. Cruz	Daimler
D. Ganss	Nissan Tech. Ctr. NA
G. C. Gunter	Phillips 66
J. Jetter	Honda R&D Am.
R. P. Lewis	Marathon Petroleum Corp.
S. Lopes	General Motors
A. Mabutol	Mitsubishi Mtrs. R&D Am.
M. E. Moore	FCA USA LLC.
B. Raney-Pablo	Ford Motor Co.
J. Russo	Shell
M. Sheehan	Chevron
J. Y. Sigelko	Volkswagen of America
W. Studzinski	General Motors
M. Valentine	Toyota

GASOLINE DEPOSIT GROUP
(Project No. CM-136)

J. Cruz, Co-Leader	Daimler
M. Sheehan, Co-Leader	Chevron

B. Alexander	BP
S. Bartley	Lubrizol
D. Bohn	Flint Hills
S. Broughton	Marathon Petroleum Corp.
K. Brunner	SwRI
R. Chapman	Innospec
J. Draper	Motiva
I. Gabrel	FCA USA LLC.
L. M. Gibbs	Consultant
S. R. Golisz	ExxonMobil
G. C. Gunter	Phillips 66
C. Huang	ITW
J. J. Jetter	Honda R&D Am.
K. Johnson	Shell
A. M. Kulinowski	Afton Chemical
D. H. Lax	API
R. P. Lewis	Marathon Petroleum Corp.
M. Lynch	ExxonMobil
I. Mathur	Haltermann
A. McKnight	Innospec
M. Miller	Sunoco Inc.
K. Mitchell	Shell Canada Ltd.
R. Monroe	General Motors
F. Parsinejad	Chevron Oronite Co.
C. M. Pyburn	Pytertech Intl.
B. Raney-Pablo	Ford Motor Co.
J. Russo	Shell
D. Schoppe	Intertek
J. Y. Sigelko	Volkswagen of America
R. Smocha	Chevron
W. Studzinski	General Motors
W. Y. Su	Huntsman Corp.
M. Valentine	Toyota
Y. Xu	ExxonMobil
H. Zhao	Huntsman Adv Tech.

GASOLINE DEPOSIT PFI IVD TEST DEVELOPMENT TEAM
(Project No. CM-136-18-1)

M. Sheehan, Co-Leader	Chevron
J. Cruz, Co-Leader	Daimler

B. Alexander	BP	B. Raney-Pablo	Ford Motor Co.
E. Chapman	General Motors	J. Russo	Shell
G. C. Gunter	Phillips 66	J. Simnick	BP
R. P. Lewis	Marathon Petroleum Corp.	R. Smocha	Chevron
J. Martinez	Chevron	M. Valentine	Toyota
R. Monroe	General Motors	Y. Xu	ExxonMobil

GASOLINE DEPOSIT SULFATE PANEL
(Project No. CM-136-18-2)

R. P. Lewis, Co-Leader	Marathon Petroleum Corp.
C. Jones, Co-Leader	General Motors

B. Alexander	BP	D. H. Lax	API
J. Axelrod	ExxonMobil	M. Lynch	ExxonMobil
J. Cruz	Daimler	A. McKnight	Innospec
K. Davis	RFA	B. Raney-Pablo	Ford Motor Co.
I. Gabrel	FCA USA LLC.	J. Russo	Shell
L. Gibbs	Consultant	M. Sheehan	Chevron
G. C. Gunter	Phillips 66	R. Smocha	Chevron
R. Hardy	Flint Hills Resources	M. Valentine	Toyota
A.M. Kulinowski	Afton Chemical		

MEMBERSHIP

GASOLINE DEPOSIT FUEL DEGRADATION IN STORAGE PROJECT PANEL (Project No. CM-136-20)

E. English, Co-Leader	FQS, Inc.
J. Simnick, Co-Leader	BP

J. Ayala	Ayalytical
D. Chu	Panair Labs
V. Colantuoni	Koehler Instruments
O. Costenoble	NEN
J. Cruz	Daimler
C. Edinger	Anton-Paar
D. Forester	Consultant
A. Gallonzelli	CAMCOM
E. Gaouyat	Total
M. Garg	Reliance Industries Ltd
R. Gil	Energy Institute
S. Golisz	ExxonMobil
G. C. Gunter	Phillips 66
J. Jetter	Honda
C. Jones	General Motors
T. King	Halterman
S. Kirby	General Motors
K. Kuenzel	Ford Motor Co.
D. Lax	API
R.Lewis	Marathon Petroleum
M. Moore	FCA
B. Morlan	Chevron
B. Raney-Pablo	Ford Motor Co.
G. Rickardq	Intertek
J. Russo	Shell
S. Ryzyi	Ford Motor Co.
R. Shah	Koehler Instrument
M. Sheehan	Chevron
Y. Xu	ExxonMobil

GASOLINE COMBUSTION GROUP

(formerly Octane Group)

(Project No. CM-137)

E. Chapman, Co-Leader	General Motors
V. Constanzo, Co-Leader	Aramco Services

B. Alexander	BP
S. Bartley	Lubrizol
T.Briggs	SwRI
S. Broughton	Marathon Petroleum Corp.
K. Brunner	SwRI
R. Chapman	Innospec Fuel Spec.
J. Cruz	Daimler
D. M. DiCicco	Ford Motor Co.
S. Golisz	ExxonMobil
G. C. Gunter	Phillips 66
A. Iqbal	FCA USA LLC.
J. J. Jetter	Honda R&D Am.
F. Khan	Nissan Tech. Ctr. NA
D. H. Lax	API
R. P. Lewis	Marathon Petroleum Corp.
M. Lynch	ExxonMobil
A. McKnight	Innospec
J. Mengwasser	Shell
M. Miller	Sunoco Inc.
K. Mitchell	Consultant
P. J. Morgan	SwRI
C. M. Pyburn	Pybertech International
B. Raney-Pablo	Ford Motor Co.
J. Russo	Shell
D. Schoppe	Intertek
M. Sheehan	Chevron
J. Y. Sigelko	Volkswagen of America
J. J. Simnick	BP
R. A. Sobotowski	US EPA
W. Studzinski	General Motors
A. Swarts	SwRI
M. Valentine	Toyota
Y. Xu	ExxonMobil

MEMBERSHIP

VOLATILITY GROUP
(Project No. CM-138)

M. Valentine, Co-Leader	Toyota
R. P. Lewis, Co-Leader	Marathon Petroleum Corp.

B. Alexander	BP	J. J. Jetter	Honda R&D Am.
S. Bartley	Lubrizol	C. Jones	General Motors
S. Broughton	Marathon Petroleum Corp.	F. Khan	Nissan Tech. Ctr. NA
K. Brunner	SwRI		
E. Chapman	General Motors	D. H. Lax	API
J. Cruz	Daimler	M. Lynch	ExxonMobil
K. Davis	RFA	K. Mitchell	Consultant
H. Doherty	Sunoco	B. Raney-Pablo	Ford Motor Co.
J. Draper	Motiva	J. Russo	Shell
I. Gabrel	FCA USA LLC.	D. Schoppe	Intertek
L.M. Gibbs	Consultant	M. Sheehan	Chevron
S. Golisz	ExxonMobil	J. Y. Sigelko	Volkswagen of America
G. C. Gunter	Phillips 66		
R. Hardy	Flint Hills Resources	W. Studzinski	General Motors
G. Herwick	Trans. Fuels Consult.	S. Van Hulzen	POET
A. Iqbal	FCA USA LLC.		

DRIVEABILITY WORKSHOP TO TRAIN AND CALIBRATE RATERS USING THE CRC TRICK CAR PROJECT PANEL
(PROJECT NO. CM-138-18-1)

M. Sheehan, Leader	Chevron
T. King , Co-Leader	Haltermann Carless

L. M. Gibbs	Consultant	J. Russo	Shell
G. C. Gunter	Phillips 66	J. Y. Sigelko	Volkswagen of America
R. P. Lewis	Marathon Petroleum Corp.	J. Simnick	BP
		M. Valentine	Toyota

DEVELOPMENT OF A REVISED ENGINE BASED TEST FOR DETERMINING THE EFFECT OF SPARK IGNITION FUEL PROPERTIES ON COMBUSTION AND VEHICLE DRIVABILITY (Project No. CM-138-19-1)

C. Jones, Leader — General Motors

V. Constanzo	Aramco	D. H. Lax	API
K. Davis	RFA	R. P. Lewis	Marathon Petroleum
L.M. Gibbs	Consultant	M. Sheehan	Chevron
G. C. Gunter	Phillips 66	J. Simnick	BP
A. Iqbal	FCA USA LLC.	M. Valentine	Toyota
J. J. Jetter	Honda R&D Am.		

DEVELOPMENT OF AUTOMATED DRIVEABILITY RATING SYSTEM USING TRICK CAR (PROJECT NO. CM-138-20)

G. C. Gunter, Leader — Phillips 66

B. Alexander	BP	B. Raney-Pablo	Ford Motor Co.
S. Broughton	Marathon Petroleum	J. Russo	Shell
S. Golisz	ExxonMobil	M. Sheehan	Chevron
A. Iqbal	FCA	J. Y. Sigelko	Volkswagen of America
J. Jetter	Honda R&D Am.	M. Valentine	Toyota
R. P. Lewis	Marathon Petroleum Corp.		

MEMBERSHIP

DIESEL PERFORMANCE GROUP
(Project No. DP)

G. C. Gunter, Co-Leader	Phillips 66
S. Lopes, Co-Leader	General Motors

H. Ahari	FCA USA LLC.
B. Alexander	BP
J. Axelrod	ExxonMobil
T. Bera	Shell
D. Bohn	Flint Hills Resources
S. Broughton	Marathon Petroleum Corp.
A. Cayabyab	CARB
R. Chapman	Consultant
J. Cruz	Daimler
D. A. Daniels	Innospec Fuel Spec.
J. Draper	Motiva
E. English	Fuel Quality Services
I. Gabriel	FCA USA LLC.
R. George	BP
B. Goodrich	John Deere
C. Hamer	PCS Instruments
D. Hess	Infineum
C. Huang	Cummins
C. Huang	ITW Global
J. J. Jetter	Honda R&D Am.
F. Khan	Nissan Tech. Ctr. N.A.
D. Kozub	Daimler
A. Kulinowski	Afton Chemical
E. Kurtz	Ford Motor Co.
P. Lacey	Delphi Diesel Systems
D. H. Lax	API
R. Leisenring	Consultant
R. P. Lewis	Marathon Petroleum Corp.
T. Livingston	Robert Bosch
R. Long	PEI
R. L. McCormick	NREL
A. McKnight	Innospec
K. Mitchell	Consultant
A. G. Morin	Eurenco
J. Morris	Navistar
N. Mukkada	Chevron
J. Porco	Gage Products
B. Raney-Pablo	Ford Motor Co.
J. Russo	Shell
K. Salem	Lubrizol
D. Schoppe	Intertek
P. Searles	API
M. Sheehan	Chevron
J. Y. Sigelko	Volkswagen of America
W. Studzinski	General Motors
T. Sutton	EMA
A. Swarts	SwRI
V. Tran	Infineum
M. Valentine	Toyota
J. VanScoyoc	Chevron Phillips Chem Co.

DP - LOW TEMPERATURE OPERABILITY PANEL
(Project No. DP-02)

S. Broughton, Leader   Marathon Petroleum Corp.

J. Axelrod	ExxonMobil	R. P. Lewis	Marathon Petroleum Corp.
J. Chandler	Consultant	S. Lopes	General Motors
D. A. Daniels	Innospec Fuel	K. Mitchell	Consultant
S. Golisz	ExxonMobil	N. Mukkada	Chevron
G.C. Gunter	Phillips 66	S.B. Rubin-Pitel	ExxonMobil
D. Hess	Infineum	P. Searles	AP
C. Hodge	Consultant	W. Studzinski	General Motors
J. J. Jetter	Honda R&D Am.	V. Tran	Infineum
A.M. Kulinowski	Afton Chemical	M. Valentine	Toyota

DP - DEPOSIT PANEL
(Project No. DP-04)

G. C. Gunter, Leader   Phillips 66

D. Abdallah	ExxonMobil	H. Huang	Cummins
H. Abi-Akar	Caterpillar	J. J. Jetter	Honda R&D Am.
M. Ahmadi	Oronite Additive	A. Kulinowski	Afton Chemical
A. Aradi	Shell	P. Lacey	Delphi Diesel Systems
T. Bera	Shell	D. H. Lax	API
D. Bohn	Flint Hills Resources	T. Livingston	Robert Bosch
S. Broughton	Marathon Petroleum Corp.	S. Lopes	General Motors
		J. Martinez	Chevron
C. Burbrink	Cummins	K. Mitchell	Consultant
R. Chapman	Consultant	N. Mukkada	Chevron
J. Draper	Motiva	M. Sheehan	Chevron
S. Fenwick	National Biodiesel Bd	T. Sutton	EMA
R. George	BP	M. Valentine	Toyota
B. E. Goodrich	John Deere	Y. Xu	ExxonMobil
P. Henderson	Consultant		

MEMBERSHIP

DP – FUEL CLEANLINESS PANEL
(Project No. DP-06-16-1)

R. Chapman, Leader — Consultant

D.Bohn	Flint Hills Resources	C. Huang	Cummins
S. Broughton	Marathon Petroleum Corp.	R. Leisenring	Consultant
		R. P. Lewis	Marathon Petroleum Corp.
C. Burbrink	Cummins	T. Livingston	Robert Bosch
J. Eichberger	Fuels Institute	S. Lopes	General Motors
E. W. English	Fuel Quality Services	N. Mukkada	Chevron
S. Fenwick	Nat. Biodiesel Board	F. Passman	BCA Inc.
S. Golisz	ExxonMobil	S. Pollock	Steel Tank Institute
G. C. Gunter	Phillips 66	S. Rubin-Pitel	ExxonMobil
R. Haerer	US EPA	P. Searles	API
J. Hove	Fuels Institute	T. Sutton	EMA

MEMBERSHIP

DP – FUEL CORROSION PANEL
(PROJECT NO. DP-07-16)

D. H. Lax, Leader API

R. Bennick	BP
T. Bera	Shell
P. Beu	Wawa
S. Broughton	Marathon Petroleum Corp.
R. Chapman	Consultant
T. Covert	Ford
J. Eckstrom	BP
J. Eichberger	Fuels Institute
E. W. English	Fuel Quality Services
S. Fenwick	Nat. Biodiesel Brd.
L. Gerber	US EPA
S. Golisz	Chevron
G. C. Gunter	Phillips 66
R. Haerer	US EPA
S. Hernandez	Chevron
J. Hove	Fuels Institute
S. Howell	Nat. Biodiesel Brd.
C. Huang	Cummins
M. Kass	ORNL
D. Lax	API
R.P. Lewis	Marathon Petroleum Corp.
R. Long	PEI
J. Martinez	Chevron
R. McNutt	Sigma
K. Moriarty	NREL
N. Mukkada	Chevron
F. Passman	Biodeterioration Cntrl Assoc.
S. Pollock	Steel Tank Institute
B. Renkes	Fiberglass Tank & Pipe
P. Searles	API
K. Spiker	Quiktrip
T. Sutton	EMA

MEMBERSHIP

DP – BIODIESEL AND RENEWABLE DIESEL PANEL (Project No. DP-08)

R. L. McCormick, Leader NREL

T. Alleman	NREL	S. Kirby	Navistar
T. Bera	Shell	D. Lax	API
D. Bohn	Flint Hills Resources	R. Lewis	Marathon Petroleum Corp.
J. Chandler	Consultant	T. Livingston	Robert Bosch
R. Chapman	Innospec	K. Mitchell	Consultant
J. Cruz	Daimler	H. Nanjundaswamy	FEV
D. Daniels	Innospec	M. Nikanjam	Chevron
E. W. English	FQS	S.B. Rubin-Pitel	ExxonMobil
S. Fenwick	Nat. Biodiesel Brd.	K. Salem	Lubrizol
R. George	BP	M. Sheehan	Chevron
B. Goodrich	John Deere	J. Y. Sigelko	Volkswagen of America
G.C. Gunter	Phillips 66	W. Studzinski	General Motors
P. Henderson	Consultant	T. Sutton	EMA
D. Hess	Infineum	M. Valentine	Toyota
C. Hodge	Consultant		
S. Howell	Nat. Biodiesel Brd		
C. Huang	Cummins		
J. J. Jetter	Honda R&D Am.		

AVIATION FUELS COMMITTEE

D. Baniszewski, Chair — DLA Energy
D. E. Kadlecek, Vice-Chair — ExxonMobil

M. Adamson	Pratt & Whitney	R. Juan	Marathon Petroleum
D. Atwood	FAA	R. Kamin	US Navy
J. Bauldreay	Bauldreay Jet Fuel Consulting Ltd	J. Kinder	Boeing
		J. Klettlinger	NASA
J.P. Belieres	Boeing	C. Lewis	Chris Lewis Fuels Consultancy Ltd.
J. Burgazli	Innospec		
A. Carico	Airlines for America	E. Lodrigueza	Phillips 66
C. Chang	NASA	T. Loegel	US Navy
A. Clark	BP	R. Midgley	Shell
E. Corporan	US Air Force	M. Rumizen	FAA
B. Culbertson	Honeywell	P. Serino	DLA Energy
D. Cyr	Chevron	J. Sheridan	Marathon Petroleum
C. Doucet	Total	J. Silvas	Citgo
T. Edwards	US Airforce	J. Stolis	Flint Hills Resources
A. Gandubert	Total	M. Thom	Baere Aerospace
J. Green	Citgo	G. Valentich	Shell
A. Hobday	Rolls-Royce	R. Williams	Consultant
M. Hunnybun	Energy Institute	S. Zabarnick	UDRI