DDC Locomotive Engine Upgrade Project Completion Report (March 20, 2020)

This Locomotive Engine Upgrade Project Completion Report is submitted in accordance with the requirements of Paragraph 31 and Appendix B of the Consent Decree in *United States v. Detroit Diesel Corporation*, Case No. 16-cv-1982 (D.D.C. Oct. 6, 2016) ("Consent Decree") and the Stipulation and Agreement Regarding Non-Material Changes to the Consent Decree ("Consent Decree Amendment"), which was filed December 12, 2019, and became effective December 16, 2019. This report and its attachments provide information describing the mitigation Project undertaken and completed by Detroit Diesel Corporation ("DDC") to fulfill the requirements of Section V and Appendix B of the Consent Decree with respect to providing financial incentives for the repowering of switching or short haul locomotives.

A. Section V and Appendix B Requirements

1. Consent Decree Requirements

Under Paragraph 11.b and Appendix B of the Consent Decree, DDC was required to implement a locomotive engine upgrade project under which two or more Tier 2 or lower switching or short haul locomotive engines were replaced with engines certified to the EPA Tier 3 or more stringent locomotive emission standards. Specifically, Paragraph 11.b required DDC to expend no less than $3,625,000 on the locomotive engine upgrade project. Appendix B specified that financial incentives for repowering locomotives must be set at no more than 40% of the cost of a locomotive engine repower with a Tier 3 certified engine, no more than 50% for a Tier 4 certified engine, and no more than 60% for an all-electric repower.

2. EPA Approval of Locomotive Mitigation Plan

Pursuant to Paragraphs 13 and 16 of the Consent Decree, DDC submitted its Locomotive Mitigation Plan on April 18, 2017. In response to this submission, EPA e-mailed DDC's counsel on May 12, 2017 and requested additional information relating to DDC's plan submission. On May 31, 2017, DDC submitted its Supplemental Locomotive Mitigation Plan addressing the questions raised and information requested by EPA in its May 12 e-mail. EPA approved DDC's Locomotive Mitigation Plan, as supplemented, on June 29, 2017.

3. Terms of Approved Locomotive Mitigation Plan

Under its Locomotive Mitigation Plan, DDC sought to repower and convert two short haul locomotive engines and one switcher locomotive engine. The locomotives to be replaced were a pre-MY 1973 EMD SDP35 diesel-electric six-axle short haul locomotive operated by the Mojave Northern Railroad Company ("MNRC"), a MY 1980 unregulated GE C30-7 diesel-electric six-axle short haul locomotive operated by the Metropolitan Stevedore Company ("MSC"), and a pre-MY 1973 unregulated EMD SW1200 diesel-electric four-axle switcher locomotive operated by the Stockton Terminal and Eastern Railroad ("STER"). All three locomotives were to be replaced by repowered Tier 4 Knoxville Locomotive Works ("KLW") diesel-electric locomotives. In addition, the replaced locomotive engines were to be permanently destroyed in accordance with the Consent Decree requirements.

4. Terms of Consent Decree Amendment

The Consent Decree Amendment, which was filed December 12, 2019, and became effective December 16, 2019, modified the Consent Decree with respect to the STER locomotive engine. In lieu of destroying the STER locomotive engine, the Consent Decree Amendment allowed the locomotive to be donated to a nonprofit organization dedicated to historical preservation and education for display at a museum, subject to certain requirements. DDC was required to ensure that both the locomotive and the engine were labeled as follows: "This locomotive, including its engine, is for display only. The engine shall

not be turned on pursuant to *United States v. Detroit Diesel Corporation*, D.D.C. Case No. 16-cv-1982." DDC was also required to ensure that holes were drilled in the air box to prevent the engine from being operated. As part of this Project Completion Report, DDC is required to submit one or more visible and readable photograph(s) of the label affixed to the locomotive and its engine, and the holes in the air box of the locomotive engine that rendered it inoperative. See Exhibit A for the STER locomotive engine photos.

B. Project Completion Report Requirements

1. Date of Project Completion

Funding contribution paid by DDC for the STER locomotive engine upgrade—the last of the three upgrades to be completed—occurred on January 23, 2020, marking the completion of the Locomotive Engine Upgrade Project. Prior to making payments, DDC confirmed that the repowered locomotives were operational and the replaced engines had been destroyed, or in the case of the STER locomotive engine, labeled and made inoperative.

2. Results and Documentation of Project Implementation

As described in the six Semi-Annual Progress Reports submitted to EPA in accordance with paragraph 30 of the Consent Decree, DDC has arranged for the replacement of two short haul locomotives and one switcher locomotive with repowered Tier 4 locomotives.

The MNRC replacement locomotive was completed and shipped from KLW in early November 2018 and received at the project site in Victorville, California, during the third week of December 2018. The locomotive was commissioned and was fully operational as of March 2019. Engine removal and destruction was completed and was documented and verified by DDC and the local air district (Mojave Desert Air Quality Management District). Funding contribution paid by DDC for the MNRC locomotive engine upgrade occurred on May 6, 2019.

The MSC replacement locomotive was completed and shipped from KLW in early February 2019 and was received at the project site in Stockton, California, during the first week of March 2019. The locomotive was commissioned and was fully operational as of March 22, 2019. Engine removal and destruction was completed and was documented and verified by DDC and the local air district (San Joaquin Unified Air Pollution Control District). Funding contribution paid by DDC for the MSC locomotive engine upgrade occurred on May 10, 2019.

The STER replacement locomotive was completed and shipped from KLW in mid-March 2019 and was received at the project site in Stockton, California, during the first week of April 2019. The locomotive was commissioned and was fully operational as of April 19, 2019. A hole was drilled in the air box, which was witnessed and verified by a representative from the San Joaquin Valley Air Pollution Control District, and labels were affixed to the locomotive and engine in accordance with the requirements of the Consent Decree Amendment. See Exhibit A for the STER locomotive engine photos. Funding contribution paid by DDC for the STER locomotive engine upgrade occurred on January 23, 2020.

To measure the emissions benefits of the Locomotive Engine Upgrade Project, DDC contracted with Air Improvement Resource, Inc. ("AIR"), an independent company providing engineering and consulting services regarding mobile and stationary source emissions modeling and technology evaluation. The table below provides AIR's analysis of emissions benefits attributable to the Project. The combined 15-year benefits are estimated to be: 590 tons NOx, 22 tons HC, and 15 tons PM10. AIR's full report is attached as Exhibit B.

Table 1. Benefits of the Locomotive Engine Upgrade Project				
Parameter	**MNRC (San Bernardino County, CA)**	**MSC (San Joaquin County, CA)**	**STER (San Joaquin County, CA)**	**Total Project Benefits (tons)**
NOx Benefit, tpy	27.77	7.38	4.22	39.36
HC Benefit, tpy	0.93	0.26	0.25	1.44
PM10 Benefit, tpy	0.61	0.16	0.23	1.01
NOx Benefit, 15-year (tons)	416.6	110.7	63.2	590.44
HC Benefit, 15-year (tons)	14.0	3.9	3.7	21.57
PM10 Benefit, 15-year (tons)	9.2	2.5	3.5	15.13

3. Actual Project Dollars Incurred

DDC paid $3,625,000 in contribution payments for the three locomotive engine upgrades, meeting its financial commitment set forth in paragraph 11.b of the Consent Decree.

4. Certification Statement

Please find the certification statement required by Paragraph 34 of the Consent Decree attached.

Certification Statement

Certification of Locomotive Engine Upgrade Project Completion Report as Required by Paragraph 34 of the Consent Decree in *United States v. Detroit Diesel Corporation*, Case No. 16-1982 (D.D.C. Oct. 6, 2016)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I have no personal knowledge that the information submitted is other than true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

3/20/20
Date

Brian Burton
Secretary
Detroit Diesel Corporation

EXHIBIT A

Figure 1: STER Locomotive Air Box Before Hole Drilling

Figure 2: Drilling Hole in STER Locomotive Air Box

Figure 3: STER Locomotive Air Box After Hole Drilling

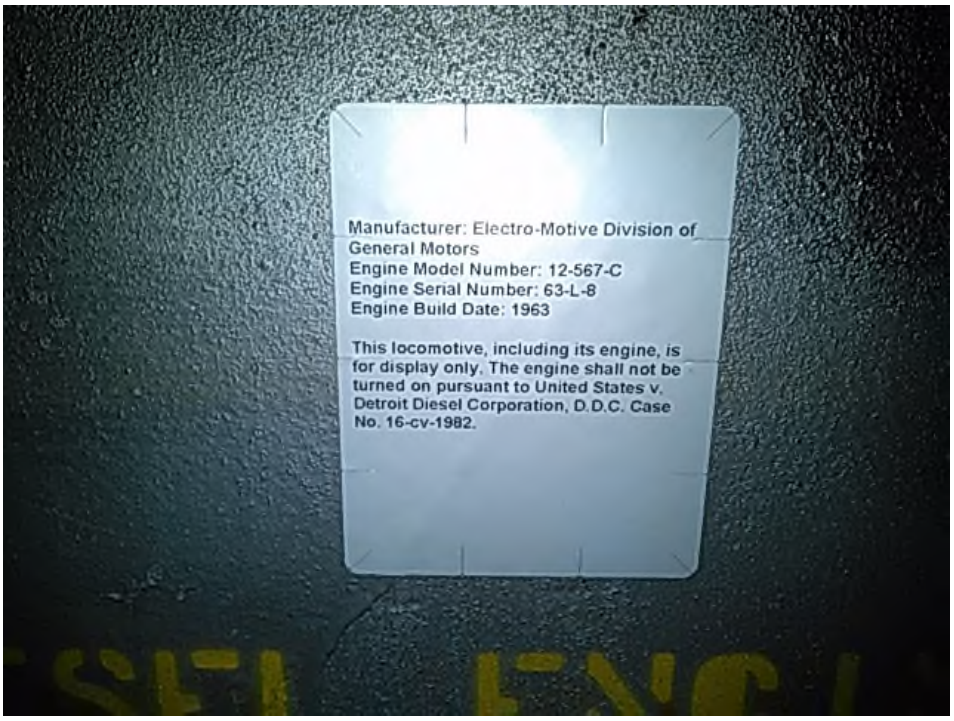

Figure 4: Text of Engine Label

Figure 5: Placement of Engine Label (1)

Figure 6: Placement of Engine Label (2)

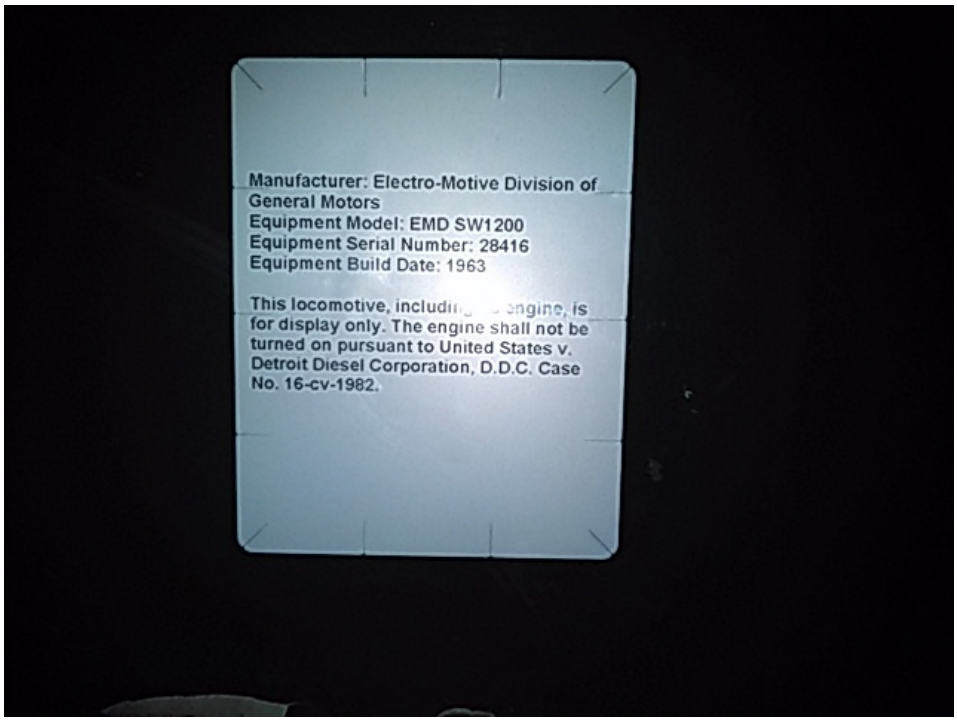

Figure 7: Text of Locomotive Label

Figure 8: Placement of Locomotive Label (1)

Figure 9: Placement of Locomotive Label (2)

EXHIBIT B

Estimated Emissions Reduction Benefits of Detroit Diesel Corporation's Locomotive Engine Upgrade Project

Air Improvement Resource, Inc.
March 20, 2020

Estimated Emissions Reduction Benefits of Detroit Diesel Corporation's Locomotive Engine Upgrade Project

Introduction

On December 19, 2016, the United States District Court for the District of Columbia entered a Consent Decree (CD) between the United States of America and Detroit Diesel Corporation ("DDC") to implement a locomotive engine upgrade project. DDC subsequently developed its Locomotive Mitigation Plan, identifying three locomotives in California.

Three locomotive engine upgrades are in this project, as follows:

1. The first upgrade replaces one pre-model year (MY) 1973 Electro-Motive Division of General Motors (EMD) diesel-electric six-axle short haul locomotive operated by the Mojave Northern Railroad Company (MNRC) in San Bernardino County, California with a Tier 4 Knoxville Locomotive Works (KLW) diesel-electric six-axle short haul locomotive.

2. The second upgrade replaces one MY 1980 unregulated General Electric (GE) diesel-electric six-axle short haul locomotive operated by the Metropolitan Stevedore Company (MSC) in San Joaquin County, California with a Tier 4 KLW diesel-electric six-axle short haul locomotive.

3. The third upgrade will replace one pre-MY 1973 unregulated EMD diesel-electric four-axle switcher locomotive operated by the Stockton Terminal and Eastern Railroad (STER) in San Joaquin County, California with a Tier 4 KLW diesel-electric four-axle switcher locomotive.

The CD requires DDC to estimate the emissions reduction benefits of these locomotive engine upgrades over a 15-year time horizon. The purpose of this report is to estimate the emission benefits of this effort.

Method

The equation we use to estimate the emission reductions is shown below:

$$\text{Benefit} = \text{Fuel Use} * (EF_0 - EF_R) * CF * \text{FuelCF}$$

Where:

Benefit = Emissions benefit in tons per year
Fuel Use = annual fuel use in gal for the existing locomotive
EF_0 = Emission factor in g/gal of the existing pre-control engine
EF_R = Emission factor in g/gal of replacement Tier 4 engine

CF = factor to convert from grams to tons
FuelCF = Fuel correction factor for California diesel

The above expression uses the existing fuel use for the current engines, and the reduced fuel use for the Tier 4 engines, along with emission factors in g/gal for the existing and Tier 4 engine, to estimate the emissions reduction benefits. The emission factors are also corrected for the use of California diesel fuel. This method is similar to the method used by the California Air Resources Board to estimate locomotive emission inventories.[1] In addition, using annual fuel usage information should prove more reliable than an alternative method using emission factors in g/bhp-hr, the horsepower of each locomotive, and some estimate of load factors for each locomotive to estimate the emissions benefit, where the locomotive operators may not have accurate information on load factor for each locomotive.

Table 1 shows information for the 3 existing locomotives in the different geographical areas. Our estimates use two pieces of information from Table 1: Fuel Use and the Type of Locomotive (line haul versus switcher). [2]

[1] *2016 Line haul Locomotive Model and Update*, California Air Resources Board, Off-Road Diesel Analysis Section, October 2017.

[2] The emission factors of these two types differ.

Table 1. Locomotive Information			
Project:	**MNRC**	**MSC**	**STER**
Manufacturer	EMD of GM	General Electric	EMD of GM
Build Date	1964	1980	1963
Original Equipment Model	SDP35	GE C30-7	EMD SW1200
UMLER Identification	SWPC 411	MSTV 474	STE 678
Serial Number	7734-12	132	28416
Locomotive Bhp	2800	3300	1350
Engine Model Number	16-645-D3	7FDL16G33R	12-567-C
Engine Serial Number	71-J3-7003	830101	63-L-8
Engine Build Date	1971	1980	1963
Operating Hours Annually	3,900–4,400	2,350–2,500	2,500
Primary Operating Service(s)	Short haul	Short haul	Switching
Fuel Usage	90,000–100,000 gallons annually	26,500 gallons annually	15,500 gallons annually
Type Fuel	California compliant #3PG3	California compliant #3PG3	California compliant #3PG3
Idle Limiting Equipped	None	None	None
Idling Hours Annually	2,500–2,800	1,500–1,600	1,700

The contractor that performed the upgrades, KLW, indicates that the new engines are experiencing reduced fuel consumption on the existing routes. The MNRC engine is consuming 73,875 gal per year, the MSC engine is consuming 13,500 gal per year, and the STER engine is consuming 8,700 gal per year.[3] These updated fuel consumption values are used to estimate the Tier 4 emissions for each project, instead of the baseline fuel consumption from Table 1.

EPA's Uncontrolled and Tier 4 emission factors are shown in Table 2.[4] These emission rates are shown in g/bhp-hr and g/gal. The g/gal emission rates utilize the

[3] *Mojave Northern Railroad-Victorville ARB DEQ.xlsx, Metropolitan Stevedore-Stockton ARB DEQ.xlsx, and STE ARB DEQ Calculations.xlsx,* obtained from KLW.

[4] *Emission Factors for Locomotives*, EPA Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009. See Tables 1, 2, and 3.

conversion factors of 20.8 for line haul locomotives and 15.2 for switching locomotives from the EPA report.

Table 2. EPA Locomotive Emission Rates				
	g/bhp-hr		g/gal	
Technology	Line Haul	Switcher	Line Haul	Switcher
Uncontrolled NOx	13.0	17.4	270.4	264.48
Uncontrolled HC	0.48	1.01	9.984	15.352
Uncontrolled PM10	0.32	0.44	6.656	6.688
Tier 4 NOx	1.00	1.00	20.8	15.2
Tier 4 HC	0.04	0.08	0.832	1.216
Tier 4 PM10	0.015	0.015	0.312	0.228

Again, KLW has measured emissions from its Tier 4 engines, and they are lower than the Tier 4 emissions shown in Table 2.[5] The measured emissions for each engine are shown in Table 3. This analysis uses the measured emissions for each Tier 4 engine instead of the EPA emissions shown in Table 2.

Table 3. Measured Tier 4 Emissions (g/bhp-hr)			
	MNRC	MSC	STER
NOx	0.14	0.14	0.21
ROG	0.10	0.10	0.10
PM	0.013	0.013	0.02

The emission rates in Table 2 (and Table 3) must be corrected for use on California diesel, which reduces NOx by 6% and PM by 14% (HC has no correction).[6] The corrected emission rates are shown in Table 4 (for Tier 4, we have corrected the KLW emission rates).

Table 4. Emissions Corrected for California Diesel				
	g/bhp-hr		g/gal	
Technology	Line Haul	Switcher	Line Haul	Switcher
Uncontrolled NOx	12.22	16.36	254.18	248.61
Uncontrolled HC	0.48	1.01	9.98	15.35
Uncontrolled PM10	0.28	0.38	5.72	5.75
KLW Tier 4 NOx	0.13	0.20	2.74	3.00
KLW Tier 4 HC	0.11	0.11	2.19	1.60
KLW Tier 4 PM10	0.01	0.02	0.23	0.26

[5] *KLW spreadsheets for each project (Ref 3).*

[6] *2016 Line haul Locomotive Model and Update,* CARB.

Utilizing the input data described previously, Table 5 shows the annual and 15-year benefits of each locomotive replacement. The combined fifteen-year benefits are estimated to be: 590 tons of NOx, 22 tons of HC, and 15 tons of PM10.

Table 5. Benefits of the Locomotive Engine Upgrade Project				
Parameter	**MNRC**	**MSC**	**STER**	**Total**
NOx Benefit, tpy	27.77	7.38	4.22	39.36
HC Benefit, tpy	0.93	0.26	0.25	1.44
PM10 Benefit, tpy	0.61	0.16	0.23	1.01
NOx Benefit, 15-year (tons)	416.6	110.7	63.2	590.44
HC Benefit, 15-year (tons)	14.0	3.9	3.7	21.57
PM10 Benefit, 15-year (tons)	9.2	2.5	3.5	15.13

Attachment 1

Air Improvement Resource, Inc. Qualifications

AIR IMPROVEMENT RESOURCE, Inc. (AIR) was formed in 1994 to provide engineering and consulting services in the area of mobile and stationary source emissions modeling and technology evaluation. AIR provides expert services on a broad spectrum of projects to national and international industries, associations, legal firms and governmental agencies. AIR performs studies in the following areas:

- emission inventory modeling and analysis
- emission characterization, including the effect of fuel composition on emissions
- statistical analysis of emission data
- technology assessment
- analysis of fuel properties and the effects of different fuel properties on emissions
- development of fuel economy models and future fuel economy projections
- costs and cost-effectiveness of on-highway and off-highway vehicle engine/fuel-related emission regulatory controls
- health effects and exposure/risk assessment of air toxins analysis of ambient air data
- emissions and air quality trends analysis
- analysis of Inspection and Maintenance (I/M) programs and program data
- air quality plan development including U.S. State and Federal Implementation Plans
- greenhouse gas (GHG) emissions analysis and modeling

Thomas L. Darlington
President, Air Improvement Resource Inc.

Profile

Thomas L. Darlington is President of Air Improvement Resource, a company formed in 1994 specializing in mobile source emission modeling. He is an internationally recognized expert in mobile source emissions modeling, lifecycle analysis, and land use modeling.

Professional Experience

1994-Present	President, Air Improvement Resource
1993-1994	Director, Mobile Source Programs, Systems Application International
1989-1994	Senior Engineer, General Motors Corporation, Environmental Activities
1988-1989	Senior Project Engineer, Detroit Diesel Corporation
1979-1988	Project Manager, U.S. EPA, Ann Arbor, Michigan

Recent Major Projects

- Participated on behalf of Growth Energy in EPA's MOVES model development stakeholder meetings
- Created a new emissions model for offroad equipment
- Published an Society of Automotive Engineers paper at 2017 SAE World Congress on modeling GHG emission reductions with a high octane, low carbon biofuel (Minnesota Corn Growers and others)
- Published an SAE paper at the 2016 World Congress on our review of EPA's EPAct fuels testing and modeling (Growth Energy)
- Developed Life Cycle reports and complete applications for 8 plants for the California Low Carbon Fuel Standard
- Participated in and provided written comments on California's three 2014 Indirect Land Use (iLUC) workshops (Growth Energy)
- With Purdue University, conducted study of iLUC emissions of rapeseed and other oilseeds in 2013 utilizing an updated version of GTAP (European Biodiesel Board)
- Reviewed EPA's palm oil iLUC emissions in 2013 (NESTE)
- Submitted comments on ARB's new GREET2.0 model
- Reviewed CARB's land use emissions for soybean biodiesel

- Reviewed the land use impacts of the RFS2 from EPA, including the notice of Proposed Rule, Regulatory Impact Analysis, and approximately one hundred documents in the rulemaking docket
- Completed a land use study for Renewable Fuels Association and reviewed California Air Resource Board's Initial Statement of Reasons for the Low Carbon Fuel Standard
- Represented three stakeholders in the recent development of the ARB Predictive Model for reformulated gasoline in California (Alliance of Automobile Manufacturers, Renewable Fuels Association and Western States Petroleum Association)
- Represented two stakeholders in EPA's development of the MOVES on-highway emissions model (Alliance of Automobile Manufacturers and Engine Manufacturers Association)
- Developed the effects of ethanol permeation on on-highway and off-highway mobile sources in California and other states for the American Petroleum Institute
- Studied gasoline and diesel fuel options for Southeast Michigan (for SEMCOG, API and Alliance of Automobile Manufacturers)

Recent Publications

Darlington, T., Herwick, G., Kahlbaum, D., and Drake, D., "Modeling the Impact of Reducing Vehicle Greenhouse Gas Emissions with High Compression Engines and High Octane Low Carbon Fuels," SAE 2017-01-0906, 2017, doi: 10.4271/2017-01-0906.

Darlington, T., Kahlbaum, D., Van Hulzen, S., and Furey, R., "Analysis of EPAct Emission Data Using T70 as an Additional Predictor of PM Emissions from Tier 2 Gasoline Vehicles", SAE Technical Paper 2016-01-0996, 2016, doi: 10.4271/2016-01-0996.

"Study of Transportation Fuel Life Cycle Analysis: Review of Economic Models Used to Assess Land Use Effects", CRC-E-88-3, July 2014.

"Land Use Change Greenhouse Gas Emissions of European Biofuel Policies Utilizing the Global Trade Analysis Project Model", Darlington, Kahlbaum, O'Connor, and Mueller, August 30, 2013.

"A Comparison of Corn Ethanol Lifecycle Analyses: California Low Carbon Fuels Standard (LCFS) Versus Renewable Fuels Standard (RFS2)", June 14, 2010. Renewable Fuels Association and Nebraska Corn Board. This study compared and

contrasted the corn ethanol lifecycle analyses performed by both CARB (as a part of the LCFS) and the EPA (as a part of RFS2).

"Review of EPA's RFS2 Lifecycle Emissions Analysis for Corn Ethanol", September 25, 2009. Conducted for Renewable Fuels Association. This study reviewed EPA's land use GHG emissions assessment for corn ethanol, including the FASOM and FAPRI models and Winrock land-use types converted and emission factors by ecosystem type. The study made many recommendations for improving the land-use and emissions modeling.

"Review of CARB's Low Carbon Fuel Standard Proposal", April 15, 2009. Conducted for Renewable Fuels Association. This study reviewed CARB's analysis of land use emissions using GTAP6 and CARB's overall lifecycle emissions for corn ethanol. This study made many recommendations for improving the land use and lifecycle emissions of corn ethanol.

"Emission Benefits of a National Clean Gasoline", August 2008. Conducted for the Alliance of Automobile Manufacturers. This study evaluated the nationwide criteria pollutant emission reductions of a national clean gasoline standard.

"Land Use Effects of Corn-Based Ethanol", February 25, 2009. Conducted for Renewable Fuels Association. This study evaluates possible land use changes and GHG emissions associated with these land use changes as a result of the renewable fuel standard mandated 15 billion gallons of corn ethanol required by calendar year 2015. The study utilized projections of land use in the US and rest of world performed by Informa Economics, LLC, as well as newer estimates of the land use credits of co-products produced by ethanol plants to evaluate possible land use changes.

"On-Road NOx Emission Rates From 1994-2003 Heavy-Duty Trucks", SAE2008-01-1299, conducted for the Engine Manufacturers Association. This study examined manufacturers consent decree emissions data to determine on-road NOx emission rates, and deterioration in emissions from heavy-duty vehicles. (Peer reviewed publication)

"Evaluation of California Greenhouse Gas Standards and Federal Energy Independence and Security Act - Part 2: CO2 and GHG Impacts", SAE2008-01-1853, conducted for the Alliance of Automobile Manufacturers. This paper evaluated the comparison of greenhouse gases from cars and light trucks in the US under both the Federal and California GHG policies. (Peer reviewed publication)

"Effectiveness of the California Light Duty Vehicle Regulations as Compared to Federal Regulations", June 15, 2007. Conducted with NERA Economic Consulting and Sierra Research for The Alliance of Automobile Manufacturers. This study compares the emission benefits of the California and Federal light duty vehicle regulations for HC, CO, NOx, PM, SOx, and Toxics taking into account the difference in emission standards, new vehicle costs and its effect on fleet turnover, new vehicle fuel economy and its effect on vehicle miles traveled, and other factors. Both the EPA MOBILE6 and ARB EMFAC on-road emissions models were used to estimate changes in emissions inventories.

"The Case for a Dual Tech 4 Model Within the California Predictive Model", May 20, 2007. Conducted with ICF International and Transportation Fuels Consulting for the Renewable Fuels Association (RFA). This study developed separate emissions vs fuel property models for lower and higher Tech 4 (1986-1995) vehicles, and showed that utilizing this alternative Predictive Model would result in a higher compliance margin for fuels containing higher volumes of ethanol. It was thought that this could lead to higher ethanol concentrations in the state, but even if the dual model is not used, it is a better representation of the 2015 inventory than the ARB single model.

"Updated Final Report, Effects of Gasoline Ethanol Blends on Permeation Emissions Contribution to VOC Inventory From On-Road and Off-Road Sources, Inclusion of E-65 Phase 3 Data and Other Updates", June 20, 2007. Conducted for the American Petroleum Institute. This report updates the earlier March 3, 2005 report for API utilizing data collected by CRC and others since of the time of the earlier report. Final Report, Development of Technical Information for a Regional Fuels Strategy, February 28, 2006. Conducted for the Lake Air Directors Consortium (LADCO). This report provided guidance to the LADCO states (Midwestern states) concerning how to model different types of fuel control programs (in particular) using EPA mobile source models, and how to set up the baseline input files so that results are consistent between the different states.

"Emission Reductions from Changes to Gasoline and Diesel Specifications and Diesel Engine Retrofits in the Southeast Michigan Area", February 23, 2005. Conducted for the Southeast Michigan Council of Governments (SEMCOG), the Alliance of Automobile Manufacturers, and the American Petroleum Institute. This study examined the on-road and off-road emission benefits of many different possible gasoline and diesel fuel specifications that the state could adopt to help meet the 8-hour ozone standards. This study formed the basis for the state's move to lower RVP summer gasoline.

"Examination of Temperature and RVP Effects on CO Emissions in EPA's Certification Database, Final Report", CRC Project No. E-74a, April 11, 2005. Conducted for the Coordinating Research Council. This study compared CO vs temperature results from the MOBILE6 model to the certification data, and recommended further testing, which is being conducted by the CRC at this time.

"Effects of Gasoline Ethanol Blends on Permeation Emissions Contribution to VOC Inventory From On-Road and Off-Road Sources" March 3, 2005. Conducted for the American Petroleum Institute (API). Using data from the CRC-E-65 program, and data collected by the California EPA and Federal EPA, this study estimated the impacts of ethanol use on increasing permeation VOC emissions from on-road vehicles, off-road equipment and vehicles, and from portable containers. Emission inventory estimates were made for a number of geographical areas including the state of California, and results showed that the permeation effect increases anthropogenic VOC inventories by 2-4%.

Review of EPA Report "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions", February 11, 2003. Conducted for the American Petroleum Institute. This study critically examined the methods that EPA used to develop the impacts of biodiesel fuels on HC, CO, NOx, and PM emissions.

"Well-To Wheels Analysis of Advanced Fuel/Vehicle Systems – A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions", May 2005. Conducted for General Motors Corporation, with Argonne National Labs. This study examined many different well to wheels pathways for various fuels, and their impacts on GHG and criteria pollutant emissions.

"Potential Delaware Air Emission Impacts of Switching From MTBE to Ethanol in the Reformulated Gasoline Program", May 26, 2005. Conducted for Lyondell Chemical Company. This study examined the HC, CO, and NOx impacts of switching from MTBE to ethanol.

"Potential Massachusetts Air Emission Impacts of Switching From MTBE to Ethanol in the Reformulated Gasoline Program" June 17, 2005. Conducted for Lyondell Chemical Company. This study is similar to the Delaware study above.

"Potential Maryland Air Emission Impacts of a Ban on MTBE in the Reformulated Gasoline Program", October 18, 2005. Conducted for Lyondell Chemical Company. This study is similar to the Delaware study above.

"MOBILE6.2C with Ethanol Permeation and Ethanol NOx Effects", February 8, 2005. Conducted for Health Canada. This study modified the MOBILE6.2C model for ethanol permeation VOC and ethanol NOx effects.

Education

B. Sc., (Materials and Metallurgical Engineering), University of Michigan, Ann Arbor, 1979

Post Graduate Courses (Business Administration), University of Michigan, Ann Arbor, 1982