Peer Review of Draft Report "Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data"

February 24, 2014

Prepared for
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U.S. Environmental Protection Agency
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Acronyms and Abbreviations

Acronym / Abbreviation	Stands For
CARB	California Air Resources Board
DTC	Diagnostic trouble code
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
evap	Evaporative emissions control system
HC	Hydrocarbon
ICF	ICF International
I/M or IM	Inspection and Maintenance
LDT	Light-Duty Truck
LDV	Light-Duty Vehicle
LEV	Low Emission Vehicle
MY	Model Year
OBD	On-Board Diagnostics system.
SHED	Sealed Housing for Evaporative Determination
WAM	Work Assignment Manager

1. Introduction

Gasoline vehicles are equipped with evaporative emissions control systems that control vapor from the fuel storage system while a vehicle is sitting or driving. When these systems or the vehicle's gasoline delivery system malfunction, excessive evaporative emissions can be emitted. Few estimates of the frequency of vehicles with evaporative emissions malfunctions, or leaks, in the fleet exist. These vehicles can have a significant impact on the hydrocarbon (HC) emissions inventory.

This report details the peer review of the subject draft report, *Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data (December 11, 2013)*, which documents results from ERG's analysis of light-duty gasoline-powered vehicle On-board Diagnostic (OBD) evaporative emissions control system (evap) diagnostic trouble codes (DTCs) using inspection and maintenance (I/M) program data. A number of independent subject matter experts were identified and the process managed to provide reviews and comments on the new evaporative data analysis. This peer review process was carried out under EPA's peer review guidelines[1].

This report is organized as follows:

- Chapter 2 details the selection of the peer reviewers
- Chapter 3 details the peer review process
- Chapter 4 summarizes the reviews
- Appendix A provides resumes and conflict of interest statements for the three selected reviewers
- Appendix B provides the charge letter sent to the selected reviewers
- Appendix C, D and E provide the actual reviews submitted by the three selected reviewers

[1] U.S. Environmental Protection Agency, Peer Review Handbook, 3rd Edition with appendices. Prepared for the U.S. EPA by Members of the Peer Review Advisory Group, for EPA's Science Policy Council, EPA/100/B-06/002. Available at http://www.epa.gov/peerreview

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2. Selection of Peer Reviewers

The EPA WAM supplied a list of five reviewers that EPA determined would be capable of reviewing the subject report. They are listed in Table 2-1.

Table 2-1. EPA Suggested Reviewers

Reviewer	Affiliation	Results
Gene Tierney	Opus Inspection Systech - ESP	Had the necessary expertise and agreed to review the report
Mike McCarthy	California Air Resources Board (acting as an independent contractor)	Had the necessary expertise and agreed to review the report
Michael St. Denis	Revecorp.	Had the necessary expertise and agreed to review the report

The three selected reviewers are listed in Table 2-2. Each had the necessary expertise, were available to review the report in a timely manner and had no conflict of interest. All were agreed upon by the EPA WAM.

Table 2-2. Final Reviewers

Reviewer	Contact Information	Necessary Expertise	Conflict of Interest
Gene Tierney	Opus Inspection (Systech – ESP) 765 Ahukini Street Honolulu, Hawaii 96825 P: 202-340-7553 Gene.Tierney@OpusInspection.com	Yes	No
Mike McCarthy	P.O. Box 8101 Mammoth Lakes, CA 93546 P: 626-771-3614 mmccarth@arb.ca.gov	Yes	No
Michael St. Denis	Revecorp 5732 Lonetree Blvd Rocklin, CA 95765 P: 916-786-1006 Michael@Revecorp.com	Yes	No

Resumes and conflict of interest statements for the three reviewers can be found in Appendix A.

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3. Peer Review Process

Once the three reviewers had been decided upon and approved by the EPA WAM, a charge letter and the subject report were sent to each reviewer via secure email. Shortly after distributing the charge letter (see Appendix B) and supporting materials for the peer review, a teleconference was held between the selected peer reviewers, the EPA WAM, EPA-identified relevant project-related staff and ICF staff to clarify any questions the peer reviewers may have regarding the report/written materials. At the conference call, EPA provided technical and/or background information on the particular report under review.

During the review process, one reviewer had a question and the question and answer were distributed to all reviewers via email. Each reviewer provided a written peer review in a timely manner. These were sent to ICF who forwarded them directly to the EPA WAM.

ICF managed the peer review process to ensure that each peer reviewer had sufficient time to complete their review of the data analysis by the deliverable data told to them (mid-January 2014). ICF adhered to the provisions of EPA's Peer Review Handbook guidelines to ensure that all segments of the peer review conformed to EPA peer review policy.

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4. Summary of Review Comments

In this section, review comments from the three reviewers are summarized. Full comments can be found in Appendix C for Gene Tierney, Appendix D for Mike McCarthy and Appendix E for Michael St. Denis. Responses are summarized below relative to the charge questions.

4.1. Responses to Charge Questions

The three reviewers provided comments on the subject report. They contained both general and specific comments. Many of the specific comments tended to be more editorial than content related and are not summarized here. General and specific comments that are content related are summarized here based upon subject. Editorial comments can be found in the individual reviews in Appendices C through E.

Project Goals

All three reviewers felt that the report did not adequately define the exact purpose of the project. The statement in the Introduction of the report, "The purpose of this Work Assignment (WA) is to perform analysis to better understand evap DTC rates for light-duty vehicles" is vague and does not get to the real purpose of the work. Mr. Tierney felt that there was not a hypothesis or research question raised. Mr. McCarthy felt that there was no suggestion of a current understanding of the work before the analyses were done. He also wanted specific questions or theories laid out. Mr. St. Denis stated that while the conclusions indicate data are used to represent evap DTC rates of the in-use fleet and the IM versus non-IM fleets, this was not made clear in the introduction.

Vehicles Included

Mr. McCarthy indicated that "enhanced evap" actually was phased in for the 95-98 MY vehicles in California and 96-99 MY vehicles federally. Mr. St. Denis and Mr. Tierney commented that the report only presents data on vehicles in the condition of being prepared for an I/M inspection and therefore does not represent the expected evap DTC rates of the operating fleet. Mr. St. Denis also noted that in California, vehicles that passed the ASM test were not failed even if they were "not ready". Therefore the not ready rates for California are artificially high and the low evap DTC rates artificially low.

States Used

All three reviewers felt that the pretense of not identifying states was done poorly. All felt that the states were easily identifiable by the data presented in Table 1, particularly States A and D. It was not clear in any of the reviewers' minds why this was done. Mr. St. Denis indicated that by hiding the states, it was not clear whether the methods used to process the data were correct.

Pending DTCs

Mr. McCarthy points out that no state program collects pending code data because they are provided via Mode $07 of SAE J1979. States only collect Mode $03. He felt it unwise to include cases of DTCs present but no MIL command because they don't necessarily indicate that the vehicle had a problem at the time of inspection. Mr. St. Denis indicated that pending DTCs could just be false positives.

Non-IM State

Mr. St. Denis indicated that State D, if Colorado, is not equivalent to a state without an I/M program. Colorado has a gas cap test and the testing provides advisory OBDII results. In addition, Colorado has and evap repair consumer assistance program which would lead to more repairs than a non-I/M state.

Not Ready Evap Monitors

Mr. Tierney indicates that the report does not explain why evap monitor unreadiness increase with age. He feels a hypothesis should be raised and tested. Mr. St. Denis indicated there is no justification to state that older vehicles could have a higher non-ready state. This could be a result of motorists disconnecting their batteries prior to an inspection to clear out potential DTCs or the result of a battery being disconnected during repair. Mr. McCarthy feels that the national percentage of evap not ready for initial inspection is not the same as what was found in IM programs.

Statistical Significance

Mr. Tierney felt that the report did not provide any statistical information on the number of vehicles in any of the cohorts. In addition, there was no discussion of statistical significance of the differences or similarities found. Mr. St. Denis thought there should be more analysis of different makes and models to see the difference in not ready and DTC rates. He noted that different environmental conditions can cause significant differences in evap emissions and cause the systems to function differently.

General

All three reviewers had many general comments correcting statements throughout the report. More details can be found in the three full reviews in Appendices C through E.

Appendix A. **Resumes and Conflict of Interest Statements**

EUGENE J. TIERNEY

765 Ahukini Street
Honolulu, Hawaii 96825

202-340-7553
Gene.Tierney@OpusInspection.com

EXPERIENCE

Opus Inspection (Systech-ESP) I/M
Consultant
Providing motor vehicle inspection services and support August 2011 to Present

U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Washington, D.C. Senior Policy Advisor, 9/2006 – 7/2011
Acting Assistant Office Director, 2/2006 – 9/2006
Ann Arbor, Michigan Director, Center for Air Quality and Modeling, 1/2000 – 1/2006
Chief, Planning and Human Resources Staff, 2/1997 – 12/1999
Chief, I/M Section, 1/1987 – 1/1996
Environmental Scientist, 11/1979 – 12/1986

Key Responsibilities and Accomplishments

- Chaired Mobile Source Technical Review Subcommittee workgroups on modeling and Transitioning I/M. Prepared key reports on use of Remote OBD in I/M programs.
- Developed MOBILE6, NONROAD2004 and MOVES.
- Drove development of PEMS for use in research and compliance.
- Authored the IM240 test procedure and evaporative system pressure and purge tests.
- Responsible for development, implementation, and oversight of motor vehicle I/M programs. Wrote and promulgated rules and guidance pursuant to Clean Air Act requirements.
- Wrote numerous technical reports, briefings, policy papers, correspondence, quality control procedures, and equipment specs related to I/M and mobile source air pollution control.
- Prepared strategic inventories and developed new methods for creating and updating national emission inventories. Prepared an inventory for Cairo, Egypt. Assisted Shanghai, China in in-use data collection and analysis of mobile sources.
- Led ground-breaking, $4 million study of light-duty vehicle PM emissions in Kansas City. Received the EPA's Science Achievement Award for this work.
- Prepared and delivered speeches at conferences and meetings. Testified before legislatures, city councils, and boards. Chaired committees and cross-organizational teams.

Hawaii State Energy Office Ridesharing Coordinator
Department of Planning and Economic Development 1978 - 1979

Developed and implemented transportation energy conservation programs.

EDUCATION

UNIVERSITY OF MICHIGAN Master of Science
School of Natural Resources Resource Policy and Management
Ann Arbor, Michigan May 1982

UNIVERSITY OF HAWAII Bachelor of Arts, Environmental Studies
Honolulu, Hawaii December 1977

HONORS

Science Achievement Award
2009

OTAQ Diversity Award
2000

EPA Medals for Exceptional, Outstanding and Superior Service
Gold 1984
Silver 1993
Bronze 1992/2002

ORGANIZATIONAL CONFLICT OF INTEREST CERTIFICATE

Customer: U.S. Environmental Protection Agency

Contractor: ICF Incorporated, LLC, 9300 Lee Highway, Fairfax, VA 22031

Prime Contract:

In accordance with EPAAR 1552.209-70 through 1552.209-73, Subcontractor/ Consultant certifies to the best of its knowledge and belief, that:

___X___ No actual or potential conflict of interest exists.

_____ An actual or potential conflict of interest exists. See attached full disclosure.

Subcontractor/Consultant certifies that its personnel, who perform work on this Contract, have been informed of their obligations to report personal and organizational conflict of interest to Contractor and Subcontractor/Consultant recognizes its continuing obligation to identify and report any actual or potential organizational conflicts of interest arising during performance under referenced contract.

_____
Subcontractor/Consultant

December 6, 2013
Date

9300 Lee Highway — Fairfax, VA 22031-1207 — 703.934.3000 — 703.934.3740 fax — icfi.com

Mike McCarthy
Chief Technology Officer
Mobile Source Control Division
California Air Resources Board
mmccarth@arb.ca.gov

Currently, Mike has responsibility at ARB for assessment of vehicle and powertrain technology and future light-duty criteria pollutant and greenhouse gas emission standards including leading the review of the GHG standards already adopted out to the 2025 model year. Previously, Mike has worked on the on-board diagnostic (OBD) programs for ARB for over 18 years including managing all aspects of the light-duty and heavy-duty OBD programs. This included regulatory development, certification and implementation, in-use enforcement, and integration with inspection and maintenance programs nationwide as well as in California.

Mr. McCarthy holds a B.S. degree in Mechanical Engineering with an emphasis in Digital Control Systems from the University of California, Los Angeles.

Chief Technology Officer, 11/2012- present
Emissions Compliance, Automotive Regulations, and Science Division
Air Resources Board

-Technical and program lead for existing and future light-duty vehicle greenhouse gas and criteria pollutant tailpipe standards including lead for review of national joint greenhouse gas and fuel economy regulations.

Manager, Advanced Engineering Section 2002-2012
Mobile Source Control Division
Air Resources Board

-Oversaw light-duty on-board diagnostics (OBD) program including regulatory updates, annual certification for all vehicles sold in the U.S. market, in-use enforcement including recall, and integration with OBD into inspection and maintenance programs nationwide and in California.
-Oversaw on-road heavy-duty OBD program from initial regulatory development through certification, and implementation in the 2010 through 2013 model years.

Engineer 1994-2002
Mobile Sources Control Division
Air Resources Board

-Worked as a lead staff in demonstrating technical feasibility for various OBD monitoring strategies, regulatory updates to the light-duty vehicle OBD regulation and associated guidance documents, and initiated an enforcement program to verify manufacturer's OBD systems met the requirements that resulted in many recalls and settlements.

Test Engineer 1992-1994
Mobile Sources Control Division
Air Resources Board

-Worked as a test engineer to demonstrate technical feasibility for the first Low Emission Vehicle tailpipe standards with prototype emission controls installed on production vehicles.

ORGANIZATIONAL CONFLICT OF INTEREST CERTIFICATE

Customer: U.S. Environmental Protection Agency

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X No actual or potential conflict of interest exists.

_____ An actual or potential conflict of interest exists. See attached full disclosure.

Subcontractor/Consultant certifies that its personnel, who perform work on this Contract, have been informed of their obligations to report personal and organizational conflict of interest to Contractor and Subcontractor/Consultant recognizes its continuing obligation to identify and report any actual or potential organizational conflicts of interest arising during performance under referenced contract.

Mike McCarthy
Subcontractor/Consultant

12/11/2013
Date

9300 Lee Highway — Fairfax, VA 22031-1207 — 703.934.3000 — 703.934.3740 fax — icfi.com

REVECORP
ENGINEERING AND DATA SOLUTIONS
www.Revecorp.com
5732 Lonetree Blvd, Rocklin, CA 95765 USA 916.786.1006

Resume
Michael J. St. Denis, D. Env.

Background

Dr. St. Denis is a recognized expert in vehicle inspection and maintenance (I/M) programs with over 20 years of industry experience. He has experience with all vehicle inspection programs in the US, vehicle emissions inspection technology including data systems, emissions measurement and safety testing equipment. Developed vehicle inspection program for regulated entities (states or municipalities) throughout the US, developed requests for proposals to retain contractors to build inspection systems and implement the programs. Dr. St. Denis has provided quality assurance services to ensure inspection systems installed by vendors perform as per requirements. He has extensive experience educating professionals in the industry on technology, market opportunities and the status of vehicle inspection programs and requirements. He performs basic vehicle emissions and safety research for the vehicle and oil companies, US EPA and state air quality agencies. Dr. St. Denis is currently responsible for managing I/M-related projects, providing assistance to numerous states in developing I/M program specifications, evaluating program benefits, program auditing, quality assurance, and analysis of vehicle emissions test data. Dr. St. Denis is regarded as a foremost expert in I/M emissions test equipment design, operation, auditing and acceptance testing and worked as an expert witness in the field of vehicle inspection technology.

Education

D. Env., Environmental Science and Engineering - UCLA, Los Angeles, CA 1993
M.S., Physical Chemistry - University of the Pacific, Stockton, CA, 1989
B.S., Chemistry - University of the Pacific, Stockton, CA, 1985

Professional Experience

2007 to Present **Principal**
Revecorp, Inc., Roseville, CA

- Management responsibilities include: business development activities; proposal preparation and submittal; project planning, logistics, management and scheduling; project implementation and operations activities; personnel and resource allocation; development of project budgets; project-level financial monitoring and reporting (both internally and to clients); report preparation; contract negotiation; and client liaison.

- Focus of work related to vehicle inspection program design, vehicle emissions testing equipment, planning, and implementation. Performing analysis of vehicle inspection data for program effectiveness and fraud through the use of triggers. Expert in the development of acceptance testing for vehicle emissions inspection test equipment (OBDII, BAR97 type analyzers, IM240 type systems, dynamometers and gas cap/pressure testing equipment).

- Significant work providing legal support related to emissions testing equipment failures to perform and vehicle emissions testing program fraud.
- Specific technical I/M project activities and responsibilities have included:
  - ✓ Member of the US EPA Remote OBDII Protocol Technical Subgroup.
  - ✓ US EPA High Evaporative Emission Vehicle Identification Pilot Project (CRC E-77-3) developing field test procedures and jointly operating the test program.
  - ✓ Project Manager for the District of Columbia Department of Motor Vehicles on the implementation of IM240 testing. Developed specifications for equipment and performed equipment acceptance testing.
  - ✓ Test and retrofit assistance to the New York Taxi and Limousine Commission
  - ✓ OBDII testing program assistance to the Louisiana Department of the Environment.
  - ✓ Developed equipment audit procedures for the District of Columbia Department of the Environment.
  - ✓ Expert witness assistance with patent validity via *Inter Partes* Review before the Patent Trial and Appeals Board
  - ✓ Assistance to the Texas Commission on Environmental Quality, through Gordon-Darby for conversion of the vehicle information database from operation by Verizon Business to operation by Gordon-Darby.
  - ✓ Assistance to legal counsel in evaluation of test equipment for compliance with BAR97 certification requirements.

2006 to Present — **President**
St. Denis Innovations, LLC., Roseville, CA

- Responsible for new product development, intellectual property management, and technology licensing. Developed two products protected by U.S. Patents. Products relate to vehicle testing equipment, aviation and remote tracking technology. Product currently being marketed nationally (www.Ready-or-Not.us).

1998 to 2007 — **Managing Partner, Senior Engineer**
Sierra Research, Inc., Sacramento, CA

- As a Managing Partner and shareholder at Sierra Research, involved in oversight of corporate business practices and marketing efforts. Responsibilities included: project, personnel and resource planning and management; participation in corporate marketing and strategic planning discussions and efforts; identifying and pursuing new business opportunities and strategic partnerships; ensuring on-time completion of projects and transmittal of deliverables to clients; client liaison; and contract, budget and schedule monitoring and reporting to clients.

- Frequent speaker and session chair at the Annual Mobile Sources/Clean Air Conferences in Colorado, as well as providing assistance to conference organizers in setting agendas for the annual sessions, and identifying and inviting speakers.

Attendance and presentations at annual Coordinating Research Council (CRC), Society of Automotive Engineers (SAE), and other air quality and vehicle emissions technical conferences as well. Past guest lecturer on emissions control technologies and standards at University of Michigan short course on motor vehicle emissions.

- Managed Sierra's I/M-related projects. Technical I/M project activities and responsibilities have included:
  - ✓ Assistance to states in development of I/M program specifications, evaluation of I/M vehicle programs, analysis of vehicle emissions testing data, I/M program auditing and quality assurance, and technical support.
  - ✓ I/M program assistance to states and others in developing test program protocols, equipment specifications, contractor RFP and other procurement-related documents, and audit plans and procedures.
  - ✓ Extensive work in acceptance testing of centralized and decentralized I/M program test equipment (gas analyzers, dynamometers and OBDII test systems), and end-to-end testing of electronic transmission systems and vehicle information databases (VIDs).
  - ✓ Auditing all aspects of I/M programs from equipment auditing to overall program auditing for compliance with federal guidelines. Also provided hands-on training to perform OBDII and other emissions test equipment audits to US EPA and state program staff.
  - ✓ For the US EPA, worked on projects under a technical support contract to evaluate new test program designs, propose changes to current technical guidance, draft new guidance, and evaluate improvements in US EPA support to states on I/M programs.
  - ✓ Evaluation of emissions reductions through the use of various emissions testing regimes and various types of emissions analysis equipment (including particulate emissions from Diesels).
  - ✓ Development of and working with state clients on all aspects necessary to implement OBDII testing programs including development of specifications, equipment testing, and development of an OBDII master reference lookup table.
  - ✓ Development of annual reports on the status of all United States I/M programs, which involved contacting all the I/M programs to determine any program changes or other developments since publication of the previous annual report as well as any planned future program changes
  - ✓ Developing/updating Sierra's master I/M and OBDII lookup tables, and program specific vehicle reference tables (VRTs) that incorporate the contents of the master lookup tables for a number of I/M programs or their contractors including Georgia, California, New York, Washington State, New Jersey, Massachusetts, Texas, Virginia, Alaska, Connecticut, Oregon, New Mexico, ESP, Applus and Testcom.

- Provided technical assistance to the following clients and I/M programs:
  - ✓ U.S. Environmental Protection Agency
  - ✓ California Air Resources Board
  - ✓ California Bureau of Automotive Repair
  - ✓ Georgia Environmental Protection Division
  - ✓ New Jersey Clean Air Program
  - ✓ Massachusetts Department of Environmental Protection
  - ✓ Connecticut Department of Motor Vehicles
  - ✓ Gordon-Darby and their customers, the New Hampshire Department of Motor Vehicles, Arizona Department of Environmental Quality, Texas Commission on Environmental Quality

- ✓ Vermont Department of Environmental Conservation
- ✓ District of Columbia Department of Motor Vehicles
- ✓ District of Columbia Department of the Environment
- ✓ Alaska Department of Environmental Conservation
- ✓ Municipality of Anchorage Alaska
- ✓ Missouri Department of Natural Resources
- ✓ Borough of Fairbanks Alaska
- ✓ New York Taxi and Limousine Commission
- ✓ Colorado Department of Public Health and the Environment
- ✓ Pacific Vehicle Testing Technologies, Ltd. (AirCare British Columbia)
- ✓ Louisiana Department of Environmental Quality
- ✓ Virginia Department of Environmental Quality
- ✓ New South Wales (Australia) Roads and Traffic Authority
- ✓ Envirotest
- ✓ Environmental System Products Inc
- ✓ Worldwide Environmental Products
- ✓ Applus Technologies
- ✓ SGS Corporation
- ✓ Coordinating Research Council
- ✓ Environmental Testing Corporation
- ✓ Dah Chong Hong Motor Service Center Ltd., (Hong Kong, China)
- ✓ Stetina Brunda Garred & Brucker PC
- ✓ Sidley Austin LLP
- ✓ Quinn Emanuel Urquhart Oliver & Hedges LLP
- ✓ Fraser Milner Casgrain LLP

- Co-developed and patented a tester for verifying proper dynamometer performance that multiple state I/M programs are currently using to conduct test system acceptance testing and audits. The tester allows for evaluation of either steady state or transient dynamometers. Developed an enhanced version of the dynamometer tester for EPA to test two- and four-wheel drive 48-inch roll certification dynamometers.

1997 to 1998 **Project Manager, Diesel Emissions Testing Program**
Clayton Industries, Inc. - City of Industry, CA

- Responsible for development of loaded-mode Diesel vehicle test systems.
- Additional responsibility for international business development for vehicle emissions test systems and for providing international technical support on new product development.
- Worked with government agencies in Hong Kong, China, Korea, Australia, Philippines, Canada, England, Germany, and California to develop vehicle emissions test systems.
- Worked with partners including Snap-On International, SPX Corporation, and Dah Chong Hong on joint development of vehicle emissions testing solutions in Asia.

1993 to 1997 **Manager and Senior Engineer**
Parsons, Inc. - Pasadena, CA

- Served as Project Manager for projects involving vehicle emissions testing and emissions modeling analyses.

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- Responsibilities in the area of vehicle testing included design and installation of computerized IM240 and ASM test lanes for testing light-duty motor vehicles, evaluation and selection of testing equipment, development of automation software, vehicle procurement, management of test center and staff, transient loaded mode vehicle emissions testing, and data analysis.
- Conducted studies evaluating the cost-effectiveness of accelerated vehicle retirement (scrap programs) for light duty vehicles, catalytic converter replacement, and I/M waiver criteria.
- Modeling responsibilities included review of vehicle emissions simulation modeling of heavy-duty Diesel vehicles and related modeling assumptions, development of a vehicle emissions reduction credit model for analysis of heavy-duty Diesel vehicle scrap programs, and evaluation and critique of heavy-duty Diesel vehicle emissions modeling performed by the US EPA.
- Project Technical Advisor to the Bureau of Automotive Repair (BAR) referee program. Developed and managed a research test center for BAR in which the first studies in California were conducted to evaluate the IM240 for use in centralized testing and to evaluate the current test procedure (ASM).
- Served as Technical Manager for the Alternative Fuel Vehicle Feasibility Study conducted for the U.S. Air Force at Hill AFB in Ogden, Utah, evaluating the air quality benefits and cost-effectiveness of seven different systems for converting Diesel vehicles to operate on compressed natural gas.

1991 to 1993 — **Contractor**
South Coast Air Quality Management District - Los Angeles, CA

- Conducted research for project jointly sponsored by the South Coast Air Quality Management District, Ford Motor Company, and the Coordinating Research Council. Managed a test and simulation research project on computerized vehicle emissions control systems to determine if vehicle emissions control systems are calibrated to have lower emissions during certification than on road.
- Instrumented an experimental vehicle using air/fuel ratio sensors, thermocouples in the exhaust stream, interface to on-board electronic engine controller, and other sensors. Collected vehicle operating parameter data on urban and freeway routes in Los Angeles.
- Developed new dynamometer driving cycles that were to be representative of actual driving patterns in Los Angeles and used these cycles to conduct transient loaded mode vehicle emissions tests at Ford's test facilities.
- Wrote two vehicle emissions computer models used to simulate driving in the Los Angeles area to aid in determining the causes of high emissions rate events.

1990 to 1993 — **Staff Research Associate**
UCLA School of Public Health, Los Angeles, CA

- For the US EPA, developed a compact and portable differential optical absorption spectrometer (DOAS) to measure the indoor air pollutants formaldehyde, nitric acid (HONO), and NO2. Designed the optical system and components, and tested and evaluated a new diode array electronic detection system for the spectrometer.
- For the South Coast Air Quality Management District, modified the Regional Human Exposure Model (REHEX) to allow for modeling of human exposure to benzene and formaldehyde in the South Coast air basin.

REVECORP INC.

Large Project Experience

California Bureau of Automotive Repair, Smog Check Referee Program, 1993 to 1997. Technical manager for vehicle inspection station network of 57 facilities throughout state of CA with over 100 staff. Responsible for budgeting and resource allocation. Total program value over $40 million.

California Bureau of Automotive Repair, Program Test Options Evaluation, 1994 to 1996. Designed, equipped and operated three test facilities, managed 20 staff. Total program value $1.5 million.

New Jersey Motor Vehicle Commission, Motor Vehicle Emission Program Replacement Planning and Oversight, 2011 - 2014. Provide evaluation, planning and oversight for implementation of a revised vehicle inspection program. Work includes complete review of the current program, modeling of emissions impacts and financial impacts of various alternative inspection delivery methods, development of a Request for Proposals for the State to retain a vendor to implement the developed plan and then oversight of the new vendor. Contract value $3.3 million, Revecorp working as a sub-contractor to ERG, Revecorp portion $900,000. New vendor contract expected to be valued at $30 to $60 million.

New Jersey Department of Motor Vehicles, Vehicle Inspection Program Privatization Oversight, 1999- 2005. Provided oversight of contractor retrofitting 37 inspection stations throughout the entire state of NJ for operation by private contractor. Performed review of facility plans, equipment and software specifications, database and communications specifications, and staff training and management plans. Provided acceptance testing and approval of installations before being allowed to become operational. Retrofit cost over $60 million.

Massachusetts Department of Environmental Protection, Vehicle Inspection Program Privatization Oversight, 2000-2005. Provided oversight of contractor equipping 1800 private inspection stations, installing new data system, and establishing program operations. Performed final acceptance testing, specification reviews, data system reviews, and program option analyses. Total program value $250 million.

Louisiana Department of Environmental Quality, Program Implementation Oversight, 2003 to present. Providing contractor oversight for implementation of new test equipment and data system developed by contractor. Total program value several million dollars.

Washington DC Department of Motor Vehicles, Test Facility Retrofit, 2005 to 2007. Project manager and overall design engineer for complete facility equipment and data system upgrades. Selected subcontractors for equipment and data system development and managed three phases of retrofit. Retrofit cost $2 million.

Performed audits of state-wide inspection programs for Colorado, Connecticut, Alaska, Missouri. Evaluated programs versus vendor contractual requirements, federal and state regulations, and best engineering practices.

Professional Organizations

- Member US EPA Federal Advisory Committee Act (FACA) Remote OBDII Protocol Technical Subgroup

REVECORP INC.

- Member the Society of Automotive Engineers
- Member of the American Chemical Society

Other Experience

- Provided expert witness services related to vehicle inspection program project failures, emissions testing equipment product defect cases, related to emissions testing fraud and vehicle inspection equipment patent infringement inter parties reviews.
- "Evaporative Emissions Control System Monitoring," U.S. Patent applied for, October 28, 2013. Inventors: G. Glinsky and M. St. Denis.
- "A Device and Method for Verifying the Operation of a Chassis Dynamometer," U.S. Patent No. 6,601,441 B1, issued August 5, 2003. Inventors: G. Torgerson and M. St. Denis, Assignee: Sierra Research Inc.
- "OBDII Readiness Status Notification Device," U.S. Patent 7,012,512 B2 issued March 14, 2006. Inventor: M. St. Denis, Assignee: St. Denis Innovations LLC.
- Guest lecturer during period 1999-2002 at University of Michigan summer courses in automotive emissions control.
- Development of VINterpreter, a vehicle identification number decoder which can provide all information necessary for vehicle inspections. Available as an Android application on the Google Play store.
- Development of ReveTHEFT, a stolen vehicle identification Android application for use by law enforcement. Available on the Google Play store.

Publications and Presentations

"Evaporative Emissions Durability Testing", CRC Project E-91, Prepared for the Coordinating Research Council, August 6, 2012 (Co-Authors Joe Roeschen, Revecorp; Keith Vertin, Gerard Glinsky, Jan Mickelsen, SGS Environmental Testing Corporation; Craig Morgan, Chrysler Corporation Chelsea Proving Grounds)

"Evaporative Emissions Reductions Using Remote Sensing," presented at I/M Solutions Conference, Sacramento, California, May 20-24, 2012.

"Changes to the Delivery of I/M Programs as OBDII Matures" Presented at the 22nd CRC Real World Vehicle Emissions Workshop, San Diego, California, March 25-28, 2012.

"Evaporative Emissions Reductions Using Remote Sensing," Presented at the 22nd CRC Real World Vehicle Emissions Workshop, San Diego, California, March 25-28, 2012.

"New Jersey Interim Report: Review of Current I/M Program and NGcontract Options", Draft Report, New Jersey Motor Vehicle Commission, December 1, 2011.

"Mentoring for Potential New I/M Non-attainment Areas" Presented at the 26th Clean Air Conference, Estes Park, Colorado, September 27, 2010 (co-author Jim Lindner, ERG).

"Evaluation of the District of Columbia Vehicle Inspection Program Options," prepared for the District of Columbia Department of the Environment, December 2008.

"Survey Results: What States Think About Future OBD", presented by Richard Joy at the 24th Annual Mobile Sources/Clean Air Conference, Breckenridge, Colorado, September 22-25, 2008 (performed study, analysis and generated results).

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ORGANIZATIONAL CONFLICT OF INTEREST CERTIFICATE

Customer: U.S. Environmental Protection Agency

Contractor: ICF Incorporated, LLC, 9300 Lee Highway, Fairfax, VA 22031

Prime Contract:

In accordance with EPAAR 1552.209-70 through 1552.209-73, Subcontractor/ Consultant certifies to the best of its knowledge and belief, that:

___X___ No actual or potential conflict of interest exists.

_____ An actual or potential conflict of interest exists. See attached full disclosure.

Subcontractor/Consultant certifies that its personnel, who perform work on this Contract, have been informed of their obligations to report personal and organizational conflict of interest to Contractor and Subcontractor/Consultant recognizes its continuing obligation to identify and report any actual or potential organizational conflicts of interest arising during performance under referenced contract.

Subcontractor/Consultant

December 6, 2013

Date

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Appendix B. **Charge Letter**

Peer Reviewer Charge

Charge to Peer Reviewers of "*Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and* DTCs *Using I/M Data"*

Gasoline vehicles are equipped with evaporative emissions control systems that control vapor from the fuel storage system while a vehicle is sitting or driving. When these systems or the vehicle's gasoline delivery system malfunction, excessive evaporative emissions can be emitted. Few estimates of the frequency of vehicles with evaporative emissions malfunctions, or leaks, in the fleet exist. These vehicles can have a significant impact on the hydrocarbon (HC) emissions inventory.

This report pulls together five states of data for an analysis of the evaporative emissions related on-board diagnostics (OBD) codes.

You are asked to review and provide expert comments on the *Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data.*

In your comments you should distinguish between recommendations for clearly defined improvements that can be readily made based on data or literature reasonably available to EPA and improvements that are more exploratory or dependent on information not readily available to EPA. Your written comments should address all aspects of the report (methodologies, analysis, conclusions, and narrative) and should be sufficiently clear and detailed to allow readers to thoroughly understand their relevance to the subject report. In addition to addressing these issues, EPA encourages you to best apply your particular area(s) of expertise to review the overall study. **Please *deliver your final written* comments *to Lou Browning at ICF International* (**Louis.Browning@icfi.com**) *by January 15, 2014.***

All materials provided to you as well as your comments should be treated as confidential, and should neither be released nor discussed with others outside of the review panel. Once EPA has made its reports and supporting documentation public, EPA will notify you that you may release or discuss the peer review materials and your review comments with others.

If the reviewer has questions about what is required in order to complete this review or needs additional background material, please contact Lou Browning at ICF International (Louis.Browning@icfi.com or 831-662-3683). If the reviewer has any questions about the EPA peer review process itself, please contact Ms. Ruth Schenk in EPA's Quality Office, National Vehicle and Fuel Emissions Laboratory (schenk.ruth@epa.gov or 734-214-4017).

Some specific areas of focus include the following:

1. Does the report meet its primary goal?
2. Is the description of analytic methods and procedures clear and detailed enough to allow the reader to develop an adequate understanding of the steps taken and assumptions made to develop the tables and figures in the report? Are examples selected for tables and figures well-chosen and designed to assist the reader in understanding the approach and methods?
3. Does the methodology, data, and analyses support the report's conclusion?

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Appendix C. **Gene Tierney Review Comments**

Gene Tierney's Review of *Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data*

I have completed my review of the draft report "*Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data*." My comments and questions follow.

My first comment is that the purpose of this analysis is not at all clear. There does not seem to be a hypothesis or research question being tested or a potential application for the data analysis discussed. It would be helpful to be able to evaluate the results of the analysis against such a hypothesis, research question or proposed application. While the report does a good job of presenting the data and the analyses, it is difficult to determine whether the report meets its "primary goal" because that is not clearly stated.

My second comment is that two of the states in this analysis are clearly identifiable by the features of their programs (California and Colorado), so the pretense of not identifying them really doesn't work! It is not clear what purpose is served by attempting to maintain anonymity of the programs.

Third, the report should address the uncertainties associated with the use of I/M data. Some motorists get repairs performed just prior to the initial inspection because the MIL is on and they know they will fail. Such repairs are generally followed by a clearing of codes and resetting of the monitors. So, the rate of monitor readiness detected at initial inspection is impacted by this phenomenon; this fact is bolstered by the decrease in unreadiness found when all inspections were considered. It is not known either how often pre-inspection repair occurs or how that might affect monitor readiness. As the report points out, this is a transitory issue. Again, depending on the ultimate use of this data analysis, this may or may not be a factor. The report mentions the idea of pursuing alternate non-I/M data sets to supplement this analysis; that would help address this issue.

Fourth, the report finds that evap monitor unreadiness appears to increase with age. It would be useful to put this into context: does readiness of other monitors change with age in a similar fashion or is just the evap monitor? If evap monitor unreadiness increases at a faster rate than other monitors this would be useful to understand. For comparison sake, a sample of the data for one other important monitor (e.g., catalyst) might sufficiently shed light on this question.

Fifth, on this same point, no discussion ensues about why evap monitor unreadiness increases with age. It might be useful to pose alternative hypotheses to explain this phenomenon that could lay the basis for future research programs. For example, one possibility is that the increase in evap monitor unreadiness has nothing to do with the evap system itself. We know that MIL on rates increase with age and, as a result of repair, the resetting of the OBD system. This kicks the monitors into a state of unreadiness.

The evap monitor is harder to set so one would expect the frequency of evap monitor unreadiness to increase as a result. Alternately, is there something about evap monitoring systems that is impacted by age or deterioration such that it becomes increasingly difficult to get the evap monitor ready?

Sixth, the I/M programs in question all exempt vehicles from inspection for more than the first 2 years of the vehicles' lives, yet the analyses show results for all states starting with vehicles at age 2 years old. This apparent contradiction should be explained in the text. I presume in the case of the California, the data is primarily for vehicles that change ownership prior to the 6 year old inspection requirement. This might also explain why in States B and C, the percent of inspections with monitors ready is apparently flat until after age 4 when the downward slope begins. Was consideration given to eliminating the pre-inspection requirement data? What impact does this have on the slopes of the lines in Figure 5 and others?

Seventh, the report does not provide any statistical information on the numbers of vehicles in any of the cohorts. No discussion is made of the statistical significance of the differences or similarities found. For example, in section 2.5, the report states that the slopes of the lines in Figure 5 for states A and D are different from states B and C. If they are different, the statistical basis for that statement should be elucidated. Likewise, after modifying the data, the slope for State B seems to fall in line with A and D but State C still appears to be different. In addition to discussing the statistical significance of these apparent differences it would be useful to address why State C does not seem to change. Is there something about the program design? The climate? There appears to be an anomaly but we don't have any ideas as to why.

Eighth, Figure 11 compared to similar figures for the other states, appears to show that failure to require motorists to repair vehicles based on OBD results in significantly higher DTC rates. A key question for EPA as it continues to improve and upgrade the MOVES model is how well it characterizes non-I/M emission rates of the national fleet, especially for evap given its outsize contribution to the inventory. Further investigation of this finding may help shed light on the emission reduction benefits of OBD I/M with regard to evap. It appears that MOVES may underestimate evap deterioration outside I/M areas that enforce OBD. Such data may also be helpful for states in assessing the efficacy of the I/M program, as required by the Clean Air Act.

Appendix D. **Mike McCarthy Review Comments**

Mike McCarthy's Review of *Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data*

1.0 Introduction

This report presents results from ERG's analysis of light-duty gasoline-powered vehicle On-board Diagnostic (OBD) evaporative emissions control system (evap) diagnostic trouble codes (DTCs) using inspection and maintenance (I/M) program data. The purpose of this Work Assignment (WA) is to perform analysis to better understand evap DTC rates for light-duty vehicles.

In this report, the results of analysis of data from four states (identified as "State A" through "State D") are presented. The data was split into calendar year for each state, and only model years 1996 and newer were included in this analysis. Pre-1996 model year vehicles weren't included in the analysis since OBDII compliance was not federally mandated until model year 1996. Also, although OBD monitoring of evap control systems was present beginning in model year 1996 vehicles, enhanced OBD evap monitoring of Tier 1/NLEV vehicles was not fully phased in until model year 1999, so some report results, such as readiness trends presented in Section 2.4 and DTC trends presented in Section 3.2, are tailored to only include model year 2000 and newer (enhanced evap) vehicles. When reviewing results, it should also be noted that federal enhanced evap phase-in requirements for Tier 2 vehicles began in model year 2004 with full compliance by model year 2007. California Air Resources Board (CARB) requirements for enhanced evap began in model year 1996 with full phase-in by MY1998, and CARB LEV II requirements began in MY2004 with complete phase-in by MY2006.

The data from these states spans the calendar years of 2004 through 2012, depending on data available from each state at the time of analysis. Table 1 shows the calendar years of data analyzed for each state as well as the I/M program cycle frequency (annual or biennial) and model year exemption period for the I/M program during the calendar years of data analyzed for each state. The last column highlights each state's readiness criteria (how many "not ready" monitors are allowed for each state's OBD test).

Table 1. Calendar Years and Other Program Information for Each State

State Code	Calendar Years of Data Available	OBD Inspection Frequency	Exemption Period	Ready Criteria (Number of monitors allowed to not be ready for an I/M inspection)
A	2004-2010	Biennial	Resale: First 4 years Biennial: First 6 years	2 allowed for all vehicles (a bit more complex: based on vehicle-specific lookup tables)
B	2007-2012	Annual	First 3 model years	1996 – 2000: 2 allowed 2001 and newer: 1 allowed

Summary of Comments on Microsoft Word - EPA-131211.docx

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Author: mmccarth Subject: Comment on Text Date: 1/10/2014 9:41:28 PM
This is a pretty vague purpose and doesn't even suggest what the current understanding was before the analyses or what observations/theories/whatever led to the need for better analyses. Doesn't set up the reader very well for why this was undertaken or what initial base of knowledge it was going to take a leap forward from to better understand. Probably could have gotten a more focused analysis if there were specific questions or theories or suspicions or whatever that led to the desire to have further analyses done.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 11:46:58 AM
For completeness, 'enhanced evap' generally referred to the first improvement that was not only phased in 95-98MY for Calif but also 96-99MY for Federal. Tier 2/LEV II evap requirements are correctly noted as phasing in 04-07/06 for Fed/Calif.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 11:55:11 AM
If you really desire to keep the states anonymous, you'll have to omit some relevant description information because readers with some IM knowledge will readily know A is Calif based on the 6 year exemption and last to change to 2/1 not ready and everyone will readily know D is Colorado as the only state with an IM program that uses IM240 and does not use OBD.

State Code	Calendar Years of Data Available	OBD Inspection Frequency	Exemption Period	Ready Criteria (Number of monitors allowed to not be ready for an I/M inspection)
C	2005-2009	Biennial	First 4 model years	1996 – 2000: 2 allowed 2001 and newer: 1 allowed
D	2004-2011	Biennial	First 4 model years	N/A, OBD not enforced

In Section 3 (DTC Analysis), all vehicles with a "not-ready" evap monitor are excluded, and the calendar year / model year percentages are based only on those vehicles with a "ready" evap monitor, unless otherwise stated. In addition, the DTC analysis performed in this report was performed on all I/M records with evap DTCs, regardless of MIL command or pass/fail status of the test. Therefore, these DTCs may include pending DTCs.

The OBD ready criteria for State D indicates that the OBD program is not enforced. This means that the OBD test result is not a criteria for passing or failing an inspection. The pass / fail determination for that state is based on results of an IM240 tailpipe test and a gas cap functionality test. A vehicle that fails the IM240 or gas cap test fails the overall test and must pass a re-inspection to receive an overall pass. A vehicle with stored OBD codes and an illuminated malfunction indicator light (MIL) will not fail the test unless the vehicle also fails the IM240 test or the gas cap functionality test.

A summary of the analysis objectives and results of analysis is provided in the following sections.

2.0 Summary of Analysis Results for Evap Monitor Readiness

In order to understand and quantify the evap DTC rates, ERG first identified vehicles with an evap monitor ready at the time of the I/M test. Therefore, the first part of the analysis involved quantifying how many vehicles had a "ready" evap monitor at the time of the initial or re- inspection for one inspection cycle.

The objectives for the analysis in this section were to quantify the percent of vehicle inspections with evap monitors "ready and "not ready" at the time of inspection, evaluate the rate of readiness as vehicles age, and compare the results among the states to determine if the increase of "not ready" vehicles was similar for each state.

2.1 Defining Initial Tests

The purpose of the analysis was to quantify the percent of inspection cycles with an evap monitor status of "not ready" for each inspection in the cycle, so ERG needed to define each

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Author: mmccarth Subject: Comment on Text Date: 1/10/2014 9:43:11 PM
No, technically they don't include pending DTCs. No state IM program in the US collects pending code data (via Mode $07 of SAE J1979). States only use Mode $03. DTCs read via Mode $03 have to be associated to MIL status---a DTC + MIL commanded on = confirmed/active DTC. A DTC + MIL commanded off = previously active DTC (MIL used to be on but has since been repaired (without a code clear) or self-healed and self-extinguished the MIL but has not yet self-cleared the DTC). And, if there are multiple DTCs read via Mode $03 and the MIL is commanded on, it is impossible to determine which of the individual DTCs are currently in the active state and which are in the previously active state.

It may not have been wise to include cases of DTCs present but no commanded MIL in the analysis because they don't necessarily indicate that the vehicle had a problem at the time of the inspection. As a point of reference, the California database shows a surprisingly high number of vehicles with MIL off but DTCs stored. The data indicates that history codes seem to linger for longer than we expect after the fault is gone, and if so, this could impact the analysis in a significant way. At a minimum, they should have analyzed how much adding them in verses leaving them out affected the results.

Author: mmccarth Subject: Comment on Text Date: 1/10/2014 9:52:07 PM
Not obvious to the reader why an objective would be determining if the increase was similar for each state.

readiness at initial inspection was in State A, where almost 12% of the vehicles receiving initial tests had evap monitors that were not ready. Table 1 shows that State A also has the oldest I/M fleet because of the 6 model year exemption for new vehicles for I/M testing.

Table 2. Initial Test Monitor Readiness Results for All States

State	Percent of Inspections for I/M Fleet with Evap Monitor Ready at Initial Inspection	Percent of Inspections for I/M Fleet with Evap Monitor Not Ready at Initial Inspection
A	88.3%	11.7%
B	90.3%	9.7%
C	91.2%	8.8%
D	91.3%	8.7%

Note: These results are for model years 1996 and newer

Table 2 shows that regardless of the details of the I/M program or the calendar years of data present, approximately 90% of the initial inspections have evap monitors ready. The results indicate that about 10% of the initial inspections in any given I/M program are going to have an evap monitor that is not ready. The similarity in this percentage for all of the states suggests that this number could approximate a national percentage of vehicles in I/M programs with "not ready" evap monitors.

2.3 Percent of Test Cycles with Ready Evap Monitors

For this analysis, ERG analyzed the readiness of all tests within inspection cycles (not just the initial test) to determine the number of inspection cycles with a "not ready" evap monitor. In many cases, there was only one test for the vehicle in the I/M cycle, but in some cycles, the vehicle received multiple inspections. In the previous section, it was found that roughly 9% to 12% of the initial inspections had an evap monitor status of "not ready". Table 3 shows that these percentages decrease to 7% to 11% for all inspections in an I/M cycle. This indicates that "not ready" evap monitors occasionally achieved readiness for retests in inspection cycles with multiple tests. As indicated in the previous section, the percentage range of "not ready" evap monitors is very close in all the states and could approximate the national percentage of vehicles in I/M programs with "not ready" evap monitors.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 1:41:28 PM
I think an important caveat might be approximating a national % of evap not ready for 'initial inspections' which is not necessarily the same as 'of vehicles in IM programs'. Calif has done random roadside testing that has historically shown much lower percentage of the fleet has any monitors 'not ready' and Oregon analysis (e.g., Gary Beyer at most recent IM solutions conf) as well as similar analysis done internally at ARB shows fleet profile is very different from initial inspection profile ('distance since code clear' and '# of warm-ups since code clear' show very big impact on 'not ready' rates shortly before inspection cycle making initial inspection look very different than how the fleet looks). i.e., initial inspection has much higher not ready rates than the actual fleet due to action by the vehicle owner in anticipation of the scheduled inspection.

Table 3. Evap Monitor Readiness Status for All Tests Within an I/M Cycle for All States

State	Percent of I/M Fleet Inspections with Evap Monitor Ready For Least One Test in the Inspection Cycle	Percent of I/M Fleet Inspections with Evap Monitor Not Ready For All Tests in the Inspection Cycle
A	89.6%	10.4%
B	92.1%	7.9%
C	92.8%	7.2%
D	91.4%	8.6%

Note: These results are for model years 1996 and newer

When comparing these results with previous analysis of non-evap OBD monitors, the percentage of "not ready" evap monitors was much higher than for other OBD monitors. For example, when ERG looked at all of the OBD monitors' readiness for one of these states, the non-evap OBD monitors had an overall "not ready" percentage in the 1% - 2% range instead of the 7%-11% range seen for the evap monitor. Although it is possible that the lower readiness rate of the OBD evap monitor could be due to attempts to mask evap system malfunctions (through a battery disconnect or code clearing), it is also likely that the more rigorous enabling criteria (specific vehicle operation and soak requirements) required to achieve evap monitor readiness results in the evap monitor being one of the last monitors to achieve readiness and is a contributing factor to the lower evap monitor readiness rates.

2.4 Trends of Evap Monitor Readiness by Age

The next analysis involved determining the trend of the increase of the percent of inspections with "not ready" evap monitors by age for each state and to compare the trends across the states. To do this ERG separated the data by calendar year and vehicle model year and tabulated the evap monitor readiness status of all the inspection cycles for each of the states. Specifically, ERG calculated percentages of inspection cycles in which the vehicle's evap monitor was "ready" for at least one test during the cycle, and results for each state were graphed to illustrate the trends of evap monitor readiness for vehicles as they age. These results are shown in Figures 1 through 4.

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Author: mmccarth Subject: Comment on Text Date: 1/10/2014 9:56:45 PM
I would suggest it is 'likely' or 'more likely' not 'also likely' because while it may be technically 'possible' that the lower readiness is due to attempts to mask evap problems, it probably is not likely thus saying the other reason (rigorous enable criteria) is 'also likely' or 'more likely' infers that the first reason (masking) is also likely. I think Calif random roadside data would also rule out the likeliness of the first reason (masking) because it would show massive evap DTC populations (to equate to the population of cars that are then being 'masked' in initial IM inspection as not ready for evap).

Readiness indicators (e.g., just the evap readiness monitor) cannot be reset individually, so it is impossible to show with the data that any "masking" attempts are specifically targeted to evap problems. For example, if someone is trying to mask an oxygen sensor problem (or maybe something not tied to readiness at all), the evap indicator is still going to be one of the last to set. ERG states the same possibility in the conclusion section. It could be related to the general practice of trying to erase any MIL illuminating codes to mask malfunctions, but that's as far as I think one can go, and there's nothing new about it.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:08:24 PM
As an added thought, does showing any analysis of the percentage of total cars failing for not ready (or maybe presenting with any not ready monitors) that have the evap monitor not ready help solidify the second reason (rigorous enable criteria) as the dominant factor in lieu of alternate theories like the first reason (masking)? e.g., if virtually all cars that fail for not ready or have at least one monitor not ready indeed have evap as not ready, doesn't it lead to the likely conclusion that the masking reason only could be valid if evap DTCs are so rampant that they dwarf all other failures put together and virtually everybody that has an evap DTC has figured out how to mask it based on how few of evap DTCs are left in initial inspections relative to how many would have had evap DTCS if most evap not ready cars were actually cars with Evap DTCs that were being masked prior to initial inspection?

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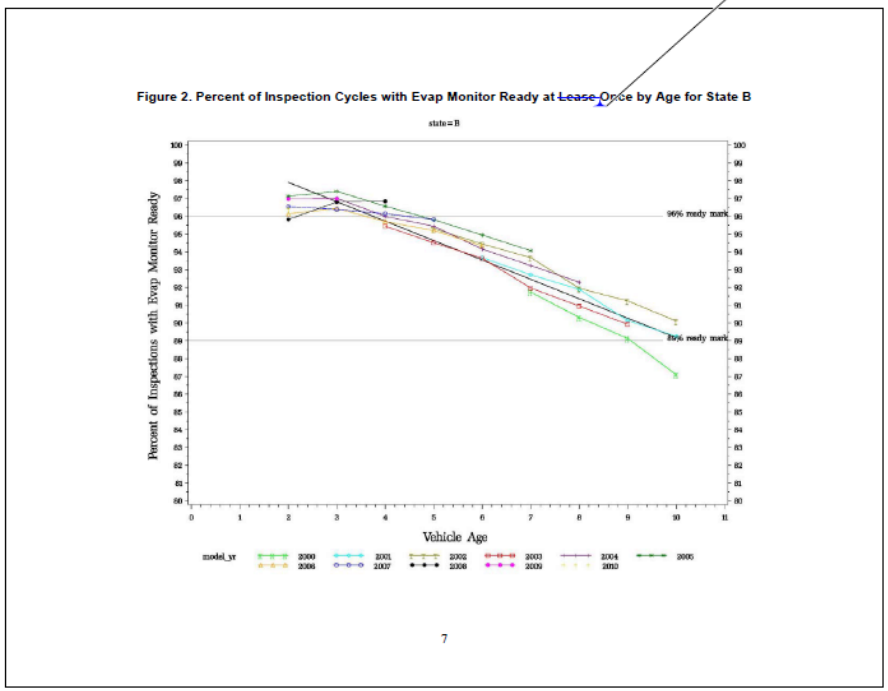
Author: mmccarth Subject: Inserted Text Date: 12/17/2013 1:49:59 PM
Least



On the figures, only model years 2000 and newer are shown. This is because although OBD evap systems were present in some 1996 vehicles, full phase-in of enhanced evap OBD did not occur until 1999. In order to develop trend lines for the evap monitor readiness percentage by age, using only 2000 and newer model years (a full year after phase-in was complete) ensures that the data used would be most representative of the trends for enhanced evap vehicles. In each graph, the different colored lines with points represent the actual data from each model year and age for the state. The solid black line with no points shows a trend line[1] for all model years which predicts the percentage of evap monitor readiness at a given vehicle age. The analysis was conducted to calculate the percentage of inspections with "ready" evap monitors for all vehicles in a given age (from 2 to 10 years old in most states). The vehicles at any given age can have a range of odometer values, so they may not all be in the same condition in terms of wear-and-tear and mileage.

Reference lines in Figures 1-4 allow comparison of the results from each state. The horizontal reference lines are set at 89% readiness and at 96% readiness. States B and C have readiness percentages that are close to these reference lines for the 2 year old and 8 year old vehicles. Two of the states, States A and D, have percentages of readiness that are well outside those reference lines.

The graph of State A differs from those of the other states. First, the range of the percentage of inspection cycles with "ready" evap monitors for all model years at a given age is larger than for the other states, especially for the newest vehicles. For example, a 2 year old vehicle in State A has a range of 87% - 99% of the inspections with an evap monitor ready, while that range is only 91% - 95% for state D. State A has a 6 model year exemption (with test-on-resale after a vehicles is 4 years old), so the 2 year old vehicles in that dataset are not representative of the fleet. This is one possible explanation for why the percentage of 2 year old vehicles with evap monitors "not ready" in State A is larger than for 2 year old vehicles in other states. Also, State A has a biennial inspection frequency. Vehicles start receiving tests when they are 6 years old and then are only tested every other year after that. The "zig-zag" on the curves follows a biennial trend (this trend is also evident but not as pronounced for states C and D, the other biennial programs). The inspection totals by calendar year and age (~~show~~ shown in the tables in Appendix B) show that the total number of inspections is lower for these "off" I/M years.

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Author: mmccarth Subject: Inserted Text Date: 12/17/2013 1:53:15 PM

[1] Trend lines were developed using linear regression techniques.

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The other state that has percentages that do not fall on the reference lines for the 2 and 8 year old vehicles is State D, which does not enforce the OBD program and therefore OBD monitor readiness is not a requirement for the I/M test.

The results in the graphs for each state show that vehicles were more likely to have an evap monitor status of "not ready" as the vehicle aged. The percentages and rates of increase of evap monitor not readiness differed for some of the states. The vehicles in state D were more likely than the other states to have an evap monitor status of "not ready", even when they were only 2 years old, and the slope of the increase of evap monitors being not ready as vehicles aged was not as steep as for States B and C.

Figure 5 shows the tendency of readiness decreasing as a function of vehicle age more clearly. Trend lines of the "predicted" percentage of vehicles with an evap monitor ready versus age are shown, and it can be seen that the slope of the lines for States B and C are steeper than for States A and D. Individual tables listing results for each state are provided in Appendix B.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 1:59:01 PM

Maybe you'll get to this later but how does this trend compare with other aspects like fail rate of cars by age or presence of a DTC by age? (e.g., is the evap readiness rate doing its own thing independent of other stuff or is it for example mirroring the increased fail rate of older cars?)

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 1:55:37 PM
Might be worth adding 'markers' to the lines to aid a reader in black/white or hard copy in distinguishing the various state trend lines from each other.

Figure 5. Slope of Percent of Inspections with Evap Monitor Ready by Age
Trend Lines with All Data Unmodified

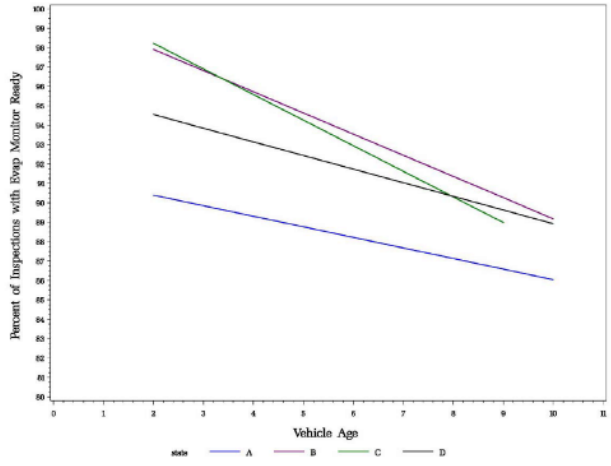

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Figure 6 shows that once the out-of-I/M-cycle inspections were removed, results from all four states have very similar percentages of vehicle readiness by age. This graph shows that as a vehicle ages, it will be more likely to have an evap monitor "not ready" during an I/M cycle, and that the increase in its likeliness of having an evap monitor "not ready" is approximately 1% per year as the vehicle ages.

Figure 7 shows combined linear trend lines of the unmodified and modified data sets. This graph is a combination of Figures 5 and 6.

2.6 Multiple Inspection Cycles with Evap Monitors "Not Ready"

The purpose of this next analysis was to identify patterns of vehicles having "not ready" evap monitors for all inspections over multiple consecutive inspection cycles. ERG evaluated the subset of vehicles for which the evap monitor was "not ready" for all tests in an inspection cycle and tracked the evap monitor status for those vehicles across inspection cycles on subsequent calendar years. Even though previous results indicated that up to 15% of inspections for older vehicles could have a "not ready" evap monitor, the results of this analysis show that those are not the same vehicles each time. The results from all states show that most vehicles (over 97%) have an evap monitor status of "not ready" only one or two times in their entire I/M history. For the vehicles that were in the data for at least 2 inspection cycles, only about 0.5% of the them have an evap monitor status of "not ready" each time they come in for an inspection, which is a very small percentage of the I/M fleet.

3.0 Summary of Analysis Results for Evap DTCs Set

For the vehicles that had a ready evap monitor for at least one inspection of their I/M cycle in each calendar year, ERG determined if one or more evap DTCs were set during any test in the I/M cycle. Several OBD P0 and P1 DTCs that pertain to the evaporative emissions control system were considered. P2 and P3 codes were not considered in this analysis due to the small numbers of those codes present in the states' data. Less than 0.1% of the DTCs present were from P2 or P3 codes. The generic (P0) SAE J2012 evap DTCs of interest for this study are listed in Table 4. In general, the evap-related P1 (manufacturer-specific) fault codes included in this analysis correspond to the generic P0 fault code categories.

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Author: mmccarth Subject: Comment on Text Date: 1/10/2014 10:06:09 PM
Carl Fulper has previously posited a theory that perhaps the vehicles were programmed to turn off evap monitors as they got older (or make them run less frequently) to avoid bringing evap leaks/problems to light that would be expected to increase as the cars age. Doesn't this finding pretty much prove such a theory is wrong and if so, might need more emphasis.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:11:58 PM
Could consider putting both of these sentences into a footnote rather than in the body itself because it is a valid but very minor point that otherwise just detracts the reader.

Author: mmccarth Subject: Comment on Text Date: 12/18/2013 10:51:41 AM
Does this mean you just assumed any P1xxx where the xxx matched the last three digits of one of the P0xxx codes Table 4 was evap related? Or did you do some investigation into service information or something else to gather evap related P1xxx DTCs by manufacturer and then count them only if they matched by manufacturer and P1xxx code (e.g., if P1457 is a Honda evap code but VW/Audi EGR code, did you count all P1457 or only if it was a Honda with a P1457)? Might be worth a note to the reader of one sentence or so to explain how you determined which P1xxx codes to include as evap related. Q quick and dirty way (can't speak to its absolute accuracy) is using a website like dtcsearch.com to see what the P1xxx codes are mapped to for various manufacturers. You will probably find some EGR and secondary air DTCs in this P1xxx range especially for VW/Audi, maybe LandRover, Mercedes, etc.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:16:22 PM
Not worded right...

Table 4. Generic P0 Evap DTCs

DTC Code	DTC Description
P0093	Fuel System Leak Detected - Large Leak
P0094	Fuel System Leak Detected - Small Leak
P0440	Evaporative Emission Control System Malfunction
P0441	Evaporative Emission Control System Incorrect Purge Flow
P0442	Evaporative Emission Control System Leak Detected (small leak)
P0443	Evaporative Emission Control System Purge Control Valve Circuit
P0444	Evaporative Emission Control System Purge Control Valve Circuit Open
P0445	Evaporative Emission Control System Purge Control Valve Circuit Shorted
P0446	Evaporative Emission Control System Vent Control Circuit Malfunction
P0447	Evaporative Emission Control System Vent Control Circuit Open
P0448	Evaporative Emission Control System Vent Control Circuit Shorted
P0449	Evaporative Emission Control System Vent Valve/Solenoid Circuit Malfunction
P0450	Evaporative Emission Control System Pressure Sensor Malfunction
P0451	Evaporative Emission Control System Pressure Sensor Range/Performance
P0452	Evaporative Emission Control System Pressure Sensor Low Input
P0453	Evaporative Emission Control System Pressure Sensor High Input
P0454	Evaporative Emission Control System Pressure Sensor Intermittent
P0455	Evaporative Emission Control System Leak Detected (gross leak)
P0456	Evaporative Emissions System Small Leak Detected
P0457	Evaporative Emission Control System Leak Detected
P0458	Evaporative Emission System Purge Control Valve Circuit Low
P0459	Evaporative Emission System Purge Control Valve Circuit High
P0465	Purge Flow Sensor Circuit Malfunction
P0466	Purge Flow Sensor Circuit Range/Performance
P0467	Purge Flow Sensor Circuit Low Input
P0468	Purge Flow Sensor Circuit High Input
P0469	Purge Flow Sensor Circuit Intermittent
P0496	Evaporative Emission System High Purge Flow
P0497	Evaporative Emission System Low Purge Flow
P0498	Evaporative Emission System Vent Valve Control Circuit Low
P0499	Evaporative Emission System Vent Valve Control Circuit High

In the following subsections provide summary analysis results, and additional details are provided in the report appendices.

3.1 Percent of Evap Monitor Ready Inspections with Stored Evap DTCs

For all vehicles with a "ready" evap monitor, ERG tabulated (by calendar year and model year) the number of vehicle test records containing evap-related DTCs for each inspection cycle. Using these results, ERG calculated the percentage of all inspection cycles containing an evap DTC.

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The results, shown in Table 5, indicate that between 0.7% and 2.5% of the inspections performed on vehicles with a "ready" evap monitor have a stored evap DTC. Approximately 10% of the inspections do not have an evap monitor ready, and for these, the percent of inspections with evap DTCs could not be calculated.

The State A percentage of 1.6% may be slightly higher than the rates for States B and C because of the six model year exemption period in State A, (which may result in an older I/M fleet than the other states). State D's 2.5% DTC rate may be due to the fact that OBD results are not enforced in State D. In State D, OBD tests are performed in an advisory capacity, but a vehicle can pass the I/M test with the MIL commanded on. The main pass/fail determination is based on the IM240 and gas cap functionality test results, unlike the other states (States A, B, and C) where the OBD test is the enforced for 1996 and newer vehicles, so an OBD failure results in an overall test failure.

Table 5. Percent of Inspections with a "Ready" Evap Monitor and One or More Evap DTCs

State	Percent of Evap Ready Inspections with an Evap DTC Set
A	1.6%
B	0.7%
C	0.9%
D	2.5%

Note: These results are for model years 1996 and newer

3.2 Trends of Evap DTCs Set by Age

The next analysis involved determining the trend of the increase of the percent of evap monitor "ready" inspections with evap DTCs by age for each state and to compare the trends across the states. ERG binned the test records with a "ready" evap monitor by calendar year and model year and tabulated the percent of inspections with stored evap DTCs by state. Results were graphed for each state to illustrate changes in the trends of evap DTCs as vehicles age. The results are shown in Figures 8 through 11.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:20:10 PM
Not sure the purpose of this sentence. Earlier in report you already covered the percentage of the initial inspections or total inspections that don't have evap ready and you led into this by saying you are now only looking at those with evap ready...

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:24:25 PM
Isn't it fairly easy to prove or disprove this statement by making a comparison across states by only using cars older than 6 years old? Is there also a possible impact of the distribution of the IM fleet at the oldest end of the fleet (e.g., if this is 1996 and newer but State A has cars that last much longer so has a disproportionally bigger share of the IM fleet that is say 1996-1998 vs another State that might have faster turn-over/rust-out of older cars and have only a small fraction of 1996-1998 MY cars left on the road? Couldn't you just overlay distribution curves of the analyzed fleet by MY and state to show if there is something significant to note?

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:31:02 PM
Is it worth noting anywhere that Calif certified cars (sold in Calif and other states that have adopted Calif stds) had 0.020" leak detection monitoring (in lieu of 0.040" leak) phasing in from 2000-2003MY while most Federal certified cars don't get the more stringent monitoring until ~2017MY. Could account for some difference in detected evap failures if some of your 4 states have the tighter monitors that can theoretically catch more failures.

Only model years 2000 and newer are shown in the figures. As stated in a previous section, this is because full phase-in of the enhanced evap OBD system did not happen until 1999, and using only 2000 and newer model years (a full year after phase-in was complete) ensures that the data used would be most representative of the trends for enhanced evap vehicles. In each graph, the different colored lines with points represent data for each model year and vehicle age for each state. The solid black line with no points shows a trend line for model year 2000 and newer vehicles, predicting the percent of vehicle tests that would have a stored evap DTC at a given age. The trend lines[3] for each state represent the percentage of stored evap DTCs at each age for each calendar year combined. The analysis was conducted to calculate the percentage of evap monitor "ready" inspections with stored evap DTCs for all vehicles in a given age (from 2 to 10 years old in most states). The vehicles at any given age can have a range of odometer values, so they may not all be in the same condition in terms of wear-and-tear and mileage.

Although linear trends were found to be most suitable for the ranges of interest of the combined data, the by-model-year graphs do show a slight curvature, especially as the vehicles age. It is likely that as vehicles age, the rate of increase of the percentage of vehicle tests with evap DTCs drops slightly. This could be due to aging vehicles retiring out of the fleet or other factors, and additional analysis could be performed to fit the data more closely for the newer and older age vehicles. The trend lines were simply provided to show the general trends for vehicles under 10 years of age.

The graphs for each state have reference lines to facilitate comparison among the states. The horizontal reference lines cross at 0.5% and at 1.5% of the vehicle inspections with "ready" evap monitors and with evap DTCs set. States B and C have percentages of evap DTCs set that are below these two horizontal reference lines at ages 2 years old and 8 years old. The other 2 states, States A and D, have DTC percentages that are at or above the 0.5% and 1.5% reference lines.

Again, State A has a 6-year exemption for new vehicles and only performs test-on-resale after a vehicles is 4 years old, so the 2 to 5 year old vehicles in that dataset may not be representative of the fleet. State D does not enforce the OBD program and therefore, having an OBD evap DTC set with a MIL illuminated is not a basis for failing an inspection. The differences in these programs may explain the higher percentage of evap DTCs set than in the other 2 states.

[3] Trend lines were developed using linear regression techniques.

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Author: mmccarth Subject: Comment on Text Date: 1/10/2014 10:10:48 PM
Is this a substantiated theory or just a WAG or ?

3.3 Trends of Evap DTCs Set by Age with Out-of-I/M-Cycle Tests Removed

The data presented in Figure 12 above shows the results of the percent of inspections with evap DTCs set versus vehicle age.

In order to account for vehicles that might not be representative of the I/M fleet, ERG modified the dataset for each of the states to only include inspections of vehicles that would be subject to the I/M program at the time of their inspection. This involved removing inspections in which the vehicle was too new for the I/M inspection and also removing inspections during an "off" year in the biennial I/M programs. Once the datasets for each state were modified in this way, ERG recalculated the trend lines for the percent of vehicle inspections with "ready" evap monitors and stored evap DTCs versus vehicle age. These revised trend lines are shown in Figures 13 and 14.

Figure 13 shows that three of the states have very similar rates of increase of evap DTCs as the vehicles get older. For these three states, the figure shows that older vehicles are more likely to have stored evap DTCs, and the likelihood that a vehicle will have a stored evap DTC during the I/M cycles increases by approximately 0.15% per year.

The slope of the fourth state, State D, is over 3 times higher than the slope of the other three states, which as stated previously is likely due to the fact that OBD is not enforced in State D. It is possible that the slope of the line for State D is indicative of the minimum rate of increase of evap DTCs in a non-I/M area. The rate of increase in a non-I/M area could be even higher than the slope for State D, because State D does have an I/M program that includes an evap testing component (gas cap test).

Figure 14 shows combined trend lines of the unmodified and modified data sets. This graph is a combination of Figures 12 and 13.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 4:08:30 PM

While I understand that from a technical perspective, the only overlap between what State D fails for vs. what OBD evap monitors cover could be in the area of a faulty gas cap, do you really think that all State D citizens categorically ignore an illuminated MIL before heading to their inspection (and just gamble on the tailpipe results) or don't you think it is reasonable that *some* of the population actually have the vehicle looked at/MIL addressed prior their inspection to reduce their chance for failure and the hassle of reinspection (because many MIL on events due correlate to higher tailpipe emissions and could cause an IM240 failure)? I'm betting that there actually are a chunk of people who do something to address a MIL before their initial inspection and some of those could include evap MIL on events that get addressed in some form or another. Bottom line is the presence of an IM program, even though it doesn't fail directly on OBD, still causes some level of attention/addressing of illuminated MILs so you would expect an even higher incidence rate in a real non-IM area than what State D shows.

The presence of cars with not ready rates similar to that in other IM states that do fail for OBD is probably overwhelming evidence to support that a significant number of people even in State D are taking action before initial inspection based solely on the presence of the MIL (because repair shops in State D don't have dynos or IM240 capability to even administer 'pre-tests' but they can easily address MIL on issues before the initial inspection).

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3.4 Evap DTC Rates for States Combined

The results from section 3.3 showed that when out-of-I/M cycle tests are removed from the data, three of the states have very similar rates of increase of evap DTCs as the vehicles get older. For these three states, the results show that older vehicles are more likely to have stored evap DTCs, and the likelihood that a vehicle will have a stored evap DTC during an I/M cycle increases by over approximately 0.15% per year.

Author: mmccarth Subject: Comment on Text Date: 1/10/2014 10:14:01 PM
Isn't State A's rate substantially flatter than B and C? Is it close enough to call it a very similar rate of increase?

Author: mmccarth Subject: Cross-Out Date: 12/17/2013 2:42:27 PM

In this section, ERG combined the number of evap DTCs set by calendar year and model year for those three states (States A, B, and C) to calculate one trend line[4] of the percent of evap DTCs set by vehicle age. ERG then plotted the trend line for States A, B, and C combined versus the trend line for State D alone so that the results of States A, B, and C combined (states with an enforced OBD program) could be compared with State D (without an enforced OBD program). In order to avoid biasing results based on how an I/M program is administered (i.e., 6 model year new vehicle exemption vs. 3 model year new vehicle exemption), all three programs were weighted equally (the slope of the composite trend line was not weighted based on the total number of tests analyzed for each program). Also, as stated previously, State D could represent the minimum evap DTC percentage in a non-I/M area because State D's OBD test result is not enforced.

Figure 15 shows the results. The points on the figure show the individual data points from States A, B, and C combined (in black) and from State D (in red). Each data point on the graph represents one calendar year and model year combination of the percent of evap DTCs set for one state. The results in Figure 15 show the differences between the percentage of evap DTCs for vehicles at different ages when there is an OBD I/M program which includes evap and when there is not an enforced OBD I/M program.

The data points on the graph show the range of values of the percentage of evap DTCs by age for two sets (states A, B, and C combined and state D). The data points on the graph show that for the three states with an enforced OBD program, at 4 years old, the percentage of tests with evap DTCs was between 0.2% and 0.8%. At 8 years old, the percentage increased to between 0.5% and 2.2%, and the rate of increase was approximately 0.15% per year. In comparison, for state D, at 4 years old the percentage of tests with evap DTCs was between 1.0% and 2.0%. At 8 years old, the percentage increased to between 2.6% and 4.2%, and the rate of increase was approximately 0.5% per year.

[4] Trend lines were developed using linear regression techniques.

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The two trend lines in the figure could be an approximation of the percentage and rate of increase of evap DTCs as vehicles age in I/M areas and in non-I/M areas. The trend line showed that for the three states with an enforced I/M program, at 4 years old the approximate percentage of tests with evap DTCs is 0.5%. This percentage increases to approximately 1.1% for 8 year old vehicles. The increase in the percentage is approximately 0.15% per year. For state D, the trend line shows that the percentage of tests with evap DTCs for 4 year old vehicles is approximately 1.4%, and this increases to approximately 3.5% for 8 year old vehicles. The increase in the percentage of tests with evap DTCs by age is approximately 0.5%.

State D does include an enforced gas cap test in their I/M program, so the trend line approximating the non-I/M area (in red) might be a conservative estimate. The trend lines show that for 8 year old vehicles in an I/M area, approximately 1.0% of them could have a stored evap DTC, while in a non-I/M area the percent of 8 year old vehicles could be over 3%.

As has been stated earlier, all of the predicted values are based on linear trends, and the data in these plots do suggest some non-linearity in the relationship. A more in-depth statistical analysis could be used to ~~predict these~~ evap DTC rates by age in a future analysis.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:47:53 PM
Pretty repetitive to previous paragraph and reader has to scan back and forth to discern the differences you are highlighting (range of DTC rates at 4 and 8 years old vs average DTC rate at 4 and 8 years old). Might be better to combine into one paragraph to repeat less and have the reader follow better (e.g., the percentage of tests with a DTC was between x and y with an average of z, etc.)

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:49:15 PM
sentence is worded awkwardly especially near the end.

Author: mmccarth Subject: Inserted Text Date: 12/17/2013 2:50:03 PM
refine these predicted

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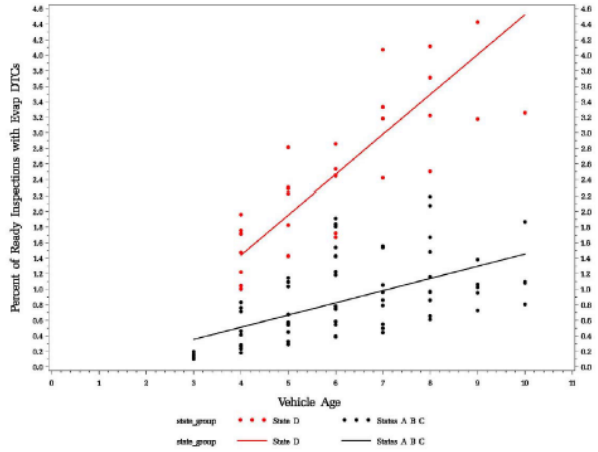
Author: mmccarth Subject: Cross-Out Date: 12/17/2013 2:51:38 PM

Figure 15. ~~Slope of~~ Percent of Evap Monitor Ready Inspections with Evap DTCs by Age
Trend Lines For States A, B, and C Combined and State D
Trend Lines with Data Modified – Out-of-I/M-Cycle Inspections Removed



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3.5 Evap DTCs over Multiple Inspection Cycles

In enforced OBD programs, less than 0.5% of the vehicles with a "ready" evap monitor and with at least one evap DTC were found to have evap DTCs in more than one I/M cycle. This suggests that it may be more common for evap DTCs to periodically occur throughout the I/M fleet rather than be limited to a smaller number of "problem" vehicles that repeatedly have evap DTCs over multiple I/M cycles.

3.6 Evaluation of Evap DTC rates based on the Prior I/M Cycle's Evap Monitor Readiness Status

For this analysis, ERG analyzed evap DTC rates for "evap ready" vehicles which had a "not ready" evap monitor in the previous I/M cycle. For every state, the evap DTC rates were between 2% and 10% higher for vehicles that previously had a "not ready" evap monitor in comparison to the overall fleet. This suggests that there might be more of a likelihood of a vehicle having an evap DTC set for a test immediately following a test where the evap monitor was not ready (i.e., a "not ready" evap monitor masking evap DTCs), but because of the differences among the states and the small subsample of vehicle tests, additional analysis would be required to investigate this more fully.

4.0 Most Common Evap DTCs

The graphs in Section 3 presented rates of evap DTCs without consideration of the specific DTC. In this section, ERG looked at the specific evap DTCs that were set in each state. This additional analysis showed the majority of evap DTCs are limited to a small subset of codes. This section summarizes the most common evap codes, either set individually or in combination with other evap codes (e.g. codes P0442 and P0455).

4.1 Most Common Individual Evap DTCs

ERG tabulated the prevalence of generic (P0) evap codes and manufacturer-specific (P1) codes to identify the trends in individual DTCs (not the multiples in this case). ERG summed the number of test records containing each of the individual evap DTCs (listed in Table 4) for each state. This count was done by DTC, regardless of which other evap DTCs were in the same test record. Table 6 shows the results of the counts of each evap DTC for each of the states. Because records with more than one evap DTC were counted more than once, the total number of test records in Table 6 will exceed the total number of test records with evap DTCs. For example, a record with 3 evap DTCs will be listed 3 times in Table 6, once for each of the 3 DTCs contained in the test record.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 2:54:30 PM
Is there anything worth noting/contrasting about this subject for State D (non-enforced OBD) such as high rate of the same cars carrying over their evap problem from cycle to cycle?

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:03:43 PM
Maybe your next sentences are attempting to cover this but is there anyway of quantifying the statistical significance of this (e.g., is a 2% increase statistically significant or even more loosely, is even a 10% increase significant even if we knew for sure it was statistically significant and above the 'noise'?) At 10% does this really mean instead of 0.5% at 4 years and 1.1% at 8 years, it is more like 0.55% and 1.2% at 8 years for cars that had evap not ready in the previous cycle to have an evap dtc present? Is that really of significance to say there is more likelihood of these cars having an evap problem? Especially after your previous section concluded that it is not the same cars that are having persistent evap problems but instead problems intermittently occurring across the fleet?

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:06:34 PM
I would delete the parenthetical because the third sentence seems to clarify what was done much better than this clause.

Author: mmccarth Subject: Inserted Text Date: 12/17/2013 3:07:10 PM
, if any,

Author: mmccarth Subject: Inserted Text Date: 12/17/2013 3:08:35 PM
individual

Author: mmccarth Subject: Inserted Text Date: 12/17/2013 3:09:28 PM
as well as the percentage of all evap DTCs that each individual DTC represents.

Table 6. Counts of Instances for Each Evap DTC by State

	State A		State B		State C		State D	
Specific P0 and P1 Evap DTCs	Number of records	%	Number of records	%	Number of records	%	Number of records	%
P_093	259	0.0%	18	0.0%	5	0.0%	3	0.0%
P_094	6	0.0%	0	0.0%	2	0.0%	3	0.0%
P_440	70,351	10.6%	11,332	14.6%	13,954	15.0%	10,424	13.4%
P_441	59,423	9.0%	8,693	11.2%	10,590	11.4%	6,529	8.4%
P_442	114,294	17.3%	14,853	19.1%	16,892	18.2%	13,524	17.4%
P_443	56,553	8.5%	3,782	4.9%	5,602	6.0%	7,422	9.6%
P_444	2,132	0.3%	298	0.4%	260	0.3%	218	0.3%
P_445	1,474	0.2%	142	0.2%	160	0.2%	214	0.3%
P_446	51,523	7.8%	6,927	8.9%	9,891	10.7%	4,617	6.0%
P_447	3,880	0.6%	570	0.7%	468	0.5%	1,291	1.7%
P_448	1,833	0.3%	442	0.6%	1,578	1.7%	442	0.6%
P_449	2,582	0.4%	1,111	1.4%	385	0.4%	359	0.5%
P_450	5,480	0.8%	544	0.7%	719	0.8%	958	1.2%
P_451	1,866	0.3%	253	0.3%	345	0.4%	440	0.6%
P_452	11,723	1.8%	1,184	1.5%	591	0.6%	2,151	2.8%
P_453	2,691	0.4%	598	0.8%	322	0.3%	518	0.7%
P_454	145	0.0%	35	0.0%	11	0.0%	103	0.1%
P_455	118,694	17.9%	15,571	20.0%	18,472	19.9%	12,310	15.9%
P_456	130,312	19.7%	8,228	10.6%	8,195	8.8%	11,672	15.1%
P_457	24,079	3.6%	2,279	2.9%	4,119	4.4%	3,837	4.9%
P_458	174	0.0%	5	0.0%	9	0.0%	10	0.0%
P_459	39	0.0%	19	0.0%	8	0.0%	6	0.0%
P_465	31	0.0%	5	0.0%	1	0.0%	1	0.0%
P_466	1	0.0%	0	0.0%	0	0.0%	1	0.0%
P_467	0	0.0%	0	0.0%	0	0.0%	3	0.0%
P_468	0	0.0%	0	0.0%	0	0.0%	3	0.0%
P_469	0	0.0%	0	0.0%	0	0.0%	2	0.0%
P_496	746	0.1%	690	0.9%	173	0.2%	251	0.3%
P_497	633	0.1%	71	0.1%	34	0.0%	104	0.1%
P_498	339	0.1%	33	0.0%	24	0.0%	85	0.1%
P_499	186	0.0%	30	0.0%	21	0.0%	37	0.0%
Total[1]	661,449	100%	77,713	100%	92,831	100%	77,538	100%

[1] These totals are for 1996 and newer vehicles. They will be larger than the total of evap DTCs presented in Appendix tables C-1 through C-4 and E-1 through E-4 because some evap DTCs are set together.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:13:42 PM

To the comment I made in an earlier section (% of evap ready cars with an evap DTC being higher in State A) about whether it is worth noting if some of your states have cars that have the tighter Calif 0.020" leak detection monitor rather than the Federal 0.040" monitor, that might account for a higher evap DTC rate. P0456 is most commonly used for 0.020" detected leaks while P0442 is most commonly used for 0.040" leaks. This table would suggest it might be significant given the much higher % of total DTCs that P0456 makes up in State A than the other states.

From Table 6, ERG identified the most common individual DTCs that were for all states combined. These include P0 and P1 codes (shaded in gray in the table) with 440, 441, 442, 443, 446, 447, 448, 449, 450, 452, 455, 456, and 457. The results are presented by calendar year and model year in Appendix D. Because the other evap DTCs were not as common, their distributions are not presented in Appendix D. The numbers in the Appendix D tables indicate that as vehicles age, the percentage of vehicles with each particular evap DTC increases slightly.

4.2 Most Common Individual Evap DTCs and Evap DTC Combinations

ERG then tabulated the prevalence of generic (P0) evap codes and manufacturer-specific (P1) codes (either individually or in combinations). Usually less than 20 different individual and combinations of evap codes comprised more than 90% of all evap codes in the data. Appendix E contains tables showing the most common evap DTCs and evap DTC combinations for each state. Table 7 lists the most common evap DTCs for all 4 states combined. The DTC definitions are based on the generic P0 codes listed in SAEJ2012 and are listed in Table 4. The percentage of all codes from all states is listed in Table 7.

Table 7. Evap DTCs Most Commonly Found in All States' Data

# of Evap codes	Specific P0 and P1 codes set	Generic description of DTCs set	Number of occurrences	Percentage of evap codes	Cumulative percentage of evap codes
1	P_456	Small leak detected	139,596	17.8%	17.8%
1	P_455	Gross leak	128,058	16.4%	34.2%
1	P_442	Small leak	114,606	14.6%	48.9%
1	P_440	Evap system malfunction	73,787	9.4%	58.3%
1	P_443	Incorrect evaporative system purge control valve flow	69,023	8.8%	67.1%
1	P_441	Incorrect purge flow	54,533	7.0%	74.1%
1	P_446	Vent control circuit malfunction	40,935	5.2%	79.3%
1	P_457	System leak detected	28,293	3.6%	82.9%
2	P_442 and P_455	Small leak and gross leak	19,718	2.5%	85.4%
3	P_440, P_441, and P_446	Evap system malfunction, incorrect purge flow, and vent control circuit malfunction	14,225	1.8%	87.3%
1	P_452	Pressure sensor low input	12,028	1.5%	88.8%
Multiple	Other Evap DTC set as 1 or 2 or 3 or more DTCs together		87,693	11.2%	100.0%
		Total	782,495		

Note: These results are for model years 1996 and newer

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:16:01 PM
Technically it is 'Very small leak detected' per SAE which is what separates it from P0442.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:18:59 PM
Technically, this is for suspected leak 'at the gas cap' (loose/missing gas cap).

Table 7 shows that for all the states combined, common codes primarily fall into two categories, leaks or purge flow. The leak codes, including P_442, P_455, P_456, and P_457, comprise more than 50% of the overall evap codes for vehicles of model years 1996 and newer. This number represents a minimum of the percent of the total evap DTCs that involve leaks, because the four codes listed above are only some of the codes that could indicate a leak in the evaporative emissions control system. Also, 50% represents the minimum percentage of evap DTCs that involve leaks, but the percentage of evaporative emissions resulting from these leak-related DTCs may be higher or lower than 50% of all evaporative emissions, since emission rates can vary significantly based on type of failure. For example, "small" and "gross" evaporative emission rates would likely differ from one another and also differ from other evaporative system malfunctions. Some malfunctions may not result in any evaporative emissions release. This analysis does not attempt to quantify the emission rates from any specific evap DTCs, it only quantifies the rate of evap DTCs.

The second most common category of evap DTCs in Table 7 involve some sort of error in the operation of the purge flow control. The codes for these DTCs include P_441 and P_443, and they make up about 15%-20% of the evap DTCs found in the data. Other types of evap codes include general evap malfunction (P_440), vent control circuit malfunction (P_446), and pressure sensor (P_450).

ERG then tabulated the leak codes for each of the states by calendar year and model year to see what percentage of the inspections with evap DTCs had leak-related evap DTCs. The detailed tables for leaks are also included in Appendix E. The tables show that in a given calendar year and model year, the percentage of the evap DTCs that are leak-related varies significantly from the overall percentage of over 50% highlighted above. In general, however, the newer model years have a higher percentage of the evap DTCs being leak-related than the older model years. In some calendar years and model years, over 75% of the evap DTCs can be leak-related. This indicates that the overall percentage of 50% of the evap DTCs being leak-related is a conservative estimate, especially if only newer model years are considered.

5.0 Conclusions

This report presented results from ERG's analysis of OBD monitor readiness status and OBD evaporative emissions control system DTCs as a function of calendar year and model year using I/M program data from four states. The main purpose of this Work Assignment was to better understand evap monitor readiness and evap DTC rates for light-duty gasoline cars and trucks.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:26:19 PM
I think you are intending to say the emission rates from 'small' leaks vs. those from 'gross' leaks would likely be very different. First, it isn't worded well but second, no, that is not the case. Past evap data (SHED testing with various leak sizes) has shown that leaks above 0.008" or so all result in 'uncontrolled' emissions (meaning from that leak and above, the emission results are the same because everything that is going to leak out does indeed leak out). OBD detects at 0.020" or 0.040" and above so everything is above the uncontrolled point. It is true that where the leak is located has a huge impact on the emission rate --much more than the size of the leak. I think I would tend to just leave out this sentence and leave it with the previous sentence about 'vary significantly based on type of failure'.

The first part of the analysis involved determining how many vehicles had a "ready" evap monitor at the times of initial and/or re-test inspections within one inspection cycle. This information is important because vehicles with evap system malfunctions will not store a DTC until the evap monitor is "ready" (i.e., a "not ready" evap monitor can "hide" evap system DTCs). The percentage of "not ready" evap monitors was evaluated and compared among each state, and that analysis showed that all states have similar evap monitor readiness percentages.

Regardless of the details of the I/M program administration or the calendar years of data analyzed, the results suggest that approximately 7-11% of the initial inspections in any given I/M program are likely to have an evap monitor that is not ready. The similarity in this percentage for all of the states suggests that this number could approximate a national percentage of vehicles in I/M programs with "not ready" evap monitors.

When comparing these results with previous analysis of non-evap OBD monitors, the percentage of "not ready" evap monitors was much higher than for other OBD monitors. For example, when ERG looked at all of the OBD monitors' status for one of these states, the non-evap OBD monitors had an overall "not ready" range of 1% - 2% instead of the 7%-11% range seen for the evap monitor. Although it is possible that the lower readiness rate of the OBD evap monitor could be due to attempts to mask evap system malfunctions (through a battery disconnect or code clearing), it is also likely that the more rigorous enabling criteria (specific vehicle operation and soak requirements) required to achieve evap monitor readiness results in the evap monitor being one of the last monitors to achieve readiness and is a contributing factor to the lower evap monitor readiness rates.

Further analysis indicated that vehicles in an I/M environment are more likely to have a "not ready" evap monitor as they age. ERG developed linear trend lines[5] for each of the states showing the percent of inspections with ready evap monitor versus vehicle age. This trend line was based on a modified dataset for each of the states that only included inspections of vehicles that would typically be subject to the I/M program at the time of their inspection. This involved removing inspections in which the vehicle was too new for the I/M inspection and also removing inspections during an "off" year in the biennial I/M programs. The results showed that as a vehicles age, they will be more likely to have a "not ready" evap monitor during an I/M cycle. The analysis was conducted by binning all vehicles in a given age (from 2 to 10 years old in most states). The vehicles at any given age can have a range of odometer values, so they may not all be in the same condition in terms of wear-and-tear and mileage.

[5] Trend lines were developed using linear regression techniques.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 3:48:36 PM
Technically, this statement is not 100% correct. evap 'not ready' does mean that at least one of the associated evap monitors has not run and completed since codes were cleared. But you cannot distinguish if one, two, or all of the associated evap monitors have not yet run. You can and do find cars that have run *some* of the evap monitors and have set an evap DTC and turned the MIL on but still have not run *all* of the evap monitors so readiness is incomplete (and in fact, many times one of the evap monitors will run and detect a fault and set a DTC/turn the MIL on and disable/prevent the rest of the evap monitors from running and thus never setting readiness to complete until the fault is corrected). That said, I agree that the appropriate way to do the analysis is by excluding vehicles with evap not ready because evap not ready means you just can't be sure if the system has an evap fault or not.

Author: mmccarth Subject: Comment on Text Date: 1/10/2014 10:16:14 PM
This whole paragraph is an exact repeat of the paragraph at the end of 2.3 (after Table 3).

For all four states, the trend lines showed that between 2% and 4% of the inspections of vehicles entering the I/M program (at about 2 years old) had a "not ready" evap monitor. The percentage increased to between 8% and 11% as the vehicles aged to 8 years old, and the rate of increase was approximately 1% per year as the vehicle ages.

ERG then analyzed evap DTC rates for all vehicles with "ready" evap monitors. The results indicate 0.7%-2.5% of the inspections with "ready" evap monitors have a stored evap DTC. The results also show that the overall percentage of inspections with a stored evap DTC is higher for State D (where OBD is not enforced) than for the other states where OBD is enforced. ERG also analyzed the percentage of inspections with evap DTCs by calendar year and model year, and developed trend lines[6] for each of the states showing the percentage of inspections with evap DTCs versus vehicle age. These trend lines were based on a modified dataset for each of the states which only included inspections of vehicles that would typically be subject to the I/M program at the time of their inspection (again, removing vehicles that are "too new" or not in their biennial test year). For the three states with an enforced I/M OBD program, between 0.1% and 0.5% of vehicles with "ready" evap monitors entering the I/M program (at about 2 years old) had an evap DTC. At 4 years old, the percentage of tests with evap DTCs increased to between 0.2% and 0.8% for those three states. At 8 years old, the percentage increased to between 0.5% and 2.2%, and the rate of increase was approximately 0.15% per year.

The rate of increase in the percentage of evap DTCs for the fourth state, State D, was over 3 times higher than the rate of the other three states. For example, at 4 years old the percentage of tests with evap DTCs was between 1.0% and 2.0% for state D. At 8 years old, the percentage increased to between 2.6% and 4.2%, and the rate of increase was approximately 0.5% per year. This higher rate of increase of the percentage of evap DTCs by age is likely due to the fact that OBD is not enforced in State D. It is possible that the percentage of evap DTCs for State D is indicative of the minimum rate of evap DTCs in a non-I/M area. The rate of increase in a non-I/M area could be even higher than the slope for State D, because State D does have an I/M program that includes an evap testing component (gas cap test).

ERG combined the percentage of evap DTCs set by calendar year and model year for those three states (States A, B, and C) to calculate a single trend line showing the percentage of evap DTCs set by vehicle age. ERG then compared the combined State A, B, C trend line with the trend line for State D (in which OBD is not enforced) as a comparison of results from states with an enforced OBD program versus a state without an enforced OBD program. The trend

[6] Trend lines were developed using linear regression techniques

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 4:09:51 PM
not clear what 'those' is referring to here. probably need to state 'the three states with enforced OBD IM programs' or something like that...

lines show that the rate of increase of evap DTCs as the vehicles age is over 3 times higher for State D versus that for the states with an enforced OBD program. For example, the trend line showed that for the three states with an enforced I/M program, at 4 years old the approximate percentage of tests with evap DTCs is 0.5%. This percentage increases to approximately 1.1% for 8 year old vehicles. The increase in the percentage is approximately 0.15% per year. For state D, the trend line shows that the percentage of tests with evap DTCs for 4 year old vehicles is approximately 1.4%, and this increases to approximately 3.5% for 8 year old vehicles. The increase in the percentage of tests with evap DTCs by age is approximately 0.5%. These trend lines might be used as one way to approximate the rate of stored evap DTCs for vehicles in I/M and non-I/M areas.

Vehicles with evap DTCs were analyzed over multiple inspection cycles, and less than 0.5% of these vehicles were found to have evap DTCs in more than one I/M cycle. Vehicles with "not ready" evap monitors throughout one inspection cycle were found to have slightly higher evap DTC rates during the subsequent inspection cycle, suggesting that "not ready" evap monitors could be masking evap problems (and hence evap DTCs). However, further analysis showed that although this evap monitor readiness rate decreased with vehicle age, less than 3% of the vehicles analyzed had an evap monitor status of "not ready" more than two times in their entire I/M history.

Further analysis showed that the majority of evap DTCs are limited to a small subset of codes. ERG analyzed records with individual evap codes as well as multiple evap codes and determined that usually fewer than 20 different individual and combinations of evap codes comprised more than 90% of all evap codes in the data. The results show that for all the states combined, common codes primarily fall into two categories, leaks or purge flow. The leak codes, including P_442, P_455, P_456, and P_457, comprise more than 50% of the overall evap codes for vehicles of model years 1996 - 2010. This number represents a minimum of the percentage of the total evap DTCs that involve leaks, because the four codes listed above are only some of the codes that could indicate a leak in the evaporative emissions control system. Also, 50% represents the minimum percentage of evap DTCs that involve leaks, but the percentage of evaporative emissions resulting from these leak-related DTCs may be higher (or lower) than 50% of all evaporative emissions, since emission rates can vary significantly based on type of malfunction. ~~For example, evaporative emission rates would likely differ between those characterized as "small" and "gross", or from other evaporative system malfunctions that don't result in an evaporative emission release at all.~~ . This analysis does not attempt to quantify the emission rates from any specific evap DTCs, it only quantifies the rate of evap DTCs.

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Author: mmccarth Subject: Comment on Text Date: 12/17/2013 4:12:06 PM
This seems to be a stronger conclusion without the caveats that the same statement had in the body of the report. Not sure that there is enough confidence in this finding to merit it being mentioned here without putting it in perspective or appropriate caveat.

Author: mmccarth Subject: Comment on Text Date: 12/17/2013 4:16:52 PM
Not sure what further analysis this is referring to, don't remember reading about it in the body of the report, and it seems to make this paragraph quite contradictory from first to second to third sentence (e.g., < 0.5% vehicles have a lingering evap problem over two cycles, then cars with evap not ready in previous cycle are more likely to have evap dtcs in the next cycle, and then back to readiness rate decreases(?) with age and < 3% (not < 0.5%) of vehicles had persistent problem over two cycles? Mixes readiness and DTC analyses and not sure what the reader is supposed to be left with as a conclusion. 1st sentence seems to be a meaningful conclusion but 2nd and 3rd are not so easy to follow and not sure what to think after the 'however'.

Author: mmccarth Subject: Cross-Out Date: 12/17/2013 4:18:00 PM

The second most common category of evap DTCs in the data involved some sort of error in the operation of the purge flow control. The codes for these DTCs included P_441 and P_443, and they made up ~~about~~ approximately ~~15%-20%~~ of the evap DTCs found in the data.

The newest vehicles in every state are not subject to the I/M program and therefore are not included in this analysis. The evap monitor readiness status decreases and evap DTC rates increase as vehicles age. It is likely the evap monitor "not ready" rates and the evap DTC rates presented in this report are actually higher than those that would be seen for the entire on-road vehicle fleet. The newer vehicles would make up a high percentage of the fleet but would have lower percentages of "not ready" evap monitors and stored evap DTCs. Also, the vehicles analyzed from each state for this report are all subject to an I/M program. State D does not have an enforced OBD program and was therefore used in this report to approximate results from a non-I/M area.

For future work, data from another source (such as some commercially available database of on-road vehicle data monitoring) could be obtained to further develop estimates of the evap monitor status and DTC rates for new vehicles and vehicles operating outside of I/M programs (as these vehicles are not currently well represented in this analysis of I/M data).

Future work could also involve evaluation of on-road I/M pullover testing to determine the evap DTC and evap monitor readiness rates for in-use vehicles and compare these rates with the I/M rates presented in this report. Other future work could also involve performing analysis of DTCs and readiness of monitors associated with engine operation (i.e., exhaust emissions) and compare these rates with the evaporative emissions control system rates presented in this report.

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Author: mmccarth Subject: Inserted Text Date: 12/17/2013 4:18:40 PM
approximately

Author: mmccarth Subject: Comment on Text Date: 12/18/2013 8:55:12 AM
I think I understand your point that the newer vehicles not yet subject to IM are under-represented in this sample and because they are newer, would be less likely to have DTCs and would have higher evap readiness (because nobody is needing to clear codes on those vehicles yet). And I agree that these younger vehicles will have lower not ready rates and lower DTC rates. On the other hand, the in-use fleet that is subject to IM probably has higher rates of evap DTCs than what you observed here--because some portion of the folks with an evap DTC will attempt to have it addressed prior to their initial inspection. On an absolute number, I suppose the higher numbers of new cars with no DTCs will overwhelm the potentially smaller population of older cars that have higher DTC rates but not absolutely sure about that.

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page

Appendix E. **Michael St. Denis Review Comments**

Michael St. Denis review of EPA Draft Report 131211 – 1/25/2014
"Analysis of Evaporative On-Board Diagnostic (OBD) Readiness and DTCs Using I/M Data"

General Comments:

It is difficult to determine the exact purpose of this project based on the description "The purpose of this Work Assignment (WA) is to perform analysis to better understand evap DTC rates for light-duty vehicles." The conclusions seem to indicate the data are to be used to represent the evap DTC rates of the in use fleet, and the IM versus non-IM fleets. However, because all of the data were collected from vehicles expecting an IM test, the data are not representative of the operating fleet during the entire operating time between IM inspections.

Because the states are not identified (it is unclear why the states are not identified), it is difficult to determine if the methods used to process the data are correct. For instance, I believe State A is California. Based on conversations with CA BAR, they were not failing most vehicles for readiness if they passed the ASM test (1996 and newer vehicles received both tests). Therefore, the not ready rates for CA are artificially high because not ready vehicles were not required to get set to ready and retested. If the vehicles were not forced to be ready, this could cause artificially low evap DTC rates since evap is one of the later monitors to get set to ready. The data from CA would be more like State D data where OBDII was not enforced but advisory. (If state A is CA, the authors should contact Garrett Torgerson at CA BAR for clarification of how the readiness requirements were implements in the time period data was used). It would also be useful for the reader to know the states because there could be temperature, altitude or vehicle fleet longevity (average age) differences between the states which might impact the results. This is important since in some cases the data are combined or compared to each other.

The report indicates on page 6 (paragraph 1, line 5) that the evap DTC data were used regardless of if the MIL was commanded on. Therefore pending DTC data may be included. Pending DTC data are NOT an indication of a problem, but could be false positives. For this reason, only evap DTC where the MIL was commanded on should have been used in this analysis. The use of the pending DTC data is incorrect.

The data for State D are referred to as "the non IM state", are not equivalent in any way to data from an actual data for an operating fleet in a state without an IM program. The state does have a fuel cap test which is motorists fail they have to get repaired in order to pass their IM inspection. In addition, motorist do get advisory OBDII results, so if there is an evap problem the motorist is told about the problem and encouraged to repair it. If State D is Colorado, the state even has an evap repair consumer assistance program which would lead to more repairs that in a non IM case. I think the authors need to

use great caution or not use the term "non-IM state" when referring to State D, and this makes some of the comparisons potentially invalid.

ERG should try to not refer to themselves in the third person as doing the work. Where it says "ERG tabulated" or ERG summed" etc., there is no reason to use "ERG". Just say the data were tabulated or summed, etc.

Specific Comments:

Page: 5

Paragraph 1, Sentence 2 - This report ONLY presents data on vehicles in the condition of being prepared for an I/M inspection and that data does not represent the expected evap DTC rates of the operating fleet.

Paragraph 2, Sentence 4 "model year 1999"... - And CARB gave exemptions to some through 2000 I believe, you would need to check with Mike McCarthy at CARB.

Table 1, State A - If state A is CA, if a vehicle passed the ASM test and failed the OBDII test, was it allowed to pass the overall inspection? I believe at least back in 2004 this was the case and could have been through 2010.

Page: 6

Paragraph 1, line 5 - Pending DTCs may not be an indication of an actual problem, so including these in the analysis is inappropriate. Why was it not simply required that the MIL also be commanded on in this case?

Paragraph 4, line 4 - It is not clear what "for one inspection cycle" is referring to.

Paragraph 6, line 1 - Change from "inspection cycles" to "inspections" as this is too difficult to understand.

Page: 7

Paragraph 5, line 7 "higher incidence" - There is no justification to state that older vehicles could therefore have a "Higher" not ready rate. In use vehicles, unless the power is disconnected, should not have not ready evap monitors, and then only for a short period of time.

Page: 8

Paragraph 1, line 2 "The oldest IM Fleet..." - This should not be assumed. The average age of vehicles which were tested should be determined and presented in the table below if this is to be claimed (it could justify the comment above as well). State B had the shortest model year exemptions, but had the second highest not ready rate.

Paragraph 2 - This logic is incorrect because it is known that motorists disconnect their battery to clear potential diagnostic trouble codes immediately prior to coming in for an inspection. That rate is not known, and must be accounted for. It is not clear when this states national percentage of "vehicles in IM programs" if this is referring to only vehicles going into an IM inspection.

Paragraph 3, lines 8 to the end - It is common during repairs to disconnect the battery of a vehicle when it is being repaired, so one would expect that the not ready rate of the evap monitor would be higher on subsequent tests. I believe overall not ready rates increase on retests in general, so this result seems counter intuitive.

Page: 9

Paragraph 1, lines 5 "although..." to the end of the paragraph - This does not read correctly. Once a monitor is set to ready it remains set to ready until there is a battery disconnect. Therefore the readiness monitor reporting not ready at a higher rate is quite possibly due to it taking longer to get ready but this is only after a battery disconnect which must have occurred to set the monitor to not ready.

Title 2.4 - I would use the term "Vehicle model year" or "vehicle age".

Figures 1 - 4 - The label "model_yr" should be cleaned up on the graphs on the bottom left and should say something like "Vehicle Model Year". The label "state = A" or B, C or D should be removed above the graph as it is in the title already.

Page: 14

Paragraph 2, line 2 - Why was the range 89% to 96% readiness chosen?

Paragraph 2, line 4 - Define "well outside". The 89% and 96% seem arbitrary, so saying a value is well outside this arbitrary line is meaningless.

Paragraph 3, line 7 and 8 - Why aren't the 2 year old State A vehicles are not representative of the fleet?

Paragraph 3, line 10 - Why would testing in an "off" I/M read cause the readiness to be lower? I would suspect that this is because these vehicles are being forced to come in for a test due to change of ownership and therefore are more likely to be tampered by disconnecting the battery.

Page: 15

Figure 5 - In figure 5, the rate of decrease in readiness with model year for states A and D are almost identical, but A is 5% lower.

Page: 17

Paragraph 1, lines 7 to 9 - Just because the number of inspections are lower, that should have no correlation on the rate of readiness.

Paragraph 1, line 7 - These vehicles may not represent the "true fleet at that age" why and in what way?

Paragraph 2, line 4 and5 - This therefore biases the data to reflect the rate of having a not ready evap monitor ONLY during the short period in a two year cycle just prior to an IM test. The vehicles which were removed are still operating in the fleet, and if the results of this study are to identify the rate of evap monitors not ready in the operating fleet, then removing these vehicles is not acceptable.

Page: 20

Paragraph 1, lines 4 and 5 - As noted in the previous comment, if other vehicles are removed, this statement ONLY applies to vehicles in their IM inspection cycle.

Paragraph 3 at the end - The last part of this sentence "which is a very small percentage of the I/M fleet", should be removed as it does not add any quantitative information.

Last sentence on the page - This says "In general". What other manufacturer P codes were considered. Was it only P1093, P1094, etc. that exactly match the generic codes?

Page: 21

Sentence under table - This sentence should be set out, the way it is formatted it appears to be a continuation of the prior section.

3.1 first sentence - Replace with "For all vehicles with a "ready" evap monitor, the number of vehicle test records containing evap-related DTCs for each inspection cycle was determined by calendar year and model year.

Page: 22

Paragraph 1, line 1 and 2 - "Of the inspections performed" is confusing to the reader when it is changed from looking at the results "per cycle" and then this seems to say "per inspection".

Paragraph 1, line 4 - Should say "was not" calculated. Even if the monitor is not complete, there can still be some evap DTCs, they are just not necessarily all that could occur.

Paragraph 2, lines 2 and 3 - Since you have the data, determine this and present it as opposed to theorizing this could be the reason.

Table 5 footnote - How does this change if only model year 2000 and newer vehicles are considered? Maybe pre 1996, post 1996 and all should be shown in the table since through 2000 the vehicles may not have been compliant.

Page: 23

Figures 8 through 11 - Take off the "state = X" at the top of the graph since it is in the title. Fix the "model_yr" title at the bottom.

Page: 27

Paragraph 2, first sentence - For State A there is an inflection point at 5 years (the rates increase significantly at year 6), but this could also somehow be attributed to the 6 model year exemption.

Paragraph 2, lines 3 and 4 - The rate of increase of the percentage of vehicle tests with evap DTCs increased the older the vehicle for State A.

Paragraph 3 - Setting arbitrary reference lines and then stating one set is generally below them and another is generally above them is not a good comparison - Figure 12 does a much better job.

Paragraph 4, second sentence - It should be noted here "therefore it is expected the failure rate would be higher because motorist are not required to repair vehicles with evap problems". And that the failure rate is twice as high as State A.

Page: 30

Paragraph 2, "might not be representative of the IM Fleet" line 1 - Once again, what is the purpose of this report? Is it to represent the evap DTC rate of vehicles "during IM" or in general? What is the hypothesis for "off cycle" inspections being non-representative and how could this be tested?

Figure 14 - Is there any theory as to why A and C are so different between the unmodified and modified, but B and D are not? There should be some discussion here for Figure 14.

Page: 33

Paragraph 1, line 3 "three states" - No, all states show that older vehicles are more likely to have stored evap DTCs.

Paragraph 2, line 10 - I am not sure "minimum" is the correct term here or at least it is confusing to me. I think you mean that it is the minimum evap DTC rate because although OBDII is not enforced, the area does have a fuel cap tests, therefore the evap DTC rate in an non IM area is expected to be higher.

Paragraph 3, line 6 - You MUST add "but there is a fuel cap inspection" so the reader is not mislead that this is the OBDII IM versus non-IM difference - which would be expected to be larger. It may be useful here to report the fuel cap failure rate in area D as a surrogate for the expected increase if the fuel cap was not inspected.

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Paragraph 1, first sentence - Although it says it below, this needs to be caveated here with the fuel cap inspection info here is you make this strong of a statement or move this sentence to the next paragraph were this is discussed.

Page: 35

Figure 15 - Move Figure 15 up one page so it follows where it was mentioned.

Page: 36

Paragraph 1, line 2 - For some of the data and model years you could only see one cycle, but for others you could see several. This should be noted and it should be pointed out that this is weighted towards older vehicles which have been through more cycles.

Paragraph 2, lines 4 to 6 - The second sentence here does not really say what the results are showing, although the part in the parenthesis does say it. It should be clear that these results imply that the actual rate of vehicles with evap problems is most likely higher than the observed rate of vehicles with evap DTCs. Also, it is expected that some of the vehicles which were not ready could be in that state because the motorist intentionally disconnected the battery, resetting the readiness monitors and DTCs because the MIL was on and a DTC - possibly an evap DTC - was set and they were trying to get through inspection without it being detected.

Paragraph 3, line 1 - "presented" should be "presents"

Page: 37

Table 6 - The horizontal lines in Table 6 for State A need to be added.

Page: 38

Paragraph 1, line 1 - It should be noted that it has been shown in other analyses that different vehicle makes and models have different not ready and DTC rates. Therefore differences in fleet mix in the various states (and differences in vehicle age) could well be contributing to the differences by state. It should also be noted that environmental conditions (temperature, pressure, etc.) can cause significantly difference evap emissions and cause the systems to function differently. It would be useful to know the environmental conditions of each state, but that would give away at least two of the states.

Paragraph 2, line 2 - The word "usually" does not seem to belong here.

Table 7 -What is the difference between P_456 "small leak detected" and P_442 "small leak"? That just does not seem correct as they seems to be the same thing (you can't have a P_442 unless you detected it).

Page: 39

Paragraph 2, line 2 - I believe there is a significant problem with Ford vehicles which set this code and it causes the results to be biased. This should most likely be mentioned here.

Paragraph 4, line 1 - Insert the word "evap" prior to "monitor"

Page: 40

Paragraph 1, second sentence - I believe this statement is untrue, but it should be checked with Mike McCarthy. The evap monitor may not be totally complete so that it indicates "ready" but it could have

run some parts of the monitor and found problems which are stored as DTCs prior to the monitor being totally complete.

Paragraph 1, last sentence - It should be noted, "even a state which does not perform pass/fail IM inspections, they are only advisory."

Paragraph 2, line 3 - "an evap monitor that is not ready" should be changed to "the evap monitor not ready", because there is only one evap monitor.

Paragraph 1, third sentence - This makes no sense. Disconnecting the battery sets ALL monitors to not ready. The second half of this sentence is the correct explanation for this observation.

Paragraph 4, first sentence - And vehicles in a non IM area do not have an increase in not ready evap monitors as they age? What did Sate D show?

Page: 42

Paragraph 1, last sentence - Should this also states that it can be used to estimate the minimum benefit of IM programs on reducing high evap emitting vehicles?

Page: 43

Paragraph 2, line 6 - This sentence starts with "also" but this sentence is not related to the sentences prior to it. It is important to note again here that there is a fuel cap test and that the OBDII test is performed, is advisory and therefore motorist could still be obtaining evap repairs based on the advisory.

Paragraph 4, last sentence - Why? How is this related or why is it suggested?

Page: 47

All B Tables - It is noted that readiness decreases with age, but for all States, the 1996 vehicles has high readiness rates. Is there any explanation for this?

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