

CRC

Annual Report 2025-2026



COORDINATING RESEARCH COUNCIL

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COORDINATING RESEARCH COUNCIL

Annual Report 2025-2026



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Part One

State of the Council



Coordinating Research Council

Introduction

The Coordinating Research Council (CRC) brings together members of the fuels, vehicles, lubricants, power equipment, analytical, regulatory, and research communities to address complex technical challenges through cooperative scientific research. CRC serves as a uniquely neutral forum where organizations can collaborate on pre-competitive research of national and global importance. CRC's work helps shape the scientific understanding of vehicle performance, fuel quality, emissions, atmospheric impacts, air quality, advanced technology, future fuels, and sustainability.

As a 501(c)(3) nonprofit research organization, CRC's mission is to foster cooperative scientific research for the benefit of the public, without advocacy or bias. Through its collaborative model, CRC generates research that supports technological advancement, informed policy development, improved environmental outcomes, and greater product reliability, safety, and affordability by leveraging resources to provide benefits to all.

History

CRC traces its origins to 1919, when leaders from the automotive and petroleum industries initiated a cooperative research effort to improve understanding of the interaction between fuels and engines. This work led to the creation of the Cooperative Fuel Research (CFR) Committee of the Society of Automotive Engineers (SAE).

In 1942, CRC was incorporated as an independent organization. During World War II, CRC grew significantly in support of military research programs. Throughout the following decades, CRC expanded its technical scope and developed a reputation as a leading organization for pre-competitive transportation research focused on fuels, lubricants, engines, and vehicle technologies.

During the 1950s, CRC began some of the earliest cooperative investigations into vehicle emissions and air quality impacts. As public concern regarding urban smog and air pollution grew, CRC expanded its focus beyond vehicle performance to include atmospheric science and

emissions research. The well-known Los Angeles Riverbed studies and other early emissions investigations helped establish CRC as a significant contributor to air pollution research.

A major milestone occurred in 1968 with the creation of the Air Pollution Research Advisory Committee (APRAC). APRAC brought together the automotive industry, petroleum industry, and the National Air Pollution Control Administration, the predecessor to the U.S. Environmental Protection Agency (US EPA), under a cooperative research framework. Between 1968 and 1982, APRAC directed a broad portfolio of engineering, atmospheric chemistry, and health-related studies aimed at understanding and reducing the impacts of vehicle emissions.

Following the formation of the Health Effects Institute in 1980, health studies became its domain, but CRC's air quality and emissions research continued to expand through the formation of technical working groups, science-focused workshops, and large-scale experimental measurement campaigns. Following the conclusion of the milestone Auto/Oil Air Quality Improvement Research Program (AQIRP, colloquially: Auto/Oil) and a major organizational restructuring in 1995, air quality-related activities were adapted into the Emissions Committee (EC) and the Atmospheric Impacts Committee (AIC).

CRC continued expanding into new technical topics with the Advanced Vehicle/Fuel/Lubricants Committee (AVFL) formed in 2000, and the launch of Sustainable Mobility Committee in 2021.

State of the Council

Modern CRC conducts research through a diverse portfolio of technical committees and working groups that collectively address transportation energy systems, fuels, emissions, air quality, aviation fuels, and sustainable mobility.

Emissions Committee (EC) and Real World Vehicle Emissions & Emissions Modeling Group

The Emissions Committee focuses on understanding the effects of fuels, engines, aftertreatment systems, and operating conditions on vehicle emissions. Recent research has included alternative oxygenated fuels, portable emissions measurement systems, fuel effects on emissions, particulate matter metrics, remote sensing campaigns, emissions modeling, and advanced testing methods. The associated Real World Vehicle Emissions & Emissions Modeling Group provides a unique forum for collaboration among regulators, researchers, and industry technical experts.

Advanced Vehicle/Fuel/Lubricants Committee (AVFL)

The Advanced Vehicle/Fuel/Lubricants Committee examines fuel and lubricant performance in advanced vehicle technologies. Recent research has addressed hydrogenated vegetable oil blendstocks, motor octane number impacts, lubricant-aftertreatment interactions, battery thermal conditioning, advanced engines, and future fuel pathways. AVFL also collaborates extensively with DOE and National Laboratories, as well as other CRC committees, particularly Performance and Sustainable Mobility, when research topics span multiple technical disciplines.

Atmospheric Impacts Committee (AIC)

The Atmospheric Impacts Committee continues APRAC's environmental research legacy by focusing on atmospheric chemistry, air quality modeling, emissions inventories, ozone formation, particulate matter, wildfire impacts, and emerging sources of air pollutants.

Recent projects have improved understanding of ozone chemistry, PM source attribution, wildfire impacts, background pollutant concentrations, soil NO_x emissions, and machine-learning-assisted air quality modeling. The committee also sponsors the Mobile Source Air Toxics (MSAT) Workshop series and continues to advance scientific understanding needed for effective air quality regulation and planning.

Performance Committee (PC)

The Performance Committee continues CRC's longstanding focus on fuel and vehicle performance characteristics. Recent work has supported ASTM International standards development, fuel performance evaluation, diesel injector deposit research, and collaborative studies examining octane requirements and engine operation.

Aviation Committee (AVC)

The Aviation Committee supports aviation fuel quality, performance, safety, and sustainability research. Recent accomplishments include international fuel quality surveys conducted with the Federal Aviation Administration (FAA) of the US Department of Transportation (DOT) and the UK's Energy Institute, jet fuel thermal stability guidance, and testing programs addressing aviation gasoline and jet fuel properties. Test procedures and analytical techniques continue to be research focal points in the AVC. The Committee also produces the *Handbook of Aviation Fuel Properties*, an essential resource for the technical community.

Sustainable Mobility Committee (SMC)

Formed in 2021, the Sustainable Mobility Committee represents CRC's newest major research platform and was created to engage emerging stakeholders and address rapidly changing transportation systems. Since its formation, the SMC has expanded participation across industry, academia, government laboratories, and other organizations interested in future mobility solutions.

Research topics have included electric vehicle charging behavior, battery durability, carbon intensity of fuels, low-carbon liquid fuels, charging and refueling infrastructure, vehicle electrification impacts, lifecycle analysis, and broader transportation decarbonization pathways. The committee has also established several topical working groups and organized new technical conferences and workshops to support collaboration across the sustainable mobility community.

Recent Accomplishments and Outlook

From 2021 through 2026, CRC has experienced significant activity and growth. The successful launch and expansion of the Sustainable Mobility Committee brought new stakeholders into CRC research while extending the organization's relevance into the evolving transportation landscape. Meanwhile, CRC's traditional committees continued producing impactful research, publishing numerous reports, hosting technical workshops, and

supporting collaborative projects involving industry, academia, and government researchers.

Recent accomplishments include advances in ozone and particulate matter science, expanded understanding of air quality impacts from wildfires and non-combustion sources, fuel and emissions studies supporting future regulatory and standards activities, research into low-carbon fuels and electrification pathways, and the application of emerging tools such as machine learning to air quality modeling. CRC also continued hosting major technical events, including the Real World Emissions Workshop, Mobile Source Air Toxics Workshop, Lifecycle Analysis of Transportation Fuels Workshop, Aviation Committee annual meetings, and Sustainable Mobility technical conferences.

In 2025, CRC's Board of Directors developed a Strategic Plan to guide the future activity and focus of the organization – this important effort affirmed continuation of CRC's mission to foster cooperative scientific research in the technological advancements of fuels, lubricants, vehicles, and equipment in matters of national and global interest. CRC's goals continue to be to facilitate high-quality, science-based precompetitive research, to provide forums for all stakeholders to participate in the research, and to make technical information available to industries, governments, and the public. CRC will continue serving as a trusted convener of researchers, scientists, and technologists with common interests. By bringing together diverse stakeholders to address increasingly complex transportation and environmental challenges, CRC remains committed to advancing scientific knowledge through cooperative research for the benefit of society.

CRC technical reports are internally peer-reviewed by the project panels, working groups, committees, and research partners that oversee the research and then made available on the CRC website, www.crcao.org. Select research projects are also reported in peer-reviewed literature, and some workshops produce summaries and proceedings.

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

Part Two

Detailed Reports of CRC Projects



Emissions Committee

The Emissions Committee originated from the Air Pollution Research Advisory Committee (APRAC) that facilitated collective effort with the National Air Pollution Control Administration from 1968-1982. The Emissions Committee focuses its research on addressing current and future regulatory needs and to understand and define the effects that changes in automotive hardware, fuel compositions, and the interactions of the two have on automotive emissions related to air quality and airborne toxics.

The primary research areas of the Emissions Committee are in new vehicle emissions, fuel market quality, fuel effects on emissions, providing data for octane and additives to support ASTM deliberations, and to support interaction with relevant regulatory agencies such as CARB and US EPA.

Current research spans advanced emissions measurement methods, including portable emissions measurement systems (PEMS) and roadside remote sensing; fuel composition and quality impacts on emissions, particulate matter formation, and on-board diagnostics; evaluation of alternative and renewable fuels such as biofuels, ethanol blends, and renewable diesel; development and assessment of fuel-property metrics such as the Particulate Matter Index (PMI); and emerging emissions concerns including non-tailpipe sources such as brake and tire wear. The committee also investigates the performance of next-generation low-emission vehicles, particulate matter measurement uncertainty at near-zero emission levels, engine deposit effects on emissions, and long-term trends in vehicle emissions. Emissions Committee projects are designated with CRC Project Nos. E.

The Real World Working Group advances the mission of the Emissions Committee by allowing interactions and collaborative efforts with agencies and other industry partners. In particular, the Real World Group focuses its effort to determine the contribution of vehicle and fuel source emissions to the environment and how current computer models reflect these contributions. Real World Group projects are designated with CRC Project Nos. RW.

The History of the (Near) Elimination of Gasoline Vehicle Emissions

CRC Project No. E-130

Leader: Bryan Just

Project Summary

Since the 1970s and earlier, the dramatic reductions of automotive pollution have contributed to significant improvements in air quality. CRC Project E-130 seeks to produce a historical 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.

A major deliverable of this project will be a published book which documents how gasoline-powered vehicle emissions evolved from a major contributor to urban air pollution into a source subject to increasingly effective controls. The history begins with the emergence of smog concerns in the 1940s and follows advances in understanding air pollution and smog formation, the identification and measurement of vehicle-related emissions, and the development of testing procedures and emissions standards, all of which shaped vehicle emissions control through the 2010s and beyond.

A central objective is to explain how research, regulation, fuel changes, and automotive technology worked together to reduce emissions. Topics include catalytic converters, electronic fuel injection and advanced electronic controls, the transition away from leaded gasoline, reformulated and oxygenated fuels, onboard diagnostics, inspection and maintenance programs, durability requirements, and progressively tighter vehicle and fuel standards. The book also addresses the supporting advances in emissions measurement, modeling, compliance testing, and in-use surveillance.

Current Status & Future Program

Steve Welstand and Dr. Kent Hoekman, consultants, have been contracted for this project, which began in 2020. A journal article highlighting the early years (1940s-1950s) was published in "Atmosphere" in November 2021. Preparation of the final chapters is underway, and the completed work is expected to be published in 2027.

Portable Emissions Measurement System (PEMS) Phase 3 — Effects of Altitude, Temperature and Grade

CRC Project No. E-134 / CRC Project No. E-134a

Leaders: Paul Loeper, Marc Henderson

Project Summary

With Europe adopting the use of portable emissions measurement systems (PEMS) to determine light duty real world emissions, there is a greater interest in PEMS functionality and use. The California Air Resources Board (CARB) and the U.S. Environmental Protection Agency (US EPA) are also conducting tests here in the United States with light duty vehicles to determine their viability to measure real world on-road emissions. This is in addition to the normal Federal Test Procedure (FTP-75), Highway Fuel Economy Test (HWFET), and US06 Supplemental Federal Test Procedures (SFTP) chassis dynamometer testing. There are several PEMS manufacturers producing these units and some studies have been conducted to understand how they perform compared to normal chassis dynamometer testing. CRC Project E-134 was conducted to assess PEMS performance relative to conventional laboratory emissions measurement methods. This project focused on the use of multiple engine technologies and different fuel properties at altitude, steep grades and at low temperatures to determine PEMS performance in measuring emission changes during both on-road and laboratory tests.

Testing was conducted at altitude in Aurora, CO using four light-duty vehicles representing multiple engine technologies. The on-road cycle, developed in the E-122 project which incorporates city, urban and highway driving, was replicated. This road test cycle used steep grades, elevated altitudes, and winter conditions. Matching speeds and grade profiles were replicated for laboratory chassis-dynamometer testing, allowing direct comparison between on-road PEMS measurements and laboratory measurements obtained using a Constant Volume Sampling (CVS) system. Emissions measurements included carbon dioxide (CO₂), carbon monoxide (CO), oxides of nitrogen (NO_x), total hydrocarbons (THC), particulate matter (PM), fuel economy, and exhaust flow.

The program evaluated two market winter gasoline fuels representing low and high Particulate Matter Index (PMI) properties. A comprehensive test matrix consisting of on-road and chassis dynamometer testing with multiple repeat runs for each vehicle and fuel combination was completed

to support assessments of measurement repeatability, PEMS-to-CVS comparability, fuel sensitivity, and exhaust flow measurement performance under severe environmental operating conditions. Additional analyses examined route development, equipment operation at altitude and low temperatures, data quality procedures, and phase-based emissions characterization to provide a comprehensive evaluation of PEMS performance.

Current Status & Future Program

The test program was conducted by 44 Energy in collaboration with TRP Laboratories, while CRC Project E-134a provided statistical design of experiments and analytical support through Southwest Research Institute (SwRI). The E-134a effort developed the test matrix, established the sequence of vehicle and fuel testing, and ensured that the data collection plan would support rigorous statistical evaluation of measurement repeatability, accuracy, and sensitivity to fuel effects. SwRI also performed the statistical analysis of the completed dataset and supported interpretation of the testing program.

The Final Report for this project was a combined effort between all contracted parties. It is available on the CRC website.

Analysis of Fuel Correlation to SimDis Method

CRC Project No. E-137

Leaders: Jeff Jetter, Steve McConnell

Project Summary

Since its introduction in a 2010 SAE paper (2010-01-2115), use of the Particulate Matter Index (PMI) metric in research related to fuel properties and resultant impact on vehicle emissions has become increasingly common. The concept was modified to better evaluate emissions effects of ethanol level in gasoline blends, as described in a series of CRC reports; RW-107-2 An Improved Index for Particulate Matter Emissions (PME) and RW-107-3a Validation of the New PM Index Formula. However, determination of PMI for a given fuel necessitates performing a detailed hydrocarbon analysis (DHA) which, in addition to being inherently time consuming, can lead to variable results across labs due to gas chromatogram (GC) post-processing methods. In the recent NPRM for light duty vehicle emissions (US EPA, April 2023), US EPA staff acknowledge the usefulness of PMI as a strategy to reduce tailpipe emissions for legacy vehicles. Given the challenges mentioned previously related to DHA-derived PMI, they suggest use of Simulated Distillation (SimDis ASTM D7096) as a time- and cost-effective method to quickly identify and regulate higher boiling point components in market gasoline fuels.

Application of SimDis for gasoline fuels is unconventional; therefore, CRC members sought to better understand how SimDis data compares to more-conventional methods for characterizing gasoline – D86, DHA, etc. Leveraging leftover fuels from previous CRC projects (E-122-2, E-133, and RW-107-3), thirteen fuel samples were submitted for SimDis D7096, D86, DHA, enhanced DHA (SSI method), updated SimDis (as described in EPA NPRM), and VUV.

Objective

Using results from the fuel analyses described in the previous section, the main objectives of this project are to 1) perform an analysis of data for the 13 fuels including DHA per ASTM D6730,

SimDis data per ASTM D7096, boiling range by atmospheric distillation per ASTM D86 and PMI data based on vacuum ultraviolet (VUV) spectroscopy per ASTM D8369. Calculate PMI and PME based on both D6730 DHA and D8369 VUV; 2) identify data gaps, correlations to: methods and/or fuel properties (e.g., PMI to SimDis boiling fractions), and

emissions data from the three aforementioned CRC projects (i.e. E-122-2, E-133, and RW-107-3); 3) explore how US EPA's use of SimDis and a 'distillation cut' could impact fuels in this set (e.g. would a 3% distillation cut exclude fuels that may not necessarily lead to high emissions i.e. C10+ aromatic content?); and 4) formalize the three previous objectives as well as general trends into a written report.

Current Status & Future Program

The Final Report for this project, completed by Desert Research Institute, was posted on the CRC website in March 2026.

Low Particulate Matter-Modeling

CRC Project No. E-140-2

Leaders: Marc Henderson, Steve McConnell

Project Summary

CRC Project E-140-2 was initiated as a follow-on effort to the original E-140 project, Low NO_x and NMOG Modeling, in response to growing concerns that current emissions measurement techniques may not be sufficiently sensitive for the extremely low particulate matter (PM) emissions expected from future light-duty and medium-duty vehicles certified to Super Ultra-Low Emission Vehicle (SULEV) standards. As vehicle emissions continue to decrease, factors such as dilution tunnel background contamination, filter handling practices, and measurement system limitations can become significant contributors to overall measurement uncertainty. The project was undertaken to better understand these limitations and identify opportunities to improve the accuracy and reliability of PM measurements.

The primary objective of the project is to develop a user-friendly modeling tool that quantifies the uncertainty associated with current PM measurement methodologies used during chassis dynamometer certification testing. Building upon the uncertainty model developed in the original E-140 project, the work converts the previous model into an accessible software platform and incorporates particulate matter calculations and associated sources of measurement error. The model uses Monte Carlo simulation techniques to estimate overall PM measurement uncertainty across a range of vehicle and test scenarios and to evaluate the contribution of individual uncertainty sources.

A key outcome of the project is to identify the factors that have the greatest impact on PM measurement uncertainty and to provide recommendations for improving test methods, equipment, and laboratory practices.

Current Status & Future Program

The contract for this project was awarded to Southwest Research Institute in March 2025. The contractors are expecting to provide a working, modifiable modeling application that can be used to evaluate future measurement approaches, support regulatory and technical discussions, and help ensure that emissions measurement capabilities remain adequate as vehicle particulate emissions approach near-zero levels. The project is expected to be completed in early 2027.

Systematic Review for Brake, Tire, and Road Wear for On-Road Light- and Heavy-Duty Vehicles

CRC Project No. E-143

Leaders: Garry Gunter, Michael Moore

Project Summary

As tailpipe Particulate Matter (PM) emissions from Light Duty (LD) vehicles declined, other types of PM emissions became more important. LD vehicles emit at least five types of PM: tailpipe, brake wear, tire wear, road wear, and resuspended road dust. Although measurement methods are still in development, total combined PM emissions for brake, tire, and road wear are estimated at about 30 mg/mi. This is an order of magnitude greater than the tailpipe PM regulatory limit of 3 mg/mi. Battery Electric Vehicles (BEV) emit four of the five types of PM; all except tailpipe PM. Some government regulatory agencies have begun studies of certain types of non-tailpipe PM including PM from brake wear.

The objective of this project is to perform a literature review of recent (past 15 years) light duty and heavy-duty vehicle emissions of non-tailpipe PM.

Topics of interest include:

- Magnitude of non-tailpipe PM emissions, preferably expressed in units like mg/mi to allow comparison with tailpipe PM emissions levels and regulatory standards.
- Source apportionment of non-tailpipe PM emissions including brake wear, tire wear, road wear, resuspended road dust, etc.
- Test methods to generate non-tailpipe PM.
- Test methods to measure non-tailpipe PM emissions, including methods to discriminate PM from various sources.
- Characterization of non-tailpipe PM, including chemical composition, morphology, and particle size distribution.
- Test methods to characterize non-tailpipe PM emissions.
- Strengths or weaknesses of particular test or measurement methods, especially affecting their ability to accurately estimate emissions from real-world on-road vehicles.

EMISSIONS COMMITTEE

- Factors known to control or affect magnitude or type of non-tailpipe PM emissions.
- Methods proposed to control or reduce LD vehicle non-tailpipe PM emissions.

Current Status & Future Program

LINK Engineering was contracted for Project E-143, which completed in November 2025. The Final Report, "Systematic Review for Brake, Tire, and Road Wear for On-road Light- and Heavy-Duty Vehicles" is available on the CRC website.

Impact of Alternative Diesel Fuels on On-Board Diagnostics (OBD) Robustness

CRC Project No. E-144 / PC-2023-1

Leaders: Sarah Funk, Garry Gunter

Project Summary

Availability of biofuels and renewable fuels is expected to increase, driven by federal and state policies like Federal Renewable Fuels Standards (RFS) and California Low Carbon Fuels Standard (LCFS) and other state mandates. While the impact of renewable fuels on engine and aftertreatment performance has been studied in other projects, the impact of fuel properties on OBD robustness is not well understood.

Fuel properties such as oxygen content, cetane number, and heating value are expected to affect combustion performance such as air-fuel ratio and exhaust energy. If combustion performance is altered, engine and aftertreatment sensors will measure the change in response. Differences in air fuel ratio may lead to differences in fuel system diagnostic response. Differences in heating value may lead to differences in exhaust temperature, affecting diagnostics based on exhaust energy, such as Diesel Oxidation Catalyst monitoring and Cold Start Emissions Reduction System monitoring. Because diagnostic thresholds are typically calibrated with standard fuel, a vehicle exposed to an alternative diesel fuel may false fail diagnostics due to the changed sensor response exceeding diagnostic thresholds. At this time, it is not well understood all of the interactions among fuel properties and sensor response and how diagnostic system performance is affected.

This project seeks to understand the impact of renewable fuels on diagnostic robustness by investigating variation in key inputs to diagnostic strategies by testing a range of alternative fuels on a variety of vehicle technologies.

Current Status & Future Program

FEV completed this project, and a Final Report, "Impact of Alternative Diesel Fuels on On-Board Diagnostics," was posted to the CRC website April 2026.

Understanding Effects of Diesel Contamination in Gasoline on PMI/PME: Phase 1

CRC Project No. E-145

Leaders: John Eckstrom, Ivan Tibavinsky

Project Summary

Small amounts of diesel fuel contamination can occur during the distribution of gasoline due to common-carrier transportation systems, pipeline transfers, and fuel truck operations where equipment is not dedicated exclusively to either gasoline or diesel service. Because diesel fuel contains higher-boiling and, in some cases, more aromatic compounds than gasoline, there has been interest in understanding whether such contamination could influence gasoline particulate matter metrics, including the Particulate Matter Index (PMI) and Particulate Matter Emissions (PME) indices.

CRC Project E-145 was conducted to evaluate whether diesel contamination at levels representative of those that may occur during fuel distribution affects gasoline PMI and PME values. The study prepared gasoline sample sets representing both low- and high-PMI fuels and blended them with diesel fuel at contamination levels intended to approximate real-world distribution scenarios. The resulting samples were analyzed to determine PMI and PME values and to assess the significance of diesel contamination on these particulate matter indicators.

In addition to evaluating potential impacts on PMI and PME, the project investigated a range of standardized ASTM analytical methods to determine their effectiveness in identifying diesel contamination in gasoline. The work included analytical testing of blended fuel samples, statistical evaluation of the resulting data, and an assessment of the sensitivity of various fuel-property measurements to diesel contamination.

The project also sought to develop recommendations regarding which analytical approaches may be useful for detecting diesel contamination and to establish practical criteria and detection thresholds for methods

found to be effective. These efforts were intended to improve understanding of both the potential effects of diesel contamination on gasoline particulate matter metrics and the analytical tools available for identifying such contamination in market fuels.

Current Status & Future Program

Southwest Research Institute completed the project, and a final report, "Effect of Diesel Contamination on PM Emissions," was posted on the CRC website in February 2026.

Mid-Level Ethanol Blends Literature Review

CRC Project No. E-146

Leaders: Melissa Przybylo, Brianne Kanach

Project Summary

CRC Project E-146 was initiated in response to findings from the CRC Project SM-F-5 project, "Research in Support of Future Fuel Specifications" which examined opportunities to modernize transportation fuel specifications to enable lower-carbon-intensity fuels while maintaining compatibility with current and future vehicles. One of the key conclusions from that effort was the need for additional research to better understand the effects of higher ethanol content fuels on modern vehicles, including the potential for malfunction indicator light (MIL) activation and other vehicle compatibility concerns.

While CRC conducted extensive research leading up to the introduction of E15, culminating in CRC Report E-97, relatively little work has been performed on mid-level ethanol blends (E16-E50) over the past decade. During that time, vehicle technologies have evolved significantly, including the introduction of Tier 3 vehicles, while interest in lower-carbon transportation fuels and higher-octane fuel strategies has continued to increase.

The objective of Project E-146 is to perform a comprehensive literature review that updates and expands upon the findings of CRC's earlier E-97 review by evaluating the current state of knowledge regarding mid-level ethanol blends (MLEB). The study will assess the potential benefits, opportunities, and barriers associated with introducing blends ranging from E16 to E50 into the U.S. market. Particular emphasis will be placed on understanding impacts to on-road vehicles, off-road engines, fuel distribution and retail infrastructure, fuel specifications, and regulatory requirements. The review will also evaluate what portion of the current U.S. vehicle fleet may be compatible with higher ethanol blends and identify technical, operational, and market challenges that could affect broader adoption.

A key outcome of the project will be the identification of critical knowledge gaps and research needs that can inform a series of future CRC studies. By synthesizing available scientific literature, industry experience, infrastructure considerations, and regulatory constraints, the project will

provide a roadmap for determining whether mid-level ethanol blends can serve as a practical pathway to lower-carbon, higher-octane gasoline while maintaining vehicle operability, durability, emissions compliance, and infrastructure compatibility. The resulting recommendations will help CRC prioritize future research needed to support informed decisions regarding the potential deployment of MLEB in the transportation sector.

Current Status & Future Program

The contract for this project was awarded to the National Laboratory of the Rockies (NLR) in October 2025. The project is expected to last approximately 1 year, concluding near the end of 2026.

Effect of Engine Deposits on Tailpipe Emissions of New-Technology Vehicles

CRC Project No. E-149

Leaders: Garry Gunter, Jeff Jetter, Marc Henderson

Project Summary

State and federal emission regulations regarding particulate matter (PM) continue to ratchet down, presenting a challenge for automotive OEMs. In response, OEMs have released multiple new models that produce certification results below 0.5 mg/mi. Engine deposits (injector, combustion chamber, etc.) are known to cause PM emissions to increase. However, this effect has not been studied in new-technology vehicles, especially those designed to meet the latest PM emission targets.

This project seeks to conduct vehicle emission testing to study the influence of engine carbon deposits on criteria emissions and fuel economy. Tailpipe emissions will be measured on a small fleet of vehicles after their engines have been mechanically cleaned of deposits and repeated after equilibration with a market-representative fuel. “Dirty-up” cycles will then be conducted using an appropriate deposit-forming test fuel, with deposit formation monitored using fuel trim and injector pulse width data. Emission tests will be conducted at a pre-determined endpoint.

The key objectives of this project are:

- Determine the emission and performance effects of maintaining combustion chambers (and injectors) in a clean condition, by comparing them with engines that have accumulated deposits.
- Conduct detailed characterization of particulate matter (PM) emissions and the relationship with engine deposit accumulation, based on changing fuel severity. This would include measurement of PM mass, number, and size distribution.
- Collect data during the deposit accumulation cycle that can provide insight into the amount of deposit formation, e.g., injector pulse width and fuel trim. Correlate these data with measured emissions.

Ideally, the results of this project will provide data that help address questions such as:

- Does this problem still exist for the latest vehicle technology? If so, to what extent? That is, how should “clean up” be defined for new-technology engines?
- Could US EPA-mandated IUVP (in-use emissions verification) testing be more challenging for vehicles designed to meet ultra-low PM standards? For example, a vehicle might have routinely been fueled with gasoline containing the Lowest Additive Concentration (LAC). The LAC is recommended by various regulatory agencies, but this low level of detergency can sometimes increase deposits.
- Do current vehicle emission certification rules allow procedural variability that could significantly affect emissions levels, particularly by allowing poor control of deposits? For example, the regulations contain no specification for the fuel used to “de-green” vehicles for 4k miles prior to emission certification testing.

Current Status & Future Program

The contract for this project was awarded to Southwest Research Institute in September 2026 following an open solicitation for proposals. The project is anticipated to last approximately 8 months.

Real World Vehicle Emissions Workshop

CRC Project No. RW-110

Leaders: Steve McConnell, Michael Moore

Project Summary

For three decades, CRC has held annual vehicle emissions workshops, 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 topic 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
- 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 & Future Program

The 2025 Workshop was held April 13-16, 2025, in Long Beach, CA. Two keynote addresses were delivered, each of which provided a historical context of the vehicle emissions field. The first was from Dr. Kent Hoekman of Desert Research Institute on the "Road to Clean Cars," a 40-year history of the scientific and regulatory accomplishments to reduce vehicle emissions. The second was from Dr. Wayne Miller of University of California, Riverside, titled "We've Come a Long Way, and Still Going!" A summary of the workshop is available on the CRC website.

The 2026 Workshop was held March 8-11, 2026, at the Hyatt Mission Bay in San Diego. Dr. Matti Maricq, consultant, delivered a keynote address of "What We Have Learned about Vehicle Emissions from 25-Years of CRC Remote Sensing Studies." Dr. Carlos Agudelo, Link Engineering, provided a keynote on a "Systematic Review for Brake, Tire, and Road Wear for On-Road light- and Heavy-Duty Vehicles." A summary article is available on the CRC website.

The 2027 Workshop is planned for March 21-24, 2027, and will be held at Marriott Long Beach Downtown in Long Beach, California.

Statistical Analysis of Nationwide PMI Fuel Survey

CRC Project No. RW-121/CM-138-22 and RW-121-2/CM-138-22-2 and RW-121a/CM-138-22a

Leaders: Michael Moore, Paul Loeper, Russ Lewis

Project Summary

CRC Projects RW-121, RW-121-2, and RW-121a were conducted as a coordinated effort to characterize contemporary U.S. gasoline properties and evaluate particulate matter index (PMI) characteristics across a broad range of market fuels. The work was undertaken to provide an updated understanding of gasoline composition, volatility characteristics, and PMI distributions in today's fuel marketplace and to establish a comprehensive dataset for assessing how analytical methods influence PMI calculations and fuel characterization. The project built upon earlier fuel survey efforts and addressed industry interest in understanding potential changes in fuel composition associated with evolving fuel formulations, renewable fuel content, and regional fuel requirements.

The first phase of the program involved the collection and characterization of gasoline samples through the Alliance for Automotive Innovation (AAI) North American Fuel Survey program. CRC Project RW-121/ CM-138 collected summer gasoline samples from all five U.S. Petroleum Administration for Defense Districts (PADDs), while RW-121-2/ CM-138-2 collected winter gasoline samples representing regular, premium, and E15 fuel grades. Fuel samples were distributed for detailed laboratory analysis and underwent extensive characterization using multiple compositional and volatility-based analytical techniques. These analyses included ASTM D6730 detailed hydrocarbon analysis (DHA), ASTM D8369 vacuum ultraviolet spectroscopy (VUV), ASTM D7096 simulated distillation, and ASTM D86 atmospheric distillation testing, providing a comprehensive database of fuel composition and physical property measurements.

CRC Project RW-121a/ CM-138a served as the analytical and statistical component of the program, integrating the summer and winter survey datasets into a unified framework for evaluation. The effort included harmonization of analytical data sources, standardization of compound classifications and fuel-property information, development of PMI calculations from detailed compositional measurements, and creation of comparable distillation profiles across analytical methods. Statistical analyses were performed to investigate relationships among fuel properties, compare PMI values generated by different measurement

techniques, assess regional and seasonal variations, and evaluate sources of variability among analytical approaches.

Current Status & Future Program

Sample collection was done in partnership with Alliance for Automotive Innovation. Laboratory analysis of the samples was conducted by Gage Product, Southwest Research Institute, and VUV Analytics. Desert Research Institute was contracted to perform the statistical analysis. The Final Report of the combined effort documented methodologies for fuel sampling, laboratory characterization, PMI calculation, and statistical evaluation. The Report and accompanying data were posted to the CRC website in October 2025.

Remote Sensing Device Summary Report

CRC Project No. RW-125

Leaders: Garry Gunter, Michael Moore

Project Summary

Roadside remote sensing devices (RSDs) provide a non-intrusive means of measuring exhaust emissions from large numbers of vehicles under real-world operating conditions. Beginning in the late 1980s, researchers at the University of Denver conducted an extensive series of RSD measurement campaigns with support from CRC, the California Air Resources Board, and other organizations. CRC's RSD research began with Project E-23, and its history includes studies conducted from 1997 through 2007 and culminated in a retrospective summary of emissions measurements available at that time. Following a pause of approximately five years, CRC resumed its RSD research through Projects E-106, E-119, and E-123, extending the available record through 2021.

CRC Project RW-125 was undertaken to provide an updated and expanded review of this body of research. The project assembled and evaluated roadside emissions data collected from 1989 through 2022, with particular emphasis on long-term measurement series from Chicago, Denver, Tulsa, and West Los Angeles. More recent campaigns from Fresno, Oakland, Phoenix, and Stockton were also included to broaden the geographic coverage and provide additional information for the later portion of the study period. The review incorporates CRC-sponsored studies as well as related RSD measurements supported by other organizations.

The primary objective was to examine the historical RSD database within the context of changing vehicle emissions standards and evolving engine and exhaust-aftertreatment technologies. The study was structured to evaluate four principal topics: changes in fleet-average emissions over time and among locations; emissions-system deterioration as vehicles age; the relationship between progressively more stringent tailpipe standards and emissions from newer vehicles; and the characteristics and relative importance of high-emitting vehicles. The review considered carbon monoxide, hydrocarbons, nitric oxide, nitrogen dioxide, and ammonia where suitable measurements were available.

The project also documented the RSD measurement approach and evaluated factors needed to interpret the historical data, including measurement uncertainty, statistical confidence, vehicle operating conditions, vehicle-specific power, fleet composition, and differences among measurement sites. Statistical methods included regression analyses of emissions trends and extreme-value analyses designed to characterize the upper end of the emissions distribution. Collectively, these activities were intended to produce a comprehensive retrospective of CRC's RSD research, build upon the earlier E-23 summary, and establish a technical foundation for considering the future application and development of roadside emissions measurement technology.

Current Status & Future Program

The historical data review and technical analyses were completed by Forest Glen Consulting. A Final Report documenting the RSD methodology, statistical approach, long-term fleet and model-year analyses, high-emitter evaluation, and considerations for future RSD applications is available on the CRC Website.

ADVANCED VEHICLE/FUEL/LUBRICANTS COMMITTEE

The Advanced Vehicles Fuels, and Lubricants (AVFL) Committee focuses its research on vehicles, fuels, and/ or lubricants which are three years or more out from current production. With this focus, its current research topics include engine and fuel fundamentals and efficiency improvements, as well as advanced automotive hardware and new fuel formulations effects on emissions.

The Fuels for Advanced Combustion Engines (FACE) is a Working Group of the AVFL Committee, which is made up of AVFL member companies and other invited stakeholders, including participants from National Laboratories. The mission of the FACE Working Group is to define the fuel impacts on performance of emerging advanced combustion systems. Examples of advanced combustion systems include low temperature combustion (LTC), lean burn direct injection (LBDI), homogenous charge compression ignition (HCCI), and high efficiency clean combustion (HECC).

The Lubricants Working Group (previously the Lubricants Advisory Panel) of the AVFL Committee is a collaboration of CRC member companies and other invited stakeholders. The AVFL Committee's technical scope includes evaluation of the impacts of current lubricants on advanced vehicles, and future lubricants on current or advanced vehicles. The Lubricants Working Group also develops studies focused primarily on lubricant impacts for consideration by the full committee.

FUELS FOR ADVANCED COMBUSTION ENGINES (FACE) WORKING GROUP

The AVFL Committee formed the FACE Working Group to foster collaboration with other industry and government research laboratory experts. 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.

The original mission of the FACE Working Group, developed in 2005, was to recommend sets of test fuels well-suited for research so researchers evaluating advanced combustion systems could compare results from different laboratories using the same set(s) of fuels.

An initial key activity of this group was in 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).

A gasoline-range fuel set design was also developed by the FACE Working Group. Ten fuels were blended into 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).

The mission statement was updated in 2015 to coordinate pre-competitive research on fuel properties and advanced combustion.

The FACE Working Group has generated several completed projects conducted by the AVFL Committee: FACE-1, AVFL-16, AVFL-18, AVFL-19, AVFL-23, AVFL-24, AVFL-26, AVFL-31, AVFL-32, AVFL-38, AVFL-40, and AVFL-44.

The Working Group meets regularly throughout the year to review project status, share results from various member research projects in support of the Working Group's mission, and develop ideas for future research projects.

LUBRICANTS WORKING GROUP

The AVFL Committee organized a Lubricants Advisory Panel of engine lubrication experts from industry to serve as a resource for CRC Committees and Project Panels to consult on matters involving lubricants; in 2026, this panel evolved into a Working Group to signal continuing interest from the AVFL Committee on this research. Project areas of interest to the Lubricants Working Group include impacts of new fuels such as biodiesel on lubricant performance and impacts of new engine technologies on lubricant performance.

Activities of the Lubricants Working Group are consistent with the original Charter of CRC “in developing the best combinations of fuels, lubricants, and the equipment in which they are used.” The goal of the Lubricants Working Group is not to set lubricant testing specifications, nor to develop an engine test for lubricant certification, but rather to perform sufficient testing to make recommendations regarding suitability of test elements. These recommendations can then be provided to existing lubricant standards-setting organizations that may develop lubricant specifications and engine wear tests as they see fit based on project findings.

The Lubricants Working Group has generated several completed projects conducted by the AVFL Committee: AVFL-28, AVFL-28-2, AVFL-28-3, AVFL-37, and AVFL-39 / E-139.

The Working Group meets periodically to develop project ideas for consideration by the AVFL Committee.

Improved Diesel Surrogate Fuels for Engine Testing and Kinetic Modeling

CRC Project No. AVFL-18a

Leaders: Steve McConnell, Scott William Wagnon

Project Summary

The objective of AVFL-18a is to establish and evaluate a methodology for formulating and testing surrogate fuels, a mixture of generally less than a dozen pure compounds that matches certain selected characteristics of a target diesel market fuel composed of many hundreds to thousands of compounds. Surrogate fuels can enable a better understanding of fundamental fuel composition and property effects on combustion and emissions formation processes in internal combustion engines.

This project has been a successful collaboration with researchers at several DOE national laboratories: Sandia National Laboratory (SNL), National Laboratory of the Rockies (NLR), 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.

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. SNL has performed optical engine measurements on the surrogate fuels; results from this research will be reported.

Current Status & Future Program

The AVFL-18 project began in 2009 and has resulted in multiple publications and reports that are available on the CRC website. Additional journal articles are anticipated to be published from this research.

Detailed Hydrocarbon Analysis (DHA) & Particulate Matter Index (PMI) Improvement

CRC Project No. AVFL-29-3

Leaders: Garry Gunter, Veronica Reilly

Project Summary

The objective of AVFL-29-3 was to study ways to improve inter-lab variability for Detailed Hydrocarbon Analysis (DHA) and Particulate Matter Index (PMI), with the ultimate goal of creating a standard procedure for data needed to calculate the PMI from the improved DHA method currently under development. The project aimed to provide data via an interlaboratory study that can be used to inform methodology development and improvement.

Over the past ten years, great improvements have been made with predictive particulate emissions indices (correlative mathematical models) based on fuel composition. Examples of these particulate indices (PI) are the Honda Particulate Matter Index (PMI) and the General Motors Particulate Evaluation Index (PEI). Both indices include the detailed molecular compositions of gasoline fuels and are weighted by those compounds which contribute the most in particulate emission as determined by controlled vehicle emission and fuel correlation studies. Because gasoline can be mixtures of hundreds of hydrocarbon compounds, these laboratory methods typically include the use of high-resolution chromatography separation techniques such as detailed hydrocarbon analysis (DHA), which can identify upwards of 500+ compounds.

In the past, a number of DHA methods have been used to identify aromatic compounds: ASTM D6729, ASTM D6733, ASTM D6730, and many other in-house laboratory methods. AVFL-29-2 showed that differences in DHA method as currently practiced in industry produce variations which affect PMI.

Current Status & Future Program

Research was conducted by the Southwest Research Institute (SwRI) and volunteer ILS labs. The final report was published on the CRC website in August 2026.

Effects of Boost Pressure and Fuel Composition on Combustion Knock Characteristics

CRC Project No. AVFL-32

Leaders: Steve McConnell, Asim Iqbal

Project Summary

The objective of AVFL-32 was 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 was to investigate how boosting affects the operation of the standard Research Octane Number (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 spark ignition (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 explored how increased boost pressure on the CFR engine affects the knocking characteristics of several fuels with similar RON and varied chemical composition.

Current Status & Future Program

Research was conducted by Argonne National Laboratory (ANL). Final reporting included three technical papers and an Executive Summary published on the CRC website in December 2025.

Fuel Effects on Wall Wetting and Stochastic Preignition (SPI) — Phase 1

CRC Project No. AVFL-33

Leaders: Elana Chapman, Garry Gunter

Project Summary

The objective of AVFL-33 Phase 1 was to understand the role of fuel-wall interaction on stochastic pre-ignition (SPI), and 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.

SPI is an abnormal combustion process that initiates combustion prior to spark discharge in boosted spark ignition engines. SPI has been shown to be heavily influenced by both operating conditions and fuel and lube properties. Fuel properties of interest include composition (e.g., alcohols, aromatics, isoparaffins, olefins) and heavy-end volatility.

The approach is to perform dynamometer testing of a GTDI engine at SPI-prone conditions to determine fuel effects on SPI and influence of wall wetting. Wall wetting is being determined using real-time Fuel-in-Oil (FiL) analysis using a dry sump oil system and fuel dye fluorescence detection. The active cylinder is instrumented with pressure transducers to collect the SPI/LSPI event data. Wall wetting will be quantified while measuring SPI/LSPI count for each oil and fuel combination.

Current Status & Future Program

Research was conducted by Oak Ridge National Laboratory (ORNL). The Executive Summary and accompanying journal article for Phase 1 were published on the CRC website in January 2025. Phase 2 testing is underway; final report publication is anticipated in 2027.

Experimental Investigation and Quantification of Fuel Effects on Fuel-Wall Interaction in Low-Speed Pre-Ignition — Phase 2

CRC Project No. AVFL-33-2

Leaders: Elana Chapman, Garry Gunter

Project Summary

The objective of AVFL-33-2 is to understand the role of fuel-wall interaction on stochastic pre-ignition (SPI), and 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.

SPI is an abnormal combustion process that initiates combustion prior to spark discharge in boosted spark ignition engines. SPI has been shown to be heavily influenced by both operating conditions and fuel and lube properties. Fuel properties of interest include composition (e.g., alcohols, aromatics, isoparaffins, olefins) and heavy-end volatility.

The approach is to perform dynamometer testing of a GTDI engine at SPI-prone conditions to determine fuel effects on SPI and influence of wall wetting. Wall wetting is being determined by completing real-time Fuel-in-Oil (FiL) analysis using a dry sump oil system and fuel dye fluorescence detection. The active cylinder is instrumented with pressure transducers to collect the SPI/LSPI event data. Wall wetting will be quantified while measuring SPI/LSPI count for each oil and fuel combination.

Current Status & Future Program

Research is being conducted by Oak Ridge National Laboratory (ORNL). The Executive Summary and accompanying journal article for Phase 1 were published on the CRC website in January 2025. Phase 2 testing is underway; final report publication is anticipated in 2027.

Using Separation-Enhanced Isotope Ratio Mass Spectrometry to Enable Increased Renewable Carbon Content in Transportation Fuels

CRC Project No. AVFL-38

Leader: Russ Lewis

Project Summary

The objective of AVFL-38 was to demonstrate the ability to use chemical separations in combination with stable isotope analysis to track the distribution of biogenic carbon across co-processed fuel streams, by compound, chemical class, or boiling point range, while obtaining a biogenic carbon balance for representative refinery conditions. Biogenic carbon is typically quantified using ^{14}C analysis by accelerator mass spectrometry (AMS), ASTM D6866 Method B, which is available at a limited number of commercial labs because of stringent requirements for labs also handling ^{14}C tracers.

This work applied chemical separation approaches as part of the isotope ratio mass spectrometry (IRMS) analyses, enabling biogenic carbon tracking in fuel product streams by boiling point (BP) range, by chemical class, or even by compound. Focusing on subclasses of compounds within the sample increases sensitivity to shifts in isotope value within that subclass, which would otherwise be obscured by sample complexity when using bulk IRMS (or AMS) analysis.

This improved resolution can provide greater insight into the chemical processes that are occurring when co-processing bio- and fossil-derived feeds. Results from each separated fraction were compared with bulk analysis to determine if detection limits, accuracy, or precision are improved.

Sample sets from industry (fossil and renewable feeds, and each liquid product stream) were tested using bulk IRMS, and a separation approach (typically gas chromatography (GC) followed by IRMS). By focusing on fuel fractions rather than analysis of all carbon atoms in the sample, differences in stable isotope distributions can be used to provide advanced quantification of the persistence of biogenic feeds through a refining process. These measurements can be used for process optimization, and the refiner, having additional process information, can obtain a renewable carbon balance.

Current Status & Future Program

Research was conducted through a Department of Energy (DOE) award (May 2021); project team participants included Pacific Northwest National Laboratory (PNNL), Natural Resources Canada (NRCan), CanMet Energy, and Argonne National Laboratory (ANL). The final report was published on the CRC website in December 2025.

Low Phosphorus Low Ash Gasoline Engine Oil to Meet Future Emission Requirements

CRC Project No. AVFL-39-2 / E-139-2

Leaders: Garry Gunter, Michael Deegan

Project Summary

The objective of AVFL-39-2 / E-139-2 is to further understand how lower phosphorous concentration enables catalyst protection and the ash levels acceptable for gasoline particulate filter (GPF) future emissions levels through experimental work and catalyst aging.

Increasingly stringent regulations on particulate emissions from vehicles may require the use of GPF in spark ignition engines. Phosphorus, present in engine oil as an antiwear additive, is known as catalyst poison, and can enter the aftertreatment system when engine oil leaks past the piston rings or through the crankcase ventilation system, burns in the combustion chamber, and leaves through the exhaust stream.

The objective of AVFL-39 was to perform a literature review to understand the effects of lube oil formulations and phosphorous levels on catalyst and GPF efficiencies, and to understand how lube additives affect ash accumulation on and pressure drops across the GPF.

Current Status & Future Program

Research for AVFL-39, the literature review, was conducted by the Southwest Research Institute (SwRI); the final report was published on the CRC website in June 2023. Research for AVFL-39-2 / E-139-2 is being conducted by the Research Institute for Energy Technology and Internal Combustion Engines (FEV); final report publication is expected in 2027.

Development of Advanced Compression Ignition Gasoline Rating Methods on a Variable Compression Ratio CFR Engine

CRC Project No. AVFL-40

Leaders: Steve McConnell, John Waldman

Project Summary

The objective of AVFL-40 was to obtain a better understanding of how a homogeneous charge compression ignition (HCCI) fuel rating metric on the variable compression ratio (CR) Cooperative Fuel Research (CFR) test F1/F2 octane test engine is affected by a wider range of fuel properties, engine speed, lambda, and thermodynamic conditions than currently operable on the carbureted CFR engine at Argonne National Laboratory (ANL).

AVFL-40 explored the possibility of a modified CFR F1/F2 octane-rating engine to rate fuels for advanced compression ignition (ACI) engines using a set of homogeneous charge compression ignition (HCCI) test conditions. This work supported the Co-Optimization of Fuels & Engines (Co-Optima) initiative, which investigates fuels and engines as dynamic design variables that can work together to boost efficiency and performance, while minimizing emissions. Potential benefits include dramatic improvements in vehicle fuel economy and increases in the use of domestically sourced fuel for transportation.

After upgrading the CFR engine at ANL to operate over a wider range of fuel properties, air/fuel ratio, thermodynamic, and temporal test conditions, a detailed characterization of multiple gasoline blends with bio-fuel blend stocks has been evaluated. These data were correlated to those from ACI engines in the Co-Optima program to identify a down-select of key HCCI fuel rating conditions and fuel properties for ACI engines.

Current Status & Future Program

Research was being conducted through a Cooperative Research and Development Agreement (CRADA) with the Department of Energy (DOE) and Argonne National Laboratory (ANL). Final report publication was published on the CRC website in September 2026.

Detailed Chemical and Physical Characterization and Analysis of New Low Carbon Liquid Fuels

CRC Project No. AVFL-42

Leaders: Russ Lewis, Melissa Przybylo

Project Summary

The objective of AVFL-42 is to build a database of chemical and physical properties of new low carbon liquid fuels from various companies covering a range of production technologies (both at commercial and pilot scales). The study will provide uniform comparisons of critical fuel properties for various low carbon fuels from different production pathways and build on previous work from AVFL-19a and AVFL-19-2 projects. The properties of these new fuels will be compared against conventional fuels (gasoline, diesel) as well as with first generation biofuels (ethanol, biodiesel).

All fuels, including electricity, have significant greenhouse gas (GHG) emissions footprints today. A wide range of fuel and vehicle technologies will be needed to achieve significant GHG reductions from the transportation sector going forward. Internal combustion engine (ICE) vehicles are projected to represent a dominant portion of industry sales for the foreseeable future and persist in the parc for decades to come. Significant GHG reductions will not be realized without improvements in ICE technologies and ICE fuels. Low carbon liquid fuels are a CO₂-reducing technology that can complement (not replace) other technologies like electrification.

Current Status & Future Program

Research is being conducted by AmSpec. Final report publication is expected in 2026.

Ducted Fuel Injection (DFI) Multi-Cylinder Engine Demo

CRC Project No. AVFL-44

Leaders: Elana Chapman, Steve McConnell

Project Summary

The objective of AVFL-44 was to implement ducted fuel injection (DFI) in a multi-cylinder engine with a low-net-carbon fuel, demonstrating at least 70% lower engine-out particulate matter (PM), NO_x, and net-carbon emissions without an efficiency penalty over steady-state and transient test cycles vs. operation of the baseline engine utilizing conventional diesel combustion and petroleum-based diesel fuel.

DFI is a simple, mechanical technology to enhance the preparation of fuel/charge gas mixtures within the combustion chambers of diesel engines. DFI with low-net-carbon fuels can dramatically reduce climate-forcing and pollutant emissions while enhancing efficiencies. DFI could be implemented within a decade or less, providing a pragmatic technology option for fighting climate change and improving air quality in a cost-effective manner, particularly for difficult-to-electrify sectors.

This project sought to facilitate the commercial adoption of this promising technology, quantifying the magnitude of its potential benefits by providing the first complete and robust multi-cylinder engine demonstrations of DFI over industry-standard test cycles using a low-net-carbon fuel. Outcomes of this project include:

- learnings from the first implementation of DFI in a multi-cylinder engine
- comparisons of performance and engine-out emissions datasets with and without DFI as well as with and without low-net-carbon fuel under standard steady-state and transient test cycles
- improved understanding of the attributes of the DFI technology in terms of combustion-system integration, part cost, manufacturing, durability, operating costs, and certification
- significantly enhanced stakeholder engagement in the development of DFI
- further exploration and optimization of DFI for implementation in production-viable engine architectures

Current Status & Future Program

Research was conducted under a Cooperative Research and Development Agreement (CRADA) with Sandia National Laboratories (SNL), John Deere, Clean Fuels Alliance America (CFAA), and Cummins. The final report was published in SAE International Journal of Fuels & Lubricants and made available on the CRC website in October 2025. Related research continues at CRC under SM-F-2025-01 / AVFL-51 / E-151.

Combustion Emissions from Renewable and Biodiesel Blends

CRC Project No. AVFL-46

Leaders: Andrew Ickes, Ivan Tibavinsky

Project Summary

The objective of AVFL-46 is to characterize the combustion behavior and resulting emissions for fuel blends of renewable diesel and biodiesel – both engine-out and post-aftertreatment systems – using a modern diesel engine with de-greened/aged aftertreatment systems.

Blends of renewable diesel and biodiesel are seeing commercial interest as a lower-carbon fuel for diesel engines, especially as renewable diesel volumes grow in the market. However, limited to no engine and emissions research has focused on these blends. A recent California Air Resources Board (CARB) study suggested tailpipe NO_x emissions may increase with mid-level RD-BD blends. A program funded by the Department of Energy (DOE) at the University of Wisconsin – already including a fuel study – provided an ideal platform for detailed investigation into engine and aftertreatment effects with RD-BD blends.

This project will compare combustion behavior for a range of renewable diesel and biodiesel (RD-BD) fuel blends (R99, R80-B20, R50-B50) across different engine operating conditions; emissions, both gaseous and particulate, and the impact on aftertreatment system ability to convert.

Current Status & Future Program

Research is being conducted by the University of Michigan. Final report publication is expected in early 2027.

Low Carbon Fuels Detailed Fuel Property Characterization and Kinetic Mechanism Development — Phase I: Laminar Flame Speed Measurement

CRC Project No. AVFL-47

Leaders: Chao Daniels, Elana Chapman, Russ Lewis, David Vuilleumier

Project Summary

The objective of AVFL-47 Phase I is to prepare a series of advanced and detailed fuel property data sets on flame speed for a few low carbon fuel concentrations on a blendstock for oxygenate blending (BOB). Phase II will focus on ignition, using the BOB, and Phase III will utilize this data to improve or prepare kinetic mechanisms.

With the potential introduction of low carbon fuels into the fuel stream, there is a need to have specialized fuel data to be used for engine combustion development. Advanced and detailed fuel property data is needed and intended to be used for modeling systems, i.e. GT-Power and computational fluid dynamics (CFD) use. Many properties models in GT Power are outdated or need to have new information provided, given enhancement in modeling tools and more sophisticated modeling programs. Previous work has been completed on the Michigan Technological University (MTU) test bench for flame speed data and equation development, and ignition energy. This project utilizes the validated setup at MTU.

Current Status & Future Program

Research for Phase I is being conducted by the Michigan Technological University (MTU). Final report publication is expected in 2027.

Fuel Survey Data Available from Public Sources

CRC Project No. AVFL-48

Leaders: Elana Chapman, Veronica Reilly, Scott Fenwick, Shawn Broughton

Project Summary

The objective of AVFL-48 is to provide a list of parties who publish fuel survey data publicly, along with a description of the data collected, frequency of the collection, location of the bulk data and/or aggregated reports. If there are sources that are found where the data can be accessed through request (either free or with a payment), this will also be studied and noted.

Fuel surveys are handled by many organizations regularly and are very expensive to procure for a comprehensive set of samples. While many organizations keep the information private, various parties provide fuel survey data publicly. It would be helpful to have a published list of those parties and the public data storage location for bulk data and reports.

Current Status & Future Program

Research is being conducted by the National Laboratory of the Rockies (NLR). Final report publication is expected in 2026.

Ducted Fuel Injection (DFI) CFD Scaling Model for Smaller Bore CI Engines

CRC Project No. AVFL-49 / E-150

Leaders: Donald Meyer, Kulwinder Singh, Elana Chapman, Steve McConnell

Project Summary

The objective of AVFL-49 / E-150 is to further research in ducted-fuel injection (DFI) work, specifically focusing on items for future work as described in the final report of AVFL-44. The project will develop the modeling techniques, guidelines, and methods for the engine from AVFL-44 to understand the fuel economy penalty. It will then develop techniques, guidelines, and methods to scale the DFI to smaller bore compression-ignition (CI) engines. After the scaling work is complete, the project aims to exercise a defined model type with low carbon fuels.

The project will employ 3D Computational Fluid Dynamics (CFD)/1D tools for matching current experimental studies at current bore and then develop DFI scaling techniques from current bore size to smaller bore diameter. Previous work focused on a 118mm bore; this project will focus on engines ranging from 84-118mm bore, with specific focus on 103mm and 84mm.

The project will also conduct a fuel consumption evaluation and energy loss breakdown at the same NO_x as the AVFL-44 data. The focus will be on DFI with diesel (federal ULSD) and with low carbon fuel (R100 and B100).

Current Status & Future Program

Research is being conducted by Wisconsin Engine Research Consultants (W-ERC). Final report publication is expected in 2028.

Atmospheric Impacts Committee

The Atmospheric Impacts Committee (AIC) traces its origins to the Air Pollution Research Advisory Committee (APRAC), the pioneering CRC program established in 1968 to coordinate cooperative research among the automotive and petroleum industries and the National Air Pollution Control Administration, predecessor to the U.S. Environmental Protection Agency. Through APRAC and its successor programs, CRC helped establish much of the scientific foundation for understanding the relationships among transportation emissions, atmospheric chemistry, air quality, and environmental regulation. Today, the AIC continues this legacy by serving as CRC's focal point for research that advances the science supporting air quality management that can be used to guide regulatory decision-making.

The committee's mission is to improve the ability of scientists, regulators, and stakeholders to predict how emissions influence air quality and to identify the most effective pathways toward continued air quality improvement. AIC focuses its resources on advancing three critical elements of air quality science: improving emissions inventories, improving understanding of atmospheric chemistry, and improving air quality modeling systems. The committee also seeks to identify and evaluate emerging issues that may influence future air quality management strategies.

The drivers of the AIC's efforts stem from the ongoing necessity to improve air quality. Regulatory demands, driven by the need to reduce mobile source emissions, are grounded in scientific analysis and modeling of emissions and their impacts on air chemistry and physics. These regulatory frameworks encompass tools like National Ambient Air Quality Standards (NAAQS) for ozone and particulate matter, state implementation plans, and updates to the National Emissions Inventory (NEI) and the U.S. Environmental Protection Agency's MOVES (Motor Vehicle Emissions Simulator) model.

The committee's research portfolio is organized around the air quality modeling system and the many inputs required to accurately represent atmospheric processes. Recent and ongoing research has addressed meteorological modeling, emissions inventory development, mobile-source emissions modeling, biogenic emissions estimation, emissions processing tools such as SMOKE, boundary condition analysis using

global transport models, and advances in atmospheric chemistry mechanisms. These efforts support the development of more accurate air quality models capable of evaluating future emissions scenarios, assessing control strategies, and informing regulatory attainment demonstrations.

Recent AIC activities have focused on advancing the scientific tools, datasets, and models needed to support air quality planning and regulatory decision-making. The committee's current portfolio includes projects addressing ozone formation and response to emissions controls (A-144, A-145), research on particulate matter sources and impacts (A-140, A-141, A-142), and improving understanding of emissions inventories and impacts of both natural and anthropogenic emissions on air quality (A-139).

To ensure that limited research resources are directed toward the highest-priority challenges, AIC periodically convenes research-needs workshops and technical forums that bring together experts from industry, academia, government agencies, and research organizations. The 2016 and 2022 Air Quality Research Needs (AQRN) Workshops and the 2018 Southern California Ozone Research Symposium (SCORES) identified many of the scientific priorities that continue to guide the committee's project selection process today. Through these activities, AIC maintains a forward-looking research strategy that addresses both current regulatory needs and emerging scientific challenges.

In addition to sponsoring targeted research projects, the committee serves as a collaborative forum for knowledge exchange among air quality professionals. AIC supports the biennial Mobile Source Air Toxics (MSAT) Workshop series, which brings together researchers from industry, regulatory agencies, academic institutions, and nonprofit organizations to discuss the latest developments in emissions measurements, atmospheric modeling, exposure assessment, and emerging air quality issues. Together, these research and outreach activities help ensure that CRC remains a significant contributor to the advancement of air quality science.

Other projects in the research portfolio described below address non-combustion emissions in urban environments, primary organic aerosol emissions, and the effects of VOC/NO_x chemistry on tropospheric ozone production. This portfolio underscores the AIC's commitment to addressing both traditional and emerging challenges in air quality science and regulation.

Development And Evaluation of Database and Estimation Methods for Predicting Air Quality Impacts of Emitted Organic Compounds

CRC Project No. A-108

Leaders: Bud Ghosh, Chris Rabideau

Project Summary

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 & Future Program

A multi-year effort was conducted by the University of California - Riverside from April 2017 to December 2025.

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" (June 2020). A third journal article on estimation of rate constants for reactions of organic compounds under atmospheric conditions has been published in "Atmosphere" (September 2021). The final report was published on the CRC web site in February 2026.

Characterizing Primary Organic Aerosol Emissions from In-Use Motor Vehicles

CRC Project No. A-114 / RW-111

Leaders: Michael Moore, Chris Rabideau

Project Summary

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 the U.S. Environmental Protection Agency Community Multiscale Air Quality Model (CMAQ).

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
- Add to the growing body of data documenting the volatility profiles of individual vehicles by tier, model, and model year, etc.

Current Status & Future Program

West Virginia University was awarded the contract for Project A-114/RW-111. The research contract transitioned to Energy Environmental Analytics. The final report publication is expected in 2026.

Quantifying the Effects of VOC/NO_x Chemistry on Tropospheric Ozone Production: Yields of Organic Nitrates from Reaction of Substituted Organic Peroxy Radicals with NO.

CRC Project No. A-128

Leaders: Chris Rabideau, Bud Ghosh

Project Summary

The formation of atmospheric secondary pollutants, including ozone and secondary organic aerosol (SOA), is driven by non-linear chemistry involving volatile organic compounds (VOCs) and oxides of nitrogen (NO_x). Direct control on ozone formation occurs via the reaction of organic peroxy radicals with NO. The peroxy radicals (RO₂), generated following reaction of OH with a VOC compound (RH), react with NO via two pathways, the first major channel generating ozone (via NO₂ photolysis) and the second limiting ozone formation via organic nitrate (RONO₂) production.

Thus, quantification of the organic nitrate formation yield for the full range of temperature and pressure conditions and VOCs encountered in the troposphere is of critical importance in constraining model uncertainty regarding tropospheric ozone production and determining the efficacy of NO_x vs VOC controls on ozone production. Detailed chemical models (e.g., Leeds MCM; GECKO-A; UC-Riverside MechGen) would employ the data obtained directly; more condensed mechanisms (e.g., SAPRC, Mozart, GEOS-Chem, RACM, etc.) would employ the data through the ‘lumping’ that occurs for complex VOC chemistry.

Organic nitrate yields from the oxidation of alkanes have been reasonably well studied and demonstrate the inherent complexity – nitrate yields depend on the size and structure of the peroxy radical, as well as on temperature and total pressure. To date however, only limited/no information is available regarding nitrate yields from the chemistry of oxygenated VOCs, including alcohols, carbonyls, ethers and multifunctional species. Thus, we propose here environmental chamber studies aimed at quantifying organic nitrate yields in the chemistry of these oxygenated VOCs, with the broad goal of improving the representation of VOC/NO_x chemistry in air quality models.

The objective of the project is to improve the state of knowledge regarding the yields of organic nitrates in VOC oxidation, and thus to further constrain model representation of the effects of VOC/NO_x chemistry on ozone and secondary organic aerosol production. Nitrate yield determinations in the reactions of organic peroxy radicals with NO will focus on radicals derived from oxygenated VOCs, including ketones, alcohols, ethers and multi-functional species, for which very little information is available. Through studies of compounds of variable size and structure, and over ranges of temperature and pressure (in some cases), a set of 'rules' will be developed that can be used by air quality modelers to describe organic nitrate (and hence ozone) production for the wide variety of VOC encountered in the troposphere, particularly in urban areas. The classes of compounds under investigation have been identified as products of standard VOC chemistry, volatile chemical products' emissions, as well as (in some cases) potential alternative fuels.

Current Status & Future Program

This research was conducted by the University Corporation for Atmospheric Research (UCAR). The final report was published on the CRC web site in April 2025.

Ozone Formation and Its Sensitivity to NO_x and VOCs from Volatile Chemical Product, Mobile Source, and Biogenic Emissions in Urban Centers

CRC Project No. A-132

Leaders: Sandy Winkler, Bud Ghosh

Project Summary

The objective of Project A-132 is to analyze data from the recent RECAP (Re-Evaluating the Chemistry of Air Pollutants, Los Angeles) and SUNVEx (Southwest Urban NO_x and VOC Experiment, Las Vegas) campaigns in the summer of 2022, the 2023 AEROMMA flights (Atmospheric Emissions and Reactivity Observed from Megacities to Marine Areas, Los Angeles, Chicago, New York, funded by NOAA) and supporting laboratory / chamber studies from the recent Secondary organic aerosol Chamber Experiments for Non-Traditional Species (SCENTS 2022, funded by NSF). Data analysis addresses the response of ozone and organic aerosol to changes in VOC and NO_x and determines urban biogenic emissions from AEROMMA flights across Southern California with a main focus on Los Angeles and comparisons with flights over New York, Chicago and Toronto.

Current Status & Future Program

This research was conducted by the NOAA Chemical Sciences Laboratory. A journal article published by Atmospheric Chemistry and Physics is available on the CRC web site. The final Executive Summary was published on the CRC web site in February 2025.

Understanding O₃ and PM_{2.5} Distributions Using Surface and Satellite Data for the Megafire Years of 2020 and 2023 Across the Entire U.S.

CRC Project No. A-135

Leaders: Greg Myers, Sandy Winkler

Project Summary

This study investigated the impact of the massive wildfires of 2023, primarily in Canada, on air quality in the United States. The project built upon previous research examining the effects of wildfires on air quality during 2020. Analyses of PM_{2.5} (particulate matter less than 2.5 μm in diameter) and ozone (O₃) during these periods showed that millions of people were exposed to unhealthy air quality and that 2020 (in the Western United States) and 2023 (in the Midwest and Eastern United States) were likely the worst air quality years of the past decade. For example, urban monitoring sites in California recorded annual fourth-highest maximum daily 8-hour average (MDA8) ozone concentrations in 2020 that were at least 6 ppb higher than the average of the previous decade, while PM_{2.5} concentrations on these days exceeded typical levels by more than 20 $\mu\text{g m}^{-3}$. Similarly, in Chicago during 2023, the annual fourth-highest MDA8 ozone concentration was more than 10 ppb above the previous decade's mean, and PM_{2.5} concentrations were also substantially elevated. These findings indicated that both the PM_{2.5} and ozone enhancements were strongly linked to wildfire emissions. While PM_{2.5} concentrations largely reflected wildfire emissions and the transport of primary and secondary particulate matter, ozone formation was more complex and depended on initial emissions, interactions with urban pollutants, particularly NO_x, and meteorological conditions. This complexity contributed to challenges associated with exceptional event designation.

The primary objectives of the project were to use surface, satellite, and meteorological observations within a machine learning and Generalized Additive Modeling framework to identify and quantify the factors controlling ozone production and concentrations during wildfire-influenced periods. The study evaluated the relative importance of wildfire emissions, atmospheric transport, chemical interactions, and meteorological

conditions in driving air quality impacts during the 2020 and 2023 fire seasons. The resulting analyses provided information intended to support state exceptional event demonstrations and documentation efforts for these and future wildfire years.

Current Status & Future Program

This research was conducted by Dan Jaffe, consultant. The final report was published on the CRC web site in February 2025.

Gas-Phase Mechanism Evaluation: How Similar to Measurements are Current Mechanisms and Could Differences Influence State Implementation Plan Strategies?

CRC Project No. A-136

Leaders: Chris Rabideau, Sandy Winkler

Project Summary

Three-dimensional Chemical Transport Models (CTMs) provide a representation of the atmospheric processes leading to the formation of secondary pollutants such as ozone (O₃) and particulate matter <2.5 μm (PM_{2.5}). Regulatory agencies use CTMs as one of their tools to determine what anthropogenic emissions to control and by how much to achieve the U.S. National Ambient Air Quality Standards (NAAQS) for O₃ and PM_{2.5}. Key components of CTMs are the gas-phase and aerosol-phase chemical mechanisms that connect primary emissions to secondary pollutants.

There are multiple gas-phase chemical mechanisms implemented in CTMs for regional-scale modeling. Currently, the mechanisms available for preparing U.S. emission control strategies include the Carbon Bond version 6 revision 3 (CB6r3), the Statewide Air Pollution Research Center 2007 (SAPRC07), and the Regional Atmospheric Chemistry Mechanism version 2 (RACM2). These mechanisms have been included in both the U.S. Environmental Protection Agency Community Multiscale Air Quality Model (CMAQ) and the Comprehensive Air Quality Model with Extensions (CAMx). Current versions of CAMx include more recent versions of the Carbon Bond mechanism, CB6r5 and CB7r1.

The U.S. Environmental Protection Agency released the Community Regional Atmospheric Chemistry Multiphase Mechanism version 1.0 (CRACMMv1.0) in CMAQ, which intricately combines gas-phase and aerosol-phase organic chemistry. There are other gas-phase chemical mechanisms used for tropospheric and stratospheric modeling, e.g. the mechanism in the GEOS-Chem model, which are used to develop continental-scale background concentrations for U.S. control strategies.

There are recent comparisons of O₃ formation when selected mechanisms are used in the same model with equivalent emissions for all mechanisms. This project compared ozone predictions generated by the CB7r1, CB6r3, SAPRC07, and RACM2 chemical mechanisms using a one-dimensional version of CAMx configured with representative inputs

of areas surrounding three Texas cities. Simulations were conducted across a range of volatile organic compound (VOC) and nitrogen oxide (NO_x) emission conditions, with particular emphasis on scenarios in which ozone formation was limited by NO_x availability. The study evaluated how differences in chemical mechanism formulation affected ozone predictions and characterized the implications of those differences for understanding ozone formation and supporting future air quality management strategies.

Current Status & Future Program

This research was conducted by Ramboll. The final report was published on the CRC web site in May 2025. A journal article was published in Atmospheric Chemistry and Physics in March 2026.

Multi-scale Analysis of PM Sources Near Highways and Transportation Corridors

CRC Project No. A-137

Leaders: Karim Hamza, Bud Ghosh

Project Summary

Emission inventories (EIs) and computer models are used to manage complex air quality issues such as PM_{2.5} and ozone. The models provide a connection between ambient concentrations, which can be measured, and emission inventories, which are managed by regulations. However, traditional ambient concentration measurements at surface monitoring sites provide limited data coverage that poorly constrains uncertainties in the models and the EIs. Pollution mapping by aircraft and/or satellites can provide much more data that can then be used to improve the EIs and/or models.

The objective of CRC Project A-137 is to utilize satellite data to calibrate fine-grid (1 km) air quality simulations and estimate the source contribution of on-road vehicle emissions to fine particulate matter (PM_{2.5}) ground-level concentrations near highways and transportation corridors.

Expected break-down of tasks includes:

- Defining modeling subdomains in three focus areas to 1-km resolution.
- Obtain and extract PM_{2.5} data for the 1-km subdomains.
- Perform simulations using 2016 data to determine the contribution of on-road vehicles to annual PM_{2.5} from the difference between the model "base case" and "onroad zero out" simulations.
- Make comparisons between 2016 and 2022 datasets to determine how emissions changes from different datasets might influence findings of the fine-scale model results.

Current Status & Future Program

This research was conducted by Ramboll. The final report was published on the CRC web site in October 2025.

2026 12th Mobile Source Air Toxics Workshop

CRC Project No. A-138

Leaders: Chris Rabideau, Sandy Winkler

Project Summary

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, 2019, and 2021 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. CARB hosted the Workshops in Riverside in 2024 and 2026. Each of these events brought together key government, academic, industry researchers, and stakeholders working in this area.

Current Status & Future Program

The 12th CRC Mobile Source Air Toxics Workshop was held in Riverside, CA, hosted by the California Air Resources Board on February 10-11, 2026. A summary report is in development for publication on the CRC website in 2026.

Improving Modeled Biogenic VOC and Anthropogenic VCP Contributions to Organic Aerosol over the San Francisco Bay Area and Evaluating Emissions Reductions

CRC Project No. A-139

Leaders: Greg Myers, Sandy Winkler, Bonyoung Koo

Project Summary

Organic aerosol (OA) comprises a substantial fraction of fine particulate matter (PM_{2.5}) in the San Francisco Bay Area and is influenced by both biogenic and anthropogenic volatile organic compound (VOC) emissions. Accurate representation of these emissions is critical for air quality planning, yet important uncertainties remain regarding the magnitude, composition, and atmospheric chemistry of VOC sources. Recent research has highlighted the increasing importance of volatile chemical products (VCPs), such as solvents, cleaning products, paints, and personal care products, as anthropogenic VOC sources, while biogenic VOC (BVOC) emissions from vegetation remain challenging to characterize in urban environments due to changing land cover, evolving vegetation patterns, and limitations in existing emissions inventories. To address these uncertainties, the Bay Area Air District initiated efforts to modernize both biogenic emissions estimates and the treatment of VOC chemistry within its regional air quality modeling framework.

CRC Project A-139 seeks to improve PM_{2.5} modeling in the San Francisco Bay Area by enhancing the representation of volatile organic compound (VOC) emissions, atmospheric chemistry, and secondary organic aerosol (SOA) formation within the Community Multiscale Air Quality (CMAQ) model. The project will update the SAPRC-22 chemical mechanism to more explicitly represent key volatile chemical product (VCP) compounds, including alcohols, ethers, esters, glycol ethers, and siloxanes. Improved treatments of SOA formation from VCPs, intermediate-volatility organic compounds (IVOCs), aromatics, and biogenic VOC precursors will also be incorporated. In parallel, the project will support the evaluation of updated biogenic VOC emissions developed by the Bay Area Air District using advanced datasets and machine learning approaches integrated within the MEGAN biogenic emissions framework.

The project will further develop the emissions-speciation mappings and modeling inputs needed to support annual CMAQ simulations using alternative combinations of chemical mechanisms and biogenic emissions inventories. Model performance will be evaluated through comparisons of predicted and measured PM_{2.5} concentrations and related atmospheric constituents throughout the Bay Area, including assessments of both total and speciated particulate matter. The relative contributions of anthropogenic and biogenic SOA precursors will be examined, and the influence of emissions characterization on modeled particulate matter formation will be assessed.

Finally, the project will evaluate the sensitivity of modeled PM_{2.5} concentrations to hypothetical reductions in anthropogenic VOC and nitrogen oxide (NO_x) emissions. A series of emission-reduction scenarios will be developed to characterize the interactions among anthropogenic emissions, naturally occurring VOC sources, and secondary pollutant formation processes. Through these analyses, the project will provide a more robust scientific basis for understanding VOC-driven PM formation and will strengthen the technical foundation for future air quality planning and emissions-control strategy development in the San Francisco Bay Area.

Current Status & Future Program

This research is being conducted by a team led by Ramboll. Final report publication is expected in 2026.

PM Source Apportionment – Primary vs Secondary Mobile Emissions

CRC Project No. A-140

Leaders: Sandy Winkler, Bud Ghosh

Project Summary

As exhaust emissions from the on-road vehicle fleet continue to decline in response to increasingly stringent emission standards, non-exhaust sources such as brake wear, tire wear, and road dust are becoming a larger fraction of direct mobile-source particulate matter (PM) emissions. At the same time, secondary PM formed through atmospheric reactions of gaseous pollutants remains an important contributor to ambient PM_{2.5} concentrations. Understanding the relative contributions of primary and secondary PM from mobile sources is therefore increasingly important for air quality planning and for assessing the implications of future vehicle technologies, including widespread fleet electrification. CRC Project A-140 is intended to address these evolving questions through advanced emissions inventory development and photochemical source apportionment modeling.

The primary objective of the project is to quantify the contribution of mobile-source emissions to ambient PM_{2.5} and distinguish the relative importance of primary emissions and secondary PM formation. The study will evaluate selected metropolitan areas representing a range of meteorological conditions, particulate matter composition, mobile-source influences, and electric-vehicle adoption scenarios. Photochemical source apportionment modeling will be conducted for both a current-year and future-year fleet to characterize how the contributions of exhaust and non-exhaust mobile sources may evolve over time.

A key component of the project is the development and refinement of emissions inventories used to support photochemical modeling. In addition to applying US EPA's latest emissions modeling tools, the study will evaluate a sensitivity scenario that incorporates recent research findings not currently represented in standard modeling platforms. Planned enhancements include updated tire-wear emission factors, consideration of electric-vehicle weight effects on tire wear emissions, revised brake and tire chemical speciation profiles, and incorporation of volatile organic compound (VOC) emissions from brake and tire wear as potential precursors to secondary particulate matter formation.

Using these inventory inputs, the project will conduct photochemical source apportionment modeling to separately track contributions from brake wear, tire wear, road dust, exhaust PM emissions, and gaseous mobile-source pollutants. The modeling framework will evaluate primary and secondary PM_{2.5} contributions, characterize seasonal and spatial variations in source impacts, identify potential hotspots of non-exhaust emissions, examine changes associated with future vehicle electrification, and assess the influence of brake- and tire-related gaseous emissions on particulate matter formation. The results are intended to improve understanding of the relative roles of exhaust and non-exhaust mobile emissions and support future assessments of mobile-source contributions to ambient PM_{2.5}.

Current Status & Future Program

This research is being conducted by ERG. A final report is expected in 2026.

Refining Estimates of U.S. Background PM_{2.5} to Support Effective Urban Air Quality Planning

CRC Project No. A-141

Leaders: Bud Ghosh, Sandy Winkler

Project Summary

Aerosol particles are primarily produced in the boundary layer, where the buoyant stability typically prevents them from mixing into the free troposphere. However, long-range transport in the free troposphere, especially from episodic events typically associated with strong winds, is frequently observed and can significantly contribute to PM_{2.5} levels in the boundary layer, affecting many U.S. cities. Recent studies also indicate that the response of aerosols to temperature has become a dominant feature of high aerosol events in cities like Los Angeles. This shift reflects changes in emission sources over time, with local vehicle emissions becoming less influential, while other (e.g., biogenic) sources are playing a more important role. As the transition to electric vehicles accelerates, Los Angeles serves as a guidepost for other U.S. megacities. These emphasize the need to understand the evolving contributions of local anthropogenic and background sources—including natural sources such as biogenic emissions, oceanic activity, lightning, and wildfires, as well as intercontinental transport—in crafting effective policies to mitigate high PM_{2.5} levels in urban areas.

However, accurately estimating the background PM_{2.5} is complex due to its uneven distribution and short atmospheric lifetime; rather it requires complex, multifaceted analysis since a more simplistic estimate based just on data or air quality models may be misleading. This study is particularly important in light of the recent US EPA's decision to lower the federal PM_{2.5} standards. A recent study found that could place up to 40% of the AQS monitors across the continental U.S. in nonattainment areas, even without considering the wildfire smoke contribution. This underscores the challenge of meeting these stricter standards and highlights the importance of understanding the contributions from various sources to effectively address high PM_{2.5} levels.

The goal of CRC Project A-141 is to develop improved estimates of background PM_{2.5} in cities across U.S. in an effort to quantify “controllable” concentrations to help mitigate high aerosol events, and to provide decision makers with better tools to enhance regulatory and mitigation efforts.

Current Status & Future Program

This research was conducted by the Desert Research Institute (DRI). The final Executive Summary was published on the CRC web site in August 2026.

Impact of Wildland Fires on 2022-2024 PM_{2.5} Design Values

CRC Project No. A-142

Leaders: Bud Ghosh, Michael Moore

Project Summary

CRC Project No. A-142 was undertaken in response to the growing influence of wildland fire emissions on fine particulate matter (PM_{2.5}) concentrations across the United States and the increasing challenge this poses for achieving compliance with the U.S. annual PM_{2.5} National Ambient Air Quality Standard (NAAQS). As anthropogenic PM_{2.5} emissions have declined, wildfire smoke has become a more significant contributor to air quality degradation, particularly following major fire seasons in the United States and Canada. The recent establishment of a more stringent annual PM_{2.5} standard further heightened the need for tools and methods to distinguish wildfire-related pollution from other sources and to support implementation of the Exceptional Events Rule, which allows air quality agencies to exclude qualifying natural-event impacts from regulatory determinations.

To address these needs, CRC Project No. A-142 developed and applied a methodology for identifying smoke-influenced days and quantifying their impact on PM_{2.5} design values across the United States. The project combined satellite observations, surface monitoring data, and meteorological analyses to classify daily air quality observations according to the likelihood of wildfire smoke influence. The approach was applied to hundreds of monitoring locations nationwide using data from the 2022-2024 period. In addition to evaluating smoke impacts on PM_{2.5} design values, the project included the development of an interactive visualization tool to support the identification of smoke-affected days and facilitate future exceptional event demonstrations by state and tribal air quality agencies.

Current Status & Future Program

This research was conducted by Dan Jaffe, consultant. The final report was published on the CRC web site in March 2026.

Rapid ozone projections for future emission scenarios using a deep learning-based emulator of CMAQ

CRC Project No. A-144

Leaders: Karim Hamza, Bud Ghosh

Project Summary

A major uncertainty in projecting ozone concentrations is the evolution of precursor emissions, primarily nitrogen oxides (NO_x) and volatile organic compounds (VOCs). The pace of policy implementation and technological advance determines the future power generation mix, resulting in a range of future emission scenarios. Despite the importance of evaluating multiple possible scenarios, the computational cost of numerical models often limits this type of extensive analysis. This limitation necessitates the development of a computationally more efficient modeling approach capable of scenario-based air quality simulations. Although the Community Multiscale Air Quality (CMAQ) model will remain an important tool for regulatory air-quality assessments, its substantial computational requirements will limit the number of future emissions scenarios that can be evaluated. This project will address that limitation by developing a faster modeling approach for conducting year-round, multi-scenario ozone analyses across the contiguous United States (CONUS).

CRC Project A-144 seeks to develop and validate a computationally efficient, deep learning-based emulator of CMAQ to simulate maximum daily 8-hour average (MDA8) ozone concentrations at a 12-kilometer resolution across CONUS. The emulator will use meteorological variables, land-surface properties, and emissions data from U.S. Environmental Protection Agency's Air Quality Time Series (EQUATES) dataset. A convolutional neural network with a U-Net architecture will be trained and evaluated using cross-validation, and predictor-selection methods will be applied to establish a compact, nonredundant, and physically interpretable set of model inputs.

The project will also develop an uncertainty-quantification framework that will estimate predictive uncertainty for each model grid cell. Following development and validation, the emulator will be used to project MDA8

ozone concentrations for 2030 and 2050 under NO_x and VOC emissions scenarios based on RCP 2.6, RCP 4.5, and RCP 8.5. Scenario-specific emissions inventories will be prepared using the EQUATES dataset and the emissions changes associated with each pathway.

To isolate the effects of changes in precursor emissions, the scenario simulations will hold meteorology constant while varying NO_x and VOC emissions. The analysis will therefore evaluate ozone sensitivity to alternative emissions pathways rather than represent comprehensive future climate scenarios, and it will support rapid, probabilistic comparisons of projected ozone concentrations among target years and pathways.

Current Status & Future Program

This research is being conducted by the University of Houston. A final report is expected in 2027.

Evaluating Differences in Ozone Response to Emission Controls under Various Chemical Mechanisms

CRC Project No. A-145

Leaders: Sandy Winkler, Bud Ghosh, Karim Hamza

Project Summary

Projecting future ozone concentrations will involve considerable uncertainty because ozone formation will depend strongly on evolving emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Although the Community Multiscale Air Quality (CMAQ) model will remain an important tool for regulatory air-quality assessments, its substantial computational requirements will limit the number of future emissions scenarios that can be evaluated. Project CRC A-145 seeks to address that limitation by developing a faster modeling approach for conducting year-round, multi-scenario ozone analyses across the contiguous United States (CONUS).

CRC Project A-145 will develop and validate a computationally efficient, deep learning-based emulator of CMAQ to simulate maximum daily 8-hour average (MDA8) ozone concentrations at a 12-kilometer resolution across CONUS. The emulator will use meteorological variables, land-surface properties, and emissions data from U.S. Environmental Protection Agency's Air Quality Time Series (EQUATES) dataset. A convolutional neural network with a U-Net architecture will be trained and evaluated using cross-validation, and predictor-selection methods will be applied to establish a compact, nonredundant, and physically interpretable set of model inputs.

The project will also develop an uncertainty-quantification framework that will estimate predictive uncertainty for each model grid cell. Following development and validation, the emulator will be used to project MDA8 ozone concentrations for 2030 and 2050 under NO_x and VOC emissions scenarios based on RCP 2.6, RCP 4.5, and RCP 8.5. Scenario-specific emissions inventories will be prepared using the EQUATES dataset and the emissions changes associated with each pathway.

To isolate the effects of changes in precursor emissions, the scenario simulations will hold meteorology constant while varying NO_x and VOC emissions. The analysis will therefore evaluate ozone sensitivity to alternative emissions pathways rather than represent comprehensive future climate scenarios, and it will support rapid, probabilistic comparisons of projected ozone concentrations among target years and pathways.

Current Status & Future Program

This research is being conducted by Carleton. A final report is expected in 2027.

Quantifying Soil NO_x Emissions Relative to Internal Combustion Across California with Novel Satellite Measurements

CRC Project No. A-146

Leaders: Greg Myers, Sandy Winkler

Project Summary

CRC Project A-146 seeks to improve understanding of the relative contributions of agricultural soil nitrogen oxides (NO_x) and internal combustion engine emissions to regional ozone formation in the United States. While regulatory controls have substantially reduced NO_x emissions from vehicles and other anthropogenic sources, soil NO_x emissions associated with fertilizer application, manure management, and agricultural activities may represent an increasingly important contributor to regional ozone formation, particularly during the ozone season. The project aims to provide improved estimates of soil NO_x emissions and evaluate how these emissions compare with transportation-related NO_x sources in regions influenced by both agriculture and mobile-source activity.

The study seeks to leverage new satellite observations, including measurements from the Tropospheric Emissions: Monitoring of Pollution (TEMPO) instrument, to quantify NO_x emissions at high spatial and temporal resolution. Four representative study areas encompassing a range of agricultural and transportation emission influences are planned for evaluation. Satellite observations, ground-based measurements, and aircraft datasets will be integrated to identify major NO_x emission sources and distinguish contributions from soil, transportation, and other emission categories.

To accomplish these objectives, CRC Project A-146 seeks to develop and apply advanced atmospheric modeling and data assimilation techniques that combine TEMPO observations with chemical transport modeling. The approach will generate updated, hourly NO_x inventories that separately characterize soil and combustion-related emissions and evaluate how these inventories differ from existing emissions estimates. Particular emphasis will be placed on improving representation of agricultural soil emissions through the incorporation of process-based soil NO_x modeling and satellite-derived constraints.

The project further seeks to assess the implications of updated NO_x inventories for ozone modeling by implementing both reference and satellite-constrained emissions inventories within a chemical transport modeling framework. Sensitivity analyses will be used to examine the relative influence of soil and combustion NO_x emissions on ozone concentrations, ozone exceedance metrics, and attainment-related indicators across the selected study regions. The resulting inventories, modeling framework, and source-apportionment methodology are intended to support improved air quality assessments and provide publicly available data resources for future research.

Current Status & Future Program

This research project has been awarded to Colorado University - Boulder. Final reporting is anticipated at the end of 2027.

Performance Committee

The Performance Committee traces its roots to CRC's earliest cooperative research activities, beginning with the Cooperative Fuel Research (CFR) Committee of the Society of Automotive Engineers. The original CFR effort brought together vehicle and engine manufacturers, fuel and lubricant producers, government researchers, and academic experts to investigate the interaction of fuels, lubricants, engines, and equipment. CRC was incorporated in 1942, during World War II, when cooperative research expanded to support the performance and reliability of military equipment, fuels, and lubricants.

For many years, CRC's research was focused on performance topics organized by equipment and fuel type, including gasoline, diesel, and aviation. During the mid-1990s, CRC's Auto/Oil reorganization expanded emphasis on emissions and air-quality research. During this time, the Performance Committee continued CRC's gasoline- and diesel-related performance research.

Today, the Performance Committee focuses on the relationship between fuel properties, engine and vehicle technologies, fuel quality, and vehicle/equipment performance. The main Committee serves in an executive capacity and oversees four topical working groups and their panels.

The working groups feature diverse membership who connect the research to a broad range of companies, research organizations, and other stakeholders. The work is informed by the needs of the research community and also supports ASTM International and other standards-setting bodies by generating data, developing or improving test procedures, and evaluating how changing fuels and vehicle technologies affect field performance. Research projects of the Performance Committee often include interlaboratory studies, test-method development and precision programs, fuel and vehicle evaluations, technical guides, and investigation of emerging performance concerns.

Additional details on the four working groups, their panels, and the current project portfolios are described herein.

GASOLINE ENGINE DEPOSITS WORKING GROUP

CRC Project Nos. CM-136

Leaders: Matt Sheehan, Ivan Tibavinsky

History and Objectives of the Gasoline Deposits Working Group

The Gasoline Engine Deposits Working Group has developed test methods and procedures for determining the quantity and impacts of deposits that form in engines that use gasoline and gasoline fuel blends. In prior decades, CRC developed specialized engines, rating techniques, and fluids to support testing and research into deposits. In recent years, the Working Group has performed research into durability impacts of fuel formulations and developed new research supporting updated intake valve deposit test methods and oxidation stability test methods.

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 & Future Program

Current projects for the Gasoline Deposits Working Group are described next.

Port Fuel Injection Intake Valve Deposit Test Development

CRC Project No. CM-136-18-1

Leaders: Matt Sheehan, Ivan Tibavinsky

Project Summary

CRC Project CM-136-18-1 was initiated as the first phase of a four-phase project to develop a modern port fuel injection (PFI) intake valve deposit (IVD) test method using the General Motors LE9 2.4-liter engine platform. This project was driven by the need to replace or supplement existing intake valve deposit procedures, including ASTM D5500 and ASTM D6201, which rely on aging vehicle and engine platforms that are increasingly difficult to maintain and are less representative of modern gasoline engine technology.

The primary objective of the project was to develop a new engine-based test method capable of demonstrating the effectiveness of gasoline detergent additives in controlling intake valve deposits. Specific objectives included identifying appropriate test fuels, establishing engine operating conditions and test cycles that promote deposit formation, defining hardware requirements, and developing a technically sound framework that could ultimately support ASTM standardization and potential acceptance by regulatory agencies for Lowest Additive Concentration (LAC) certification programs.

Phase 1 of this effort included an initial scoping phase utilizing the ASTM D6201 platform, followed by three phases of test development using the GM LE9 engine. These activities focused on developing and validating a repeatable test cycle, evaluating candidate fuel formulations representative of current market conditions, assessing detergent additive response, and refining the procedures required to measure intake valve deposits. The work included selection and characterization of test fuels and additives, engine dynamometer testing, development of deposit measurement techniques, and evaluation of operating parameters necessary to establish a robust and practical test procedure.

In addition, the program examined factors affecting test performance and repeatability, including fuel injector characteristics, cylinder-head configuration, intake-valve and valve-spring behavior, hardware usage considerations, and other operational variables relevant to deposit formation. Deliverables included development of the complete LE9 test

methodology, supporting technical documentation, recommended operating practices and test specifications, and a comprehensive final report documenting the technical approach, test development process, and the information required to support future implementation of the procedure by industry stakeholders and standards organizations.

Current Status & Future Program

Phase 1 of this project was completed and published as Final Report No. 676 on the CRC website in January 2025. Follow on Phases are planned.

Port Fuel Injection Intake Valve Deposit Test Development — LAC Passing Criteria Development

CRC Project No. CM-136-18-4

Leaders: Yi Xu, Matt Sheehan

Project Summary

CRC Project CM-136-18-4 builds upon the test-development work conducted under CRC Project CM-136-18-1 and documented in CRC Report No. 676. The earlier program was initiated to develop a modern, engine-based method for evaluating the effectiveness of gasoline detergent additives in controlling port fuel injection intake valve deposits. It examined the GM 2.4-liter LE9 engine as a potential replacement for the older ASTM D5500 vehicle test, whose vehicles, components, and associated test fuels have become increasingly difficult to obtain and less representative of current technologies. The broader goal of that work was to provide a test methodology that could support Lowest Additive Concentration, or LAC, certification programs administered by the U.S. Environmental Protection Agency and potentially the California Air Resources Board.

The purpose of CRC Project CM-136-18-4 is to advance the GM LE9-based port fuel injection intake valve deposit test by developing LAC passing criteria that align with the certification framework associated with the BMW ASTM D5500 method. Establishing these criteria is intended to support consideration of the LE9 procedure as an updated means of demonstrating detergent performance for US EPA LAC certification. A secondary, optional objective is to evaluate the response of selected fuel-additive combinations at elevated additive treat rates, subject to available funding and industry support.

The project will identify and obtain currently available intake valve deposit certification fuels and corresponding detergent additives approved or used for LAC testing under ASTM D5500 or ASTM D6201. Fuel-additive combinations will be selected in consultation with the CRC project group, and the additives will be obtained, handled, and blind coded with support from the appropriate industry participants. Up to five fuel-additive combinations are expected to be initially evaluated at their established LAC treat rates using both the GM LE9 test platform and the Ford 2.3-liter platform operated according to ASTM D6201.

Based on the initial test series, selected fuel-additive combinations will undergo additional testing to evaluate and, where appropriate, optimize additive treat rates in the LE9 platform. Testing will use the operating protocol developed during the preceding CRC LE9 test-development program, while the Ford 2.3-liter evaluations will follow ASTM D6201. Post-test activities will include intake-valve deposit mass measurements, photographic documentation and merit ratings of relevant engine components, deposit-thickness measurements, and collection of combustion-chamber deposits. The resulting data will be used to characterize base-fuel and additized-fuel performance across the two test platforms and to provide the technical basis for defining LAC passing criteria for the LE9 procedure.

Current Status & Future Program

Contracting for this project is underway. The final deliverables will document additive performance near the applicable LAC treat rates, comparisons with relevant historical ASTM D5500 or ASTM D6201 information, and proposed LAC passing criteria for the GM LE9 engine platform. If the optional work is conducted, the documentation will also address the response of selected combinations at higher additive treat rates.

GASOLINE COMBUSTION WORKING GROUP

CRC Project Nos. CM-137

Leaders: Melissa Przybylo, Marc Henderson, Steve McConnell

History and Objectives

In the past, this group was responsible for planning large-scale investigations of the octane requirements of the in-use vehicle fleet. The group operated under the name “Octane” for many years, then was renamed to the Gasoline Combustion Working Group in 2020 to reflect the broader interests of the membership. In recent years, the group has investigated the potential for increased efficiency from higher octane fuels, studied the impact of octane parameters on modern / future engine technology, and for updates to the octane measurement methods using the CFR engine, named for the Cooperative Fuels Research Committee that became CRC in 1942.

The objectives of this group are to assess 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

Current Projects of the Gasoline Combustion Working Group are described next.

Alternatives to Tetraethyl Lead (TEL)

CRC Project No. CM-137-21

Leaders: Sheryl Rubin-Pitel, Beth Raney-Pablo

Project Summary

Both ASTM D2699 and D2700 require tetraethyl lead (TEL) blends with isooctane as reference fuels to rate gasolines with Octane number (ON) > 100. There is a desire to develop an alternative to TEL blends for the rating of gasoline with ON > 100. Both CRC and ASTM agree that the best way forward is to identify and evaluate an alternative to TEL. CRC Project CM-137-21 was initiated to identify and evaluate alternatives to tetraethyl lead (TEL) for use in high-octane reference fuel blends needed to determine Research Octane Number (RON) and Motor Octane Number (MON) above 100. The project evaluates potential alternative compounds through a staged program considering factors such as toxicity, material compatibility, low-temperature behavior and stability, fuel-handling requirements, and octane performance. The overall objective is to identify a suitable alternative reference-fuel component and establish the information necessary for its use in high-octane laboratory testing.

Following the initial screening and precursor studies, the program advanced to evaluation of t-butyl aniline blended with iso-octane. The current phase includes a multi-laboratory octane study measuring RON and MON in eight blend concentrations, material-compatibility testing of fuel-wetted CFR engine components, and a long-term stability study evaluating selected blends under typical laboratory storage conditions for approximately six months. The multi-laboratory work is intended to confirm blending rates and octane ratings, while the supporting studies are intended to identify compatibility or storage considerations and inform appropriate laboratory guidance.

Current Status and Future Program

Project CM-137-21 is currently in the laboratory testing phase. A multi-laboratory octane study, with nine volunteer labs is being planned, and a long-term stability study has been initiated.

AKI Study at Altitude with Modern Vehicles and Statistical Analysis

CRC Project No. CM-137-25 / E-147 and CM-137-25a / E-147a

Leaders: Melissa Przybylo, Marc Henderson, Steve McConnell

Project Summary

Gasoline antiknock performance remains a critical factor influencing engine calibration, vehicle performance, fuel economy, emissions, and overall vehicle design. Existing guidance regarding octane requirements at altitude is largely based on studies conducted using pre-1984 vehicle technologies that lacked the sophisticated engine controls, combustion systems, and knock-management strategies found in modern vehicles. As the automotive fleet continues to evolve toward highly optimized, turbocharged, direct-injected, and electronically controlled powertrains, questions have emerged regarding the continued applicability of historic octane recommendations, particularly in regions where lower-octane fuels are marketed at higher elevations. CRC Projects CM-137-25 / E-147 and CM-137-25a / E-147a were initiated to provide contemporary data that can support future discussions regarding fuel specifications, vehicle performance, and the potential benefits of higher-octane and emerging lower-carbon-intensity gasoline fuels in modern vehicles.

The primary objective of CM-137-25 / E-147 is to evaluate the effects of gasoline anti-knock index (AKI) on vehicle performance high-altitude (>5,000 ft) operating conditions using a representative fleet of modern light-duty vehicles. Future phases are planned for testing at sea level. The contractor will test approximately 10 model year 2015 and newer vehicles, including passenger cars, SUVs, and light-duty trucks commonly used for towing, using market-representative 85, 87, and 91 AKI gasoline fuels with comparable ethanol content. The study is designed to determine how fuel octane influences vehicle power delivery, acceleration, and engine operating behavior in real-world operating conditions that are often limited by knock control, such as wide-open-throttle operation and heavily loaded vehicle use.

The experimental program will employ chassis dynamometer testing and a comprehensive series of performance evaluations to characterize vehicle response across fuel grades and altitudes. Testing will include full Federal Test Procedure (FTP-75), Highway Fuel Economy Test (HWFET), and US06 chassis cycles conducted before and after the performance test program, providing a consistent framework for vehicle

checkout and monitoring. Vehicle performance testing will focus on wide-open-throttle operation at multiple engine speeds, transient power development, stabilized power output, and loaded acceleration events. Extensive vehicle data, including engine control unit (ECU) and onboard diagnostic (OBD) parameters such as spark timing, manifold pressure, knock indicators, load, and air-fuel control metrics, will be collected to improve understanding of the mechanisms through which fuel octane and altitude influence vehicle performance. The project is expected to provide valuable insight into the practical benefits of higher-octane fuels, the sensitivity of modern vehicles to AKI changes, and the degree to which advanced vehicle technologies can capitalize on increased fuel antiknock quality.

The companion project, CM-137-25a / E-147a, will provide independent statistical design, analysis, and interpretation support throughout the test program. This effort will develop the experimental design, determine appropriate repeat testing requirements, evaluate data quality, identify potential outliers, quantify sources of variability, and assess statistical significance of observed fuel, vehicle, altitude, and environmental effects. Advanced statistical and machine-learning techniques will be applied to evaluate relationships among fuel properties, vehicle technologies, operating conditions, and measured performance metrics. Together, CM-137-25 / E-147 and CM-137-25a / E-147a are intended to provide a robust technical foundation for understanding octane-performance relationships in modern vehicles and for informing future fuel quality, vehicle calibration, and standards-development activities.

Current Status & Future Program

TRP Laboratories has been awarded the contract for CM-137-25/ E-147. The project is underway and is expected to continue through mid-2027. Southwest Research Institute is performing the statistical analysis and support under Project CM-137-25a/ E-147a, with a concurrent timeline. A single Final Report of the complete project is anticipated in the second half of 2027.

VOLATILITY WORKING GROUP

CRC Project Nos. CM-138

Leaders: David Kovach, Beth Raney-Pablo

History and Objectives

The Volatility Group has been responsible for large-scale experimental investigations into the interaction between possible modern fuel parameters and the latest production vehicles, during extreme conditions of temperature and altitude. The most recent of these programs was the 2014 CRC Hot-Fuel-Handling Program, published in March of 2015. In recent years, the Working Group has investigated techniques for measuring Driveability in a laboratory setting, conducted a workshop to train Driveability raters, and developed a specialized instrumented vehicle that can be used to train raters. This vehicle was also used to investigate automated methods for measuring Driveability, correlated with the human driver methods used in previous studies.

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

Current active and recently completed projects of the Volatility Working Group are described below. The Volatility Working Group is currently planning new research investigating the future of assessing vehicle Driveability and considering potential future research with the Sustainable Mobility Committee's Fuels Working Group.

Evaluating the Driveability Index Relevance in Modern Gasolines and Vehicles

CRC Project No. CM-138-21-1

Leaders: Russ Lewis, Beth Raney-Pablo

Project Summary

The Driveability Index (DI) has been used for decades as a gasoline volatility parameter within ASTM fuel specifications to help ensure satisfactory vehicle cold-start and warm-up performance. However, significant changes in gasoline composition, emissions regulations, fuel production practices, and vehicle technologies, including widespread adoption of fuel injection, turbocharging, hybridization, and advanced engine controls, have raised questions regarding whether the historical basis for DI remains fully applicable to the modern transportation fleet. As a result, CM-138-21-1 was initiated to examine the continued relevance of the Driveability Index and to assess whether current fuel volatility metrics remain appropriate for contemporary gasoline vehicles.

CM-138-21-1 conducted a comprehensive review of the technical foundation of the Driveability Index, including its historical development, its relationship to vehicle driveability performance, and the evolution of gasoline specifications over time. The project evaluated prior CRC driveability studies, industry research, and regulatory developments to better understand how changes in engine and vehicle technologies have influenced the relationship between gasoline volatility characteristics and vehicle operation. Particular attention was given to advancements in fuel delivery systems, emissions-control technologies, engine downsizing, turbocharging, hybridization, and other factors that have altered fuel requirements relative to those that existed when DI was originally established.

The study also examined the influence of key gasoline volatility parameters, including distillation characteristics, vapor pressure, vapor-liquid ratio temperature, and ethanol content, on vehicle performance and operability. In addition, the project reviewed gasoline production and distribution practices, regulatory requirements, and fuel volatility specifications in major global markets to provide broader context for understanding how volatility controls are currently applied and managed throughout the fuel supply chain.

The overall objective of CM-138-21-1 was to provide a technically sound assessment of the role and relevance of the Driveability Index in today's vehicle fleet and fuel marketplace. The study is intended to support fuel producers, vehicle manufacturers, standards organizations, and regulators by improving understanding of the relationships between fuel volatility, vehicle performance, emissions compliance, and fuel quality specifications, and seeks to inform future discussions regarding gasoline volatility standards and contribute to maintaining reliable vehicle operation while accommodating ongoing changes in fuel composition and vehicle technology.

Current Status & Future Program

CRC Project CM-138-21-1 was conducted by Advanced Power Systems Research Center at Michigan Technological University (MTU). The Final Report was issued on the CRC website in July 2026.

DIESEL PERFORMANCE WORKING GROUP

CRC Project Nos. DP

Leaders: Garry Gunter, Shailesh Lopes

Scope and Objective

After CRC's Auto/Oil reorganization in the mid-1990s, this group was formed under the Performance Committee to continue research relating to the performance of diesel (compression ignition) engines and fuels.

The objective of the Diesel Performance Group (DPG) is to conduct research supporting definition of the minimum diesel fuel requirements for diesel engines. This technical information is needed by the fuel, engine, equipment, and additive industries, and is used by technical groups such as ASTM International, the International Organization for Standardization (ISO), and the National Conference on Weights and Measures (NCWM). This Group works closely with industry stakeholders and benefits from their contributions. The large technical scope and membership of the Working Group have led to the formation of numerous panels for specific topic areas. Panels are formed as needed to address important current technical issues, and when they are no longer needed, they become inactive, returning to operation if there is a technical need. The current active panels of the Diesel Performance Working Group include the following:

Low Temperature Operability Panel

(CRC Project Nos. DP-02)

The Panel conducts studies evaluating various test methods used to characterize fuel low temperature operability, investigating their ability to predict whether vehicles experience fuel-related operability problems in low temperature test conditions.

Deposit Panel

(CRC Project Nos. DP-04)

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.

Biodiesel & Renewable Diesel Panel

(CRC Project Nos. DP-05)

This Panel has a lineage from earlier research activity relating to biodiesel that had generated multiple panels, which were consolidated and updated to include renewable diesel. The Panel develops research investigating biodiesel and renewable diesel compatibility with modern vehicles.

Past panels which are currently inactive have included:

DP-01 – Lubricity

DP-03 – Cetane Number

DP-06 – Cleanliness

DP-07 – Corrosion

Low Temperature Filterability of Diesel Fuel at Retail Pumps

CRC Project No. DP-02-23-1

Leader: Shawn Broughton

Project Summary

CRC Project DP-02-23-1, Low Temperature Operability, is evaluating the filterability of cold diesel fuel through 10- and 30-micron dispenser filters used with above-ground tanks.

The testing program includes controlled particulate loading using ISO 12103-1 A2 Fine Test Dust at concentrations of 1 and 5 mg/L. The project is also examining water loading and differences in the behavior of 10- and 30-micron filters. Planned additional work includes testing two R100 fuel samples using the same general testing approach as the CARB fuel, along with experiments using different pump pressures and rates to evaluate differential pressure across the filter.

Current Status & Future Program

The work is being conducted at Innospec as a scoping study and includes evaluation of filtration behavior under low-temperature conditions, as well as the effects of particulate and water contamination on fuel flow through the dispenser filters. Particulate testing and water-loading studies have begun, two R100 samples have been obtained for additional testing, and further pump-pressure/rate experiments are planned; the project panel is expected to determine the appropriate path forward following this additional work.

Heavy Duty Diesel (HDD) Internal Diesel Injector Deposit (IDID) Test Rig Precision – Solve Decay of Deposit Level with Time

CRC Project No. DP-04-22-1B

Leaders: Garry Gunter, Shailesh Lopes

Project Summary

Growing interest in understanding and mitigating internal diesel injector deposits (IDID) has increased the need for laboratory methods capable of reliably reproducing deposit formation and quantifying its severity. CRC Project No. DP-04-22, "Fuel Research Using the Internal Diesel Injector Deposit (IDID) Rig", previously developed and evaluated the CRC Internal Diesel Injector Deposit (IDID) Test, which combined a dedicated deposition rig with advanced measurement techniques to characterize deposit growth on diesel injector components. While the initial study demonstrated the potential of the test system, it also identified questions regarding rig-to-rig consistency, test precision, and time-dependent changes in deposit formation that warranted additional investigation.

As a follow-on effort, CRC Project No. DP-04-22-1B was undertaken to improve the precision, repeatability, and overall robustness of the IDID test rig. The project focused on understanding factors that influenced deposit growth and evaluating how deposits evolved over time under controlled operating conditions. To achieve these objectives, the Contractor implemented a series of mechanical, instrumentation, control-system, and procedural modifications designed to reduce sources of variability that had been observed during earlier testing.

The study conducted a structured matrix of experiments using both sodium-doped and undoped fuels while varying key operating parameters, including injector duty cycles and other test conditions associated with deposit formation. Deposits generated during testing were measured and characterized using advanced analytical techniques, including optical methods for quantifying deposit thickness and evaluating deposit development on injector pintles. The program also examined how hardware preparation, operating temperatures, fuel composition, and test conditions influenced the repeatability and consistency of deposit formation within the test system.

The overall objective of CRC Project No. DP-04-22-1B was to further mature the IDID test methodology into a dependable research tool for evaluating the deposit-forming tendencies of diesel fuels and fuel components. By advancing the precision and reproducibility of the test method, the project seeks to establish a stronger foundation for future studies aimed at maintaining injector performance, durability, and fuel-system reliability in modern diesel engines. The knowledge gained from this work is intended to support future fuel and additive development efforts, improve understanding of injector deposit mechanisms, and enhance confidence in laboratory-based assessments of deposit formation.

Current Status & Future Program

Southwest Research Institute completed this project, and the Final Report was published in June 2026 on the CRC website.

Investigation of Solubility of Various Components in Renewable Diesel

CRC Project No. DP-05-22

Leaders: Shailesh Lopes, Randy Jennings, Garry Gunter

Project Summary

The increased use of renewable diesel (RD) as a drop-in replacement for conventional ultra-low sulfur diesel (ULSD) has created a need to better understand how renewable diesel interacts with biodiesel and other fuel components. Unlike petroleum-derived diesel, renewable diesel contains very low levels of aromatic compounds and is generally less polar in nature, raising questions about the solubility of biodiesel constituents, impurities, and fuel additives when blended into renewable diesel. These concerns are important because poor solubility can contribute to low-temperature operability issues, including the formation of precipitates that may affect fuel handling, storage, and vehicle performance.

CRC Project No. DP-05-22 was conducted to investigate the solubility behavior of various biodiesel components in renewable diesel and to assess how fuel composition influences blend stability under cold-temperature conditions. The study evaluated renewable diesel fuels representing a range of cloud points, along with biodiesel samples that differed in feedstock characteristics, cloud point properties, and cold-soak filtration performance. Conventional ULSD was also included as a benchmark to provide a basis for comparison.

The contractor for this project prepared and evaluated a series of biodiesel blends containing varying biodiesel concentrations in both renewable diesel and conventional diesel base fuels. Fuel characterization included measurement of key physical properties, followed by controlled cold-soak testing at multiple temperatures to examine the tendency for haze, precipitate formation, phase separation, and component settling. Additional analytical techniques were employed to identify and characterize any materials that separated from the fuel blends during testing.

The overall objective of CRC Project No. DP-05-22 was to develop a better understanding of the factors governing biodiesel component solubility in renewable diesel and to identify conditions that could influence blend stability and low-temperature operability. By improving

understanding of fuel compatibility and blend behavior, the study provides information that can help support reliable fuel performance, facilitate the use of renewable diesel and biodiesel blends, and inform future fuel quality and specification considerations.

Current Status & Future Program

CRC Project DP-05-22 was conducted by the National Laboratory of the Rockies. The Final Report is available and was posted to the CRC website in June 2026.

Aviation Committee

The Aviation Committee (AVC) has a history spanning the existence of the Coordinating Research Council. As one of the main pillars of research activity in the decades following CRC's incorporation in 1942, it has always been an important part of CRC. It has operated continuously even though it only recently received a dedicated section in the CRC Annual Report, after several years of reporting only publications. The AVC was re-chartered as a separate, self-funded entity during CRC's Auto/Oil reorganization of the mid-1990s.

The objectives of the AVC are:

- Provide an organization and forum for aviation fuel producers, users and equipment manufacturers, government, and academia to collectively address and fund fuel research.
- Develop the technical information and data required to allow the aviation industry to resolve fuel-related problems and issues.
- Provide a forum for the dissemination of technical information, to foster relationships between the development of industry experts, and to discuss research, problems, issues, and concerns.

The AVC has produced an Aviation Fuels Handbook for more than 60 years. The Handbook is a compendium of valuable technical information for aviation industry professionals and is periodically updated with information from CRC research projects and other sources. The Handbook is offered for sale by CRC, and the proceeds are used to support future versions.

AVC's annual meeting in the 1st week of May is open to the public at the working group level. This event combines elements of technical workshop, including a broad range of technical presentations and networking opportunities, with the meetings of the technical working groups.

AVIATION COMMITTEE

The current active working groups and major panels of the AVC are:

- Advanced Research and Test Methods
- Fuel Handline, Contamination, and Microbiology
- Operability
- Aviation Gasolines & Piston Fuels
- Fuel System Safety
- Fuel System Stability
- Publications
- Properties and Emissions
- Production and Delivery
- Emerging Fuels
- Thermal Stability Panel

The Quality of Aviation Fuel Available in the United Kingdom Annual Survey 2018-2019

CRC Project No. AV-18-19/19

Leader: Martin Hunnybun

Project Summary

This report, jointly funded by the Coordinating Research Council (CRC) and the Energy Institute, contains a summary of the data relating to the specification properties for AVTUR (Jet A-1) supplied in the United Kingdom during 2018 and 2019. The data for each year is expressed separately, in the form of histograms and mean values, which are graphically compared over the period 1986–2019. This report is the 40th in a series of survey reports.

Surveys relating to the specification properties of aviation turbine fuels supplied in the UK from 1974 onwards have been published annually by the Fuels and Lubricants Centre (FLC). This report covers a similar survey for aviation fuel (Jet A-1) supplied during the years 2018 and 2019, including 114 and 185 batches respectively complying with Defence Standard 91-091. Historically, this survey was funded by the UK Ministry of Defence (MoD) in support of their specification development activities. In previous years the work was part-funded by the Energy Institute (EI). As the MoD ceased to fund the activity after the 2008 survey was produced, the EI and the CRC have jointly funded the survey in full.

The information contained in this report has been supplied by oil companies and associated test houses for main batches of aviation fuel released during 2018 and 2019. The data have been expressed in the form of histograms and mean values, which are graphically compared over the period of 1986 to 2019. Due to the variation in volume of each fuel batch, the mean values are expressed as weighted means according to the relative volume associated with each data point.

Historically, most batches of aviation fuel used for this survey were refined in the UK. However, over time many UK refineries have closed, resulting in more finished fuels being imported into the UK. Whilst the data provided does not give exact details on the number of imports, it is expected that a large proportion.

of the data contained in this survey are from imported batches. Therefore, the data presented is likely to be partly representative of aviation fuel available worldwide.

In this survey, the percentage of results near to the specification limits are reported for selected properties, which were chosen for historical reasons (to allow comparisons with previous years) and include some properties that appear to limit aviation fuel production. For the purposes of this report “near specification limit” results are those that lie within the reproducibility of the method at the specification limit.

The survey also contains a short discussion on each property and how results are changing. Results of interest, such as those that are close to, or outside, specification limits are noted. Other data points of interest, such as the distribution of results, are also commented on. Changes and trends may be of interest and importance to specification authors, original equipment manufacturers (OEMs), users, and refiners, and may be significant even though they do not approach current specification limits. It is expected that this survey will be of most use for specification development and the development of associated test methods.

The data reported have been collated from test certificates or from electronic data supplied by oil companies for new batches of AVTUR, either produced in or imported into the UK during 2018 and 2019. The data for all but four of the properties detailed in Defence Standard 91-091 for AVTUR are summarised in tables and figures in the annexes. The data for copper corrosion and thermal stability were not included as most results were identical. Copper corrosion results, where provided, were typically 1A with a number of 1B results, and thermal stability results were typically a <1 tube rating with no pressure drop. No deposit thickness data were reported. All thermal stability results were reported at 260 °C. The data for electrical conductivity were also not included, as at the point of testing, the conductivity of many batches was below the specification limits. This is permitted on the condition that static dissipater additive (SDA) is added further downstream to ensure that the conductivity limits are met at the point of delivery into aircraft.

Current Status & Future Program

This research was jointly funded with and conducted by the Energy Institute. The final report was published in April 2025.

THE QUALITY OF AVIATION FUEL AVAILABLE IN THE UNITED KINGDOM ANNUAL SURVEY 2021-2022

CRC Project No. AV-18-21/22

Leader: Martin Hunnybun

Project Summary

This report, jointly funded by the Coordinating Research Council (CRC) and the Energy Institute (EI), contains a summary of the data relating to the specification properties for AVTUR (Jet A-1) supplied in the United Kingdom during 2021 and 2022. The data for each year is expressed separately, in the form of histograms and mean values, which are graphically compared over the period 1986-2022. This report is the 41st in a series of survey reports.

Surveys relating to the specification properties of aviation turbine fuels supplied in the UK from 1974 onwards have been published annually by the Fuels and Lubricants Centre (FLC) 1-27. This report covers a similar survey for aviation fuel (Jet A-1) supplied during the years 2021 and 2022, including 477 and 840 batches respectively complying with Defence Standard 91-09128. Historically, this survey was funded by the UK Ministry of Defence (MoD) in support of their specification development activities. In previous years the work was part-funded by the Energy Institute (EI). As the MoD ceased to fund the activity after the 2008 survey was produced, the EI and the CRC have jointly funded the survey in full.

The information contained in this report has been supplied by oil companies and associated test houses for main batches of aviation fuel released during 2021 and 2022. The production of aviation fuel during 2020 was likely to have been very low due to the pandemic, and this survey has not included data from that year. The data have been expressed in the form of histograms and mean values, which are graphically compared over the period of 1986 to 2022. Due to the variation in volume of each fuel batch, the mean values are expressed as weighted means according to the relative fuel volume associated with each data point.

Historically, most batches of aviation fuel used for this survey were refined in the UK. However, over time many UK refineries have closed, resulting in more finished fuels being imported into the UK. Whilst the data provided do not give exact details on the number of imports, it is expected that a large proportion of the data contained in this survey are from imported batches. Therefore, the data presented is likely to be partly representative of aviation fuel available worldwide.

In this survey, the percentage of results near to the specification limits are reported for selected properties, which were chosen for historical reasons (to allow comparisons with previous years) and include some properties that appear to limit aviation fuel production. For the purposes of this report 'near specification limit' results are those that lie within the reproducibility of the method at the specification limit.

This survey also contains a short discussion on each property and how results are changing. Results of interest, such as those that are close to, or outside, specification limits are noted. Other data points of interest, such as the distribution of results, are also commented on. Changes and trends may be of interest and importance to specification authors, original equipment manufacturers (OEMs), users, and refiners, and may be significant even though they do not approach current specification limits. It is expected that this survey will be of most use for specification development and the development of associated test methods.

Current Status & Future Program

This research is jointly funded with and being conducted by the Energy Institute. The final report is expected to be published in 2026.

Thermal Stability Task Force

CRC Project No. AV-24-16

Leaders: Amy Carico, Jim Sheridan

Project Summary

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 & 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.

Feasibility Analysis: Alternative Approaches to the Replacement of ASTM D909 Supercharge Rating

CRC Project No. AV-28-19

Leaders: Mark Rumizen, Roger Gaughan

Project Summary

The ASTM D909 supercharge rating characterizes the knock resistance of aviation gasoline. Knocking combustion has the potential for catastrophic engine failure and must be prevented in aviation engines. The D909 test method uses a CFR engine in F4 configuration to rate the maximum knock-limited engine load as expressed by the indicated mean effective pressure (IMEP). The D909 method provides a framework of expected IMEP targets for reference fuels. Knocking combustion is an abnormal combustion phenomenon that creates high-frequency pressure oscillations. The D909 test method relies on audible knock detection by the operator to determine the knock limit.

This study performed a literature analysis of the development and specifications of the D909 test method and provides a detailed overview of knocking combustion and knock detection systems. CFR Engines Inc. upgraded its F4 engine with state-of-the-art combustion research instrumentation to allow for detailed combustion and knock characterization.

Two sets of tests of D909 conditions were conducted. First, a purely audible unbiased knock detection test was conducted regardless of the framework IMEP targets of the D909 test method. Second, the IMEP framework targets of D909 were used without consideration of the perceived knock limit. Subsequently, while operating under D909 conditions, neither of these two tests met the requirements of the D909 test method due to conflicting requirements. The knock intensity for the performed D909 tests was determined by the maximum amplitude of pressure oscillations (MAPO) for the installed piezoelectric pressure transducer, an accelerometer-based automotive knock sensor, and a microphone. Previous knock detection devices likely suffered from knockless knock measurements which created rating uncertainties and prevented the implementation of knock instrumentation on the CFR F4 engine.

This study also includes a thermodynamic analysis of in-cylinder pressure-temperature conditions of standard D909 ratings based on GT-Power simulations.

Current Status & Future Program

This research was conducted in cooperation with CFR Engines, Inc. and conducted by Argonne National Laboratory. The final report was published on the CRC web site in February 2026.

A Survey of Aviation Gasoline Properties Based on Certificate of Analysis Data

CRC Project No. AV-30-22

Leader: Alisdair Clark

Project Summary

In 2010, data were provided in support of FAA work to review the measured properties of the 100LL aviation gasoline being produced in the U.S. market. The findings were published as an FAA Technical Note, DOT/FAA/AR-TN11/20. Data evaluated during the FAA study included Certificate of Analysis (CoA) information on lead content, MON, and Supercharge rating, these values versus lead content, and aromatic concentration versus lead. That analysis was used to evaluate the range of fuels that met ASTM D910 requirements with less than the 0.56 gPb/L maximum allowable 100LL lead content.

Efforts to reduce the amount of lead within the aviation piston engine community continued unabated and it was desirable to understand the current situation both here and, if possible, outside of the U.S. Recognizing the likelihood of policy pressures to further reduce the lead emissions from the market, it was desirable to have an idea of the trend towards 100VLL production where lead concentration is limited to 0.45 gPb/L maximum. In addition to the continuation of the lead review, it was also deemed useful to evaluate how other fuel properties may have changed over time. This research included analyses and presentation of aviation gasoline data provided as blinded CoAs for contemporary review, as a comparison to the original 2010 study with respect to lead, and as a review of other available properties over time.

Current Status & Future Program

This research was conducted by Baere Aerospace. The final report was published on the CRC web site in September 2025.

Microbial Test Kit Evaluation

CRC Project No. AV-31-22

Leaders: Mark Vaughn, Jack Buffin, Dhvani Sharma

Project Summary

Microbial contamination monitoring is essential to maintaining aviation fuel quality, which is a critical aspect of aircraft safety. This research was developed to evaluate the technical performance and reliability of methods recommended by the International Air Transport Association (IATA) for assessment of microbiological contamination in aviation fuel. The project was conducted in accordance with the protocol developed by the IATA Microbiological Contamination Panel (CRC Project N° AV-31-22).

The experimental work was mainly divided in two stages:

1. Creation of laboratory microcosms simulating microbial contamination in jet fuel tanks.
2. Evaluation of the performance of different test kits for the assessment of microbiological contamination of the different laboratory microcosms and field jet fuel samples.

Four microbiological test kits supplied by the manufacturers were evaluated and compared to the traditional test method (IP 385). Quantitative polymerase chain reaction (qPCR) protocols targeting bacteria and fungi were also developed and applied to assess the extent of microbiological contamination in jet fuel. The microbial contamination of field samples was evaluated by the different methods and next-generation sequencing (NGS) was used to identify the microorganisms present in the field samples.

Current Status & Future Program

This project was conducted in partnership with the International Air Transport Association (IATA) and performed by SGS Portugal. The final report was published on the CRC website in January 2026.

Investigate JP-5 Vapor Pressure values in Figure 2-12 of CRC Fuel Handbook

CRC Project No. AV-32-22

Leaders: Melanie Thom, Alisdair Clark

Project Summary

A literature review was conducted to identify potential original source(s) of CRC Handbook (4th edition) vapor pressure data, specifically for grade JP-5 jet fuel. Several reports were examined from a variety of US government agencies, e.g., US Navy, US Air Force, and US Bureau of Mines. Many of the reports were dated between the 1950s through to the 1970s. Much of the information found regarding vapor pressure seemed to be repeated, in some form, amongst the many references, i.e., true vapor pressure was often derived from Reid vapor pressure and distillation information (especially for more volatile fuels such as AVGAS and JP-4). Since vapor pressure is not a specification property for JP-5 grade fuel, there is a notable absence of measured vapor pressures reported in the historical record. There is less information available for JP-7 grade fuel in the open literature, likely due to the military development and use of this fuel.

Current Status & Future Program

This research was conducted by the University of Dayton Research Institute. The final report was published on the CRC website in April 2025.

World Jet Fuel Survey Part 1: 2023-2024

CRC Project No. AV-33-22

Leader: Zachary West

Project Summary

This research was a coordinated worldwide survey of current aviation turbine fuels (i.e., fuels at a refinery and not in the field or distribution systems) to support the development of a jet fuel technical property database. The project aimed to:

1. Provide a snapshot of physicochemical and performance properties of current jet fuels on the world market.
2. Establish a baseline of fuel properties for comparison to new/synthetic fuels.
3. Become a reference benchmark of property data for designers, operators, producers, researchers, and other fuels practitioners. Where possible, comparisons were made with historical fuel data, primarily CRC Report 647.

The report included sections covering certificate of analysis (CoA) data, fit-for-purpose data, and composition to-property (C2P) modeling. The titles align with the Fit-for-Purpose Properties Table in ASTM D4054-23: “Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives”. In addition to fit-for-purpose property data, specific test methods, errors, and instrumentation are described. Additional descriptions and analysis are available for select fit-for-purpose properties in the Appendix. The C2P modeling work demonstrates preliminary correlations between fuel chemistry and physicochemical properties. These models are meant to be illustrative, not definitive; more details about the models and the techniques used are included.

The samples collected for this research were intended to be representative of (1) typical manufacturing conditions for jet fuel at the point of manufacture, and (2) representative of the batch of fuel being sampled.

Current Status & Future Program

This research was conducted in partnership with the US Federal Aviation Administration and performed by the University of Dayton Research Institute. The final report was published on the CRC website in December 2025.

Investigation on the Composition and Source of Brown Deposits Found in Aircraft Fuel System

CRC Project No. AV-34-24

Leaders: Jean-Philippe Belières, Tad Vrana, Alyssa Roche, Enrico Lodrigueza

Project Summary

Brown deposits have been found on every commercial airframe and engine combination in North America. The deposits are found throughout the fueling system, including the fuel tank and can affect aircraft operations, resulting in thrust instability events (TIE), inaccurate fuel gauging, and unplanned maintenance.

A panel has been formed from the Aviation Committee technical community to investigate this topic. The panel meets regularly in support of their efforts to characterize the composition of the brown deposits, with the goal of determining a root cause, and summarizing the findings in a CRC report. Their work includes performing compositional analyses of brown deposits found in various components of aircraft fueling system.

Current Status & Future Program

This research is being conducted by members of the CRC Aviation Committee's technical community. Publication of results is anticipated in 2027.

Evaluation of Modern Experimental Methods and Equipment to Determine the Calorific Energy Content of Aviation Fuels

CRC Project No. AV-35-24 / EI-SC-B-10

Leaders: Alisdair Clark, Romaeo Dallanegra

Project Summary

Aviation fuel energy content represents a fundamental thermodynamic property, the energy available when a given weight of fuel is fully burnt under ideal conditions. Aviation specifications set minimum values for this property to ensure aircraft will have sufficient flight range when loading a given quantity of fuel.

Experimental determination of energy content can be achieved by complete combustion of a known mass of fuel in excess oxygen using a Bomb Calorimeter. Such instruments must be carefully designed and operated to ensure accurate measurements, for example taking into account heat loss / gain from surroundings and thermal mass. Due to this complexity the aviation industry prefers to utilize correlations to estimate fuel energy content, for example ASTM D3338 based on distillation, density and sulfur.

CRC project AV-23-15/17 Review of Existing Test Methods Used for Aviation Jet Fuel and Additive Property Evaluations with Respect to Alternative Fuel Compositions, identified possible issues with applying correlation energy content methods to non-standard fuel compositions. Given the importance of such information for fuel development and flight operations, a more detailed evaluation was undertaken, CRC project AV-29-20 A Review of Current Experimental and Correlation Methods to Determine the Calorific Energy Content of Liquid Fuels. This further highlighted:

- Advancements in laboratory equipment to accurately determine fuel energy content, potentially superseding traditional, listed, methods.
- The limitation of correlation methods developed on data sets from many years ago to estimate fuel energy content.

As the industry moves forward with sustainable aviation fuel development and unleaded Avgas, an evaluation of modern experimental methods to determine fuel energy content would be helpful together with a comparison versus correlation techniques. This research aims to perform a technical evaluation using a set of pure samples / fuels to identify appropriate experimental methods which offer the potential precision for aviation use. Results can also be compared with correlation estimates adding technical value.

The project objectives are to identify up to 3 different modern bomb calorimeters from AV-29-20 for inclusion in the study and undertake a laboratory program by:

1. Procuring a set of aviation fuel samples, for example
 - Five (5) Aviation gasolines, (<10, 10-25% v/v aromatics + high octane unleaded proposals)
 - Five (5) Jet A / A-1 aviation turbine fuels (<10, 10-20, 20-25% v/v aromatics, <10% and >30% cycloparaffins)
 - Three (3) Synthetic aviation turbine fuel components (synthetic paraffinic, synthetic aromatic and synthetic cycloparaffin based).
 - Three (3) pure reference chemicals (Iso-octane, n-Decane, Dodecane)
2. Analyze the above in both traditional and the modern bomb calorimeters as a blinded matrix in duplicate.
 - Comparing the results with ASTM / IP correlation estimates for energy content.
 - Preparing a report summarizing the methods and results.

Current Status & Future Program

This research has been developed in partnership with the Energy Institute and will be conducted by Baere Aerospace. The final report is expected to be published in 2027.

CRC Aviation Fuel Properties Handbook

5th Edition

CRC Project No. AV-36-25

Leaders: Melanie Thom, Alisdair Clark, Romaeo Dallanegra, Tom Loegel

Project Summary

The CRC Aviation Fuel Properties Handbook has been a staple in the arena of fuel properties for decades. As aviation fuels have evolved and industry has grown, improvements in analytical methods have allowed an even greater insight into fuel physical and chemical attributes. The current (4th) edition was released in 2014. The 5th edition is being developed to meet the following goals:

1. **Key Data and Chart Review.** Where data is available, charts will be updated to include:
 - Minimum, maximum and mean values
 - Bar charts illustrate data distribution.
2. **Materials Compatibility Chart.** Reintroducing the material compatibility chart featured in earlier editions of the Handbook with assistance from the Aviation Steering Committee to capture current knowledge.
3. **Non-Standard Fuel Types.** A section consolidating C-1, RP and TS-1 fuel data from the other parts of the handbook.
4. **Heat of Vaporization / Enthalpy.** Incorporate CRC Project AV-20-14 Heat of Vaporization / Enthalpy data, revising current text, tables and charts as appropriate.
5. **Gas Solubility.** Using provided information and guidance, update the section covering ASTM D2779 gas solubility.
6. **Synthetic Jet Fuel.** A general explanatory section on the history of synthetic aviation fuel to date and include references to other documents for greater detail, covering both standalone synthetic blending components (ASTM D7566) and coprocessed synthetic streams (ASTM D1655).
7. **Dielectric Constant.** Incorporate dielectric constant data and methods of measurement.

8. **Cetane.** Include text and data charts related to Jet Cetane quality and usage relevance covering:
 - A discussion / definition of Cetane in Handbook Section 1.
 - A discussion of aviation diesel piston engine developments.
 - New cetane data from the new CRC Jet World Survey.
9. **Aviation Gasoline (Avgas).** Update aviation gasoline text covering ASTM D7826, where appropriate, and include:
 - Charts where new CRC Certificate of Analysis data is available.
 - Additional Grade UL91 and UL94 Avgas data if available.

Current Status & Future Program

The 5th edition of the CRC Aviation Fuel Properties Handbook is being developed by CRC with support from the Aviation Technical Committee. Publication is expected in 2027.

API Jet Fuel Survey 2022

CRC Project No. AV-37-25

Leaders: Doug Cyr, Amy Carico

Project Summary

Fuel producers have created a database of fuel properties from COQs (COAs) of aviation fuel (Jet A and Jet A-1) batches from 2022. API serves as a third-party to gather and incorporate data, ensuring anonymization of the information. The API Statistics Department has created an excel file containing this information for ~6000 batches from 9 contributing companies.

Objective

Host the dataset online where it can be available for all to access. The public will gain easy access to the dataset. The posted dataset will be official version that will remain uncorrupted and can be updated or corrected, if necessary, with versioning.

Current Status & Future Program

This project is being conducted by Aviation Committee members. Publication is expected in 2027.

Incident Materials Identification

CRC Project No. AV-38-25

Leaders: Amy Carico, Peter Eversly

Project Summary

This project seeks to generate analytical data to evaluate the occurrence and concentration of FAME, DRA and MDA within the jet fuel supply and distribution system. The resulting data will support the industry's understanding of incidental material presence, assess alignment with existing specifications, and inform potential future considerations for fuel quality management and standards development.

Scope of Work

The CRC technical panel will assist with the selection and procurement of 8-16 jet fuel samples, which will be submitted to the selected laboratory inspection company to perform the required analysis or most of the analysis at a specific location. We also expect an aliquot to be sent to another laboratory for some additional specialized analysis.

FAME analysis

- Perform analysis and report results in accordance with ASTM D7797/IP 583
- Perform analysis and report results in accordance with IP 585, including identification and quantification of FAME specs per Table 3 of the test method.

DRA analysis

- Conduct testing and report results in accordance with ASTM D7872

MDA analysis

- Conduct testing and report results in accordance with ASTM D8545, specifying Method A or B

Nitrogen and Conductivity

- Conduct testing and report results in accordance with ASTM D4629
- Conduct testing and report results in accordance with ASTM D2624

All results shall include the following information:

- Unique sample identification code
- Identification of any samples that were improperly collected (wrong container, etc.) or appear compromised (unusual color, water, particulates)
- Sample origin (country, state/province, and PADD/region; no specific address)
- General fuel quality observations (C&B, hazy, water, particulates, etc.)
- Relevant COQ, COA or recertification testing submitted with the sample if provided.
- Density results by ASTM D4052
- Nitrogen content by ASTM D4629
- Conductivity and temperature by ASTM D2624

Current Status & Future Program

Testing for this project is being conducted by Camin. Final report publication is expected in 2027.

Sustainable Mobility Committee

The Sustainable Mobility Committee (SMC) was formed by the CRC Board of Directors in March 2021 to provide an expansive and flexible new forum for research in technology and energy transitions affecting member company industries outside the scope of current CRC Committees at that time.

The vision of the Sustainable Mobility Committee is to be a multi-stakeholder forum for collaborative scientific research studies focused on pathways towards a carbon neutral future through significant greenhouse gas reductions from mobility while seeking to understand tangential impacts.

A distinguishing feature of the Sustainable Mobility Committee is to offer full membership to stakeholders outside of the auto & oil industries that form the core membership of CRC, called Funding Members. This allows the technical community working on the challenges within the Committee's vision to expand, broadening both participation and resources to support the research program.

As the Committee's membership and list of research projects grew, the SMC developed topical working groups under the guidance of the Committee to better align expertise from the large group of researchers with the diverse set of research projects. The initial Working Groups included: Electrification, Fuels, Novel Carbon Reduction Strategies, and Life Cycle Analysis. In addition, a special external group called the Partner Members meets monthly to support continuing collaboration with government agencies and National Labs. In 2024, the Novel Carbon Reduction Strategies Working Group was renamed to the Hydrogen and Novel Carbon Reduction Working Group, reflecting a growing interest in hydrogen-focused research within the Committee.

Sustainable Mobility Committee Workshop 2026

CRC Project No. SM-2026-01

Leaders: David Vuilleumier, Andrea Lubawy, Steve McConnell

Project Summary

The CRC Sustainable Mobility Committee hosted a session at SAE World Congress (WCX) on April 13-16, 2026. Thirteen speakers presented on CRC research, including SM-E-4/8 'Effects of VGI on Battery Life,' SM-LCA-17 'Literature Review of Biofuels Models,' SM-F-2/A-134 'Effects of Electrification on Air Quality,' SM-CR-9 'Future ZEV Adoption - VGI Grid Impacts, Fleet Mix Sensitivity,' SM-CR-2023-01 'Carbon Sources for E-Fuels,' and SM-E-20 'Carbon Return on Investment for Electrified Powertrains.'

Evaluation of the Use of EVs for Transient Grid Storage (V2G) on Battery Life

CRC Project No. SM-E-4/8

Leaders: Elana Chapman, Chris Brooks, Ivan Tibavinsky

Project Summary

The objective of SM-E-4/8 was to model the battery life effects of vehicle-to-grid (V2G) activity on top of ordinary EV battery usage such as mobility related discharge, slow and fast charging, and calendar aging. A variety of V2G strategies are possible and their effects on battery life were modeled. The model includes the effects of various ordinary uses as described above. This project identified V2G cycles that, when coupled with certain mobility and charging usages, result in a battery deteriorating below the warranty requirement and identification of the salient modes of deterioration.

The battery model is of the Newman two-point discrimination (2PD) type with variables populated from the characteristics of a real cell. It models carbon anode and higher nickel (nickel-manganese-cobalt) NMC or nickel-cobalt-aluminum/nickel-cobalt-manganese-aluminum (NCA / NMCA) cathode batteries and has multiple degradation modes. The modeled battery has 75kWh of capacity and the failure threshold is 70% performance. The maximum rate of V2G discharge is 10 kW.

For this project, a variety of likely V2G duty cycles for use in the model were researched; these included full grid load leveling, peak shaving, and V2Building. Using an up-to-date battery use and life model, the V2G duty cycles were layered onto a variety of existing vehicle use and charging scenarios based upon Level 2 and higher power DC fast charging. The model simulates up to 8 years of use.

Current Status & Future Program

Research was conducted by University of Michigan. The final report was published on the CRC website in May 2025.

Carbon Return on Investment for Electrified Vehicles — Phase 2

CRC Project No. SM-E-20-2

Leaders: Melissa Przybylo, Karim Hamza

Project Summary

The objective of SM-E-20-2 is to build upon the work in Phase 1, SM-E-20. The previously completed project studied optimal allocation of resources (battery materials) among different mix of powertrain types (Hybrids, Plug-in Hybrids, Battery Electric). Phase 2 brings in a consumer choice modeling via the National Laboratory of the Rockies' (NLR) ADOPT software towards more realistic future scenario predictions and models the carbon intensity for producing batteries based on size and battery technology (i.e. mineral content) using real world data from a variety of vehicle models. It will then combine this data with in-use driving behavior and real-world consumer uptake drivers to determine the actual carbon return on investment (CROI).

This current project adds important fidelity and nuance to the Phase 1 analyses. For instance, the simplified Phase I approach using representative vehicles neglects the complicated dynamics of the actual vehicle market, where considerations beyond carbon emissions reductions (such as vehicle cost, performance, and how policy concepts are implemented) tend to drive consumer uptake of new vehicles and realized greenhouse gas (GHG) impacts.

Current Status & Future Program

Research is being conducted by the National Laboratory of the Rockies (NLR). Final report publication is expected in 2026.

Survey of Public EV Charger Interoperability

CRC Project No. SM-E-2023-2

Leaders: Jeff Jetter, Elana Chapman

Project Summary

The objective of SM-E-2023-2 is to use actual testing in the field to survey and evaluate public charging stations' interoperability performance. The results will identify gaps in current electric vehicle supply equipment (EVSE) codes and standards, and provide technical information for charger OEMs, auto OEMs, and entities planning EVSE installations. There is a wide variation in public EVSE performance and usability, with recent studies indicating that >27.5% of EV charger attempts failed. Large EV charger installations continue across the country and reported "uptime" – claimed to be >90% – does not reflect the actual charging experience. There has been no effort to investigate the root cause of charging failure.

Current Status & Future Program

Project development is ongoing.

Understanding Inefficiencies in an EV-EVSE Charger Ecosystem During Charging

CRC Project No. SM-E-2025-01

Leader: Vivek Raj-Mohan

Project Summary

The objective of SM-E-2025-01 is to provide a comprehensive overview of the energy losses in the electric vehicle (EV) charger and electric vehicle supply equipment (EVSE) system for a DC fast charging session. Much heat is generated during the charging process both on the charger side and on the EV side, especially for DC fast charging sessions.

This project aims to generate an assessment of available information from OEM technical specifications, measurement of electrical and thermal parameters during controlled testing, quantification of losses via data analysis and model development, Sankey diagrams to illustrate energy flow, and identification of key parameters for efficient charging.

Current Status & Future Program

Project development is ongoing.

Understanding Commercial Vehicle Battery Technology — Heavy-Duty BEV Teardown

CRC Project No. SM-E-2026-01

Leader: Eric Bunnelle

Project Summary

The objective of SM-E-2026-01 is to understand battery technology strategies deployed for use in heavy-duty (HD) commercial vehicle applications and compare those with passenger vehicle norms. Through a teardown of a constant voltage (CV) battery from a BYD 8TT truck, the project aims to collect real-world context regarding technical feasibility and impact assessment, including how state-of-the-art battery cell technology and battery architecture differ when applied to HD and light-duty (LD) use cases.

In various regions, including China and California, the commercial vehicle industry is expecting to increase electrification adoption. This project aims to better understand potential solutions for increased battery electric vehicle (BEV) adoption through understanding alternative approaches to battery technology.

Current Status & Future Program

Research is being conducted by Research Institute for Energy Technology and Internal Combustion Engines (FEV) and Texas A&M Transportation Institute (TTI). Final report publication is expected in 2027.

Research in Support of Future Fuel Specifications

CRC Project No. SM-F-5

Leaders: Melissa Przybylo, Matt Sheehan, David Vuilleumier

Project Summary

The objective of this project is to examine opportunities to alter current specifications for transportation fuels to enable lower fuel carbon intensity while remaining relevant to modern/future vehicles.

A variety of low carbon fuel components may become available in the future. Current fuel specification may need to evolve to accommodate these components. In addition, current fuel specifications drive refinery processes that decrease refinery and life cycle carbon emissions.

Current Status & Future Program

Research was conducted by the Southwest Research Institute (SwRI); final reporting is being conducted by the National Laboratory of the Rockies (NLR). Final report publication is expected in 2026.

GHG Quantity of Oil & Gas Infrastructure-Destined Biomass Feedstock

CRC Project No. SM-F-2023-2

Leaders: Steve McConnell, Becca Bennick, John Pendray, Elana Chapman, Ian Sutherland

Project Summary

The objective of SM-F-2023-2 is to assess the quantity of sustainably-sourced biomass available to refinery/processing facility locations in the US, as well as the estimated yield of drop-in biofuel available for blending. Locations of interest may be constrained to several areas in North America. The threshold of feasible distance from biomass source to refinery will be determined by the break-even point between the carbon reduction potential of the feedstock and the emissions produced during collection, transport, and conversion.

This project is a sensitivity analysis of carbon reduction potential and the hypothetical volume of biomass feedstock available as a function of delivery distance to select US refineries and/or other processing facilities located in biomass-rich regions (e.g. regions identified in the Billion-Ton Report maps).

Current Status & Future Program

Research is being conducted by the National Laboratory of the Rockies (NLR). Final report publication is expected in 2027.

CLIMR: Ducted-Fuel Injectors (DFI) for Heavy-Duty Applications

CRC Project No. SM-F-2025-01 / AVFL-51 / E-151

Leaders: Elana Chapman, Steve McConnell

Project Summary

The objective of SM-F-2025-01 / AVFL-51 / E-151, which is a Department of Energy (DOE) Core Laboratory Infrastructure for Market Readiness (CLIMR) project, is to focus on research, development, and demonstration activities to facilitate the successful commercial deployment of ducted fuel injection (DFI) with low-lifecycle-CO₂ fuels in heavy-duty applications that are difficult to electrify or convert to carbon-free fuels.

DFI is a small, mechanical, retrofittable engine technology that is both compatible with current diesel fuels and synergistic with emerging domestically produced sustainable diesel fuels. It has the potential to reduce lifecycle-CO₂ and toxic emissions rapidly and dramatically at a fraction of the cost of competing technologies, because it uses existing manufacturing capacity and supply chains. This approach provides valuable, effective diversification in humanity's portfolio of technology options for meeting environmental and economic goals now and into the future.

The purpose of the project is to provide:

- Economic analyses quantifying cost-savings for the engine original equipment manufacturer (OEM) and the end-user, as well as a list of benefits to society, to be obtained by the successful commercialization of DFI.
- A production-viable DFI multi-cylinder engine (MCE) implementation including quantitative performance data over the industry-standard ISO8178 steady-state test cycle and with strong commercialization potential demonstrated by a payback period of less than 2.5 years.
- Demonstration of a technical path to achieving ~100% and 90% lower engine-out soot and nitrogen oxides (NO_x), respectively, without additional timing retard, exhaust-gas recirculation (EGR), or aftertreatment.

Current Status & Future Program

Research is being conducted through a Department of Energy (DOE) Core Laboratory Infrastructure for Market Readiness (CLIMR) award, under a Cooperative Research and Development Agreement (CRADA) with Sandia National Laboratories (SNL), John Deere, Clean Fuels Alliance America (CFAA), and Cummins. Final report publication is expected in late 2027.

Carbon Sources for E-Fuels

CRC Project No. SM-CR-2023-1

Leaders: Sourabh Pansare, Steve McConnell, Andrea Lubawy, Douglas Lau

Project Summary

The objective of SM-CR-2023-1, a collaborative research project with the Oil and Gas Climate Initiative (OGCI), was to learn where large sources of carbon for large-scale synthetic fuels can be found, and to understand what technoeconomic and carbon intensity analyses say about the economic viability and sustainability of fuels derived from those sources.

The project identified and categorized various CO₂ supply chains (biogenic / bioenergy with carbon capture, utilization, and storage (BECCUS), direct air capture, direct ocean capture) for e-fuels production. This included an investigation on the regulatory and policy landscape of various regions to examine the suitable conditions for use of the various CO₂ sources identified and consideration of public / social acceptance of e-fuels and utilization of captured CO₂.

It then evaluated the cost of emissions reductions for e-fuels by conducting a techno-economic assessment of each CO₂ source identified, and considered the economic value of CO₂ (i.e., carbon capture price per ton), particularly in relation to CO₂ utilization versus sequestration.

It also completed a deep dive on e-fuels hubs through evaluating regional demand for drop-in e-fuels from various segments of the transport sector, with particular focus on the heavy-duty on-road, light-duty on-road, and aviation segments.

Current Status & Future Program

Research was conducted by Ricardo and in collaboration with the Oil and Gas Climate Initiative (OGCI). The final report was published on the OGCI website, and the accompanying Executive Summary was published on the CRC website in December 2025.

Component-Level Techno-Economic Analysis of Various Hydrogen and Electrified Powertrains for Commercial- and Heavy-Duty Vehicles

CRC Project No. SM-CR-2024-01

Leaders: Rafael Sari, Madhur Bloor, Steve McConnell, Andrea Lubawy, Becky Wilkinson

Project Summary

The objective of SM-CR-2024-01 is to evaluate technology options for different vehicle segments regarding performance, efficiency, greenhouse gas emissions, and cost of operation relative to conventional powertrains. Technologies include hydrogen internal combustion engines, fuel cells, and battery electric vehicles with on-board charging and battery swapping.

Powertrain performance and cost of operation are technology dependent but typically overlooked in total cost of ownership analysis. The aim of this project is to identify component options for each powertrain architecture; technology maturity and adoption, efficiency improvement potential, and associated benefits and limitations will be studied using available data. Two optimized surrogate vehicle platforms may be developed based on potential for improvement.

Current Status & Future Program

Project development is ongoing.

Literature Review of Models Used for Biofuels GHG Emissions Modeling and Comparison of Results on Some Commonly Available Fuels — Follow-On

CRC Project No. SM-LCA-17b

Leaders: Robb De Kleine, Xiaoyi He

Project Summary

The objective of SM-LCA-17b is to build upon the work in SM-LCA-17, which was a review of selected models used for biofuels greenhouse gas (GHG) determinations and a comparison of results for two fuels.

A wide range of results have been reported in existing LCA of biofuel GHG emissions. Differences in modeling approaches (assumptions, scopes, data sources, etc.) make it challenging to compare results and understand GHG impacts of different biofuels. It is beneficial to conduct a critical review of biofuel LCA for some common fuels & feedstocks, identify sources of uncertainties, and establish common consensus. Global regulatory frameworks rely on Life Cycle Analysis (LCA) to determine Carbon Intensity (CI) and award credits. However, they often yield different results, raising the question: why do they differ for the same fuel pathway?

This project evaluates 10 global regulatory frameworks across 4 major fuel groups (Biodiesel/HEFA, Hydrogen, Dairy RNG, and Ethanol/ETJ) and compares default model configurations against a standardized run using GREET 2024 inputs to isolate methodological differences.

Current Status & Future Program

Research is being conducted by Trinity. Final report publication is expected in 2026.

Lifecycle environmental impacts of future critical mineral extraction

CRC Project No. SM-LCA-2023-1

Leaders: Robb De Kleine, Diep Vu, Andrea Lubawy

Project Summary

The objective of SM-LCA-2023-1 is to create a report of the environmental impact of future pathways with simulated results of system-wide life cycle emissions assuming different scenarios for critical material extraction pathway weighting, and to conduct an analysis of conventional and emerging critical material extraction pathways and the corresponding environmental impacts (greenhouse gas (GHG) emissions, water consumption, criteria air pollutants, etc.).

The total GHG emissions attributed to critical mineral mining and the production of electric vehicle (EV) batteries will increase due to rising consumer demand. However, there remains uncertainty surrounding what the future emissions trajectory will look like. On one hand, easy-to-access resources have been largely discovered and targeted for extraction, meaning that future battery minerals may require more energy or water to obtain. On the other hand, technology innovation (e.g., direct lithium extraction) and unconventional exploration (e.g., deep sea mining) are increasing the potential of accessing mineral reserves while utilizing fewer resources.

Current Status & Future Program

Research is being conducted by KeyLogic. Final report publication is expected in 2027.

Life Cycle Analysis Workshop

CRC Project No. SM-LCA-2025-02

Leaders: Robb De Kleine, Aaron Levy, Diep Vu

Project Summary

CRC hosts biennial, invitation-only Life Cycle Analysis (LCA) of Transportation Fuels Workshops at Argonne National Laboratory (ANL). Since its inception in 2009, each workshop has been attended by LCA experts from government, industry, academia, and non-governmental organizations (NGOs). Past workshop summaries and proceedings are posted on the CRC website.

The latest workshop was held October 7-9, 2025, and had 130 registrants from six countries - half of which were first-time attendees. The workshop was organized into seven technical sessions and had 30 technical presentations. The goals of the workshop were to:

- Outline technical needs arising out of policy actions and ability of LCA analysis to meet those needs.
- Identify data gaps, methodology issues, areas of uncertainties, validation/verification, model transparency, and data quality issues.
- 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.
- Establish priorities for directed research to narrow knowledge gaps and gather experts' opinions on where scarce research resources would best be spent.

The workshop was co-sponsored by Argonne National Laboratory, American Petroleum Institute, Canadian Fuels Association, Clean Fuels Alliance America, and the Renewable Fuels Association.

Current Status & Future Program

A summary article for the 2025 LCA Workshop can be found on the CRC website.

Part Three

Released Reports



RELEASED REPORTS: 2024

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
A-133	Improved Treatment of Fire Emissions for Ozone and PM 2.5 Modeling	Journal Article Published in EM magazine July 2025: Evaluating and Improving Deterministic Modeling of Near Real-Time Wildfire Emissions Impacts on Ozone and PM2.5 Concentrations
SM-LCA-17	Review of Selected Models Used for Biofuels GHG Determinations and Comparison of Results for Two Fuels	Pending
SM-F-2 / A-134	Sustainability and Local Air Quality Impacts of Future Electrification and New Vehicle Emission Regulation Scenarios in the U.S.	Science of the Total Environment Journal Article https://doi.org/10.1016/j.scitotenv.2023.169577 Environmental Pollution Journal Article https://doi.org/10.1016/j.envpol.2025.126061
A-125	The Rising Importance of Non-Combustion Emissions in Urban Atmospheres	Pending
SM-E-20	Analyzing Potential Greenhouse Gas Emissions Reductions from Plug-In Electric Vehicles: Report for CRC Project SM-E-20, “Carbon Return on Investment for Electrified Vehicles”	Pending

RELEASED REPORTS: 2025

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
AVFL-33 Phase 1	Fuel-Wall Interaction Effects and Dependencies on Stochastic Preignition	Journal article published by SAE available here. DOI: https://doi.org/10.4271/2023-01-1615
CM-136-18-1	Port Fuel Injection (PFI) Intake Valve Deposit (IVD) Test Development	Pending
CRC Sustainable Mobility Committee – SAE EPC Workshop	CRC Sustainable Mobility Committee – SAE EPC Workshop Proceedings November 12-14, 2024	Pending
A-132	Ozone Formation and its Sensitivity to NOx and VOCs from Volatile Chemical Product, Mobile Source, and Biogenic Emissions in Urban Centers	Journal article published by Atmospheric Chemistry and Physics available here. https://doi.org/10.5194/acp-25-1121-2025
A-135	Understanding O3 Production and PM2.5 Distributions Across the U.S. Using Surface and Satellite Data for 2019-2023	Pending
AV-18-18/19	The Quality of Aviation Fuel Available in the United Kingdom – Annual Survey 2018-19	Pending
AV-32-22	Investigate JP-5 Vapor Pressure values in Figure 2-12 of CRC Fuel Handbook	Pending
A-128	Quantifying The Effects of VOC/NOx Chemistry on Tropospheric Ozone Production: Yields of Organic Nitrates from Reaction of Substituted Organic Peroxy Radicals with NO	Pending

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
A-136	Comparing Ozone Production Efficiency (OPE) of Chemical Mechanisms Using Chemical Process Analysis (CPA)	Article Published in Atmospheric Chemistry and Physics March 2026 – https://acp.copernicus.org/articles/26/4173/2026/
SM-E-4/8	Predictive Lifetime Battery Simulations of Intra- and Inter-Cycle Degradation for V2G Use	Journal Article – https://doi.org/10.1016/j.est.2024.114242
E-134	PEMS Phase 3 – Altitude, Temperature, and Grade Effects	Pending
AV-30-22	A Survey of Aviation Gasoline Properties Based on Certificate of Analysis Data	Pending
A-137	Multi-scale Analysis of PM Sources Near Highways and Transportation Corridors	Pending
AVFL-44	First Investigation of Ducted Fuel Injection on a Retrofitted Heavy-Duty Multi-Cylinder Production Engine	Pending
RW-121a/CM-138-22a	Statistical Analysis of Nationwide PMI Fuel Survey	Pending
E-143	Systematic Review for Brake, Tire, and Road Wear for On-road Light- and Heavy-Duty Vehicles	Pending
AVFL-32	Effects of Boost Pressure and Fuel Composition on Combustion Knock Characteristics	Fuel, vol. 304, Nov. 2021: https://doi.org/10.1016/j.fuel.2021.120722 Fuel, vol. 342, Jun. 2023: https://doi.org/10.1016/j.fuel.2023.127694 SAE Technical Paper: https://doi.org/10.4271/2025-01-8451

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
SM-CR-2023-01	Carbon Sources for eFuels	Pending
AVFL-38	Using Separation-Enhanced Isotope Ratio Mass Spectrometry to Enable Increased Renewable Carbon Content in Transportation Fuels	OSTI.gov Publication - https://www.osti.gov/servlets/purl/3006405
AV-33-22	World Jet Fuel Survey Part 1: 2023-2024	Pending

RELEASED REPORTS: 2026

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
A-108	Development and Evaluation of Databases and Estimation Methods for Predicting Air Quality Impacts of Emitted Organic Compounds	Pending
E-145	Effect of Diesel Contamination on PM Emissions	Pending
AV-28-19	Investigation of Operational and Combustion Characteristics of the ASTM D909 Supercharge Rating	Pending
AV-31-22	Microbial Test Kit Evaluation	Pending
E-137	Fuel Correlation to SimDis Method – Analysis and Reporting	Pending
A-142	Impact Of Wildland Fires On 2022-2024 PM2.5 Design Values	Pending
E-144/PC-2023-1	Impact of Alternative Diesel Fuels on On-Board Diagnostics	Pending
RW-125	Remote Sensing of Vehicle Emissions: Summary Report 1991-2022	Pending
DP-04-22-1b	Internal Diesel Injector Deposit (IDID) Test Rig Precision – Solve Decay of Deposit Level with Time	Pending

CRC PROJECT NO.	TITLE	PUBLICATION /NTIS ACCESSION NO.
DP-05-22	Investigation of Solubility of Various Components in Renewable Diesel	Pending
CM-138-21-1	Evaluating The Driveability Index Relevance in Modern Gasolines and Vehicles	Pending
AVFL-29-3	Method Development for Fid and Fid-Ms Detailed Hydrocarbon Analysis	Pending
A-141	Refining Estimates of U.S. Background PM2.5 To Support Effective Urban Air Quality Planning	Pending
AVFL-40	Development of Advanced Compression Ignition (ACI) Gasoline Rating Methods on a Variable Compression Ratio CFR Engine	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 the CRC website, www.crao.org.

The 2024 reports were completed and submitted to NTIS for an Accession Number as listed in the 2023-2024 CRC Annual Reports. Due to government delays, the NTIS Accession Numbers are still pending. Missing information will be included in a future report.

Part Four

Organization & Membership

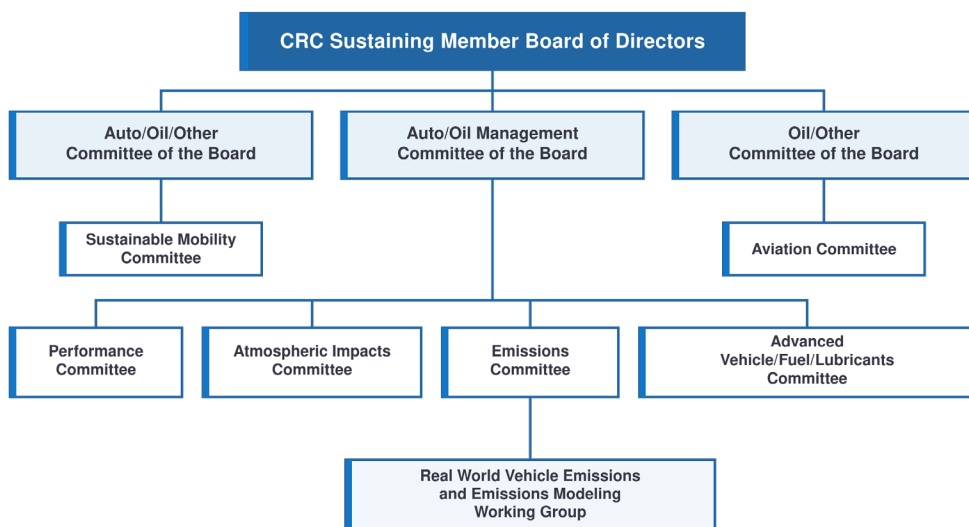


Organization 2025-2026

The sustaining members of the CRC are the American Petroleum Institute (API) and a consortium of automobile manufacturers (Stellantis, Mercedes Benz, Ford, General Motors, Honda, Toyota, and Volkswagen). For more than 80 years, CRC has provided the means for the automotive and petroleum industries to study problems of mutual interest. CRC's mission is:

The Coordinating Research Council (CRC) fosters cooperative scientific research in the technological advancements of fuels, lubricants, vehicles, and equipment in matters of national and global interest.

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.

Coordinating Research Council, Inc.

Board of Directors

Becca Bennick	BP	Michael E. Moore	Stellantis
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Prem Lehr	Project Manager
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Emissions Committee

	Steve McConnell, Co-Chair	Marathon Petroleum Corp.	
	Michael Moore, Co-Chair	Stellantis	
Ahfaz Ahmed	ExxonMobil	John Mengwasser	Shell
Eric Bunnelle	ExxonMobil	Nick Mukkada	Chevron
Elana Chapman	General Motors	Dan Nagashima	Honda Development and Manufacturing of America, LLC
Stephen Doerner	Volkswagen		General Motors
John Eckstrom	BP	Thomas Powell	General Motors
Garry Gunter	Phillips 66	Melissa Przybylo	Toyota Motor North America
Marc Henderson	Honda Development and Manufacturing of America, LLC	Prentiss Searles	API
	Honda RNDAM	Jenny Sigelko	Volkswagen
Jeff Jetter	API	Terri Teller	Volkswagen
Bryan Just	API	Ivan Tibavinsky	Mercedes-Benz
Brianne Kanach	ExxonMobil	David Torres	Volkswagen
Russ Lewis	Marathon Petroleum Corp.	Jose Velasco	Volkswagen
Cristina Marcillo	BP	Alexander Voice	Aramco
Mark McCarthy	Toyota Motor North America	David Warm	Ford Motor Company

E-130 Panel

	Bryan Just, Leader	API	
Ahfaz Ahmed	ExxonMobil	Russ Lewis	Marathon Petroleum Corp.
Eric Bunnelle	ExxonMobil	Mark McCarthy	Toyota Motor North America
Elana Chapman	General Motors	Steve McConnell	Marathon Petroleum Corp.
Marc Henderson	Honda Development and Manufacturing of America, LLC	Michael Moore	Stellantis
Brianne Kanach	ExxonMobil		

E-134/E-134a Panel

	Paul Loeper, Co-Leader	Chevron	
	Marc Henderson, Co-Leader	Honda Development and Manufacturing of America, LLC	
Ahfaz Ahmed	ExxonMobil	Brianne Kanach	ExxonMobil
Eric Bunnelle	ExxonMobil	Cristina Marcillo	BP
Elana Chapman	General Motors	Steve McConnell	Marathon Petroleum Corp.
John Eckstrom	BP	Michael Moore	Stellantis
Sarah Goralksi	General Motors	Nick Mukkada	Chevron
Garry Gunter	Phillips 66	Melissa Przybylo	Toyota Motor North America
Jeff Jetter	Honda RNDAM	David Warm	Ford Motor Company
Bryan Just	API		

E-137 Panel

	Jeff Jetter, Co-Leader	Honda RNDAM	
	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
Ahfaz Ahmed	ExxonMobil	Brianne Kanach	ExxonMobil
Eric Bunnelle	ExxonMobil	Russ Lewis	Marathon Petroleum Corp.
Elana Chapman	General Motors	Cristina Marcillo	BP
John Eckstrom	BP	Michael Moore	Stellantis
Garry Gunter	Phillips 66	Nick Mukkada	Chevron
Marc Henderson	Honda Development and Manufacturing of America, LLC	Melissa Przybylo	Toyota Motor North America
		John Salyers	General Motors
Bryan Just	API	Ivan Tibavinsky	Mercedes-Benz

E-140-2 Panel

	Marc Henderson, Co-Leader	Honda Development and Manufacturing of America, LLC	
	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
Ahfaz Ahmed	ExxonMobil	Michael Moore	Stellantis
Noelle Baker	Mercedes-Benz	Nick Mukkada	Chevron
Eric Bunnelle	ExxonMobil	Jason Peabody	Honda
Elana Chapman	General Motors	Pete Romkowski	Honda
Steve DeCarteret	General Motors	Ben Schwartz	Honda
Carly Jeanne Gardiner	Ford Motor Company	Jenny Sigelko	Volkswagen
Steve George	US EPA	Ivan Tibavinsky	Mercedes-Benz
Garry Gunter	Phillips 66	David Warm	Ford Motor Company
Brianne Kanach	ExxonMobil	Daniel Westerwick	Honda
Yilin Ma	CARB	Mahmoud Yassine	Stellantis

E-143 Panel

	Garry Gunter, Co-Leader	Phillips 66	
	Michael Moore, Co-Leader	Stellantis	
Ahfaz Ahmed	ExxonMobil	Cara Learman	General Motors
David Antanaitis	General Motors	Russ Lewis	Marathon Petroleum Corp.
Eric Bunnelle	ExxonMobil	Steve McConnell	Marathon Petroleum Corp.
Elana Chapman	General Motors	Nick Mukkada	Chevron
Lorne Dyar	Honda	Chris Rabideau	Chevron
Bud Ghosh	Phillips 66	Jenny Sigelko	Volkswagen
Karim Hamza	Toyota Motor North America	Ivan Tibavinsky	Mercedes-Benz
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jose Velasco	Volkswagen
		Phil Wetzel	Stellantis
Ed Hosni	Honda	Sandy Winkler	Ford Motor Company
Jeff Jetter	Honda RNDAM	Mahmoud Yassine	Stellantis
Brianne Kanach	ExxonMobil	Alexandra Zack	General Motors

E-144 / PC-2023-1 Panel

	Sarah Funk, Co-Leader	General Motors	
	Garry Gunter, Co-Leader	Phillips 66	
Ahfaz Ahmed	ExxonMobil	Brianne Kanach	ExxonMobil
Bruce Alexander	BP	Russ Lewis	Marathon Petroleum Corp.
Becca Bennick	BP	Michael Litsey	Mercedes-Benz
Tushar Bera	Shell	Shailesh Lopes	General Motors
Eric Bunnelle	ExxonMobil	Chris Machuca	General Motors
Elana Chapman	General Motors	Cristina Marcillo	BP
Joseph Ciaravino	General Motors	Steve McConnell	Marathon Petroleum Corp.
Dominic Dadabbo	General Motors	Michael Moore	Stellantis
Steve DeCarteret	General Motors	Nick Mukkada	Chevron
John Eckstrom	BP	Michiel Van Nieuwstadt	Ford Motor Company
Scott Fenwick	Clean Fuels Alliance America	Erik Platzek	Mercedes-Benz
Brien Fulton	Ford Motor Company	Beth Raney-Pablo	Ford Motor Company
Yichao Guo	Stellantis	Kulwinder Singh	General Motors
Marc Henderson	Honda Development and Manufacturing of America, LLC	Ivan Tibavinsky	Mercedes-Benz
Eric Israelson	General Motors	Alexander Voice	Aramco
Lonny Johnson	Stellantis	Yi Xu	ExxonMobil

E-145 Panel

	John Eckstrom, Co-Leader	BP	
	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
Ahfaz Ahmed	ExxonMobil	Cristina Marcillo	BP
Eric Bunnelle	ExxonMobil	Steve McConnell	Marathon Petroleum Corp.
Elana Chapman	General Motors	John Mengwasser	Shell
Garry Gunter	Phillips 66	Michael Moore	Stellantis
Marc Henderson	Honda Development and Manufacturing of America, LLC	Nick Mukkada	Chevron
Jeff Jetter	Honda RNDAM	Melissa Przybylo	Toyota Motor North America
Bryan Just	API	Jenny Sigelko	Volkswagen
Brianne Kanach	ExxonMobil	Alexander Voice	Aramco
Russ Lewis	Marathon Petroleum Corp.	David Warm	Ford Motor Company

E-146 Panel

	Melissa Przybylo, Co-Leader	Toyota Motor North America	
	Brianne Kanach, Co-Leader	ExxonMobil	
Ahfaz Ahmed	ExxonMobil	Steve McConnell	Marathon Petroleum Corp.
Jim Anderson	Ford Motor Company	Michael Moore	Stellantis
Becca Bennick	BP	Nick Mukkada	Chevron
Eric Bunnelle	ExxonMobil	Thomas Powell	General Motors
Elana Chapman	General Motors	Beth Raney-Pablo	Ford Motor Company
Alexander Freer	ExxonMobil	Rafael Lago Sari	Aramco
Garry Gunter	Phillips 66	John Shabaker	BP
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jenny Sigelko	Volkswagen
Jeff Jetter	Honda RNDAM	Nestor Soriano	Shell
Bryan Just	API	Ivan Tibavinsky	Mercedes-Benz
Jeff Klopfenstein	Cummins	Alexander Voice	Aramco
Thomas Leon	SwRI	David Vuilleumier	Chevron
Russ Lewis	Marathon Petroleum Corp.	Reid Wagner	Growth Energy
Mark McCarthy	Toyota Motor North America	David Warm	Ford Motor Company

E-149 Panel

	Garry Gunter, Co-Leader	Phillips 66	
	Jeff Jetter, Co-Leader	Honda Development and Manufacturing of America, LLC	
	Marc Henderson, Co-Leader	Honda Development and Manufacturing of America, LLC	
Holmes Ahari	Stellantis	Nick Mukkada	Chevron
Ahfaz Ahmed	ExxonMobil	Thomas Powell	General Motors
Mendy Bradley	Volkswagen	Beth Raney-Pablo	Ford Motor Company
Eric Bunnelle	ExxonMobil	Veronica Reilly	General Motors
Elana Chapman	General Motors	John Shabaker	BP
Stephen Doemer	Volkswagen	Matthew Sheehan	Chevron
John Eckstrom	BP	Jenny Sigelko	Volkswagen
Brianne Kanach	ExxonMobil	Nestor Soriano	Shell
David Kovach	BP	Terri Teller	Volkswagen
Russ Lewis	Marathon Petroleum Corp.	Ivan Tibavinsky	Mercedes-Benz
Cristina Marcillo	BP	David Torres	Volkswagen
Steve McConnell	Marathon Petroleum Corp.	David Warm	Ford Motor Company
John Mengwasser	Shell	Yi Xu	ExxonMobil
Michael Moore	Stellantis		

Real World Vehicle Emissions & Emissions Modeling Group

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Michael Moore, Co-Leader	Stellantis	
Ahfaz Ahmed	ExxonMobil	Shailesh Lopes	General Motors
Nick Barsic	John Deere	Cristina Marcillo	BP
Matthew Bruchon	NLR	Mark McCarthy	Toyota Motor North America
Eric Bunnelle	ExxonMobil	John Mengwasser	Shell
Elana Chapman	General Motors	Nick Mukkada	Chevron
Angela Cullen	US EPA	Thomas Powell	General Motors
Stephen Doemer	Volkswagen	Melissa Przybylo	Toyota Motor North America
John Eckstrom	BP	Rada	
Sara Forestieri	CARB	Purushothaman	Caterpillar
Tim French	EMA	Chris Ruehl	CARB
Pat Geng	General Motors	Jenny Sigelko	Volkswagen
Garry Gunter	Phillips 66	Terri Teller	Volkswagen
Marc Henderson	Honda Development and Manufacturing of America, LLC	Ivan Tibavinsky	Mercedes-Benz
Mohammad Islam	CARB	David Torres	Volkswagen
Jeff Jetter	Honda RNDAM	Jose Velasco	Volkswagen
Bryan Just	API	Alexander Voice	Aramco
Brianne Kanach	ExxonMobil	David Warm	Ford Motor Company
Yusuf Khan	Cummins	Mahmoud Yassine	Stellantis
Russ Lewis	Marathon Petroleum Corp.	Seungju Yoon	CARB

RW-121a / CM-138-22a Panel

	Michael Moore, Co-Leader	Stellantis	
	Paul Loeper, Co-Leader	Chevron	
	Russ Lewis, Co-Leader	Marathon Petroleum Corp.	
Ahfaz Ahmed	ExxonMobil	Jeff Jetter	Honda RNDAM
Peg Broughton	Marathon Petroleum Corp.	Bryan Just	API
Eric Bunnelle	ExxonMobil	Brianne Kanach	ExxonMobil
Elana Chapman	General Motors	Cristina Marcillo	BP
John Eckstrom	BP	Steve McConnell	Marathon Petroleum Corp.
Pat Geng	General Motors	Nick Mukkada	Chevron
Sarah Goralksi	General Motors	Nestor Soriano	Shell
Lance Gremillion	Motiva	Ivan Tibavinsky	Mercedes-Benz
Garry Gunter	Phillips 66	Alexander Voice	Aramco
Marc Henderson	Honda Development and Manufacturing of America, LLC	Yi Xu	ExxonMobil
Asim Iqbal	Stellantis		

RW-125 Panel

	Garry Gunter, Co-Leader	Phillips 66	
	Michael Moore, Co-Leader	Stellantis	
Ahfaz Ahmed	ExxonMobil	Steve McConnell	Marathon Petroleum Corp.
Eric Bunnelle	ExxonMobil	Nick Mukkada	Chevron
Tim French	EMA	Melissa Przybylo	Toyota Motor North America
Pat Geng	General Motors	Rada	
Marc Henderson	Honda Development and Manufacturing of America, LLC	Purushothaman	Caterpillar
		Terri Teller	Volkswagen
Brianne Kanach	ExxonMobil	David Warm	Ford Motor Company

36th and 37th Real World Emissions Workshop

	Steve McConnell, Co-Chair	Marathon Petroleum Corp.	
	Michael Moore, Co-Chair	Stellantis	
Ahfaz Ahmed	ExxonMobil	Yusuf Khan	Cummins
Michael Aldridge	US EPA	Andrew Kotz	NLR
Matthew Bruchon	NLR	Joseph Martin	US EPA
Sam Cao	SCAQMD	Nick Mukkada	Chevron
Elana Chapman	General Motors	Melissa Przybylo	Toyota Motor North America
Karim Hamza	Toyota Motor North America	Rada	
Marc Henderson	Honda Development and Manufacturing of America, LLC	Purushothaman	Caterpillar
		David Torres	Volkswagen
Jeff Jetter	Honda RNDAM	Heidi Vreeland	US EPA
Bryan Just	API	Reddy Yatavelli	CARB
Brianne Kanach	ExxonMobil	Seungju Yoon	CARB

Advanced Vehicle/Fuel/Lubricants Committee

	Ivan Tibavinsky, Co-Chair	Mercedes-Benz	
	Andrew Ickes, Co-Chair	Chevron	
Jim Anderson	Ford Motor Company	Shailesh Lopes	General Motors
Tushar Bera	Shell	Mark McCarthy	Toyota Motor North America
Brogan Beyette	Volkswagen	Steve McConnell	Marathon Petroleum Corp.
Elana Chapman	General Motors	John Mengwasser	Shell
Abhijeet		Michael Moore	Stellantis
Chausalkar	ExxonMobil	Thomas Powell	General Motors
Michael Foster	BP	Melissa Przybylo	Toyota Motor North America
Izabela Gabrel	Volkswagen	Beth Raney-Pablo	Ford Motor Company
Garry Gunter	Phillips 66	John Shabaker	BP
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jenny Sigelko	Volkswagen
	Stellantis	Nestor Soriano	Shell
Asim Iqbal	Volkswagen	Terri Teller	Volkswagen
Torin Jensen	Honda RNDAM	Xin Yu	Aramco
Jeff Jetter	API		
Bryan Just	Marathon Petroleum Corp.		
Russ Lewis			

Fuel For Advanced Combustion Engines (FACE) Working Group

	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
	Andrew Ickes, Co-Leader	Chevron	
Jim Anderson	Ford Motor Company	Nick Killingsworth	Lawrence Livermore National Laboratory
Tim Bays	Pacific Northwest National Laboratory		
	Shell	Russ Lewis	Marathon Petroleum Corp.
Tushar Bera	General Motors	Steve McConnell	Marathon Petroleum Corp.
Elana Chapman	ExxonMobil	Michael Moore	Stellantis
Abhijeet Chausalkar	Toyota Motor North America	Chuck Mueller	Sandia National Laboratories
Venkat Deshpande	BP	Thomas Powell	General Motors
Michael Foster	Natural Resources Canada	Melissa Przybylo	Toyota Motor North America
Rafal Gieleciak	Argonne National Laboratory	Beth Raney-Pablo	Ford Motor Company
Scott Goldsborough	Phillips 66	Derek Splitter	Oak Ridge National Lab
Garry Gunter	Chevron	Nestor Soriano	Shell
Andrew Ickes	Stellantis	Scott Wagnon	Lawrence Livermore National Laboratory
Asim Iqbal	API		Aramco
Bryan Just		Xin Yu	

Lubricants Working Group

	Elana Chapman, Co-Leader	General Motors	
	Hyeok Hahn, Co-Leader	Chevron	
Dennis Bachelder	API	Steve McConnell	Marathon Petroleum Corp.
Michael Blumenfeld	ExxonMobil	Kalyan Mutyala	Ford Motor Company
Maria Chiappelli	Infineum	Garrett Parker	Lubrizol
Chris Cleveland	Afton Chemical	Michael Raney	General Motors
Frank Cooney	General Motors	Andrew Ritchie	Infineum
Timothy Cushing	General Motors	Luca Salvi	ExxonMobil
Michael Deegan	Ford Motor Company	Haiying Tang	Stellantis
Venkat Deshpande	Toyota Motor North America	Ivan Tibavinsky	Mercedes-Benz
Joan Evans	Infineum	Jonathan Vilaro	Phillips 66
Izabela Gabrel	Volkswagen	Arren Washington	Phillips 66
Aleise Gauer	General Motors	Angela Willis	Infineum
Garry Gunter	Phillips 66	Beth Wilson	API
Scott Halley	Lubrizol	Rob Zdrodowski	Ford Motor Company
Carmen Chu		Khaled Zreik	General Motors
Harkenrider	General Motors		
Teri Kowalski	Toyota Motor North America		

AVFL-18a Panel

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Scott Wagon, Co-Leader	Lawrence Livermore National Laboratory	
Jim Anderson	Ford Motor Company	Mike Kweon	US Army Research Lab
Elana Chapman	General Motors	Chuck Mueller	Sandia National Laboratories
Heather Dettman	Natural Resources Canada	Stuart Neill	Natural Resources Canada
Rafal Gieleciak	Natural Resources Canada	Beth Raney-Pablo	Ford Motor Company
Andrew Ickes	Chevron	Jacob Temme	US Army Research Lab

AVFL-29-3 Panel

	Garry Gunter, Co-Leader	Phillips 66	
	Veronica Reilly, Co-Leader	General Motors	
Jim Anderson	Ford Motor Company	Brandon Kadulski	Gage Products Company
Kevin Bardwell	Total Energies	Christina Kelly	LECO Corporation
Tushar Bera	Shell	Amy Klinkenberger	Daimler Truck
Araz Bidradi	Marathon Petroleum Corp.	Lenny Kouwenhoven	DaVinci
Peggy Broughton	Marathon Petroleum Corp.	Russ Lewis	Marathon Petroleum Corp.
Jonathan Brown	Valero	Steve McConnell	Marathon Petroleum Corp.
Maribel		Coleen McFarland	Envantage
Castaneda	Ecopetrol	Harm Moes	Da Vinci Laboratory Solutions
Elana Chapman	General Motors	Michael Moore	Stellantis
Abhijeet		Renuka Polimera	TotalEnergies
Chausalkar	ExxonMobil	Amanda Prefontaine	InnoTech Alberta
Kenneth Childress	SwRI	Beth Raney-Pablo	Ford Motor Company
Judson Cohan	CARB	Michelle Ratchford	SwRI
Don Crider	Windward Analytical	Dan Sanchez	SwRI
Cherilyn Dossett	Phillips 66	Ryan Schonert	VUV Analytics
John Dozier	General Motors	Frank Schröder	Haltermann Carless
James Dyson	Phillips 66	Mike Scussel	Gage Products Company
Ulf Freckmann	Shell	John Shabaker	BP
Alida Furler-Grant	InnoTech Alberta	Hilda Sola-Soto	US EPA
Izabela Gabrel	Volkswagen	Steve Tapp	Coryton
Manuel Garbalena	Valero	Ivan Tibavinsky	Mercedes-Benz
Pat Geng	General Motors	Jennifer Titterington	Core Labs
Scott Harvie	FCL	Linh Tran	InnoTech Alberta
Marc Henderson	Honda Development and Manufacturing of America, LLC	Alexander Voice	Aramco
		Dan Wispinski	VUV Analytics
Stefan Heppes	SGS	Nay Yee	Chevron
Alex Hodgson	VUV Analytics	Xin Yu	Aramco
Stephanie	Haltermann Carless		
Hutfless			
Asim Iqbal	Stellantis		
Jeff Jetter	Honda RNDAM		
Heath Jones	Marathon Petroleum Corp.		

AVFL-32 Panel

	Steve McConnell, Leader	Marathon Petroleum Corp.	
Marc Henderson	Honda Development and Manufacturing of America, LLC	Nestor Soriano	Shell
Beth Raney-Pablo	Ford Motor Company		

AVFL-33 Panel

	Elana Chapman, Co-Leader	General Motors	
	Garry Gunter, Co-Leader	Phillips 66	
Chinta Balki	General Motors	Kyle Kress	Phillips 66
Doyle Boese	Infineum	Mark McCarthy	Toyota Motor North America
Abhijeet		Steve McConnell	Marathon Petroleum Corp.
Chausalkar	ExxonMobil	John Mengwasser	Shell
Joseph Ciaravino	General Motors	Beth Raney-Pablo	Ford Motor Company
Scott Halley	Lubrizol	Ivan Tibavinsky	Mercedes-Benz
Marc Henderson	Honda Development and Manufacturing of America, LLC	Xin Yu	Aramco
Andrew Ickes	Chevron		
Asim Iqbal	Stellantis		

AVFL-38 Panel

	Russ Lewis, Leader	Marathon Petroleum Corp.	
Jim Anderson	Ford Motor Company	Won Kim	ExxonMobil
Elana Chapman	General Motors	Steve McConnell	Marathon Petroleum Corp.
Abhijeet Chausalkar	ExxonMobil	Melissa Przybylo	Toyota Motor North America
Rafal Gieleciak	Natural Resources Canada	Ed Sampler	Lubrizol
Garry Gunter	Phillips 66	John Shabaker	BP

AVFL-39-2 / E-139-2 Panel

	Garry Gunter, Co-Leader	Phillips 66	
	Michael Deegan, Co-Leader	Ford Motor Company	
Elana Chapman	General Motors	Mihir Patel	Chevron
Abhijeet Chausalkar	ExxonMobil	Beth Raney-Pablo	Ford Motor Company
Venkat Deshpande	Toyota Motor North America	Luca Salvi	ExxonMobil
Michael Geller	MECA	Andrea Strzelec	USCAR
Hyeok Hahn	Chevron	Na Tyrer	General Motors
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jose Velasco	Volkswagen
		Alexander Voice	Aramco
		David Warm	Ford Motor Company
Andrew Ickes	Chevron	Arren Washington	Phillips 66
Bryan Just	API	Angela Willis	Infineum
Cory Koglin	Afton Chemical	Xin Yu	Aramco
Kyle Kress	Phillips 66	Khaled Zreik	General Motors
Sharon Xiaobin Li	General Motors		
Steve McConnell	Marathon Petroleum Corp.		
Caroline Mui	Ford Motor Company		

AVFL-40

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	John Waldman, Co-Leader	General Motors	
Garry Gunter	Phillips 66	Asim Iqbal	Stellantis
Joseph Holland	Phillips 66	Bryan Just	API
Andrew Ickes	Chevron		

AVFL-42 Panel

	Melissa Przybylo, Co-Leader	Toyota Motor North America	
	Russ Lewis, Co-Leader	Marathon Petroleum Corp.	
Jim Anderson	Ford Motor Company	Bryan Just	API
Tushar Bera	Shell	Steve McConnell	Marathon Petroleum Corp.
Elana Chapman	General Motors	Michael Moore	Stellantis
Abhijeet Chausalkar	ExxonMobil	Beth Raney-Pablo	Ford Motor Company
Joseph Ciaravino	General Motors	Veronica Reilly	General Motors
Garry Gunter	Phillips 66	John Shabaker	BP
Marc Henderson	Honda Development and Manufacturing of America, LLC	Nestor Soriano	Shell
		Ivan Tibavinsky	Mercedes-Benz
Andrew Ickes	Chevron		
Asim Iqbal	Stellantis		

AVFL-44 Panel

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Elana Chapman, Co-Leader	General Motors	
Craig Allen	DENSO	Adam Klingbeil	Wabtec Corporation
Kirby Baumgard	Sandia National Laboratories	Russ Lewis	Marathon Petroleum Corp.
Tushar Bera	Shell	Dan Nehmer	John Deere
Abhijeet Chausalkar	ExxonMobil	Ryan Ogren	John Deere
Nam Cho	John Deere	Diego Palacios	DENSO
Danan Dou	John Deere	Joe Pizzo	DENSO
Fadi Elias	DENSO	Melissa Przybylo	Toyota Motor North America
Scott Fenwick	Clean Fuels Alliance America	Beth Raney-Pablo	Ford Motor Company
Bryan Geisick	John Deere	Tobias Schoeffler	Daimler Truck
Manuel Gonzalez	General Motors	Tim Shipp	Cummins
Masanori Goto	DENSO	Gurpreet Singh	US Department of Energy
Garry Gunter	Phillips 66	Nestor Soriano	Shell
Scott Halley	Lubrizol	Kevin Stork	US Department of Energy
Marc Henderson	Honda Development and Manufacturing of America, LLC	John Sulaski	DENSO
		Ivan Tibavinsky	Mercedes-Benz
		Rick Wilson	Sandia National Laboratories
		Xin Yu	Aramco
Steve Howell	MARC-IV		
Andrew Ickes	Chevron		
Bryan Just	API		

AVFL-46 Panel

Ivan Tibavinsky, Co-Leader	Mercedes-Benz
Andrew Ickes, Co-Leader	Chevron
Usman Asad	General Motors
Elana Chapman	General Motors
Abhijeet Chausalkar	ExxonMobil
Joseph Ciaravino	General Motors
Stephen Doemer	Volkswagen
Michael Foster	BP
Sarah Funk	General Motors
Manuel Gonzalez	General Motors
Garry Gunter	Phillips 66
Hyeok Hahn	Chevron
Peter Hubl	General Motors
Eric Israelson	General Motors
Bryan Just	API
Stephen Kirby	General Motors
Swaminatha Kumaraguru	General Motors
Jean-Yves Lavallee	General Motors
Russ Lewis	Marathon Petroleum Corp.
Shailesh Lopes	General Motors
Steve McConnell	Marathon Petroleum Corp.
Donald Meyer	General Motors
Rahul Mital	General Motors
Michael Moore	Stellantis
Sai Vithal	
Pennumacha	General Motors
Beth Raney-Pablo	Ford Motor Company
Ashish Shah	General Motors
Jenny Sigelko	Volkswagen
Nestor Soriano	Shell
Andrea Strzelec	USCAR
Arren Washington	Phillips 66

AVFL-47 Panel

Elana Chapman, Co-Leader	General Motors
Russ Lewis, Co-Leader	Marathon Petroleum Corp.
Chao Daniels, Co-Leader	General Motors
David Vuilleumier, Co-Leader	Chevron
Tushar Bera	Shell
Abhijeet Chausalkar	ExxonMobil
Joseph Ciaravino	General Motors
Izabela Gabrel	Volkswagen
Pat Geng	General Motors
Garry Gunter	Phillips 66
Marc Henderson	Honda Development and Manufacturing of America, LLC
Andrew Ickes	Chevron
Bryan Just	API
Steve McConnell	Marathon Petroleum Corp.
Donald Meyer	General Motors
Thomas Powell	General Motors
Melissa Przybylo	Toyota Motor North America
Beth Raney-Pablo	Ford Motor Company
Jenny Sigelko	Volkswagen
Nestor Soriano	Shell
Ivan Tibavinsky	Mercedes-Benz
Alexander Voice	Aramco
Xin Yu	Aramco

AVFL-48 Panel

	Elana Chapman, Co-Leader	General Motors	
	Scott Fenwick, Co-Leader	Clean Fuels Alliance America	
	Veronica Reilly, Co-Leader	General Motors	
	Shawn Broughton, Co-Leader	Marathon Petroleum Corp.	
Tushar Bera	Shell	Michael Moore	Stellantis
Abhijeet Chausalkar	ExxonMobil	Melissa Przybylo	Toyota Motor North America
Michael Foster	BP	Beth Raney-Pablo	Ford Motor Company
Izabela Gabrel	Volkswagen	John Shabaker	BP
Garry Gunter	Phillips 66	Jenny Sigelko	Volkswagen
Marc Henderson	Honda Development and Manufacturing of America, LLC	Nestor Soriano	Shell
		Michael Sweet	General Motors
		Terri Teller	Volkswagen
Andrew Ickes	Chevron	Ivan Tibavinsky	Mercedes-Benz
Bryan Just	API		
Steve McConnell	Marathon Petroleum Corp.		

AVFL-49 / E-150 Panel

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Elana Chapman, Co-Leader	General Motors	
	Donald Meyer, Co-Leader	General Motors	
	Kulwinder Singh, Co-Leader	General Motors	
Kirby Baumgard	Sandia National Laboratories	Bryan Just	API
Tushar Bera	Shell	Russ Lewis	Marathon Petroleum Corp.
Eric Bunnelle	ExxonMobil	Michael Moore	Stellantis
Abhijeet Chausalkar	ExxonMobil	Chuck Mueller	Sandia National Laboratories
Stephen Doemer	Volkswagen	Ryan Ogren	John Deere
Danan Dou	John Deere	Thomas Powell	General Motors
Fadi Elias	DENSO	Melissa Przybylo	Toyota Motor North America
Izabela Gabrel	Volkswagen	Beth Raney-Pablo	Ford Motor Company
Jian Gao	General Motors	Yuji Sato	DENSO
Bryan Geisick	John Deere	John Shabaker	BP
Ronald Grover	General Motors	John Sulaski	DENSO
Garry Gunter	Phillips 66	Ivan Tibavinsky	Mercedes-Benz
Hyeok Hahn	Chevron	David Warm	Ford Motor Company
Andrew Ickes	Chevron		

Atmospheric Impacts Committee

	Bud Ghosh, Co-Chair	Phillips 66	
	Sandy Winkler, Co-Chair	Ford Motor Company	
Mendy Bradley	Volkswagen	Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Betty Pun	Chevron
Meraj Faiz	General Motors	Chris Rabideau	Marathon Petroleum Corp.
Karim Hamza	Toyota Motor North America	Akanksha Singh	ExxonMobil
Bryan Just	API	Terri Teller	Volkswagen
Michael Moore	Stellantis	Ivan Tibavinsky	Mercedes-Benz
Greg Myers	Marathon Petroleum Corp.	Fred Turatti	Toyota Motor North America
Dan Nagashima	Honda	Ziming Yan	Aramco

Atmospheric Impacts Working Group

	Bud Ghosh, Co-Leader	Phillips 66	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Zac Adelman	LADCO	Bonyoung Koo	Bay Area Air District
David Choi	US EPA	Toshi Kuwayama	ARB
Tyler Fox	US EPA	Sang-Mi Lee	AQMD
Tim French	EMA	Rohit Mathur	US EPA
Justine Geidosch	US EPA	Kathryn Sargeant	US EPA
Mohan Gupta	FAA	Saffet Tanrikulu	Bay Area Air District
Mark Janssen	LADCO	Catherine Yanca	US EPA
Jim Kelly	US EPA	Josias Zietsman	Texas A&M University

A-114 Panel

Michael Moore, Co-Leader	Stellantis		
Chris Rabideau, Co-Leader	Marathon Petroleum Corp.		
Justine Geidosch	US EPA	Radha Purushothaman	Caterpillar
Michael Hays	US EPA	Matt Smith	Navistar
Toshi Kuwayama	ARB	Diep Vu	Marathon Petroleum Corp.
Paul Loeper	Chevron	Alexandra Zack	General Motors
Ben Murphy	US EPA		

A-128 Panel

Chris Rabideau, Leader	Marathon Petroleum Corp.		
Tim French	EMA	Greg Myers	Marathon Petroleum Corp.
Mark Janssen	LADCO	Sandy Winkler	Ford Motor Company
Toshi Kuwayama	ARB		

A-132 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Elana Chapman	General Motors	Greg Myers	Marathon Petroleum Corp.
Toshi Kuwayama	CARB	Melissa Przybylo	Toyota Motor North America

A-135 Panel

	Greg Myers, Co-Leader	Marathon Petroleum Corp.	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Elana Chapman	General Motors	Mark Janssen	LADCO
Bud Ghosh	Phillips 66	Bryan Just	API
Karim Hamza	Toyota Motor North America	Ziming Yan	Aramco

A-136 Panel

	Sandy Winkler, Leader	Ford Motor Company	
Tim French	EMA	Mark Janssen	LADCO
Bud Ghosh	Phillips 66	Bonyoung Koo	Bay Area Air District
Karim Hamza	Toyota Motor North America		

A-137 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Karim Hamza, Co-Leader	Toyota Motor North America	
Mark Janssen	LADCO	Sandy Winkler	Ford Motor Company
Bryan Just	API	Ziming Yan	Aramco

A-138 Panel

	Bud Ghosh, Co-Chair	Phillips 66	
	Sandy Winkler, Co-Chair	Ford Motor Company	
Elena Craft	Health Effects Institute	Wayne Miller	UC Riverside
Justine Geidosch	US EPA	Greg Myers	Marathon Petroleum Corp.
Karim Hamza	Toyota Motor North America	Jennifer Ofodile	Bay Area Air District
Kate Hoag	Bay Area Air District	Terri Teller	Volkswagen
Bryan Just	API	Abhilash Vijayan	UC Riverside
Georgios		Ziming Yan	Aramco
Karavalakis	UC Riverside	Seungju Yoon	CARB
Bonyoung Koo	Bay Area Air District		
Sang-Mi Lee	AQMD		

A-139 Panel

	Bonyoung Koo, Co-Leader	Bay Area Air District	
	Karim Hamza, Co-Leader	Toyota Motor North America	
	Greg Myers, Co-Leader	Marathon Petroleum Corp.	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Elana Chapman	General Motors	Michael Moore	Stellantis
Bud Ghosh	Phillips 66	Chris Rabideau	Marathon Petroleum Corp.
Bryan Just	API		

A-140 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Michael Aldridge	US EPA	Toshi Kuwayama	CARB
Brian Dinkelacker	ExxonMobil	Sang-Mi Lee	AQMD
Karim Hamza	Toyota Motor North America	Betty Pun	Chevron
Mark Janssen	LADCO	Chris Rabideau	Marathon Petroleum Corp.
Bonyoung Koo	Bay Area Air District	Akanksha Singh	ExxonMobil

A-141 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Karim Hamza	Toyota Motor North America	Betty Pun	Chevron
Bryan Just	API	Chris Rabideau	Marathon Petroleum Corp.
Sang-Mi Lee	AQMD		

A-142 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Michael Moore, Co-Leader	Stellantis	
Karim Hamza	Toyota Motor North America	Sandy Winkler	Ford Motor Company
Bryan Just	API		

A-144 Panel

	Karim Hamza, Co-Leader	Toyota Motor North America	
	Betty Pun, Co-Leader	Chevron	
Meraj Faiz	General Motors	Michael Moore	Stellantis
Bud Ghosh	Phillips 66	Chris Rabideau	Marathon Petroleum Corp.
Jim Kelly	US EPA	Akanksha Singh	ExxonMobil
Bonyoung Koo	Bay Area Air District	Sandy Winkler	Ford Motor Company
Sang-Mi Lee	AQMD		

A-145 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Meraj Faiz	General Motors	Toshi Kuwayama	TARB
Karim Hamza	Toyota Motor North America	Sang-Mi Lee	AQMD
Jim Kelly	US EPA	Betty Pun	Chevron
Bonyoung Koo	Bay Area Air District	Chris Rabideau	Marathon Petroleum Corp.

A-146 Panel

	Bud Ghosh, Co-Leader	Phillips 66	
	Greg Myers, Co-Leader	Marathon Petroleum Corp.	
	Sandy Winkler, Co-Leader	Ford Motor Company	
Chris Rabideau	Marathon Petroleum Corp.	Akanksha Singh	ExxonMobil

Performance Committee

	Russ Lewis, Co-Chair	Marathon Petroleum Corp.	
	Beth Raney-Pablo, Co-Chair	Ford Motor Company	
Becca Bennick	BP	Steve McConnell	Marathon Petroleum Corp.
Mendy Bradley	Volkswagen	Michael Moore	Stellantis
Shawn Broughton	Marathon Petroleum Corp.	Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Sheryl Rubin-Pitel	ExxonMobil
John Eckstrom	BP	John Shabaker	BP
Lance Gremillion	Motiva	Matt Sheehan	Chevron
Garry Gunter	Phillips 66	Jenny Sigelko	Porsche (Volkswagen)
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jay Silvas	CITGO
Asim Iqbal	Stellantis	Nestor Soriano	Shell
Jeff Jetter	Honda RNDAM	Terri Teller	Volkswagen
Bryan Just	API	Ivan Tibavinsky	Mercedes-Benz
David Kovach	BP	Chris Vergona	Motiva
Shailesh Lopes	General Motors	David Vuilleumier	Chevron
Mark McCarthy	Toyota Motor North America	Yi Xu	ExxonMobil
		Xin Yu	Aramco

Gasoline Deposit Working Group

	Matt Sheehan, Co-Leader	Chevron	
	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
Becca Bennick	BP	Farsan Parsinejad	Chevron
Shawn Broughton	Marathon Petroleum Corp.	Melissa Przybylo	Toyota Motor North America
Kevin Brunner	SwRI	Beth Raney-Pablo	Ford Motor Company
Rick Chapman	Fuel Quality Consultants	Dean Schoppe	Intertek
Jennifer Draper	Motiva	Jim Simnick	Simnick Consulting LLC
Garry Gunter	Phillips 66	Nestor Soriano	Shell
Alex Kulinowski	Afton Chemical	Kristie Tan	ITW Professional Automotive Products
Russ Lewis	Marathon Petroleum Corp.	Yi Xu	ExxonMobil
Indresh Mathur	Haltermann Solutions	Haibo Zhao	Huntsman
Andrew McKnight	Innospec		
Mike Miller	Sunoco		

PFI IVD Engine Test Workstream Main Panel [CM-136-18-1 Main Panel]

	Matt Sheehan, Co-Leader	Chevron	
	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
Becca Bennick	BP	Andrew Rohlfling	Afton Chemical
Joe Ciaravino	General Motors	Dean Schoppe	Intertek
Mary Dery	Innospec	John Shabaker	BP
Alex Kulinowski	Afton Chemical	Nestor Soriano	Shell
Russ Lewis	Marathon Petroleum Corp.	Bill Studinski	Center for Quality Assurance
Sohan Nair	BASF	George Szappanos	Lubrizol
Beth Raney-Pablo	Ford Motor Company	Yi Xu	ExxonMobil
Veronica Reilly	General Motors		

Port Fuel Injection Intake Valve Deposit Test Development – LAC Passing Criteria Development [CM-136-18-4]

	Matt Sheehan, Co-Leader	Chevron	
	Yi Xu, Co-Leader	ExxonMobil	
Becca Bennick	BP	Veronica Reilly	General Motors
Kevin Brunner	SwRI	Andrew Rohlfling	Afton Chemical
Joe Ciaravino	General Motors	Dean Schoppe	Intertek
Mary Dery	Innospec	John Shabaker	BP
Andre Grange	Lubrizol	Nestor Soriano	Shell
Alex Kulinowski	Afton Chemical	Bill Studinski	Center for Quality Assurance
Russ Lewis	Marathon Petroleum Corp.	George Szappanos	Lubrizol
Sohan Nair	BASF	Ivan Tibavinsky	Mercedes-Benz
Beth Raney-Pablo	Ford Motor Company		

Gasoline Combustion Working Group

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Melissa Przybylo, Co-Leader	Toyota Motor North America	
Becca Bennick	BP	Mike Miller	Sunoco
Thomas Briggs	SwRI	Peter Morgan	SwRI
Shawn Broughton	Marathon Petroleum Corp.	Beth Raney-Pablo	Ford Motor Company
Kevin Brunner	SwRI	Sheryl Rubin-Pitel	ExxonMobil
Rick Chapman	Fuel Quality Consultants	Dean Schoppe	Intertek
Richard George	BP	Brent Schuchmann	TRP Laboratories
Lance Gremillion	Motiva	Matt Sheehan	Chevron
Garry Gunter	Phillips 66	Jim Simnick	Simnick Consulting LLC
Clive Hamer	PCS Instruments	Andre Swarts	SwRI
Asim Iqbal	Stellantis	Kristie Tan	ITW Professional Automotive Products
Farrukh Khan	Nissan		
Russ Lewis	Marathon Petroleum Corp.	Ivan Tibavinsky	Mercedes-Benz
Andrew McKnight	Innospec	Yi Xu	ExxonMobil
John Mengwasser	Shell	Xin Yu	Aramco

Alternative to Tetraethyl Lead [CM-137-21]

	Jeff Davis, Co-Leader	ExxonMobil	
	Beth Raney-Pablo, Co-Leader	Ford Motor Company	
	Sheryl Rubin-Pitel, Co-Leader	ExxonMobil	
Gianna Bell-Eunice	Phillips 66	Enrico Lodrigueza	Phillips 66
Lance Campbell	Marathon Petroleum Corp.	Brian Logan	Phillips 66
Alisdair Clark	BP	Ravi Manchiraju	CFR Engines
Davide Faedo	Camcom	Ruel Paryag	SwRI
Rattanjit Gill	Energy Institute	Mical Renz	Dixie Services
Garry Gunter	Phillips 66	Dallanegra	
Joseph Holland	Phillips 66	Romaeo	BP
Daniel Kadlecek	ExxonMobil	Mark Rumizen	FAA
Robert Legg	SwRI	Rudolf Terschek	ROFA
Russ Lewis	Marathon Petroleum Corp.	Matthew Teyssier	FAA

AKI Study at Altitude with Modern Vehicles and Statistical Analysis [CM-137-25 / E-147 and CM-137-25a / E-147a]

	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Melissa Przybylo, Co-Leader	Toyota Motor North America	
	Marc Henderson, Co-Leader	Honda Development and Manufacturing of America, LLC	
Becca Bennick	BP	Phillipp Seyfried	General Motors
Shawn Broughton	Marathon Petroleum Corp.	John Shabaker	BP
Elana Chapman	General Motors	Matt Sheehan	Chevron
John Eckstrom	BP	Jenny Sigelko	Porsche (Volkswagen)
Garry Gunter	Phillips 66	Jay Silvas	CITGO
Asim Iqbal	Stellantis	Nestor Soriano	Shell
Bryan Just	API	Terri Teller	Volkswagen
Justin Ketterer	General Motors	Ivan Tibavinsky	Mercedes-Benz
David Kovach	BP	Lynn Totten	General Motors
Russ Lewis	Marathon Petroleum Corp.	Chris Vergona	Motiva
Shailesh Lopes	General Motors	David Vuilleumier	Chevron
Michael Moore	Stellantis	John Waldman	General Motors
Nick Mukkada	Chevron	Yi Xu	ExxonMobil
Beth Raney-Pablo	Ford Motor Company		

Volatility Working Group

	David Kovach, Co-Leader	BP	
	Beth Raney-Pablo, Co-Leader	Ford Motor Company	
Shawn Broughton	Marathon Petroleum Corp.	Farrukh Khan	Nissan
Kevin Brunner	SwRI	Russ Lewis	Marathon Petroleum Corp.
Elana Chapman	General Motors	Melissa Przybylo	Toyota Motor North America
Kelly Davis	RFA	Sheryl Rubin-Pitel	ExxonMobil
Jennifer Draper	Motiva	Dean Schoppe	Intertek
Lance Gremillion	Motiva	Matt Sheehan	Chevron
Garry Gunter	Phillips 66	Jim Simnick	Simnick Consulting LLC
Marc Henderson	Honda Development and Manufacturing of America, LLC	Ivan Tibavinsky	Mercedes-Benz
Asim Iqbal	Stellantis		

Evaluating the Driveability Index Relevance
in Modern Gasolines and Vehicles [CM-138-21-1]

	Russ Lewis, Co-Leader	Marathon Petroleum Corp.	
	Beth Raney-Pablo, Co-Leader	Ford Motor Company	
Shawn Broughton	Marathon Petroleum Corp.	David Kovach	BP
Kevin Brunner	SwRI	Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Sheryl Rubin-Pitel	ExxonMobil
Garry Gunter	Phillips 66	Dean Schoppe	Intertek
Marc Henderson	Honda Development and Manufacturing of America, LLC	Jim Simnick	Simnick Consulting LLC

Diesel Performance Working Group

	Garry Gunter, Co-Leader	Phillips 66	
	Shailesh Lopes, Co-Leader	General Motors	
Homayoun		Nick Mukkada	Chevron
"Holmes" Ahari	Stellantis	Sohan Nair	BASF
Becca Bennick	BP	Joe Porco	Gage Products Company
Tushar Bera	Shell	Melissa Przybylo	Toyota Motor North America
Shawn Broughton	Marathon Petroleum Corp.	Beth Raney-Pablo	Ford Motor Company
Adrian Cayabyab	CARB	Sheryl Rubin-Pitel	ExxonMobil
Rick Chapman	Fuel Quality Consultants	Dean Schoppe	Intertek
Jennifer Draper	Motiva	Matt Seuberling	Daimler Truck
Ed English	FQS	John Shabaker	BP
Richard George	BP	Matt Sheehan	Chevron
Barbara Goodrich	B. E. Goodrich Consulting	Jim Simnick	Simnick Consulting LLC
Clive Hamer	PCS Instruments	Elliot Smith	Lubrizol
Isis Johnson	Daimler Truck	Brandyn Sobecki	Daimler Truck
Kenneth Kar	Infineum	Nestor Soriano	Shell
Farrukh Khan	Nissan	Julie Stolis	Flint Hills Resources
Jeff Klopfenstein	Cummins	Andre Swarts	SwRI
Alex Kulinowski	Afton Chemical	Kristie Tan	ITW Professional Automotive
Russ Lewis	Marathon Petroleum Corp.		Products
Robert McCormick	National Laboratory of the Rockies	Ivan Tibavinsky	Mercedes-Benz
		Jonathan	
Jeanelle Morris	Navistar	VanScoyoc	Chevron Phillips Chemical

Low Temperature Operability Panel [DP-02]

	Shawn Broughton, Leader	Marathon Petroleum Corp.	
Alex Belly	Innospec	Shailesh Lopes	General Motors
Ed English	FQS	Nick Mukkada	Chevron
Suzanne Golisz	Innospec	Sheryl Rubin-Pitel	ExxonMobil
Garry Gunter	Phillips 66	John Shabaker	BP
Kenneth Kar	Infineum	Jenny Sigelko	Porsche (Volkswagen)
Alex Kulinowski	Afton Chemical	Elliot Smith	Lubrizol
Russ Lewis	Marathon Petroleum Corp.		

IDID Test Rig Precision [DP-04-22]

	Garry Gunter, Co-Leader	Phillips 66	
	Shailesh Lopes, Co-Leader	General Motors	
Shawn Broughton	Marathon Petroleum Corp.	Beth Raney-Pablo	Ford Motor Company
Ed English	FQS	Elliot Smith	Lubrizol
Jeff Klopfenstein	Cummins	Arvind	
Keith Knoll	PACCAR	Thiruvengadam	PACCAR
Alex Kulinowski	Afton Chemical	Jonathan	
Russ Lewis	Marathon Petroleum Corp.	VanScoyoc	Chevron Phillips Chemical
		Joshua Ward	Intertek
		Yi Xu	ExxonMobil

Solubility of Various Components in Renewable Diesel [DP-05-22]

	Garry Gunter, Co-Leader	Phillips 66	
	Shailesh Lopes, Co-Leader	General Motors	
Becca Bennick	BP	Jeff Klopfenstein	Cummins
Tushar Bera	Shell	Alex Kulinowski	Afton Chemical
Shawn Broughton	Marathon Petroleum Corp.	Matt Leuck	Neste
John Eckstrom	BP	Russ Lewis	Marathon Petroleum Corp.
Ed English	FQS	Robert McCormick	National Laboratory of the Rockies
Scott Fenwick	Clean Fuels Alliance America		
Joe Franklin	Intertek	Jeanelle Morris	Navistar
Barbara Goodrich	B. E. Goodrich Consulting	Nick Mukkada	Chevron
Asim Iqbal	Stellantis	Beth Raney-Pablo	Ford Motor Company
Bryan Just	API	John Shabaker	BP
Kenneth Kar	Infineum	Elliot Smith	Lubrizol
		Ivan Tibavinsky	Mercedes-Benz

Diesel Fuel Haze/Cleanliness Panel [DP-06-20]

	Shailesh Lopes, Leader	General Motors	
Shawn Broughton	Marathon Petroleum Corp.	Russ Lewis	Marathon Petroleum Corp.
Rick Chapman	Fuel Quality Consultants	Ranzy Morgan	Choice Analytical
John Eichberger	Transportation Energy Institute	Nick Mukkada	Chevron
Ed English	FQS	Fred Passman	BCA, Inc.
Scott Fenwick	Clean Fuels Alliance America	Steve Pollock	Steel Tank
Garry Gunter	Phillips 66	Sheryl Rubin-Pitel	ExxonMobil
Ryan Haerer	US EPA	Elliot Smith	Lubrizol
Jeff Hove	Fuels Institute		

Corrosion Panel [DP-07]

	Bryan Just, Leader	API	
Tushar Bera	Shell	Jeff Hove	Fuels Institute
Paul Beu	Wawa	Mike Kass	Oak Ridge National Laboratory
Shawn Broughton	Marathon Petroleum Corp.	Russ Lewis	Marathon Petroleum Corp.
John Eckstrom	BP	Kristi Moriaty	National Laboratory of the Rockies
John Eichberger	Transportation Energy Institute		
Ed English	FQS	Nick Mukkada	Chevron
Scott Fenwick	Clean Fuels Alliance America	Fred Passman	BCA, Inc.
Garry Gunter	Phillips 66	Steve Pollock	Steel Tank
Ryan Haerer	US EPA	Beth Raney-Pablo	Ford Motor Company
Sandra Hernandez		Sheila Rzyzi	Ford Motor Company
	Chevron		

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Joanna Bauldreay	Bauldreay Jet Fuel Consulting Ltd	Jennifer Klettlinger	NASA
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Glenn Benner	Shell	Thomas Loegel	US Navy
Hana Bennis	IATA	Timothy Owen	FAA
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Jessica Boze	Innospec	Mark Rumizen	Consultant
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Bradley Culbertson	Chevron	Tim Sigler	Gammon Technical Products, Inc.
Douglas Cyr	BP	Jay Silvas	CITGO
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Terrance Dickerson	TotalEnergies Aviation	Julie Stolis	Flint Hills Resources
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Jonathan Doyle	Shell Aviation		Marathon Petroleum Corp.
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Uwe Bauder	DLR	Indresh Mathur	Haltermann Solutions
Scott Bergey	US Navy	Robert McCormick	National Laboratory of the Rockies
Tom Bronson	Honeywell		
Amy Carico	Airlines for America	Bruno Miller	Alder Renewables
Steve Csonka	CAAFI	Ian Mitchell	PAC
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Douglas Cyr	Chevron	Micki Overberg	CAMIN Cargo Control, Inc.
Terrance Dickerson	US Navy	Karthik Ramasamy	Pacific Northwest National Laboratory
Clarisse Doucet	TotalEnergies Aviation		
Georg Eckel	DLR	Samee Rana	US Navy
Peter Eversley	Shell Aviation	Bastian Rauch	DLR
Katie Foster	UK Ministry of Defence	Alyssa Roche	Chevron
Ana Gabrielian	FAA	James Sheridan	Marathon Petroleum Corp.
Roger Gaughan	RGG Aviation Consulting Services	Mickail Sicard	ONERA
Jennifer Green	CITGO	Melanie Thom	Baere Aerospace Consulting, Inc.
Zhenning Gu	Shell	Paul Wells	ExxonMobil
Martin Hunnybun	Energy Institute	Zach West	UDRI
Scott Hutzler	SwRI	Paul Wrzesinski	FAA
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Carl Bennett	Afton Chemical	Ian Mitchell	PAC
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Liz Locklear	Explorer Pipeline	George Wilson	SwRI
Enrico Lodrigueza	Phillips 66	Paul Wrzesinski	FAA
Hung Nguyen	American Airlines		

AV-28-1

	Roger Gaughan, Co-Leader	RGG Aviation Consulting Services	
	Mark Rumizen, Co-Leader	Consultant	
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Joanna Bauldrey	Bauldrey Jet Fuel Consulting Ltd	Christopher Kolodziej	Argonne National Laboratory
		Enrico Lodrigueza	Phillips 66
Hana Bennis	Shell	Douglas Macnair	EAA
Chris D'Acosta	Swift Fuels	Mical Renz	Dixie Services
Clarisse Doucet	TotalEnergies Aviation	George Wilson	SwRI
Lars Hjelmberg	Hjelmco Oil		

AV-30-22

Dave Atwood	FAA	Enrico Lodrigueza	Phillips 66
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Clarisse Doucet	TotalEnergies Aviation	Mark Rumizen	Consultant
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AV-31-22

	Jack Buffin, Co-Leader	US Navy	
	Dwani Sharma, Co-Leader	IATA	
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Dave Atwood	FAA	Daniel Kadlec	ExxonMobil
Daniel Baniszewski	DLA Energy	Jennifer Klettlinger	NASA
Joanna Bauldrey	Bauldrey Jet Fuel Consulting Ltd	Enrico Lodrigueza	Phillips 66
		Thomas Loegel	US Navy
Hana Bennis	Shell	Robert Midgley	Shell Aviation
Michael Blakemore	FQS	David Parmenter	Airbus
Farah Bouhedda	Merck	Jay Patel	Conidia Bioscience
Jack Burgazli	Innospec	Oscar Ruiz	CycloKinetics
Amy Carico	Airlines for America	Mark Rumizen	Consultant
Myrsini		Sam Santiago	Merck
Chronopoulou	Conidia Bioscience	Andreas Schmidt	Lufthansa Technik
Bradley Culbertson	Honeywell	James Sheridan	Marathon Petroleum Corp.
Douglas Cyr	Chevron	Jay Silvas	CITGO
Roy Dean	Airbus	Renato siqueira	Embraer
Bert deKoning	KLM Royal Dutch Airlines	Christian Siry	Lufthansa Technik
Clarisse Doucet	TotalEnergies Aviation	Julie Stolis	Flint Hills Resources
Darren Dunlap	Boeing	Melanie Thom	Baere Aerospace
Edward English	FQS		Consulting, Inc.
Leif Friestad	Conidia Bioscience	Rommy Ulloa	IATA
Bill Geck	American Airlines	Zach West	UDRI
Jennifer Green	CITGO	Patricia Wilkins	DLA Energy
Graham Hill	ECHA Microbiology	Gareth Williams	ECHA Microbiology
Alastair Hobday	Rolls-Royce	Paul Wrzesinski	FAA
Andrea Hoffmann	UDRI	Martin Hunnybun	Energy Institute

AV-33-22 Panel

Zach West, Leader		UDRI	
Gurhan Andac	GE Aerospace	Daniel Kadlecek	ExxonMobil
Daniel Baniszewski	DLA Energy	Georg Leng	OMV
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Terrance Dickerson	US Navy	Alyssa Roche	Chevron
Clarisse Doucet	TotalEnergies Aviation	Prentiss Searles	API
Peter Eversley	Shell Aviation	Brook Urban	Marathon Petroleum Corp.
Alastair Hobday	Rolls-Royce	George Wilson	SwRI
Martin Hunnybun	Energy Institute	George	
		Zombanakis	United Airlines

AV-34-24 Panel

Enrico Lodrigueza, Co-Leader		Phillips 66	
Alyssa Roche, Co-Leader		Chevron	
Tad Vrana, Co-Leader		Southwest Airlines	
Jessica Boze	Boeing	Daniel Kadlecek	ExxonMobil
Dave Brady	GE Aerospace	Ilya Kosilkin	Boeing
Krege Christison	Chevron	Lisa Myers	Phillips 66
Douglas Cyr	Chevron	Paul Ryder	Phillips 66
Alec Durrell	Phillips 66	James Sheridan	Marathon Petroleum Corp.
Peter Eversley	Shell Aviation	Brook Urban	Marathon Petroleum Corp.
Amanda Graves	ExxonMobil	Zach West	UDRI
Zhenning Gu	Shell	Matt Wulfers	Phillips 66

AV-37-25 Panel

Amy Carico, Co-Leader		Airlines for America	
Douglas Cyr, Co-Leader		Chevron	
Harper Cohen	API	Makeena Stephens	DLA
Bryan Just	API		

AV-38-25 Panel

Amy Carico, Co-Leader		Airlines for America	
Peter Eversley, Co-Leader		Shell Aviation	
Jessica Boze	Boeing	Enrico Lodrigueza	Phillips 66
Krege Christison	Chevron	Julie Stolis	Flint Hills Resources
Daniel Kadlecek	ExxonMobil	Zach West	UDRI

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Bryan Just	API	Corey Trobaugh	Cummins
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Jeff Klopfenstein	Cummins	David Vuilleumier	Chevron
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Shailesh Lopes	General Motors	Sandy Winkler	Ford Motor Company

SM-2026-01 Panel

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	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	David Vuilleumier, Co-Leader	Chevron	
Elana Chapman	General Motors	Brianne Kanach	ExxonMobil

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	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
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Mendy Bradley	Volkswagen	Helmut Kindl	Ford Motor Company
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Arjun Chandrashekar	ExxonMobil	Shailesh Lopes	General Motors
Elana Chapman	General Motors	Andrea Lubawy	Toyota Motor North America
Alex Freer	ExxonMobil	Steve McConnell	Marathon Petroleum Corp.
Taylor Garrick	General Motors	Pete Morgan	SwRI
Kammie George	Marathon Petroleum Corp.	Jeffrey Myrom	General Motors
Bastian Hartmann	Ford Motor Company	Heechang Oh	Hyundai
Xin He	Aramco	Sorin Panainte	Mercedes-Benz
Marc Henderson	Honda Development and Manufacturing of America, LLC	Vivek Raj Mohan	Shell
Asim Iqbal	Stellantis	Terry Riesen	Marathon Petroleum Corp.
Jeff Jetter	Honda RNDAM	Matt Sheehan	Chevron
		Terri Teller	Volkswagen
		David Vuilleumier	Chevron
		Armin Warm	Ford Motor Company

SM-E-4/8 Panel

	Elana Chapman, Co-Leader	General Motors	
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	Ivan Tibavinsky, Co-Leader	Mercedes-Benz	
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Aron Butler	US EPA		
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Tad Hepner	RFA	Yuangjiang Pei	Aramco
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Nick Kothari	General Motors	Daniel Santosa	Pacific Northwest National Laboratory
Matthew Langholtz	Oak Ridge National Laboratory	Kathryn Sargeant	US EPA
Michael Machala	Toyota Research Institute	Michael Shell	US Department of Energy
Mark McCarthy	Toyota Motor North America	Courtney Videchak	Clean Fuels Alliance America

SM-E-20-2 Panel

	Karim Hamza, Co-Leader	Toyota Motor North America	
	Melissa Przybylo, Co-Leader	Toyota Motor North America	
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Mendy Bradley	Volkswagen	Matthew Mattozzi	US Department of Energy
Eric Bunnelle	ExxonMobil	Jeffrey Myrom	General Motors
Elana Chapman	General Motors	Vivek Raj Mohan	Shell
Robb De Kleine	Ford Motor Company	Brian Schmidt	John Deere
Alex Freer	ExxonMobil	John Sulaski	DENSO
Xin He	Aramco	Ian Sutherland	General Motors
Chul Kim	Ford Motor Company	Ivan Tibavinsky	Mercedes-Benz
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Andrea Lubawy	Toyota Motor North America		

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	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Michael E. Moore, Co-Leader	Stellantis	
	Reid Wagner, Co-Leader	Growth Energy	
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Becca Bennick	BP	Pete Morgan	SwRI
Mendy Bradley	Volkswagen	Heechang Oh	Hyundai
Eric Bunnelle	ExxonMobil	Sourabh Pansare	Phillips 66
Arjun	ExxonMobil	Yuangjiang Pei	Aramco
Chandrashekar		Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Beth Raney-Pablo	Ford Motor Company
Alex Freer	ExxonMobil	Terry Riesen	Marathon Petroleum Corp.
Jeff Jetter	Honda RNDAM	Chris Sharp	SwRI
Bryan Just	API	Matt Sheehan	Chevron
Brianne Kanach	ExxonMobil	Nestor Soriano	Shell
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Rafael Lago Sari	Aramco	David Vuilleumier	Chevron
Tom Leone	SwRI	Shailesh Lopes	General Motors

SM-F-5 Panel

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	Matt Sheehan, Co-Leader	Chevron	
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Eric Bunnelle	ExxonMobil	Shailesh Lopes	General Motors
Elana Chapman	General Motors	Steve McConnell	Marathon Petroleum Corp.
Christina Daniels	BP	Michael E. Moore	Stellantis
Scott Fenwick	Clean Fuels Alliance America	Sourabh Pansare	Phillips 66
Jeff Jetter	Honda RNDAM	Yuangjiang Pei	Aramco
Bryan Just	API	Beth Raney-Pablo	Ford Motor Company
Brianne Kanach	ExxonMobil	Ivan Tibavinsky	Mercedes-Benz

SM-F-2023-2 Panel

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Madhur Bloor	Toyota Research Institute	Jeff Klopfenstein	Cummins
Eric Bunnelle	ExxonMobil	Tom Leone	SwRI
Joe Ciaravino	General Motors	Andrea Lubawy	Toyota Motor North America
Christina Daniels	BP	Michael Machala	Toyota Research Institute
Robb De Kleine	Ford Motor Company	Pete Morgan	SwRI
Alex Freer	ExxonMobil	Sourabh Pansare	Phillips 66
Hector Garcia	BP	Melissa Przybylo	Toyota Motor North America
Karim Hamza	Toyota Motor North America	Beth Raney-Pablo	Ford Motor Company
Xiaoyi He	Phillips 66	Nestor Soriano	Shell

SM-F-2025-01 / AVFL-51 / E-151 Panel

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Abhijeet	ExxonMobil	Donald Meyer	General Motors
Chausalkar		Nick Mukkada	Chevron
Danan Dou	John Deere	Dan Nehmer	John Deere
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Jian Gao	General Motors	Beth Raney-Pablo	Ford Motor Company
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Garry Gunter	Phillips 66	Kevin Stork	US Department of Energy
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	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
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Jessey Bouchard	Aramco	Robert Mitchell	SwRI
Mendy Bradley	Volkswagen	Michael E. Moore	Stellantis
Eric Bunnelle	ExxonMobil	Heechang Oh	Hyundai
Arjun	ExxonMobil	Sourabh Pansare	Phillips 66
Chandrashekar		Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Vivek Raj Mohan	Shell
Christina Daniels	BP	Terry Riesen	Marathon Petroleum Corp.
Alex Freer	ExxonMobil	Matt Sheehan	Chevron
Vickey Kalaskar	SwRI	Terri Teller	Volkswagen
Brianne Kanach	ExxonMobil	Ivan Tibavinsky	Mercedes-Benz
Jinho Kim	Hyundai	David Vuilleumier	Chevron
Rafael Lago Sari	Aramco		

SM-CR-2023-01 Panel

	Andrea Lubawy, Co-Leader	Toyota Motor North America	
	Steve McConnell, Co-Leader	Marathon Petroleum Corp.	
	Sourabh Pansare, Co-Leader	Phillips 66	
Madhur Bloor	Toyota Research Institute	Lizzy Mahoney	Toyota Research Institute
Jessey Bouchard	Aramco	Vivek Raj Mohan	Shell
Veronica Bradley	Clean Fuels Alliance America	Michael E. Moore	Stellantis
Mendy Bradley	Volkswagen	Melissa Przybylo	Toyota Motor North America
Elana Chapman	General Motors	Ivan Tibavinsky	Mercedes-Benz
Joe Ciaravino	General Motors	David Vuilleumier	Chevron
Jeff Klopfenstein	Cummins		

Life Cycle Analysis Working Group

	Robb De Kleine, Co-Leader	Ford Motor Company	
	Diep Vu, Co-Leader	Marathon Petroleum Corp.	
Damian Allen	Shell	Ian Laurenzi	ExxonMobil
Madhur Bloor	Toyota Research Institute	Shailesh Lopes	General Motors
Jessey Bouchard	Aramco	Andrea Lubawy	Toyota Motor North America
Mendy Bradley	Volkswagen	Andy Mabutol	Mitsubishi Motors
Arjun	ExxonMobil	Karthik Marimuthu	Phillips 66
Chandrashekar		Michael E. Moore	Stellantis
Elana Chapman	General Motors	Heechang Oh	Hyundai
Jonathan Cook	BP	Terry Riesen	Marathon Petroleum Corp.
Alex Freer	ExxonMobil	Ian Sutherland	General Motors
Xiaoyi He	Phillips 66	Sarah Tea	General Motors
Paul Hernley	General Motors	Terri Teller	Volkswagen
Asim Iqbal	Stellantis	Ivan Tibavinsky	Mercedes-Benz
Enze Jin	Aramco	David Vuilleumier	Chevron
Brianne Kanach	ExxonMobil	Luyao Yuan	General Motors
Chul Kim	Ford Motor Company		
Jinho Kim	Hyundai		

SM-LCA-17b Panel

	Robb De Kleine, Co-Leader	Ford Motor Company	
	Xiaoyi He, Co-Leader	Phillips 66	
Damian Allen	Shell	Shailesh Lopes	General Motors
Madhur Bloor	Toyota Research Institute	Karthik Marimuthu	Phillips 66
Veronica Bradley	Clean Fuels Alliance America	Steve McConnell	Marathon Petroleum Corp.
Joe Ciaravino	General Motors	Michael E. Moore	Stellantis
Jonathan Cook	BP	Melissa Przybylo	Toyota Motor North America
Scott Fenwick	Clean Fuels Alliance America	Terry Riesen	Marathon Petroleum Corp.
Alex Freer	ExxonMobil	Sarah Tea	General Motors
Michael Fulton	FedEx	Diep Vu	Marathon Petroleum Corp.
Xin He	Aramco	David Vuilleumier	Chevron
Enze Jin	Aramco	Luyao Yuan	General Motors
Ian Laurenzi	ExxonMobil		

SM-LCA-2023-1 Panel

	Robb De Kleine, Co-Leader	Ford Motor Company	
	Melissa Przybylo, Co-Leader	Toyota Motor North America	
	Diep Vu, Co-Leader	Marathon Petroleum Corp.	
Madhur Boloor	Toyota Research Institute	Ian Laurenzi	ExxonMobil
Karim Hamza	Toyota Motor North America	Andrea Lubawy	Toyota Motor North America
Paul Hernley	General Motors	Karthik Marimuthu	Phillips 66
Enze Jin	Aramco	Vivek Raj Mohan	Shell
Chul Kim	Ford Motor Company	Sarah Tea	General Motors
Ikeda Koichiro	Toyota Research Institute	Luyao Yuan	General Motors

SM-LCA-2025-02 Panel

	Aaron Levy, Co-Leader	US EPA	
	Robb De Kleine, Co-Leader	Ford	
	Diep Vu, Co-Leader	Marathon Petroleum Corp.	
Hanna Alve	Neste	Jeremy Martin	Union of Concerned Scientists
Andrea Baily	US Department of Energy	Colin Murphy	UC Davis
Linden Barton	Environment and Climate Change Canada	Devin O'Grady	Canadian Fuels
Anastasia Behr	UL	Sara Ohrel	US EPA
Veronica Bradley	Clean Fuels Alliance America	Gonca Seber Olcay	ICCT
Francois	Environment and Climate Change Canada	Anna Oldani	FAA
Charron-Doucet	Change Canada	Anil Prabhu	California Air Resources Board
Sara Eskandarifar	Natural Resources Canada	S. Richman	RFA
Bill Goldner	USDA	Susan Sanchez	UL
Xiaoyi He	Phillips 66	Corinne Scown	Lawrence Berkeley National Lab
Brent Heard	National Academies of Science	Andrea Strzelec	USCAR
Tad Hepner	RFA	Melanie Thom	BAE
Sara Herman	Cargill	Michael Wang	Argonne National Laboratory
		Matt Herman	Iowa Soybean Association
		Ian Laurenzi	ExxonMobil