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Expanding and Updating the Master List of Compounds Emitted by Mobile Sources - Phase III

Final Report

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Final Report

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

and

ICF, Inc.
Fairfax, VA

Prepared for EPA by
ENVIRON International Corporation
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APPENDICES

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1. INTRODUCTION

In order to build a comprehensive database of the compounds emitted by mobile sources, EPA initiated a literature search for studies reporting detailed speciation of mobile source exhaust and evaporative emissions. To date, this work has been comprised of three phases. In the first phase, 46 studies were analyzed by Sierra Research and over 700 specific compounds were identified.[1] These compounds were listed in "The Master List of Compounds Emitted by Mobile Sources and Fuels" (Master List) with compound names, CAS numbers, and emissions type and emission

[1] prepared for the U.S. Environmental Protection Agency, Sierra Research, Inc. "A List Of Compounds Emitted From On-Road And Non-Road Mobile Sources", February 5, 2001

rate information. Building on the initial investigation of the literature, Environ subsequently reviewed the data reported in 41 additional studies in which mobile source toxic compounds were speciated (Phase II of this project) and added this information to the Master List.

In the work reported here (Phase III) Environ added speciated mobile source emissions data to the Master List from four additional references, completed a thorough search for CAS numbers for compounds on the Master List and cross-referenced the list of compounds on the Master List with EPA's Integrated Risk Information System (IRIS) list of compounds.

2. STUDIES REVIEWED

In work by Sierra Research, as noted above, 46 references were analyzed and the compounds emitted were used to develop a Master List Spreadsheet. This reference list was expanded in Phase II of the project and 41 additional references were examined by Environ. Subsequently, in Phase III of the project, four additional references were reviewed by Environ, including one reference reporting speciated aircraft emissions. Tables 1 and 2 list all of the references reviewed by Environ for inclusion into the Master List in Phases II and III of this project.

Table 1. Studies reviewed in Phases II and III for which data were incorporated into the Master List of Compounds Emitted by Mobile Sources.

Study Code	Authors/Title	Onroad/ Off-road	Fuel
47	Nine, Ralph D., Nigel N. Clark, Brian E. Mace and Laila E.lGazzar. 1997. "Hydrocarbon Speciation of a Lean Burn Spark Ignited Engine." SAE #972971.	Off-road	CNG
48	Whitney, K. Bailey, B. 1994. "Determination of Combustion Products from Alternative Fuels - Part I: LPG and CNG Combustion Products." SAE #941903.	On-road	CNG, LPG, CA Phase II RFG
50	Benson, J.; Koehl, W.; Burns, V.; Hochhauser, A.; Knepper, J.; Leppard, W.; Painter, L.; Rapp, L.; Reuter, R.; Rippon, B.; Rutherford, J. 1995. "Emissions with E85 and Gasolines in Flexible/ Variable Fuel Vehicles - The Auto/Oil Air Quality Improvement Research Program." SAE #952508.	On-road	E85, Gasoline
53	Schauer, James J.; Kleeman, Michael J., Cass, Glenn R. and Bernd R.T. 2002. "Simoneit Measurement of Emissions from Air Pollution Sources. 5. C1 - C32 Organic Compounds from Gasoline-Powered Motor Vehicles." *Env. Sci & Tech.* 36(36), 1169-1180.	On-road	Gasoline
61	Kleeman, Michael J.; Schauer, James J. ; and Glen R. 2000. "Cass Size and Composition of Fine Particulate Matter Emitted from Motor Vehicles." *Env. Sci & Tech.* 34(7), 1132-1142.	On-road	Gasoline, Diesel
62	Schauer, James J.; Kleeman, Michael J., Cass, Glenn R. and Bernd R.T. 1999. "Simoneit Measurement of Emissions from Air Pollution Sources. 2. C1 - C30 Organic Compounds from Medium Duty Diesel Trucks." *Env. Sci & Tech.* 33(10), 1578-1587.	On-road	Diesel
87	Cadle, Steven H.; Mulawa, Patricia A.; Hunsanger, Eric C.; Nelson, Ken; Ragazzi, Ronald A.; Barrett, Richard; Gallagher, Gerald L.; Lawson, Douglas R.; Knapp, Kenneth T.; and Richard Snow. 1998. " Measurement of Exhaust Particulate Matter Emissions from In-Use Light-Duty Motor Vehicles in the Denver, Colorado Area." CRC E-24-1.	On-road	Gasoline, Diesel

Study Code	Authors/Title	Onroad/ Off-road	Fuel
92	Ullman, Terry L. Ullman; Lawrence Smith; Joseph W. Anthony; Warren J. Slodowske; William M. Trestrail; William Bunn; Charles A. Lapin; Kenneth J. Wright; and Charles R. Clark. 2003. "Comparison of Exhaust Emissions, Including Toxic Air Contaminants, From School Buses in Compressed Natural Gas, Low-Emitting Diesel, and Conventional Diesel Engine Configurations." SAE #2003-01-1381.	On-road	Diesel, CNG
95	Lev-On, Miriam; Chuck LeTavec; Ken Kimura; Jim Uihlien; Teresa Alleman; Doug Lawson; Keith Vertin; Gregory Thompson; Nigel Clark; Mridul Gautam; Scott Wayne; Barbara Zielinska; John Sagebiel; Sougato Chatterjee; Kevin Hallstrom; Robert A. Okamoto; Paul Rieger; Gary M. Yee. 2002. "Speciation of Organic Compounds From the Exhaust of Trucks and Buses: Effect of Fuel and After-Treatment on Vehicle Emission Profiles." SAE #2002-01-2873.	On-road	Diesel, CNG
98	Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 1. the Effect of Fuels and Engine Operating Modes on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH." SAE #2001-01-3627.	On-road	Diesel, Fischer-Tropsch Diesel
99	Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 2. the Effect of Fuels on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH Using a Composite of Engine Operating Modes." SAE #2001-01-3628.	On-road	Diesel, Fischer-Tropsch Diesel
100	Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 3. the Effect of Pilot Injection, Fuels and Engine Operating Modes on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH." SAE #2001-01-3630.	On-road	Diesel, Fischer-Tropsch Diesel
101	Siegl, Walter O.; Travis J. Henney; Mark Guenther. 2000. "Identifying Sources of Evaporative Emissions-Using Hydrocarbon Profiles to Identify Emission Sources." SAE #2000-01-1139.	On-road	Gasoline
102	Sharp, Chris A.; Steve Howell; Joe Jobe. 2000. "The Effect of Biodiesel Fuels on Transient Emissions From Modern Diesel Engines-Part Ii: Unregulated Emissions and Chemical Characterization." SAE #2000-01-1968.	On-road	Diesel, B20, Biodiesel
115	Silva, Philip J.; Kimberly A. Prather. 1997. "On-line Characterization of Individual Particles from Automobile Emissions." *Env. Sci & Tech*. 31(11), 3074-3080.	On-road	Gasoline
131	Sweeney, Edward G.; John H. Baudino; Carolyn H. Schmidt. 1992. "Composition of Gasoline Vehicle Emissions--An Analytical Speciation Program." SAE #922253.	On-road	Gasoline
138	Pakko, James D.; Andrew A. Adamczyk; Walter O. Siegl; Robert J. Pawlowicz. 1994. "Measurements of Total and Speciated Hydrocarbon Removal From Engine Exhaust Using Activated Carbon." SAE # 941999.	On-road	Gasoline
147	Leppard, William R.; Larry A. Rapp; Vaughn R. Burns; Robert A. Gorse, Jr.; Jay C. Knepper; William J. Koehl. 1992. "Effects of Gasoline Composition on Vehicle Engine-Out and Tailpipe Hydrocarbon Emissions--The Auto/Oil Air Quality Improvement Research Program." SAE #920329. Pp. 435-459	On-road	Gasoline
155	Howes, Peter and Greg Rideout. N. "Evaluation of Biodiesel in an Urban Transit Bus Powered by a 1988 DDECII6V92 TA Engine." MSED #95-26743-1.	On-road	Diesel, Biodiesel

Study Code	Authors/Title	Onroad/ Off-road	Fuel
166	Gautam, Mridul; Nigel Clark; W. Scott Wayne; Gregory Thompson; Donald W. Lyons; Wesley C. Riddle; Ralph D. Nine; Benjie Staggs; V. Andy Williams; Timothy Hall; Sairam Thiagarajan. 2003. "Heavy-Duty Vehicle Chassis Dynamometer Testing for Emissions Inventory, Air Quality Modeling, Source Apportionment and Air Toxics Emissions Inventory." CRC E-55/E-59.	On-road	Diesel
170	Carroll, James N. 1991. "Emission Tests of In-Use Small Utility Engines – Task III Report Non-Road Source Emission Factors Improvement." SwRI #3426-006.	Off-road	Gasoline
173	Kado, N.Y., P.A. Kuzmicky, K.L. Kiefer, R.L. Maddalena, Tung-Liang Huang, R.A. Okamoto. 1998. "Exposure to Emissions from Alternative Fuel Combustion: Bioassay and Chemical Analyses of the Particle and Semi-Volatile Emissions from Hydrogenated Biodiesel Fuels."	On-road	Biodiesel
175	Lloyd's Register. 1995. "Lloyd's Register Work in Marine Based Air Pollution and Its Relationship to Other Work in the Field."	Off-road	Diesel
177	Norbeck, J., T.D. Durbin, T.J. Truex. 1998. "Characterization of Particulate Emissions from Gasoline-Fueled Vehicles."	On-road	Gasoline
180	Sharp, C. A. 1996. "Emissions and Lubricity Evaluation of Rapeseed Derived Biodiesel Fuels." Final Report. SwRI #7507.	On-road	Biodiesel
183	Truex, Dr. T.J., Dr. J. M. Norbeck, M.R. Smith, J. Arey, N. Kado, B. Okamoto, K.Kiefer, P. Kuzmicky, I. Holcomb. 1998. "Evaluation of Factors that Affect Diesel Exhaust Toxicity."	On-road	Diesel
184	White, J., M.N. Ingalls, J.N.Carroll, L. Chan. 1999. "Three-Way Catalyst Technology for Off-Road Equipment Powered by Gasoline and LPG Engines."	Off-road	Gasoline, LPG
187	Fritz, Steven G. 2000. "Diesel Fuel Effects on Locomotive Exhaust Emissions."	Off-road	Diesel
188	CARB (Project Engineer: Jerry Ho, Alternate Project Engineer: David Lee). "CARB Vehicle Surveillance Program Database, Series 17, Project 2S03C1."	On-road	Gasoline
189	Three SULEV vehicles tested for DOE and EPA at SwRI. "Assignment Title: "Characterization of Exhaust Emissions from California-Certified SI SULEVs". 2004	On-road	Gasoline
190	Gerstle, Thomas; Virage, Peter; Kimm, Maj Larry; Wade, Mark. 1999. "Aircraft Engine and Auxiliary Power Unit Emissions Testing: Volume 2, Detailed Sampling Approach and Results."	Off-road	Jet-fuel
191	Helmer, Kent; Cook, Richard; Volckens, John; Baldauf, Richard; Starr, Michael. 2004. "Regulated and Air Toxic Exhaust Emissions from Nonroad Diesel Engines and Equipment."	Off-road	Diesel
192	Collier, A.; Hillebrand, C.; Kelly, G.; Brett, S.; Elliot, G.; Blair, D.; Sturgeon, K.; Tancell, P.; Brogan, M. 2001. "Investigation into Testing and Controlling Emissions of Hydrogen Sulfide from Gasoline Vehicles", SAE paper 2001-01-3530.	On-road	Gasoline
193	Graham, Lisa. 2003. "Gaseous and Particulate Matter Emissions from In-Use Light Duty Gasoline Motor Vehicles." Environment Canada , ERMD Report #99-67.	On-road	Gasoline

Table 2. Studies not incorporated into the Master List of compounds emitted by mobile sources, with reasons for omission.

Study Code	Authors/Title	Onroad/ Offroad	Diesel/ Gas	Reason for Omission
57	Tobias, HJ; Beving, DE; Ziemann, PJ; Sakurai, H; Zuk, M; McMurry, PH; Zarling, D; Waytulonis, R; Kittelson, D.B. 2001. "Chemical analysis of diesel engine nanoparticles using a nano-DMA/thermal desorption particle beam mass spectrometer." *Env.*	Off-road	Diesel	no detailed compound names in data

Study Code	Authors/Title	Onroad/ Offroad	Diesel/ Gas	Reason for Omission
	Sci & Tech. 35(11), 2233-2243.			
63	Marr, Linsey C.; Kirchstetter, Thomas W.; Harley, Robert A.; Miguel, Antonio H.; Hering, Susanne V.; and S. Katharine. 1999. "Hammond Characterization of Polycyclic Aromatic Hydrocarbons in Motor Vehicle Fuels and Exhaust Emissions." *Env. Sci & Tech*. 33(18), 3091-3099.	On-road	In-use	tunnel study
64	Miguel, Antonio H.; Kirchstetter, Thomas W.; Harley, Robert A.; and Susanne V. Hering. 1998. "On-road Emissions of Particulate Polycyclic Aromatic Hydrocarbons and Black Carbon from Gasoline and Diesel Vehicles." *Env. Sci & Tech*. 32(4), 450-455.	On-road	Gasoline, Diesel	tunnel study
74	Cadle, Steven H.; Mulawa, Patricia A.; Hunsanger, Eric C.; Nelson, Ken; Ragazzi, Ronald A.; Barrett, Richard; Gallagher, Gerald L.; Lawson, Douglas R.; Knapp, Kenneth T.; and Richard Snow. 1999. "Composition of Light-Duty Motor Vehicle Exhaust Particulate Matter in the Denver, Colorado Area." *Env. Sci & Tech*. 33(14), 2328-2339.	On-road	Gasoline, Diesel	same data as study code 87
104	Lanning, Lisa A.; Kurt W. Smith; Chris J. Tennant. 2000. "A New Method for Diesel HC Collection and Speciation." SAE #2000-01-2951.	On-road	Diesel	no detailed compound names in data
168	Zielinska, Barbara. 1999. "Changes in Diesel Engine Emissions." HEI Communications 7, 115-132.	On-road	Diesel	review, no original data
169	EPA. 2002. "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions." EPA420-P-02-001.	On-road	Diesel, Biodiesel	same data as study code 102
171	Gertler, A.W.; J.C. Sagebiel; W.A. Dippel; R.J. Farina. 1998. "Measurements of Dioxin and Furan Emission Factors from Heavy-Duty Diesel Vehicles." *J. Air & Waste Mngmnt. Assoc.*, 48, march, 276-278.	On-road	Diesel	tunnel study
176	Sharp, C. A. 1998. "Biodiesel: Literature Search and Characterization of Exhaust Emissions as Required under Section 211(b) and 211(e) of the Clean Air Act: Appendix 2 Characterization of Biodiesel Exhaust Emissions."	On-road	Biodiesel, Diesel	same data as study code102
179	Sharp, C. A. 1998. "Characterization of Biodiesel Exhaust Emission for EPA 211 (b) – Final Report." SwRI #08-1039.	On-road	Biodiesel Diesel	same data as study code 102

3. METHODOLOGY

Extracting data from additional references and incorporating into Master List

The procedure used to extract data from each reference is as follows. First the relevant tables were isolated from the paper. If the paper was hard copy only and not already in pdf format, then the tables were scanned into pdf. Using the software ScanSoft OmniPage Pro 11.0, the pdf file was converted into Word format, and then subsequently imported into Excel.

A simple directory structure was maintained for each reference. A folder "Ref_xx" was created for each paper being examined. Inside each folder three more files were located: (1) "Ref_xx.pdf" consisted of either the pdf version of the paper, or a pdf document containing the relevant tables from the paper; (2) "Ref_xx_data.doc" was the Microsoft Word document created

from the conversion software; and (3) "Ref_xx_tables.xls" contained the Excel file with the data, and the final list of compounds (with appropriate names and highlights). This final Excel file had the data in the proper format for a macro to incorporate into the Master List (see details below). All of the data in these folders for the studies are included on a CD accompanying this report along with a 'read me' file describing the CD's contents.

For each paper, tables were created in which the minimum and maximum emission rates for each reported compound were calculated. Compound names were standardized, where necessary, to match those already present in the Master List. This may have involved hyphenation or may have consisted of finding equivalent names for the compounds (for example chrysene = benzo(a)phenanthrene).

One aim of this work was to obtain the greatest level of detail regarding compound identification possible. In some cases authors reported compound classes or general names for compounds for which specific isomers exist (e.g., dimethylpenanthrene vs. 1,7-dimethylphenanthrene). The compound names as well as isomer names were maintained in the database. Compounds in the Master List are presented in the order in which articles reporting them were reviewed. When a compound was present in the database (either the specific isomer or the general compound name) the new addition to the list was highlighted in blue to help the user identify these similar compound groups. In some cases, two organic compounds are listed in the same row of the Master List. This result is due to co-elution of organic species during sample analysis. Where possible, CAS numbers for the co-eluting species are listed.

Two macros were developed in order to read the data from each individual reference-specific spreadsheet into the Master Table. The first macro, "name_match", was run on the "Ref_xx" worksheet in the final Excel file created for each reference ("Ref_xx_tables.xls"). This macro ran through the list of compounds compiled from the study and highlighted any that did not match the current list of compounds in the Master List. After checking the potentially new compounds for spelling, naming or other inconsistencies with compounds present on the Master List, and making the necessary corrections, the macro was run again to end up with a final list with all of the new compounds highlighted in yellow.

The second macro, "add_reference_file", was run to incorporate the data from each separate paper (including compounds and emission rates) into the Master List. This macro was run from the Master List spreadsheet; it prompts the user to choose the reference file location (note that the file must be set to open up on the appropriate worksheet which contains the data). The macro then updates the Master List with the new emission rates from the paper, any new compounds that it might have contained, and the reference number is added in the spreadsheet next to each appropriate compound. If a compound was already present in the Master List, then just the emission rate information was updated, and the reference number was noted. If any new compounds were added to the Master List, they were highlighted in yellow (and the new compounds in blue for each paper remained highlighted blue when added to the Master List as well).

For this work, the macro, "add_reference_file" was able to process two different unit types – "mg/mi" or "mg/hp-hr". The Master List was expanded to include separate columns for both data types, and the macro reported the emission rates in the appropriate column when reading in data from each reference. In a few cases compounds were reported by authors as "trace" (which the authors verified meant the compound concentration was above the detection limit, but no

emission rate data were provided). For these cases, a function was created so that the macro incorporated the compounds into the Master List without any emission rate information. For some references, compound names were listed but no emission rate information was given (or it was given in non-compatible units). Using the "trace" functionality of the macro, these compounds were flagged as "trace" in the "Ref_xx_.data.xls" file in order for only their names to be included into the Master List.

The Chemical Abstract Service (CAS) Registry Numbers for most of the substances on the master list were found by searching on www.chemfinder.com. If the CAS number was not available on this website, a search was made (for a fee) on the CAS registry's website (stneasy.cas.org). CAS numbers were found for a few of the hopane and sterane molecules from online sources.

In addition to incorporating the compounds into the Master List, other information on testing methods, test fuels, test vehicles, and bibliographic information was manually entered into the final Master List file (see below for description of worksheets).

The final Master List file consists of the following worksheets:

- Master List – List of compounds, CAS numbers (one column includes Sierra's CAS numbers in their initial format of "00000-00-00", and a second column has these CAS numbers with any extra leading zeroes removed), emissions type (i.e. Gas Exhaust), Minimum and Maximum emission rates (columns for either of two units – mg/mi or mg/hp-hr), a field named "Applicable References" which contains all the numbers of the references for which the compound was reported, and columns to indicate if the emissions data came from a nonroad or onroad source with a filter to easily sort the data (Note: this nonroad/onroad designation was based only on the references that were reviewed in phases II and III by Environ, not for studies reviewed by Sierra Research);
- Bibliography – information on reference title, author, data, author affiliation, sponsor and other bibliographic information (e.g., the number assigned to each paper);
- Testing Methods – Information on mobile source characteristics, test fuel characteristics, drive schedule, testing laboratory and measurement technique;
- Test Fuel – detailed fuel property data;
- Test Vehicle or Engine – detailed information on tested engine or vehicle (make, model, fuel, model year, odometer reading, displacement, fuel system, rated horsepower, torque, etc.).

Appendix A is a detailed notes file on issues about each set of data from each reference. This appendix also indicates which tables from the paper were extracted, and the units in which the data were reported.

IRIS data extraction and cross-referencing with Master List

EPA's Integrated Risk Information System is a database of human health effects that may result from exposure to various substances found in the environment. In early 2004 when accessed by Environ, it contained 544 substances. IRIS includes health information on the Reference Dose for Chronic Oral Exposure (RfD), Reference Concentration for Chronic Inhalation Exposure (RfC), and Carcinogenicity information (e.g., Weight-of-Evidence Characterization, Oral Slope Factor, and Inhalation Unit Risk).

To extract these data, as well as the dates each compound and each health benchmark value was reviewed, the IRIS compound files (in html format) were first downloaded from the EPA website (http://www.epa.gov/iris/stand-al.htm) and were converted to text format using a script written in the python programming language (html2text.py).

Then, using Unix commands including "grep", the relevant data lines were extracted from these text files. The information in the IRIS record in the section titled "STATUS OF DATA" was extracted first to determine which of the health values were contained in the database for each substance. Subsequently, values for RfC, RfD, weight-of-evidence (WOE), Oral Slope Factor, and Inhalation Unit Risk (if any were available) were extracted for each substance and transferred into Excel.

Because the IRIS files were not of a completely consistent format, for less than 15 percent of the substances, the files were manually examined to extract the needed information. The other 85 percent (or more depending on the field extracted) were automatically processed using the Unix commands alone.

The following fields were extracted from IRIS data files:

- STATUS OF DATA (used to determine if data were available for a particular substance)
- Species # (number in IRIS assigned to each compound)
- Name of the compound
- CAS Number
- Date compound/element was last reviewed
- Reference Dose for Chronic Oral Exposure (RfD) - (mg/kg-day)
- Oral RfD Assessment - date last revised
- Reference Concentration for Chronic Inhalation Exposure (RfC) - (mg/cu.m)
- Inhalation RfC Assessment - date last revised
- Carcinogenicity Assessment - date last revised
- Weight-of-Evidence Characterization for Carcinogenicity
- Oral Slope Factor (per (mg/kg)/day)
- Inhalation Unit Risk (per ug/cu.m)

After the information from the IRIS substance files was extracted and compiled into an Excel worksheet, these substances were cross-referenced with those on the Master List by matching CAS numbers (note: some compounds on the Master List do not have CAS numbers, but by a visual search, it was determined that none of these compounds were contained in the IRIS database).

A worksheet was created that contained only those substances among this cross-reference for which IRIS lists an RfC, RfD, and/or a carcinogenicity assessment.

From 2001-2003, EPA's Office of Research and Development National Center for Assessment (NCEA) conducted a search of health and toxicology literature for all compounds and elements on IRIS (except for 86 substances which were being reassessed under the IRIS program). This literature search is titled "Summary Report for the Screening-Level Review of Toxicity

Information Contained in the Integrated Risk Information System (IRIS) Database" for Phase I, II & III, 2003[2]. The search was conducted in order to determine if data exist that could be used in an updated assessment of any of the compounds listed in IRIS. The following codes developed for the NCEA literature search were included in the worksheet containing the compounds in common to the IRIS database and the Master List:

- "C" - The literature published since the IRIS consensus review does not appear to contain study data that could potentially produce a change in the IRIS summary. The existing IRIS summary is considered current;
- "N" - New health effects information that could potentially affect the IRIS summary was identified;
- "O" - No toxicity value is available in the existing IRIS file. Potentially relevant information was identified during evaluation of the literature compilations or literature search results. This information may or may not support the derivation of an IRIS toxicity value of WOE designation. The narratives for individual chemicals provide further discussions about the nature of this information.

4. RESULTS

New Compounds

From the references reviewed by Environ (Phases II and III of this project), many new compounds were added to the Master List; these compounds are listed in Table 3 with CAS numbers (if found).

Table 3. New compounds that were added to the Master List during the review of the literature in the current work.

Compound Name	CAS Number
(E)-1,3-hexadiene	20237-34-7
(E)-2,3-dimethyl-3-hexene	
(E)-2-heptenal	18829-55-5
(E)-3-nonene	20063-92-7
(E)-4-octene	14850-23-8
(E)-decalin	493-02-7
(Z)-1,3-pentadiene	1574-41-0
(Z)-2,5-dimethyl-3-hexene	10557-44-5
(Z)-2-methyl-3-hexene	15840-60-5
(Z)-2-nonene	6434-77-1
(Z)-3-nonene	20237-46-1
1,1,1,2-Tetrafluoroethane	811-97-2
1,1,2-trimethylcyclohexane	7094-26-0
1,1,4-trimethylcyclohexane	7094-27-1
1,1'-biphenyl, 3-methyl-	643-93-6
1,1'-biphenyl, 4-methyl	644-08-6
1,1'-ethylidenebis-benzene	612-00-0
1,2,4-trimethylbenzene + 1,2,4-tributylbenzene + 1-decene[1]	95-63-6;14800-16-9;872-05-9
1,2,8-trimethylnaphthalene	3876-97-9
1,2-dimethylcyclohexane	583-57-3

[2] Prepared by Eastern Research Group, Inc. for National Center for Environmental Assessment (NCEA), U.S. EPA.

Compound Name	CAS Number
1,3+1,6+1,7dimethylnaphthalene	575-41-7; 575-43-9; 575-37-1
1,3-dichlorobenzene	541-73-1
1,3-dimethyldibenzothiophene	31317-15-4
1,3-dinitronaphthalene	606-37-1
1,3-isobenzofurandione	85-44-9
1,3-pentadiene	504-60-9
1,4 + 1,2-dimethylcyclopentane	X[2]; 2452-99-5
1,4,5-trimethylnaphthalene	2131-41-1
1,4+1,5+2,3-dimethylnaphthalene	571-58-4; 571-61-9; 581-40-8
1,4-pentadiene	591-93-5
1,5-dinitronaphthalene	605-71-0
1,6- + 1,8-dinitropyrene	42397-64-8; 42397-65-9
1,7-dimethylphenanthrene	483-87-4
1,8-dimethyl-dibenzothiophene	31317-42-7
1,8-dimethylnaphthalene	569-41-5
1,8-dinitronaphthalene	602-38-0
1,cis-2,trans-3-trimethylcyclopentane	
10-methyl-benzo(b)naphtho(2,1-d)thiophene	
17a(h),18a(h),21b(h)-25,28,30-trisnorhopane	
17a(h),18a(h),21b(h)-28,30-bisnorhopane	
17a(h),21b(h)-22,29,30-trisnorhopane	
17a(H),21b(H)-29-norhopane	
17a(h),21b(h)-30-norhopane	53584-60-4
17a(h),21b(h)-hopane	13849-96-21
17a(H)-22,29,30-trisnorhopane	53584-59-1
17b(h),21a(h)-hopane	1176-44-9
17b(h),21b(h)-hopane	471-62-5
18a(h),21b(h)-22,29,30-trisnorhopane	
18a(h),21b(h)-30-norneohopane	
18a(h)-22,29,30-trisnorneohopane	
1-butene + isobutene	106-98-9 & 115-11-7
1-ethyl-2-methylnaphthalene	17057-93-1
1-ethylnaphthalene+2-ethylnaphthalene	1127-76-0 & 939-27-5
1-methyl-3-isopropylbenzene + 1-methyl-4-isopropylbenzene	535-77-3; 99-87-6
1-methyl-7-isopropylphenanthrene	483-65-8
1-methylfluorene	1730-37-6
1-methylindane	767-58-8
1-methylphenanthrene	832-69-9
1-methylpyrene	2381-21-7
2,2,4-trimethylhexane + 1,1-ethyl methylcyclopentane	16747-26-5; X
2,2,4-trimethylpentane + 1-heptene	540-84-1;592-76-7
2,2,5-trimethylhexane+t-1,3-ethylmethylcyclopentane	3522-94-9; X
2,2-dimethylheptane	1071-26-7
2,2-dimethylhexane + 2,4,4-trimethyl-2-pentene	590-73-8; 107-40-4
2,3,5-trimethylhexane + cis-1,2-dimethylcyclohexane	1069-53-0; 2207-01-4
2,3-benzofuran	271-89-6
2,3-dimethyl-1-hexene	16746-86-4
2,3-dimethylhexane + 3-ethyl-2-methylpentane	584-94-1;609-26-7
2,4,5-trimethylnaphthalene	17057-91-9
2,4-dimethylhexane + 2,2,3-trimethylpentane	589-43-5;564-2-3
2,4-dimethylpentane + 2,3-dimethyl-2-butene	108-08-7; 563-79-1
2,4-dinitrophenol	51-28-5
2,5-dimethylhexane + 2,2,3-trimethylpentane	592-13-2; 564-02-3
2,5-dimethylhexane + ethylcyclopentane	592-13-2;1640-89-7

Compound Name	CAS Number
2,6,10-trimethyltridecane	3891-99-4
2,6-dimethylheptane + cis-1,2-dimethylcyclohexane	1072-5-5;2207-1-4
2,7-dinitrofluorene	5405-53-8
20R,5a(H),14b(H),17b(H)-cholestane	69483-47-2
20R+S-5a(H),14b(H),17b(H)-ergostane	
20R+S-5a(H),14b(H),17b(H)-sitostane	
20R-13b(H),17a(H)-diacholestane	
20S-13b(H),17a(H)-diacholestane	
22,29,30-trisnorneohopane	
22r+s,17a(h),21b(H)-30-bishomohopane	
22r+s,17a(H),21b(H)-30-homohopane	
22r-17a(h),21b(h)-30,31,32-trishomohopane	
22r-17a(h),21b(h)-30,31-bishomohopane	
22r-17a(h),21b(h)-30-homohopane	60305-22-8
22s-17a(h),21b(h)-30,31,32-trisomohopane	
22s-17a(h),21b(h)-30,31-bishomohopane	
22s-17a(h),21b(h)-30-homohopane	60305-23-9
2-butoxy ethanol	111-76-2
2-ethyl-1-butene	760-21-4
2-hexanone	591-78-6
2-methyl-1-phenyl-1-propene	768-49-0
2-methyl-3-ethylpentane + 2,5-dimethyl-2-hexene	609-26-7; 3404-78-2
2-methylanthracene	613-12-7
2-methyl-benzo(b)naphtho(2,1-d)thiophene	
2-methylbiphenyl	643-58-3
2-methyl-dibenzothiophene	20928-02-3
2-methylfluorene	1430-97-3
2-methylhexane + cyclohexene + 2,3-dimethylpentane	591-76-4; 110-83-8; 565-59-3
2-methylphenanthrene	2531-84-2
2-methylphenol	95-48-7
2-methylpropyl-cyclohexane	1678-98-4
2-methylundecane	31807-55-3
2-nitrophenol	88-75-5
2-propyltoluene	1074-17-5
3, 3-dimethylhexane + 1-cis-2-trans-4-cis-trimethylcyclopentane	563-16-6; X
3,3,4,4-tetramethylhexane	5171-84-6
3,3-dimethyl-1-pentene	3404-73-7
3,3-dimethylpentane +cyclohexane	562-49-2; 110-82-7
3,4-dimethylheptane + 4-methyloctane	922-28-1 ;2216-34-4
3,6-dimethylphenanthrene	1576-67-6
3-ethyl-cis-2-pentene	816-79-5
3-ethylheptane	15869-80-4
3-ethylhexene + t-1,4-dimethylcyclohexane	X; 2207-04-7
3-ethyloctane	5881-17-4
3-ethylpentane + t-1,2-dimethylcyclopentane	617-78-7; X
3-ethylpentane + trans-1,3-dimethylcyclopentane	617-78-7;1759-58-6
3-methylcholanthrene	56-49-5
3-methyloctane + 3,3-diethylpentane + 3-ethylheptane	2216-33-3; 1067-20-5; 15869-80-4
3-methylpentane + cis-1,3-dimethylcyclohexane	96-14-0; 638-04-0
3-methylphenanthrene	832-71-3
3-nitro-1,1'-Biphenyl	2113-58-8
3-nitrofluorene	5397-37-5
3-nitrophenanthrene	17024-19-0

Compound Name	CAS Number
3-propyltoluene	1074-43-7
4,4 + 2,2-dimethylheptane	1068-19-5;1071-26-7
4,6-dimethyldibenzothiophene	1207-12-1
4-ethylguaiacol	2785-89-9
4-formyl guaiacol	
4-methyl syringol	6638-05-7
4-methyl-1-pentene + 3-methyl-1-pentene	691-37-2; 760-20-3
4-methyl-2-pentene	4461-48-7
4-methylguaiacol	93-51-6
4-methylheptane + 3-ethyl-3-methylpentane + 1-methylcyclohexene	589-53-7;1067-08-9;591-49-1
4-methylheptane + 3-methyl-3-ethylpentane + 3,5,5-trimethyl-1-hexene	589-53-7; 1067-08-9; 4316-65-8
4-methyloctane + 2-octyne	2216-34-4; 2809-67-8
4-methylpyrene	3353-12-6
4-nitrophenanthrene	82064-15-1
4-nitrophenol	100-02-7
4-n-propyltoluene + 1,4-diethylbenzene	1074-55-1; 105-05-5
4-propyltoluene + butyl-1,3-dimethyl-5-ethylbenzene + 1-ethyl-3,5-dimethyl-benzene	1074-55-1;X;934-74-7
5+6-methylchrysene	3697-24-3 & 1705-85-7
5-isopropyl-m-xylene	4706-89-2
5-methyl-benzo(b)naphtho(2,1-d)thiophene	
5-methyl-naphtho(2,1-b)thiophene	
6-methyl-benzo(b)naphtho(2,1-d)thiophene	
7-methylbenz[a]anthracene	2541-69-7
7-methylbenzo(a)pyrene	63041-77-07
7-nitrobenzo(a)anthracene	63041-91-8
8b,13a-dimethyl-14b-[3'-methylbutyl]podocarpane	
8b,13a-dimethyl-14b-n-butylpodocarpane	
8-methyl-benzo(b)naphtho(1,2-d)thiophene	
8-methyl-benzo(b)naphtho(2,3-d)thiophene	24964-07-6
8-methyl-naphtho(2,1-b)thiophene	
9-anthraldehyde	642-31-9
9-Fluorenone	486-25-9
9-methylanthracene	779-02-2
9-methylphenanthrene	883-20-5
9-nitrophenanthrene	954-46-1
abietic acid	514-10-3
acenaphthenequinone	82-86-0
acephenanthrylene	201-06-9
acetic acid	64-19-7
acetophenone	98-86-2
acetovanillone	498-02-2
alpha-pinene	80-56-8
ammonia	7664-41-7
ammonium	14798-03-9
anthanthrene	191-26-4
anthracene/phenanthrene	120-12-7; 85-01-8
anthraquinone	84-65-1
azelaic acid	123-99-9
benz(a)anthracene-7,12-dione	2498-66-0
benzene, 1,1'(1-methyl-1,2-ethanediyl)bis-	
benzo(a)fluorene	238-84-6
benzo(b)fluorene	243-17-4
benzo(b+j+k)fluoranthene	205-99-2; 205-82-3; 207-08-9

Compound Name	CAS Number
benzo(j)fluoranthene	205-82-3
benzoic acid	65-85-0
benzonaphthothiophene	61523-34-0
benzyl alcohol	100-51-6
beta-pinene	127-91-3
bis[2-ethylhexyl]phthalate	117-81-7
bishomohopane-1	
bishomohopane-2	
butenyl dimethylbenzene	
butylbenzylphthalate	85-68-7
butylcyclopentane	2040-95-1
c21 aaa-sterane	
c21 abb-sterane	
c21 tricyclic terpane	
c22 abb-sterane	
c22 tricyclic terpane	
c23 ab-dimethyl-a-butylpodocarpane	
c24 ab-dimethyl-a-methylbutylpodocarpane	
c25 tricyclic terpane	
c26 tricyclic terpane	
c26 tricyclic triterpane 22r	
c26 tricyclic triterpane 22s	
c27 20r-baa-cholestane	481-20-9
c27 20s-abb-cholestane	
c27 tetracyclic terpane 22r	
c27 tetracyclic terpane 22s	
c27 trisnorhopane tm	
c27-20r-13a(h),17b(h)-diasterane	
c27-20r-13b(h),17a(h)-diasterane	
c27-20r5a(h),14a(h),17a(h)-cholestane	481-21-0
c27-20r5a(h),14b(h)-cholestane	
c27-20s-13a(h),17b(h)-diasterane	
c27-20s-13b(h),17a(h)-diasterane	
c27-20s5a(h),14a(h)-cholestane	
c27-20s5a(h),14b(h),17b(h)-cholestane	
c27-tetracyclic terpane	
c28 20r/s?-ba-diasterane	
c28 20r-aaa-methylcholestane	
c28 20r-abb-methylcholestane	71117-90-3
c28 20r-ba-diasterane	
c28 20s-aaa-methylcholestane	
c28 20s-abb-methylcholestane	
c28-20r5a(h),14a(h),17a(h)-ergostane	
c28-20r5a(h),14b(h),17b(h)-ergostane	
c28-20s-13b(h),17a(h)-diasterane	
c28-20s5a(h),14a(h),17a(h)-ergostane	
c28-tetracyclic terpane	
c29 20r-aaa-ethylcholestane	62446-14-4
c29 20r-abb-ethylcholestane	71117-92-5
c29 20s-aaa-ethylcholestane	
c29 20s-abb (20r-baa)-ethylcholestane	
c29 20s-ba-diasterane	
c29 ab-25-norhopane	53584-60-4
c29 ba-norhopane	3258-87-5

Compound Name	CAS Number
c29-20r-13a(h),17b(h)-diasterane	
c29-20r5a(h),14a(h),17a(h)-stigmastane	
c29-20r5a(h),14b(h),17b(h)-stigmastane	
c29-20s5a(h),14a(h),17a(h)-stigmastane	
c29-20s5a(h),14b(h),17b(h)-stigmastane	
c2-fluorene	
c2-naphthalene	
c30 tricyclic terpane 22r	
c30 tricyclic terpane 22s	
c3-naphthalene	
c4-benzene or c2-benzene	
c4-naphthalene	
carbon disulfide	75-15-0
carbon tetrachloride	56-23-5
cerium	7440-45-1
cholestane-1	
cholestane-2	
cholestane-3	
cis- + trans-3-hexene	7642-09-3;13269-52-8
cis,cis,cis-1,2,3-trimethylcyclopentane	2613-69-6
cis-1,2-dichloroethene	156-59-2
cis-1,2-dimethylcyclopentane + methylcyclohexane	1192-18-3; 108-87-2
cis-1,3-ethylmethylcyclopentane + 2-ethyl-2-hexene	2613-66-3; X
cis-cis-trans-1,2,4-trimethylcyclopentane + cis-1,3-dimethylcyclohexane	X;638-04-0
cis-decalin	493-01-6
cis-pinonic acid	473-72-3
ctc-123-trimethylcyclopentane	
ctc-124-trimethylcyclohexane	
ctt-124-trimethylcyclohexane	
cyanide compounds	
cylcoheptane + 3-ethylhexene-1 + t-1,2-ethylmethylcyclopentane	886-65-7; X; X
decanal	112-31-2
decanoic acid	334-48-5
decylcyclohexane	1795-16-0
dehydroabietic acid	1740-19-8
diasterane-1	
diasterane-2	
dibenzofuran	132-64-9
dibenzothiazole	
diethyl phthalate	84-66-2
dimethyl dodecane	
dimethyl undecane	79004-83-4
dimethylbenzaldehyde	
dimethylphenanthrene	29062-98-4
di-n-butylphthalate	84-74-2
di-nitropyrene	
docosane	629-97-0
docosanoic acid	112-85-6
dodecanal	112-54-9
dodecene	25378-22-7
dodecylcyclohexane	1795-17-1
elaidic acid	112-79-8
ergostane	25318-39-2
ethyl dimethyl benzene	

Compound Name	CAS Number
ethyl hexanol	104-76-7
ethylbiphenyl	40529-66-6
ethylcyclohexane + n-propylcyclopentane	1678-91-7; 2040-96-2
eugenol	97-53-0
farnesane	3891-98-3
fluoride	16984-48-8
formic acid	64-18-6
furfural	98-01-1
glutaric acid	110-94-1
guaiacol	90-05-1
henicosane	629-94-7
henicosanoic acid	2363-71-5
henicosylcyclohexane	
hepenoic acid, ethyl ester	
heptadecane_pristane	629-78-7; 1921-70-6
heptadecanoic acid	506-12-7
heptadecylcyclohexane	19781-73-8
heptanal	111-71-7
heptanedioic acid	111-16-0
heptenoic acid, methyl ester	
heptylcyclohexane	5617-41-4
hexadecadienoic acid methyl ester	
hexadecane_norpristane	544-76-3; 3892-00-0
hexadecanoic acid	57-10-3
hexadecanoic acid, ethyl ester	628-97-7
hexadecene	26952-14-7
hexadecylcyclohexane	6812-38-0
hexanedioic acid	124-04-9
hexanoic acid	142-62-1
hexyl cyclohexane	4292-75-5
hexylcyclohexane	4292-75-5
homohopane-1	
homohopane-2	
hopane-1	
hopane-2	
hopane-3	
hydrogen cyanide	74-90-8
hydrogen sulfide	7783-06-4
icosane	112-95-8
icosanoic acid	506-30-9
icosene	3452-07-1
icosylcyclohexane	
indanone	83-33-0
indeno(1,2,3-cd)fluoranthene	00193-43-1
isoamylbenzene	2049-94-7
isobutylbenzene + n-decane	538-93-2; 124-18-5
isobutylcyclopentane	3788-32-7
isobutyraldehyde + butyraldehyde	78-84-2 & 123-72-8
isoeugenol	97-54-1
isophthalic acid	121-91-5
isopropylcyclopentane	3875-51-2
isopropyltoluene	25155-15-1
lauric acid	143-07-7
limonene	138-86-3

Compound Name	CAS Number
m- + p-cresol	108-39-4; 106-44-5
m/p-tolualdehyde	620-23-5 & 104-87-0
m+p-xylene + 2,3-dimethylheptane	1330-20-7; 3074-71-3
maleic acid	110-16-7
malonic acid	141-82-2
methyl chloride	74-87-3
methyl dodecane	90454-15-2
methyl ester undecenoic acid	
methyl ethyl naphthalene	29253-36-9
methyl propyl benzene	1074-17-5
methyl tert-amyl ether	994-05-8
methyl tridecane	
methyl vinyl ketone	78-94-4
methylbenzoic acid	12167-74-7
methylbiphenyl	28652-72-4
methylcyclohexane + cis-1,2-dimethylcyclopentane + 1,1,3-trimethylcyclopentane	108-87-2;1192-18-3;4516-69-2
methylcyclopentane + trans-3-methyl-2-pentene	96-37-7; 616-12-6
methylfluorene	26914-17-0
methylisopropylbenzene	25155-15-1
methylphenanthrene	28652-81-5
methylpyrene	2381-21-7
methylpyrene/methylfluoranthene	2381-21-7; 30997-39-8
methylpyridine + methylfluorene	1333-41-1; 26914-17-0
methylsuccinic acid	498-21-5
Myristic Acid	544-63-8
naphtho(2,1-b)thiophene	
n-octane + cis-1,4-dimethylcyclohexane+trans-1,3-dimethylcyclohexane	111-65-9; 624-29-3; 2207-03-6
n-octane + trans-1,2-dimethylcyclohexane	111-65-9;6876-23-9
nonadecane	629-92-5
nonadecanedioic acid	6250-70-0
nonadecanoic acid	646-30-0
nonadecylcyclohexane	22349-03-7
nonanal	124-19-6
nonanoic acid	112-05-0
nonene	27215-95-8
nonylcyclohexane	2883-02-5
norfarnesane	6864-53-5
norhopane-1	
norhopane-2	
norpristane	3892-00-0
n-propylcyclopentane + cis,cis,cis-1,3,5-trimethylcyclohexane + ethylcyclohexane	2040-96-2; X;1678-91-7
n-undecane + 1,2-dimethyl-3-ethylbenzene	1120-21-4;933-98-2
octadecane	593-45-3
octadecanedioic acid	871-70-5
octadecanoic acid	57-11-4
octadecene	27070-58-2
octadecenoic acid methyl ester	
octadecylcyclohexane	4445-06-1
octanal	124-13-0
octanedioic acid	505-48-6
octanoic acid (caprylic acid)	124-07-2
octylcyclohexane	1795-15-9

Compound Name	CAS Number
oleic acid	112-80-1
o-tolualdehyde	529-20-4
p-cresol	106-44-5
pentachlorophenol	87-86-5
pentadecanoic acid	1002-84-2
pentadecylcyclohexane	6006-95-7
pentamethylbenzene	700-12-9
pentylcyclohexane	38792-89-1
perinaphthenone	548-39-0
phenanthro(2,1-b)thiophene	
phenanthro(2,3-b)thiophene	
phenanthro(3,4-b)thiophene	
phenanthro(4,3-b)thiophene	
phenyl ethanone	
phosphates	14265-44-2
phthalic acid	88-99-3
phytane	638-36-8
picolinic acid	98-98-6
pinacolin	75-97-8
p-methylstyrene	622-97-9
pristane	1921-70-6
propionic acid	79-09-4
propyltoluene	28729-54-6
pyrene/fluoranthene	129-00-0; 206-44-0
sitostane	
sitosterol	83-46-5
stearic acid	57-11-4
succinic acid	110-15-6
sulfates or phosphates	
syringol	91-10-1
tert-butyl alcohol	75-65-0
tert-butyl-2-methyl-benzene	
tert-butyl-3,5-dimethyl-benzene	
tert-butyl-4-ethyl-benzene	
tert-butylbenzene + 1,2,4-trimethylbenzene	98-06-6 & 95-63-3
tetrachloroethylene	127-18-4
tetradecene	26952-13-6
tetradecylcyclohexane	1795-18-2
tetrahydro dimethyl naphthalene	
tetrahydromethylnaphthalene	31291-71-1
tetralin	119-64-2
tetramethyl butane	594-82-1
tetramethyl hexadecane	
tetramethyl pentadecane	
toluene + 2,3,3-trimethylpentane	108-88-3; 560-21-4
trans-3,4-dimethyl-2-pentene + 1-heptene	4914-92-5; 592-76-7
trans-hexene-2 + cis-3-hexene + cis-2-hexene + 2-methyl-2-pentene	X; 7642-09-3; 7688-21-3; 625-27-4
trichloroethene	79-01-6
trichlorofluoromethane	75-69-4
tricosanoic acid	2433-96-7
tridecanal	10486-19-8
tridecanoic acid	638-53-9
tridecylcyclohexane	6006-33-3
trimethyl dodecane	

Compound Name	CAS Number
trimethyl pentadecane	
trimethylacetaldehyde + 3-methyl-2-butanone	630-19-3;563-80-4
trimethylnaphthalene	28652-77-9
triphenylene	217-59-4
trisnorhopane-1	
trisnorhopane-2	
undecanal	112-44-7
undecanoic acid	112-37-8
undecylcyclohexane	54105-66-7
xanthone	90-47-1

Notes regarding Table 3:
[1]Where more than one chemical species is listed on a row, these compounds could not be separated by the analytical technique used. The corresponding CAS numbers are listed in order, respectively.
[2]An 'X' denotes a compound for which the CAS number could not be identified.

The compounds identified in Table 3 as well as the compounds that were already listed in the Mater List were cross-referenced with the IRIS file. Compounds in the Master list that are included in IRIS with a health benchmark value or cancer hazard identification are listed in Table 4.

Table 4. Compounds on the Master List that are included in IRIS with health information.

Compound Name	CAS Number
1,1,1,2-Tetrafluoroethane	811-97-2
1,1,1-Trichloroethane	71-55-6
1,1-Biphenyl	92-52-4
1,2-Dibromoethane	106-93-4
1,2-Dichlorobenzene	95-50-1
1,3-Butadiene	106-99-0
2,4-Dinitrophenol	51-28-5
2-Methylnaphthalene	91-57-6
2-Methylphenol	95-48-7
4-Methylphenol	106-44-5
Acenaphthene	83-32-9
Acetaldehyde	75-07-0
Acetone	67-64-1
Acetophenone	98-86-2
Acrolein	107-02-8
Ammonia	7664-41-7
Anthracene	120-12-7
Antimony	7440-36-0
Arsenic, inorganic	7440-38-2
Barium and compounds	7440-39-3
Benz[a]anthracene	56-55-3
Benzaldehyde	100-52-7
Benzene	71-43-2
Benzo [a] pyrene (BaP)	50-32-8
Benzo[b]fluoranthene	205-99-2
Benzo[k]fluoranthene	207-08-9
Benzoic acid	65-85-0
Beryllium and compounds	7440-41-7
Boron (Boron and Borates only)	7440-42-8
Bromomethane	74-83-9
Butyl benzyl phthalate	85-68-7
Cadmium	7440-43-9
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorine	7782-50-5
Chlorobenzene	108-90-7
Chloroform	67-66-3
Chromium III	16065-83-1
Chromium VI	18540-29-9
Chrysene	218-01-9
Crotonaldehyde	4170-30-3
Cumene	98-82-8
Cyclohexane	110-82-7
Cyclohexanone	108-94-1
Di(2-ethylhexyl)phthalate (DEHP)	117-81-7
Dibenz[a,h]anthracene	53-70-3
Dibutyl phthalate	84-74-2
Dichloromethane	75-09-2
Diesel Exhaust	
Diethyl phthalate	84-66-2
Dioxins and Furans	
Ethylbenzene	100-41-4
Ethylene glycol monobutyl ether (EGBE)(2-Butoxyethanol)	111-76-2

Compound Name	CAS Number
Fluoranthene	206-44-0
Fluorene	86-73-7
Formaldehyde	50-00-0
Furfural	98-01-1
Hexachlorodibenzo-p-dioxin, mixture (Dioxin/Furans)	19408-74-3
Hydrogen cyanide	74-90-8
Hydrogen sulfide	7783-06-4
Indeno[1,2,3-cd]pyrene	193-39-5
Lead and compounds (inorganic)	7439-92-1
Manganese	7439-96-5
Mercury, elemental	7439-97-6
Methanol	67-56-1
Methyl chloride	74-87-3
Methyl ethyl ketone (MEK)	78-93-3
Methyl isobutyl Ketone (MIBK)	108-10-1
Methyl tert-butyl ether (MTBE)	1634-04-4
Molybdenum	7439-98-7
Naphthalene	91-20-3
Nickel compounds	
n-Hexane	110-54-3
Nitrate	14797-55-8
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitroso-di-n-butylamine	924-16-3
N-Nitrosodi-N-propylamine	621-64-7
N-Nitrosopyrrolidine	930-55-2
Pentachlorophenol	87-86-5
Phenol	108-95-2
Phosphorus	7723-14-0
Phthalic anhydride	85-44-9
Pyrene	129-00-0
Selenium and compounds	7782-49-2
Silver	7440-22-4
Strontium	7440-24-6
Styrene	100-42-5
Tetrachloroethylene	127-18-4
Toluene	108-88-3
Trichlorofluoromethane	75-69-4
Vanadium	1314-62-1
Xylenes	1330-20-7
Zinc and compounds	7440-66-6

Nonroad references

Table 5 lists the seven nonroad references that were reviewed by Environ, and the engines and fuels listed in each:

Table 5. Nonroad references studied by Environ in Phase II and III.

Nonroad Reference Number	Mobile Source Characteristics	Test Fuel Characteristics
47	Hercules GTA 3.7 L Medium Duty CNG Engine	95.6mol% methane CNG fuel
170	5 in-use small lawn and garden equipment engines	emissions grade, unleaded, certification gasoline
175	Six marine vessels	Fuel Oil and Gas Oil
184	5 off-road gasoline engines tested (out of these, only 2 were tested for unregulated emissions)	Phase II Gasoline and LPG
187	Six Locomotives (3 EMD and 3 GE engines) and DDC Series 60 test engine	4 Diesel Fuels (CARB Fuel, On-Highway Fuel, High Sulfur Nonroad, 0.3% Sulfur Nonroad)
190	16 jet engines, 2 helicopter engines, and 2 auxiliary power units (APUs)	military JP-8 jet fuel
191	fifteen nonroad diesel engines were tested (construction, utility and agricultural equipment applications)	Certification-grade Type-2D diesel fuel, high-sulfur Nonroad-2D diesel fuel, California 2D fuel, clean emissions control diesel (ARCO "ECD" fuel)

Description of files

The file "MSAT Master List Template Tables_ENVIRON_PhIII.xls" contains data from the literature review from both phases of the work, with the following worksheets (as described in the previous section):

- Master List
- Bibliography
- Testing Methods
- Test Fuel
- Test Vehicle or Engine

The file "IRIS_MasterList_xref.xls" contains the data extracted from the IRIS database, and the cross reference of this information with the Master List. It contains the following worksheets

- "IRIS" – all the data extracted from EPA's IRIS database (from html files downloaded from http://www.epa.gov/iris/stand-al.htm)
- "xref" - The cross section of compounds that are listed in the Master List and on IRIS, (all IRIS extracted data plus the associated screening level codes from the contractor study)

- "xref_2" - A subset of "xref" - only those compound/elements for which IRIS lists an RfC, RfD, and/or a compound that is classifiable according to human carcinogenicity (all IRIS extracted data plus the associated screening level codes from the NCEA study)
- "All_screen_codes" – the reported values of the screening level codes from the EPA ORD NCEA literature search study

The file "Reference_List_PhI-III.xls" contains a full list of references. This includes studies that were analyzed in both phases of the work, as well as a list of references that were not reviewed. These references that were not reviewed, but which may contain Mobile Source Air Toxics, are listed in Appendix B.

APPENDIX A

NOTES FILE FOR REFERENCES

STUDIES FROM WHICH DATA WERE INCORPORATED INTO THE MASTER LIST – PHASE II

Reference #47

Nine, Ralph D., Nigel N. Clark, Brian E. Mace and Laila E.lGazzar. 1997. "Hydrocarbon Speciation of a Lean Burn Spark Ignited Engine." SAE #972971.

Included data from tables: Table 4, Table 5, and Table 6

Units in mg/hp-hr (after conversion)

- "g/mode" values were converted to "mg/bhp-hr" values using the data in Table 6 and 10 and finding conversion factors for each mode.

Reference #48

Whitney, K. Bailey, B. 1994. "Determination of Combustion Products from Alternative Fuels - Part I: LPG and CNG Combustion Products." SAE #941903.

Included data from tables: Table 6, Appendix Table 2,3,4

Units in mg/mi

- This reference included 3 fuel types (LPG, CNG and RFG) – so only compounds were marked (with an X) that were emitted by each particular fuel.

Reference #50

Benson, J.; Koehl, W.; Burns, V.; Hochhauser, A.; Knepper, J.; Leppard, W.; Painter, L.; Rapp, L.; Reuter, R.; Rippon, B.; Rutherford, J. 1995. "Emissions with E85 and Gasolines in Flexible/ Variable Fuel Vehicles - The Auto/Oil Air Quality Improvement Research Program." SAE #952508.

Included data from tables: Appendix 3,4,5,6

Units in mg/mi

- Appendix 8 contained Hot Soak Evaporative emissions data as g/test values. Thus, no emission rate data was included from this Appendix, instead, for these compounds, the box for "Gas-Evap" was checked.

Reference #53

Schauer, James J.; Kleeman, Michael J., Cass, Glenn R. and Bernd R.T. 2002. "Simoneit Measurement of Emissions from Air Pollution Sources. 5. C1 - C32 Organic Compounds from Gasoline-Powered Motor Vehicles." *Env. Sci & Tech.* 36(36), 1169-1180.

Included data from Table 2, Table 3

Units in mg/mi

- Table 3 had gas phase and particle phase data– the minimum and maximum emission rates for both phases together were calculated for inclusion into the master list

- Only compounds present in exhaust were included - and not ones only present in the gasoline itself (i.e. did not include 2,2-dimethyl propane, 2,2,4-trimethylhexane, 1-butene, 4-methyl-1-pentene, 1,3-butadiene, ethylcyclohexane, isopropyl benzene, naphthalenecarboxaldehydes)
- For data in Table 2 (fine-particle chemical composition) – only those values that were greater than zero by at least 2 standard errors were included into the master list (these were labeled in bold in the paper). Data in Table 2 was reported as a wt% of fine particle mass, so no emission rates were included
- Did not include the following records due to lack of specificity (C1-MW 202 PAH, C1-MW 226 PAH, C1-MW 228 PAH, C2-MW 178 PAH, C3-MW 178 PAH
- Hopanes and Steranes were listed
- General groups (c2-fluorene, c2-naphthalene, c3-naphthalene, c4-naphthalene) were included as named

Reference #61

Kleeman, Michael J.; Schauer, James J. ; and Glen R. 2000. "Cass Size and Composition of Fine Particulate Matter Emitted from Motor Vehicles." *Env. Sci & Tech.* 34(7), 1132-1142.

Included data from Figures 2,3,4,5,6,7

No emission rate information included

- Paper includes testing from a subset of vehicles involved in References 53 and 62 – but this paper deals with a more specific elemental analysis
- From figures 2 through 7, compound names (10 records) were manually copied
- Emission rates were not included as they were reported as a % mass of the particle

Reference #62

Schauer, James J.; Kleeman, Michael J., Cass, Glenn R. and Bernd R.T. 1999. "Simoneit Measurement of Emissions from Air Pollution Sources. 2. C1 - C30 Organic Compounds from Medium Duty Diesel Trucks." *Env. Sci & Tech.* 33(10), 1578-1587.

Included data from Tables 1, 2

Units in mg/mi

- For data in Table 1 (fine-particle chemical composition) – only those values that were greater than zero by at least 2 standard errors were included into the master list (these were in bold in the paper). Data in this table was reported as a wt% of fine particle mass, so no emission rates were included.
- Table 2 had gas phase and particle phase data– the minimum and maximum emission rates for both phases combined were calculated for inclusion into the master list
- Only compounds present in exhaust were included - and not ones only present in the gasoline itself (i.e. did not include undecane).
- Did not include the following records due to lack of specificity (C1-MW 202 PAH, C1-MW 228 PAH, C2-MW 178 PAH, C3-MW 178 PAH)
- Hopanes and Steranes were listed individually

- General groups (c2-naphthalene, c3-naphthalene, c4-naphthalene) were included as named.

Reference #87

Cadle, Steven H.; Mulawa, Patricia A.; Hunsanger, Eric C.; Nelson, Ken; Ragazzi, Ronald A.; Barrett, Richard; Gallagher, Gerald L.; Lawson, Douglas R.; Knapp, Kenneth T.; and Richard Snow. 1998. " Measurement of Exhaust Particulate Matter Emissions from In-Use Light-Duty Motor Vehicles in the Denver, Colorado Area." CRC E-24-1.

Included data from Table 1, 6.9, 6.10, 6.18, 6.19, 6.30 and 6.31

Units in mg/mi

- Compounds like "A-methylbiphenyl" or "G-Trimethylnaphthalene" – (this nomenclature is a general naming convention for fused aromatic compounds) were lumped together under a general isomer name (for instance, a- through h-trimethylnaphthalene were just called "trimethylnaphthalene")
- Table 6.29 and 6.30 had data on Hopanes and Steranes –these compounds were included, but corresponding CAS#'s were not found.
- Vehicles were tested using the as-received, on-board fuel. Vehicle fuel samples were not collected, however ~16-20 fuel samples were collected from service stations in the area and were tested for sulfur content (Table 6.6 and 6.7)– this information was not included in the Test Fuel Section.

Reference #92

Ullman, Terry L. Ullman; Lawrence Smith; Joseph W. Anthony; Warren J. Slodowske; William M. Trestrail; William Bunn; Charles A. Lapin; Kenneth J. Wright; and Charles R. Clark. 2003. "Comparison of Exhaust Emissions, Including Toxic Air Contaminants, From School Buses in Compressed Natural Gas, Low-Emitting Diesel, and Conventional Diesel Engine Configurations." SAE #2003-01-1381.

Included data from Tables 7,11,13,14

Units in mg/mi

- Table 14 contained data for dioxins and furans –only those compounds that were detected above the detection limit were included, as well as a group named "dioxins and furans"
- Also included group named "cyanide compounds"

Reference #95

Lev-On, Miriam; Chuck LeTavec; Ken Kimura; Jim Uihlien; Teresa Alleman; Doug Lawson; Keith Vertin; Gregory Thompson; Nigel Clark; Mridul Gautam; Scott Wayne; Barbara Zielinska; John Sagebiel; Sougato Chatterjee; Kevin Hallstrom; Robert A. Okamoto; Paul Rieger; Gary M. Yee. 2002. "Speciation of Organic Compounds From the Exhaust of Trucks and Buses: Effect of Fuel and After-Treatment on Vehicle Emission Profiles." SAE #2002-01-2873.

Included data from tables 3-11

Units in mg/mi

- In Table 3 in the paper, a list of all detected 95 NMHC's is included without emission rates. Thus, these compounds were included into the Master List with no emission rate info.
- The paper refers to a "data archive being developed for the study" which contains more extensive data and emission rates for all the compounds detected – for this project, only the compounds listed in the paper were included.
- Dioxins and Furans were tested, but the report states that "None of the samples showed any positive hits above the detection limit" – so none were included into the Master List
- In tables, changed "0" emissions to "Not Detected"
- In Tables 4 and 5 used "Test-Uncorrected" Data
- Informationon drive cycle, vehicles and fuels obtained from Reference #93
- For CNG fuel properties, took average of replicate test results (Table 2, Ref 93)

Reference #98

Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 1. the Effect of Fuels and Engine Operating Modes on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH." SAE #2001-01-3627.

Included data from Tables 6,7,8,10

Units in mg/hp-hr

Reference #99

Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 2. the Effect of Fuels on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH Using a Composite of Engine Operating Modes." SAE #2001-01-3628.

Included data from Tables 3,4,5,6

Units in mg/hp-hr

- Diesel HC was considered the same as Diesel VOC in this and following papers

Reference #100

Ball, James; Charles A. Lapin; Janet P. Buckingham; Edwin A. Frame; Douglas M. Yost; Manuel Gonzalez; Eleanor M. Liney; Mani Natarajan; James P. Wallace; John A. Garbak. 2001. "Dimethoxy Methane in Diesel Fuel: Part 3. the Effect of Pilot Injection, Fuels and Engine Operating Modes on Emissions of Toxic Air Pollutants and Gas/Solid Phase PAH." SAE #2001-01-3630.

Included data from Tables 2,3,4,6

Units in mg/hp-hr

Reference #101

Siegl, Walter O.; Travis J. Henney; Mark Guenther. 2000. "Identifying Sources of Evaporative Emissions-Using Hydrocarbon Profiles to Identify Emission Sources." SAE #2000-01-1139.

Included data from Table 4

Units were in ppmC, so only names included in master list

- The data was in units of ppmC (since it was measurements of diurnal emissions) – these were listed in the master list without emission rate
- Paper had very detailed Fuel Speciation data – but this was not included into the Master List spreadsheet (since no similar fields)
- Paper did not have very much information on types and numbers of vehicles tested

Reference #102

Sharp, Chris A.; Steve Howell; Joe Jobe. 2000. "The Effect of Biodiesel Fuels on Transient Emissions From Modern Diesel Engines-Part Ii: Unregulated Emissions and Chemical Characterization." SAE #2000-01-1968.

Included data from tables: Table A1 through A12

Units in mg/hp-hr

- Dealing with "trace" – it was decided that anything below the detection limit is not entered into the Mater List, and anything reported as trace emissions will be listed in the Master List, but without emission rate information.
- CAS#s could not be found for all the new compounds to the list, so some were left blank

Reference #115

Silva, Philip J.; Kimberly A. Prather. 1997. "On-line Characterization of Individual Particles from Automobile Emissions." *Env. Sci & Tech*. 31(11), 3074-3080.

Included data from Table 1

- Author assigned MS peaks to various compounds – so some records are listed as "sulfates or phosphates", "anthracene/phenanthrene", etc
- Emission rates not given in mg/mi, so compounds are listed in master list without emission rate information

Reference #131

Sweeney, Edward G.; John H. Baudino; Carolyn H. Schmidt. 1992. "Composition of Gasoline Vehicle Emissions--An Analytical Speciation Program." SAE #922253.

Included data from Appendix A

No emission rate information reported

- Paper references "Table 2" with emission rate information, and "Appendix B" with aldehyde/ketone information, but these were not found in the hard copy.
- Instead, only names of compounds listed in Appendix A (C3-C12's) and in the text of paper were included, without emission rate information
- 27 of the new compounds listed were co-elutes (two or more species that eluted together and listed with a "+" sign)
- Note: deleted record for 2,2,4-Trimethylpentene-1 (no such structure exists– due to typo in paper)

Reference #138

Pakko, James D.; Andrew A. Adamczyk; Walter O. Siegl; Robert J. Pawlowicz. 1994. "Measurements of Total and Speciated Hydrocarbon Removal From Engine Exhaust Using Activated Carbon." SAE # 941999.

Included data from Table 1

Units were in ppmC, so only names included in Master List

- Emissions were reported as ppmC, but these were not converted to g/mi. Instead, compound names (but no emission rate information) were included into the Master List, and compounds with zero reported emissions were not included into the Master List
- The paper did not have much fuel property data, but did have very detailed GC speciation data for the 2 fuels – from this only benzene was included into the Master List's test fuel page (since this was the only compound that was listed as ppmC%)

Reference #147

Leppard, William R.; Larry A. Rapp; Vaughn R. Burns; Robert A. Gorse, Jr.; Jay C. Knepper; William J. Koehl. 1992. "Effects of Gasoline Composition on Vehicle Engine-Out and Tailpipe Hydrocarbon Emissions--The Auto/Oil Air Quality Improvement Research Program". SAE #920329. Pp. 435-459.

Included data from Tables 5,7 and Figures 10,11,12,13

- Emissions were listed in Figures 10,11,12 in bar charts only - only names of toxic compounds were included in Master List, no emission rate
- Names were taken off of bar charts (Fig 10,11,12&13) manually from the converted word file
- Paper contained detailed fuel speciation data

Reference #155

Howes, Peter and Greg Rideout. N. "Evaluation of Biodiesel in an Urban Transit Bus Powered by a 1988 DDECII6V92 TA Engine." MSED #95-26743-1.

Included data from Tables 6-20 (PM and VOC), and Appendix B (aldehydes and ketones)
Units in mg/mi

- Author Greg Rideout was contacted for electronic data – he replied and stated that due to a major server crash, all the electronic data was lost. Because the quality of the hard copy and pdf was so poor –none of the data in Appendix D: Detailed Hydrocarbon Analysis was included.
- No detailed test fuel data given

Reference #166

Gautam, Mridul; Nigel Clark; W. Scott Wayne; Gregory Thompson; Donald W. Lyons; Wesley C. Riddle; Ralph D. Nine; Benjie Staggs; V. Andy Williams; Timothy Hall; Sairam Thiagarajan. 2003. "Heavy-Duty Vehicle Chassis Dynamometer Testing for Emissions Inventory, Air Quality Modeling, Source Apportionment and Air Toxics Emissions Inventory." CRC E-55/E-59.

Included data from Appendix E (and manually from tables 17,18,21-24,26- 28 for HC, PM data)
Units in mg/mi

- Electronic data was obtained from the author, and this contained all the data in Appendix E that was needed
- Tables 17-28 were manually examined to get "diesel VOC" and "diesel particulate matter" data in mg/mile
- Similar to reference 87, isomers such as b-trimethylnaphthalene were named simply as "trimethylnaphthalene"
- The data included VOC, Carbonyls, Polar Compounds, methane, high alkanes, TENAX samples, Hopanes and Steranes, PAH, Nitro PAH, Nitrosoamines, and inorganics
- Everything but NitroPAH had emissions in mg/mi – for NitroPAH, units were in g/cycle, for these no emission rate information was included into the Master List
- In the study, only the first three vehicles were analyzed in detail for unregulated emissions (toxics)– so just these three vehicles were listed in the "Test Vehicle" page, and the three fuel samples into the "Test Fuel" page

Reference #170

Carroll, James N. 1991. "Emission Tests of In-Use Small Utility Engines – Task III Report Non-Road Source Emission Factors Improvement." SwRI #3426-006.

Included data from Table 6,7
Units in mg/hp-hr

- In the Appendix, author had included detailed data by each test mode - but in the current analysis only summary tables (table 6,7) were used.

Reference #173

Kado, N.Y., P.A. Kuzmicky, K.L. Kiefer, R.L. Maddalena, Tung-Liang Huang, R.A. Okamoto. 1998. "Exposure to Emissions from Alternative Fuel Combustion: Bioassay and Chemical Analyses of the Particle and Semi-Volatile Emissions from Hydrogenated Biodiesel Fuels."

Included data from Table II-1 (particulate phase PAHs), Table III-2 (vapor-phase PAHs) and Table III-3 (Nitro-PAHs)

Units in mg/hp-hr

- Minimum and maximum emission rates were calculated using data from both phases
- In Table III-3 (Nitro-PAHs) – only two compounds were detected above the detection limit
- No detailed fuel informationgiven (paper states that fuels are specified and described in the Caterpillar report on the regulated emissions)

Reference #175

Lloyd's Register. 1995. "Lloyd's Register Work in Marine Based Air Pollution and Its Relationship to Other Work in the Field."

Included data from Tables 13, 14, 15

No emission rate information in appropriate units given

- Data was given in units of ug/m^3 – so no emission rates added to
- No detailed fuel or vessel information given
- Paper had limited bibliographic information (cited as Lloyd's Register)
- From table 15, "Dioxins and Furans" were reported as group
- Emissions type labeled as "Other – Exh" in master list

Reference #177

Norbeck, J., T.D. Durbin, T.J. Truex. 1998. "Characterization of Particulate Emissions from Gasoline-Fueled Vehicles."

Included data from Table ES-10 and Table 18

Units in mg/mi

- From table ES-10 – only included those compounds that had averages at least twice the average uncertainty (marked in bold in the paper)
- Note: only used nonzero minimum emission rates (if minimum rate reported was less than or equal to zero, used average rate instead)
- Compounds such as "a-methylfluorene" are named as "methylfluorene", etc
- For fuel information(from Table 2) – data was averaged between both sets of analyses
- Vehicle informationwas only listed from those 10 vehicles that had detailed speciation data (List from Appendix O and Table ES-9)

Reference #180

Sharp, C. A. 1996. "Emissions and Lubricity Evaluation of Rapeseed Derived Biodiesel Fuels." Final Report. SwRI #7507.

Included data from Tables 3,6,7, and Appendix B

Units in mg/hp-hr

- Heavy HC data was qualitative only – so no emission rates were included for these compounds
- For Appendix B (C1-C12 Speciation data)– the tables were manually examined, and compounds that had nonzero emissions for at least one test were selected for inclusion into Master List – (without emission rate information)
- Emissions were marked as "Diesel-Exhaust" – (all biodiesel data was marked as "diesel")

Reference #183

Truex, Dr. T.J., Dr. J. M. Norbeck, M.R. Smith, J. Arey, N. Kado, B. Okamoto, K.Kiefer, P. Kuzmicky, I. Holcomb. 1998. "Evaluation of Factors that Affect Diesel Exhaust Toxicity."

Included data from Summary Tables 1-8

Units in mg/hp-hr

- Used weighted total emission rates in summary tables
- Dioxins and Furans were detected (p. xx of executive summary) and in Figure 1, but no emission rates were given in needed units) – the group "dioxins and furans" was included into the master list with no emission rate.
- Fuel informationwas taken from Table 2 – (analysis from Core Labs was used since this was the most detailed dataset)

Reference #184

White, J., M.N. Ingalls, J.N.Carroll, L. Chan. 1999. "Three-Way Catalyst Technology for Off-Road Equipment Powered by Gasoline and LPG Engines."

Included data from Appendix B (p.161-164, 175-182,191-198), Appendix C (p.211-214, 219-222), and Appendix D (p.233-236)

Units in mg/hp-hr

- Data tables (36pgs) were scanned and imported to excel and double-checked for importing errors
- No vehicle information given (CARB kept manufacturer ID confidential)

Reference #187

Fritz, Steven G. 2000. "Diesel Fuel Effects on Locomotive Exhaust Emissions."

Included data from Tables 6,9,12,13,14,15,17,19, & App. K

Units in mg/hp-hr

- Numbered Reference as #187 – this was one of the add-ons to the original list
- Tables were directly obtained from author, Steve Fritz

- There were pages of detailed test data in the appendices, only composite emissions data in summary tables were included
- Detailed emissions from six locomotive engines, as well as one DDC test engine (PM and HC from four test fuels) were included
- For metal particulate data – only Chromium was detected – and emission rate information was not included into the master list as it was reported in mg/hr
- for sulfates data – emissions were reported as "composite 'wet' sulfate emissions" where "wet" Sulfate = "dry" sulfate x
- In Table 14, PAH data –an emissions value of zero was assumed to mean that the compound was "not detected"

Reference #188 CARB database

CARB (Project Engineer: Jerry Ho, Alternate Project Engineer: David Lee). "CARB Vehicle Surveillance Program Database, Series 17, Project 2S03C1."
Included data from VEDSDBA_EXH_SPECIES, and VEDSBA_DILUTE
Units in mg/mi

- Reference was numbered as #188 – this was one of the add-ons to the original list
- Speciation data was obtained from database table "VEDSDBA_EXH_SPECIES", all zero records were removed, and file was saved as "VEDSBA_EXH_SPECIES_nonzero.xls". Methane data from table "VEDSBA_DILUTE" was also included.
- Vehicles: The TEST_ID field was obtained from the"VEDSDBA_EXH_SPECIES" table, and this was matched to "VEH_ID" field in the "VEDSDBA_TEST_GEN_INFO" table. Vehicle data was obtained from table "VEDSDBA_VEH_PC". (As of 7/15/04 - some of the vehicle data was missing in the database (vehicles 6000-7000), so all available data was included into master list with a comment)
- Fuels: The TEST_ID field was obtained from the "VEDSDBA_EXH_SPECIES" table, this was matched to the "FUEL_TYPE", "BATCH_ID" and "FUEL_SMP_ID" fields in the "VEDSDBA_TEST_GEN_INFO" table. Fuel data was taken from "VEDSDBA_FUEL_PROPERTY"

Reference #189

Three SULEV vehicles tested for DOE and EPA at SwRI. "Assignment Title: "Characterization of Exhaust Emissions from California-Certified SI SULEVs". 2004
Included data from files: "Ford Focus speciation summary.xls", "Honda Accord speciation summary.xls", "Nissan Sentra speciation summary.xls", "speciation det limits - LA92 UDC.xls"
Units in mg/mi

Reference was numbered as #189 – this was one of the add-ons to the original list

- Assumed methane was detected above the detection limit (as no value was specified in the file)
- Did not include compounds reported as "unidentified C5 olefins" for inclusion into the Master List.
- Only included those composite emission rates for which at least one bag was

above the detection limit – took Minimum and Maximum of all valid composite emission rates
- For this data – the GC peak was split equally between co-elutes in the tables, it is this value that is included in master list

STUDIES FROM WHICH DATA WERE INCORPORATED INTO THE MASTER LIST – PHASE III

Ref #190 –
Gerstle, Thomas; Virage, Peter; Kimm, Maj Larry; Wade, Mark. 1999.
"Aircraft Engine and Auxiliary Power Unit Emissions Testing: Volume 2, Detailed Sampling Approach and Results."

- Reference includes emission factors – but these were not included into master list due to the difficulty of conversion of the data
- Paper included compound names and CAS numbers, and these CAS numbers were used in matching compounds with the Master List
- Any data with the following notes were not included into the Master table
  - B: "Compound present in the laboratory blank greater than reporting limit"
  - J: "The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met."
  - UJ: "The analyte was not detected above the reported sample quantitation limit…"
  - bb: "The sample media blank and/or sample field blank value was two times the sample value – sample result should be considered suspect due to contamination"
- If the species was clearly detected above the detection limit in any one test mode (i.e idle, approach, etc.), then the species was included in the master list.
- The file "Ref_190_aircraft_data.xls" contains a chart showing in which modes each species was detected for each engine tested

Ref #191 –
Helmer, Kent; Cook, Richard; Volckens, John; Baldauf, Richard; Starr, Michael. 2004.
"Regulated and Air Toxic Exhaust Emissions from Nonroad Diesel Engines and Equipment."
Included data from Excel files sent by Kent Helmer
Units in mg/hp-hr

- this paper referenced three studies: as was noted in the "Bibliography" page of the Master List File
  - 1) Starr, M.E., "Transient and Steady-State Emissions Testing of Ten Different Nonroad Diesel Engines Using Four Fuels", SwRI # 08.03316, prepared for CARB and EPA, 2003

- 2) Starr, M.E., EPA's "Three Engine Program", EPA contract #68-C-98-169, work assignments #03-05 and #02-03, "Nonroad Duty Cycle Testing for Toxic Emissions" SwRI 08.05004.05, 2004
- 3) Starr, M.E., EPA's "Four In-Use Engines Program", EPA Contract #68-C-98-158, work assignment #03-04, 2004. "Air Toxic Emissions from In-Use Nonroad Diesel Equipment", SwRI 08.05004.04.

- Data was obtained in excel format from Kent Helmer
  - for the 10 engine study in "ss10Eng062304.xls" and "Transient_3studies_final.xls"; tab "all_eng" (for the 10 engine steady state data, only data in g/hp-hr from modes 1-7 was included - mode 8 was not included since it was reported as g/hr)
  - for the 3 and 4 engine studies in "SS3&4_brfing.xls" tab "3 & 4 Eng" and "Transient_3-04&3-05_final.xls"
  - It was assumed "0" emissions meant not detected

Ref #192

Collier, A.; Hillebrand, C.; Kelly, G.; Brett, S.; Elliot, G.; Blair, D.; Sturgeon, K.; Tancell, P.; Brogan, M. 2001. "Investigation into Testing and Controlling Emissions of Hydrogen Sulfide from Gasoline Vehicles", SAE paper 2001-01-3530.

- hydrogen sulfide was the only compound from this paper
- no emission rates found in paper in units needed for master list

Ref #193 -

Graham, Lisa. 2003. "Gaseous and Particulate Matter Emissions from In-Use Light Duty Gasoline Motor Vehicles." Environment Canada , ERMD Report #99-67.
Included data from Tables 18,19,20,25,26,29-33, 43, 46, 50, and Appendix D
Units in mg/mi

- vehicle information was taken from Table 14 in the paper – (Odometer reading was converted to miles from km)

Ref #197 -

Harvey, CA; Garbe RJ; Baines TM; Somers JH; Hellman KH; Carey PM. 1983 A Study of the Potential Impact of Some Unregulated Motor Vehicle Emissions. SAE 830987.

- Emission information for hydrogen cyanide was take from Table 1 in the paper

STUDIES NOT INCORPORATED INTO THE MASTER LIST

Reference #57:

Tobias, HJ; Beving, DE; Ziemann, PJ; Sakurai, H; Zuk, M; McMurry, PH; Zarling, D; Waytulonis, R; Kittelson, D.B. 2001. "Chemical analysis of diesel engine nanoparticles using a nano-DMA/thermal desorption particle beam mass spectrometer." *Env. Sci & Tech*. 35(11), 2233-2243.

Not included into master list due to lack of specific data

- From paper – "a nano-differential mobility analyzer was used to size-select nanoparticles from diesel engine exhaust for subsequent chemical analysis by thermal desorption particle beam mass spectrometry."
- Mass Spectra are given in Figure 3 of the paper, and general assignments are given i.e. "the spectra show an intense series of peaks at m/z 57,71,85...which are indicative of normal and branched alkanes..."

Reference #63 - omitted since it was a tunnel study

Marr, Linsey C.; Kirchstetter, Thomas W.; Harley, Robert A.; Miguel, Antonio H.; Hering, Susanne V.; and S. Katharine. 1999. "Hammond Characterization of Polycyclic Aromatic Hydrocarbons in Motor Vehicle Fuels and Exhaust Emissions." *Env. Sci & Tech*. 33(18), 3091-3099.

Reference #64 – omitted since it was a tunnel study

Miguel, Antonio H.; Kirchstetter, Thomas W.; Harley, Robert A.; and Susanne V. Hering. 1998. "On-road Emissions of Particulate Polycyclic Aromatic Hydrocarbons and Black Carbon from Gasoline and Diesel Vehicles." *Env. Sci & Tech*. 32(4), 450-455.

Reference #74 – omitted since it contained the same data as Reference #87

Cadle, Steven H.; Mulawa, Patricia A.; Hunsanger, Eric C.; Nelson, Ken; Ragazzi, Ronald A.; Barrett, Richard; Gallagher, Gerald L.; Lawson, Douglas R.; Knapp, Kenneth T.; and Richard Snow. 1999. "Composition of Light-Duty Motor Vehicle Exhaust Particulate Matter in the Denver, Colorado Area." *Env. Sci & Tech*. 33(14), 2328-2339.

Reference #104

Lanning, Lisa A.; Kurt W. Smith; Chris J. Tennant. 2000. "A New Method for Diesel HC Collection and Speciation." SAE #2000-01-2951.

Not included into master list due to lack of specific data

- In Figure 4, the GC analysis of the diesel exhaust is displayed, but assignments are given just as "nC1 and up to nC2" etc... - no specific compounds were listed.

Reference #168 – omitted since it did not contain any original data

Zielinska, Barbara. 1999. "Changes in Diesel Engine Emissions." HEI Communications 7, 115-132.

Reference #169

EPA. 2002. "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions." EPA420-P-02-001.

See comments below

- Online database lists HC and PM biodiesel emissions, but no toxics are included http://www.epa.gov/otaq/models/analysis/biodsl/biodsldb.xls
- Report references two Sharp Papers (ref 180 and Ref 179), on
- On p. 85 of EPA report – "For the purpose of evaluating biodiesel effects on toxics, we focused on mobile source air toxics (MSATs) as defined in a recent rulemaking … 21 MSATs as shown in Table VI-A-1."
- Per instruction from EPA (email on 5/17/04) –this paper will not be formally included in the review since it is a subset of the more detailed information available in Sharp et al – Ref 102 (Sharp, Chris A.; Steve Howell; Joe Jobe - "The Effect of Biodiesel Fuels on Transient Emissions From Modern Diesel Engines-Part II: Unregulated Emissions and Chemical Characterization", 2000, SAE paper 2000-01-1968)

Reference #171 - omitted since it was a tunnel study

Gertler, A.W.; J.C. Sagebiel; W.A. Dippel; R.J. Farina. 1998. "Measurements of Dioxin and Furan Emission Factors from Heavy-Duty Diesel Vehicles." *J. Air & Waste Mngmnt. Assoc.*, 48, march, 276-278.

Reference #176 – omitted since it contained the same data as Reference #102

Sharp, C. A. 1998. "Biodiesel: Literature Search and Characterization of Exhaust Emissions as Required under Section 211(b) and 211(e) of the Clean Air Act: Appendix 2 Characterization of Biodiesel Exhaust Emissions."

Reference #179 – omitted since it contained the same data as Reference #102

Sharp, C. A. 1998. "Characterization of Biodiesel Exhaust Emission for EPA 211 (b) – Final Report." SwRI #08-1039.

APPENDIX B

ADDITIONAL REFERENCES THAT WERE NOT REVIEWED

Appendix B lists additional references that might report compounds not listed on the Master List.

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
49	Bass, E.;Bailey, B.;Jaeger, S.	LPG Conversion and HC Emissions Speciation of Light-Duty Vehicle	932745	SAE	1993				Southwest Research Inst.; National Renewable Energy Lab., Golden, CO; Texas Railroad Commission	x
51	Domingo, Norberto; John Storey; Sam Lewis	Hydrocarbon Speciation for Lean-Nox Catalyst Analysis			2001				Oak Ridge National Laboratory	US DoE, Office of Transportation Technologies
52	Aust, Ann E , James C Ball, Autumn A Hu, JoAnn S Lighty, Kevin R Smith, Ann M Straccia, John M Veranth, and Willie C Young	Particle Characteristics Responsible for Effects on Human Lung Epithelial Cells	HEI 110		2002				Utah State University, University of Utah, University of California Davis, and Ford Motor Company	Health Effects Institute
54	Durbin, Thomas D. and Joseph M. Norbeck	Effects of Biodiesel Blends and Arco EC_Diesel on Emissions from Light Heavy-Duty Diesel Vehicles		Environmental Science & Technology	2002	36	8	1686-1691	CE-CERT, University of California - Riverside	South Coast Air Quality Management District
55	Zervas, E., Montagne, X. and J. Lahaye	Emission of Alcohols and Carbonyl Compounds from a Spark Ignition Engine. Influence of Fuel and Air/Fuel Equivalence Ratio		Environmental Science & Technology	2002	36	11	2414-2421	Institut Francais du Petrole, Institut de Chimie des Surfaces et Interfaces	x
56	Westerholm, Roger; Christensen, Anders; Tornqvist, Margareta; Ehrenberg, Lars; Rannug, Ulf; Sjogren, Michael; Rafter, Joseph; Soontjens, Carol; Almen, Jacob; and Kerstin Gragg	Comparison of Exhaust Emissions from Swedish Environmental Classified Diesel Fuel (MK1) and European Program on Emissions, Fuels and Engine Technologies (EPEFE) Reference Fuel: A Chemical and Biological Characterization, with Viewpoints on Cancer Risk		Environmental Science & Technology	2001	35	9	1748-1754	Stockholm University, Karolinska Institutet, MTC AB	Swedish Environmental Protection Agency, Foundation for Strategic Environmental Research - Sweden, Swedish Cancer Society
58	Molders, N; Schilling, PJ; Wong, J; Roos, JW; Smith, IL	X-ray fluorescence mapping and micro-XANES spectroscopic characterization of exhaust particulates emitted from auto engines burning MMT-Added gasoline		Environmental Science & Technology	2001	35	15	3122-3129	Louisiana State University, University of New Orleans, Lawrence Livermore National Laboratory, Ethyl Corporation	Center for Advanced Microstructures and Devices - Louisiana State University

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
59	Kean, AJ; Grosjean, E; Grosjean, D; Harley, RA	On-road measurement of carbonyls in California light-duty vehicle emissions		Environmental Science & Technology	2001	35	21	4198-4204	University of California - Berkeley, DGA, Inc.	University of California Transportation Center, Health Effects Institute, Chevron Products Co., Bay Area Air Quality Management District
60	Durbin, Thomas D.; Collins, John R.; Norbeck, Joseph M.; and Matthew R. Smith	Effects of Biodiesel Blends, and a Synthetic Diesel on Emission from Light Heavy-Duty Diesel Vehicles		Environmental Science & Technology	2000	34	3	349-355	CE-CERT, University of California - Riverside	South Coast Air Quality Management District
65	Fraser, Matthew P., Cass, Glenn R. and Bernd R.T. Simoneit	Gas-Phase and Particle-Phase Organic Compounds Emitted from Motor Vehicle Traffic in a Los Angeles Roadway Tunnel		Environmental Science & Technology	1998	32	14	2051-2060	California Institute of Technology, Oregon State University	Electrical Power Research Institute
66	Kirchstetter, Thomas W.; Singer, Brett C.; Harley, Robert A.; Kendall, Gary R.; and Waymond Chan	Impact of Oxygenated Gasoline Use on California Light-Duty Vehicle Emissions		Environmental Science & Technology	1996	30	2	661-670	University of California - Berkeley; Bay Area Air Quality Management District	US DoT, Cal-DOT, UC Transportation Center
67	Touaty, M. and B. Bonsang	Hydrocarbon emissions in a highway tunnel in the Paris Area		Atmospheric Environment	2000	34		985-996	Laboratoire des Sciences du Climat et de l'Environment	Agence de l'Environment et de la Maitrise de l'Energie, Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique, Commissariat a l'Energie Atomique
68	Kourtidis, K.A.; Ziomas, I.C.; Rappenglueck, B.; Proyou, A.; and D. Basilis	Evaporative traffic hydrocarbon emissions, traffic CO and speciated HC traffic emissions from the city of Athens		Atmospheric Environment	1999	33		3831-3842	Aristotle University of Thessaloniki, University of Munich	European Union
69	Weingartner, E.; Burtscher, H.; and U. Baltensperger	Hydroscopic Properties of Carbon and Diesel Soot Particles		Atmospheric Environment	1997	31	15	2311-2327	ETH-Zurich, Paul Scherrer Institute	AC Laboratorium Spiez

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
70	Magnusson, Roger; Nilsson, Calle; and Barbo Andersson	Emissions of Aldehydes and Ketones from a Two-Stroke Engine Using Ethanol and Ethanol-Blended Gasoline as Fuel		Environmental Science & Technology	2002	36	8	1656-1664	Swedish University of Agricultural Sciences, Umea University	Center for Environmental Research in Umea, The Swedish Council for Work Life Research
71	Cardone, Massimo; Prati, Maria Vittoria; Rocco, Vittorio; Seggiani, Maurizia; Senatore, Adolfo; and Sandra Vitolo	Brassica carinata as an Alternative Oil Crop for the Production of Biodiesel in Italy: Engine Performance and Regulated and Unregulated Exhaust Emissions		Environmental Science & Technology	2002	36	21	4656-4662	Universita Federico II di Napoli, Instituto Motori CNR, Universita di Roma "Tor Vergata", Universita di Pisa	European Community Project Interreg II Toscana/Corsica
72	Bishop, Gary A.; Morris, Jerome A.; and Donald H. Stedman	Snowmobile Contributions to Mobile Source Emissions in Yellowstone National Park		Environmental Science & Technology	2001	35	14	2874-2881	University of Denver	US DOE Western Regional Bioenergy Program, National Park Service, International Snowmobile Manufacturers Association, West Yellowstone Chamber of Commerce, Town of West Yellowstone, Environmental Systems Products, Inc., Montana Dept. of Environmental. Quality, Yellowstone Foundation
73	Baum, Marc M.; Kiyomiya, Eileen S.; Kumar, Sasi; Lappas, Anastasios M.; Kapinus, Vadym A.; Harry C. Lord III	Multicomponent Remote Sensing of Vehicle Exhaust by Dispersive Absorption Spectroscopy. 2. Direct On-Road Ammonia Measurements		Environmental Science & Technology	2001	35	18	3735-3741	Oak Crest Institute of Science, California Institute of Technology, Air Instruments & Measurements, Inc.	Mobile Source Air Pollution Reduction Review Committee
75	Kirchstetter, Thomas W.; Singer, Brett C.; Harley, Robert A.; Kendall, Gary R.; and James M. Hesson	Impact of California Reformulated Gasoline on Motor Vehicle Emissions. 2. Volatile Organic Compound Speciation and Reactivity		Environmental Science & Technology	1999	33	2	329-336	University of California - Berkeley; Bay Area Air Quality Management District	UC Transportation Center, CARB

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
76	Zayed, Joseph; Hong, Bande; Gilles L'Esperance	Characterization of Manganese-Containing Particles Collected from the Exhaust Emissions of Automobiles Running with MMT Additive		Environmental Science & Technology	1999	33	19	3341-3346	University of Montreal, Ecole Polytechnique de Montreal	Ministere des Ressources Naturelles du Quebec
77	Venkataraman, Chandra; Lyons, James M.; and Sheldon K. Friedlander	Size Distribution of Polycyclic Aromatic Hydrocarbons and Elemental Carbon. 1. Sampling, Measurement Methods, and Source Characterization		Environmental Science & Technology	1993	28	4	555-562	UCLA	US EPA
78	Sagebiel, John C.; Zielinska, Barbara; Pierson, William R.; and Alan W. Gertler	Real-world Emissions and Calculated Reactivities of Organic Species from Motor Vehicles		Atmospheric Environment	1996	30	12	2287-2296	Desert Research Institute	Coordinating Research Council, US DOE NREL, Auto/Oil Air Quality Improvement Research Program, US EPA, University Corporation for Atmospheric Research
79	Gertler, Alan W.; Fujita, Eric M.; Pierson, William R.; and David N. Wittorff	Apportionment of NMHC Tailpipe vs. Non-tailpipe Emissions in the Fort McHenry and Tuscarora Mountain Tunnels		Atmospheric Environment	1996	30	12	2297-2305	Desert Research Institute	Coordinating Research Council, US DOE NREL, Auto/Oil Air Quality Improvement Research Program, US EPA, University Corporation for Atmospheric Research
80	Tsai, Jium-Horng; Liu, Yu-Yin; Yang, Chang-Yu; Chiang, Hung-Lung; and Li-Peng Chang	Volatile Organic Profiles and Photochemical Potentials from Motorcycle Engine Exhaust		J. Air & Waste Management Association	2003	53		516-522	National Cheng-Kung University, Fooyin Institute of Technology, U-Tech Technology Corp.	National Science Council Taiwan

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
81	Zielinska, Barbara; Sagebiel, John C.; Harshfield, Gregory; Gertler, Alan W.; and William R. Pierson	Volatile Organic Compounds up to C20 Emitted from Motor Vehicles; Measurement Methods		Atmospheric Environment	1996	30	12	2269-2286	Desert Research Institute	Coordinating Research Council, US DOE NREL, Auto/Oil Air Quality Improvement Research Program, US EPA, University Corporation for Atmospheric Research
82	Duffy, Bronwyn and Peter F. Nelson	Non-Methane Exhaust Composition in the Sydney Harbour Tunnel: A Focus on Benzene and 1,3-Butadiene		Atmospheric Environment	1996	30	15	2759-2768	CSIRO - Division of Coal and Energy Technology	x
83	Sjogren, Michael; Li, Hang; Rannug, Ulf; and Roger Westerholm	Multivariate Analysis of Exhaust Emissions from Heavy-Duty Diesel Fuels		Environmental Science & Technology	1996	30	1	38-49	Stockholm University	Swedish Environmental Protection Agency
84	McLaren, R; Singleton, D.L.; Lai, J.Y.K; Khouw, B.; Singer, E.; Wu, Z.; and H. Niki	Analysis of Motor Vehicle Sources and Their Contribution to Ambient Hydrocarbon Distributions at Urban Sites in Toronto During the Southern Ontario Oxidants Study		Atmospheric Environment	1996	30	12	2219-2232	National Research Council Canada, York University	Panel on Energy Research and Development and Transport Canada, Ontario Ministry of Environment and Energy, Atmospheric Environment Service, National Science and Engineering Research Council
85	Gertler, Alan W.; Gillies, John A.; Pierson, William R.; Rogers, C. Fred; Sagebiel, John C.; Abu-Allaban, Mahmoud; Coulombe, William; Tarnay, Leland; and Thomas A. Cahill	Real-World Particulate Matter and Gaseous Emissions from Motor Vehicles in a Highway Tunnel	HEI 107	In "Emissions from Diesel and Gasoline Engines Measured in Highway Tunnels"	2002			5-56	Desert Research Institute, University of Nevada - Reno, University of California - Davis,	Health Effects Institute

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
86	Grosjean, Daniel and Eric Grosjean	Airborne Carbonyls from Motor Vehicle Emissions in Two Highway Tunnels	HEI 107	In "Emissions from Diesel and Gasoline Engines Measured in Highway Tunnels"	2002			57-78	DGA, Inc.	Health Effects Institute
88	Bagley, Susan T. and Linda D. Gratz	Evaluation of Biodiesel Fuel and a Diesel Oxidation Catalyst in an Underground Metal Mine, Part 3 - Biological and Chemical Characterization			1998				Michigan Technological University	Diesel Emissions Evaluation Program (DEEP) Technical Committee
89	Bagley, Susan T.; Watts, Jr., Winthrop F.; Johnson, Jason P.; Kittelson, David B., Johnson, John H. and James J Schauer	Impact of low-emission diesel engines on underground mine air quality			2002				Michigan Technological University, University of Minnesota, University of Wisconsin - Madison	National Institute for Occupational Safety and Health
90	Bagley, Susan, Linda D. Gratz, John.H. Johnson, and Joseph F. McDonald	Effects of an Oxidation Catalytic converter and a Biodiesel Fuel on the Chemical, Mutagenic, and Particle Size Characteristics of Emissions from a Diesel Engine		Environmental Science & Technology	1998	32	9	1183-1191	Michigan Technological University, University of Minnesota	USBM, National Biodiesel Board, Agricultural Utilization Research Institute, US Department of Agriculture - CSRS
91	Knapp, Kenneth; Steven H. Cadle; Silvestre Tejada; Douglas R. Lawson; Richard Snow; Barbara Zielinska; John Sagebiel; Jacob McDonald	Central Carolina Vehicle Particulate Emissions Study	2003-01-0299	SAE	2003				US EPA, General Motors R&D, National Renewable Energy Laboratory, Clean Air Vehicle Technology Corp., Desert Research Institute	Coordinating Research Council, US DOE NREL

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
93	Lev-On, Miriam; Chuck A. Letavec; Jim Uihlein; Teresa L. Alleman; Keith D. Vertin; Douglas Lawson; Gregory J. Thompson; Mridul Gautam; Scott Wayne; Barbara Zielinska and John Sagebiel, Sougato Chatterjee; Kevin Hallstrom	Chemical Speciation of Exhaust Emissions From Trucks and Buses Fueled on Ultra-Low-Sulfur Diesel and Cng	2002-01-0432	SAE	2002				BP, National Renewable Energy Laboratory, West Virginia Univ., Desert Research Institute, Johnson Matthey Inc., Engelhard Corp.	South Coast Air Quality Management District, California Air Resources Board
94	Kean, Andrew J.; Robert F. Sawyer; Robert A. Harley; Gary R. Kendall	Trends in Exhaust Emissions From In-Use California Light-Duty Vehicles, 1994-2001	2002-01-1713	SAE	2002				Univ. of California-Berkeley, Bay Area Air Quality Management District	US Dept. of Transportation, CA Dept. of Transportation, Bay Area Air Quality Management District
96	Gillies, J.A.; A.W. Gertler; J.C. Sagebiel; W.A. Dippel	On-Road Particulate Matter (PM2.5 and PM10) Emissions in the Sepulveda Tunnel, Los Angeles, California		Environmental Science & Technology	2001	35	6	1054-1063	Desert Research Institute	Coordinating Research Council, South Coast Air Quality Management District
97	Pitkänen, Mikko; Keijo Torkkell; Anu Jäntti; Sari Laanti;Tuomo Lapinlampi; Esa Elonen	Cutting the Noxious Emissions in 2-Stroke Engines	2001-01-3534	SAE	2001				Kemira Metalkat Oy, Technical Research Centre of Finland, Fortum Oil & Gas Oy, Oulu Regional Inst. of Occupational Health, MTT Agrifood Research Finland	National Technology Agency of Finland
103	Saitoh, Katsumi; Koichiro Sera; Tadashi Shirai; Tatsuji Sato; Matsuo Odaka	Determination of Elemental and Ionic Compositions for Diesel Exhaust Particles by Particle Induced X-ray Emission and Ion Chromatography Analysis		Analytical Sciences	2003	19		525-528	Environmental Research & Information Center of Akita Prefecture, Iwate Mediacal University, Tokyo Dylec Co., Ltd., National Traffic Safety and Environment Laboratory	x

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
105	Neumann, K.-H.; D. Schurmann; P. Kohoutek; J. Beyersdorf; A. Hartung; C. Nagel; J. Schulze	Unregulated Exhaust Gas Components of Modern Diesel Passenger Cars	1999-01-0514	SAE	1999				Volkswagen AG	x
106	Reynolds, E. G.; Diane E. Hall; F. Kvinge; R. Jorgensen	Methodology for Hydrocarbon Speciation for Heavy-Duty Diesel Engines Operating Over the European ECE R49 Cycle	1999-01-1466	SAE	1999				BP Amoco, Statoil	BP, Statoil
107	Lowenthal, Douglas H.; Barbara Zielinska; Judith C. Chow; John G. Watson; Mridul Guatam; Donald H. Ferguson; Gary R. Neuroth; Kathy D. Stevens	Characterization of Heavy-Duty Diesel Vehicle Emissions		Atmospheric Environment	1994	28	4	731-743	Desert Research Institute, West Virginia Univ., Arizona Dept. of Environmental Quality	US Dept. of Energy, Arizona Dept. of Environmental Quality
108	Andrews, G. E.; R. B Ishaq, J. R Farrar-Khan, Y. Shen and P.T. Williams	The Influence of Speciated Diesel Fuel Composition on Speciated Particulate SOF Emissions	980527	SAE	1998				Univ. of Leeds	EPSRC Grant
109	Cadle, Steven H.; Patricia A. Mulawa; James Ball; Claudia Donase; Arnie Weibel; John C. Sagebiel; Kenneth T. Knapp; Richard Snow	Particulate Emission Rates from In-Use High-Emitting Vehicles Recruited in Orange County, California		Environmental Science & Technology	1997	31	12	3405-3412	General Motors Research and Development Center, Ford Motor Company, Chrysler Corporation, Desert Research Institute, US EPA Mobile Source Emissions Branch, ManTech Environmental Technology	US EPA
110	Collier, Anthony R.; Carl A. Jemma; Barbara Wedekind; Diane E. Hall; Peter Heinze	Sampling and Analysis of Vapor-Phase and Particulate-Bound PAH From Vehicle Exhaust	982727	SAE	1998				Ricardo, BP Oil International, Ltd., Concawe	Ricardo Consulting Engineers
111	Ball, James C.; Ann M. Straccia, Willie C. Young, Ann E. Aust	The Formation of Reactive Oxygen Species Catalyzed by Neutral, Aqueous Extracts of NIST Ambient Particulate Matter and Diesel Engine Particles		J. Air & Waste Management Association	2000	50		1897-1903	Ford Motor Co., Utah State Univ.	x

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
112	Gertler, Alan W.; John C. Sagebiel; William A. Dippel, and Michael O'Connor	The Impact of California Phase 2 Reformulated Gasoline on Real-World Vehicle Emissions		J. Air & Waste Management Association	1999	49		1339-1346	Desert Research Institute	Coordinating Research Council, US DOE NREL, Auto/Oil Air Quality Improvement Research Program, South Coast Air Quality Management District
113	Sagebiel, John C.; Barbara Zielinska; Patricia A. Walsh; Judith C. Chow; Steven H Cadle; Patricia A. Mulawa; Kenneth T. Knapp; Roy B. Zweidinger; Richard Snow	PM-10 Exhaust Samples Collected during IM-240 Dynamometer Tests of In-Service Vehicles in Nevada		Environmental Science & Technology	1997	31	1	75-83	Desert Research Institute, General Motors Research and Development Center, US EPA Mobile Source Emissions Branch, ManTech Environmental Technology	General Motors Research and Development Center, State of Nevada
114	Schmitz, Thomas; Dieter Hassel, Franz-Josef Weber	Determination of VOC-components in the exhaust of gasoline and diesel passenger cars		Atmospheric Environment	2000	34		4639-4647	Institut fur Chemie der Belasteten Atmosphaere, TUV Rheinland Sicherheit und Umweltschultz GmbH	BMBF
116	Reisel, John R. ; Tracy A. Kellner; Kenneth F. Neusen	Speciated Hydrocarbon Emissions form Small Utility Engines		J. Air & Waste Management Association	2000	50		522-528	University of Wisconsin-Milwaukee	Wisconsin Small Engine Consortium, State of Wisconsin Department of Administration
117	Clark, Nigel N.; Christopher M. Atkinson; David L. McKain; Ralph D. Nine; Laila El-Gazzar	Speciation of Hydrocarbon Emissions From a Medium-Duty Diesel Engine	960322	SAE	1996				West Virginia Univ.	US DoE Office of Transportation Technologies

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
118	Chen, Kuo Chiang; Wai K. Cheng; Doren Jane M. Van; James P. Murphy; Matthew D. Hargus; Sarah A. McSweeney	Time-Resolved, Speciated Emissions From An SI Engine During Starting and Warm-Up	961955	SAE	1996				Massachusetts Institute of Technology; College of the Holy Cross	Industrial Consortium for Engine and Fuel Interactions (Chevron Research and Technology, Exxon Research and Engineering Co., Nippon Oil Co., Shell Development Co., and Shell Research Ltd.), Industrial Consortium for Engine Research (Chrysler Motors Corp., Ford Motor Co., General Motors Corp., Peugeot S.A., Regie Nationale des Usines Renault, and Volvo Car Corp.); US EPA Center on Airborne Organics
119	Rantanen, Leena; Ari Juva; Aapo Niemi; Seppo Mikkonen; P\amivi Aakko; Maija Lappi	Effect of Reformulated Diesel Fuel on Unregulated Emissions of Light-Duty Vehicles	961970	SAE	1996				Neste Oy; Technical Research Centre of Finland	Finnish Energy Technology Programme, Technology Development Centre Finland (TEKES)
120	Higinbotham, Erin; Bill Platz; Wendy Clark	Effect of Selected LPG Fuel Components on Speciated Exhaust Emissions	961990	SAE	1996				Automotive Testing Laboratories, Inc.; Propane Vehicle Council; Automotive Testing Laboratories, Inc.	x
121	Gautam, Mridul; Deepak Gupta; Laila El-Gazzar; Donald W. Lyons; Sriram Popuri	Speciation of Heavy-Duty Diesel Exhaust Emissions Under Steady-State Operating Conditions	962159	SAE	1996				West Virginia Univ.	US DoE Office of Transportation Technologies

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
122	Crawford, John G.; James S. Wallace	Engine Operating Parameter Effects on the Speciated Aldehyde and Ketone Emissions From a Natural Gas Fuelled Engine	952500	SAE	1995				University of Toronto	Nissan Canada Inc.
123	Poulsen, J. H.; J. S. Wallace	Operating Parameter Effects on the Speciated Hydrocarbon Emissions From a Natural Gas Fueled Engine	942007	SAE	1994				University of Toronto	Nissan Canada Inc.
124	Leppard, William R.; William J. Koehl; Jack D. Benson; Vaughn R. Burns; Albert M. Hochhauser; Jay C. Knepper; Louis J. Painter; Larry A. Rapp; Brian H. Rippon; Robert M. Reuter; James A. Rutherford	Effects of Gasoline Properties (TD5D0, TD9D0 and Sulfur) on Exhaust Hydrocarbon Emissions of Current and Future Vehicles: Speciation Analysis--The Auto/Oil Air Quality Improvement Research Program	952505	SAE	1995				General Motors Research and Development. Center, Mobil Technology Co., Chrysler Motors Corp., Exxon Research and Engineering Co., Amoco Oil Research and Development, Statistics PLUS, ARCO Products Co., Ford Motor Co., Texaco, Inc., Chevron Research and Technology	x
125	Siegl, W. O.; M. Zinbo; T. J. Korniski; J. F. O. Richert; E. Chladek; M. C. Paputa Peck; J. E. Weir; D. Schuetzle; T. E. Jensen	Air Toxics: a Comparison of the Gas- and Particle-Phase Emissions From a High-Emitter Vehicle With Those From a Normal- Emitter Vehicle	940581	SAE	1994				Ford Motor Co.	x
126	Kaiser, Edward W.; Walter O. Siegl; Lanise M. Baidas; Gerald P. Lawson; Carl F. Cramer; Kelvin L. Dobbins; Paul W. Roth; Michael Smokovitz	Time-Resolved Measurement of Speciated Hydrocarbon Emissions During Cold Start of a Spark-Ignited Engine	940963	SAE	1994				Ford Motor Co.	x
127	Gautam, Mridul; Brian Kelly; Deepak Gupta; Nigel Clark; Richard Atkinson; Laila El-Gazzar; Donald W. Lyons	Sampling Strategies for Characterization of the Reactive Components of Heavy-Duty, Diesel Exhaust Emissions	942262	SAE	1994				West Virginia Univ.	US DoE Office of Transportation Technologies & Office of Alternative Fuels

Study Code	Authors	Title	ID #	Journal/ Title	Year	Vol	Issue	Pages	Author Affiliation	Sponsor
128	Noorman, Mike T.	The Effect of MTBE, DIPE and TAME on Vehicle Emissions	932668	SAE	1993				Mobil Research and Development Corp.	x
129	Kubo, Shuichi; Masami Yamamoto; Yoshimi Kizaki; Satoshi Yamazaki; Toshiaki Tanaka; Kiyoshi Nakanishi	Speciated Hydrocarbon Emissions of SI Engine During Cold Start and Warm-Up	932706	SAE	1993				Toyota Central R&D Labs., Inc., Toyota Motor Corp	x
130	Hirota, Toshio; Kazuo Kojima; Keiji Yakushiji; Toshiaki Inoue	Effects of Exhaust Emission Control Devices and Fuel Composition on Speciated Emissions of S.I. Engines	922180	SAE	1992				Nissan Motor Co., Ltd.	x
132	Jemma, C. A.; D. L. Lance; P. R. Shore	Speciation of Hydrocarbon Emissions From European Vehicles	922376	SAE	1992				Ricardo Consulting Engineers Ltd.	x
133	Hirakouchi, Nobuyoshi; Izumi Fukano; Hayami Nagano	Measurement of Unregulated Exhaust Emissions From Heavy Duty Diesel Engines With Mini-Dilution Tunnel	900643	SAE	1990				Mitsubishi Motors Corp., Mitsubishi Heavy Industries, Ltd.	x
134	Schuermann, D.; K. H. Lies; H. Klingenberg	Unregulated Motor Vehicle Exhaust Gas Components	902116	SAE	1990				Volkswagen AG	x
135	Hammerle, Robert H.; Walter O. Siegl; Heiko M. Herrmann; Bernd W. Wenclawiak	A Method for the Speciation of Diesel Fuel and the Semi- Volatile Hydrocarbon Fraction of Diesel-Fueled Vehicle Exhaust Emissions	952353	SAE	1995				Ford Motor Co.; Universitat-GH-Siegen	x
136	Mikkonen, Seppo; Leena Rantanen; Veli-Matti Alve; Lars Nylund; Pirkko Kociba; Kari Korhonen; Lasse Lindroos	Effect of Diesel Fuel Composition on Fork-Lift Truck Emissions	952365	SAE	1995				Neste Oy; Finnish Institute of Occupational Health; Lappeenranta Regional Institute of Occupational Health	Finnish Ministry of Trade and Industry
137	Lepperhoff, G.; G. Haxthwohl, B. Laxers-Jongen	Methods to Analyze Non-Regulated Emissions From Diesel Engines	941952	SAE	1994				FEV Mototertechnik	x
139	Hoekman, S. Kent	Speciated Measurements and Calculated Reactivities of Vehicle Exhaust Emissions from Conventional and Reformulated Gasolines		Environmental Science & Technology	1992	26	6	1206-1216	Chevron Research and Technology Co.	x

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140	Mason, Grant, Jan-Ake Gustafsson, Roger N. Westerholm, Hang Li	Chemical Fractionation of Particulate Extracts from Diesel Vehicle Exhaust: Distribution of Ligands and the Dioxin Receptor		Environmental Science & Technology	1992	26	8	1635-1638	Huddinge Hospital, Stockholm University	x
141	Kaiser, Edward W.; Walter O. Siegl; Yitshak I. Henig; Richard W. Anderson; Frederick H. Trinker	Effect of Fuel Structure on Emissions from a Spark-Ignited Engine		Environmental Science & Technology	1991	25	12	2005-2012	Ford Motor Co.	x
142	Kaiser, Edward W.; Walter O. Siegl; David F. Cotton; Richard W. Anderson	Effect of Fuel Structure on Emissions from a Spark-Ignited Engine. 2. Naphthene and Aromatic Fuels		Environmental Science & Technology	1992	26	8	1581-1586	Ford Motor Co.	x
143	Kaiser, Edward W.; Walter O. Siegl; David F. Cotton; Richard W. Anderson	Effect of Fuel Structure on Emissions from a Spark-Ignited Engine. 3. Olefinic Fuels		Environmental Science & Technology	1991	25	12	2005-2014	Ford Motor Co.	x
144	Hammerle, R.H.; D.A. Ketcher; R.W. Horrocks; G. Lepperhoff; G. H\axthwohl; B. L\axers	Emissions From Current Diesel Vehicles	942043	SAE	1994				Ford Motor Co., FEV Motorentechnik GmbH and Co.	x
145	Rantanen, Leena; Seppo Mikkonen; Lars Nylund; Pirkko Kociba; Maija Lappi; Nils-Olof Nylund	Effect of Fuel on the Regulated, Unregulated and Mutagenic Emissions of DI Diesel Engines	932686	SAE	1993				Neste Oy, Institute of Occupational Health, Technical Research Centre of Finland	Finnish Ministry of Trade and Industry
146	Burns, Vaughn R.; Robert M. Reuter; Jack D. Benson; Robert A. Gorse; Albert M. Hochhauser; William J. Koehl; Louis J. Painter	Effects of Gasoline Composition on Evaporative and Running Loss Emissions--Auto/Oil Air Quality Improvement Research Program	920323	SAE	1992			257-321	Chrysler Corp., Texaco Inc., General Motors Research Labs., Ford Motor Co., Exxon Research and Engineering Co., Mobile Research and Development Corp.	x
148	Franklin, Pamela M.; Catherine P. Koshland; Donald Lucas; Robert F. Sawyer	Evaluation of combustion by-products of MTBE as a component of reformulated gasoline		Chemosphere	2001	42		861-872	Univ. of California - Berkeley, Lawrence Berkeley National Laboratory	US Toxic Substances Research and Teaching Program
149	Gabele, Peter A.	Characterization of Emissions from a Variable Gasoline/Methanol Fueled Car		J. Air & Waste Management Association	1990	40	3	296-304	US EPA	x

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150	Zielinska, Barbara; Kochy K. Fung	The composition and concentration of hydrocarbons in the range of c2 to c18 emitted from motor vehicles		The Science of the Total Environment	1994	146/147		281-288	Desert Research Institute, AtmAA, Inc.	CARB
151	Staehelin, Johannes; Kurt Schlapfer; Toni Burgin; Urs Steinemann; Stefan Schneider; Dominik Brunner; Martin Baumle; Markus Meier; Cristoph Zahner; Stephan Keiser; Werner Stahel; Christian Keller	Emission factors from road traffic from a tunnel study (Gubrist tunnel, Switzerland). Part I: concept and first results		The Science of the Total Environment	1995	169		141-147	ETH-Honggerberg, Carbotech AG, ATAL-Zurich, Ingenieurburo Steinemann, Planungsburo Jud AG, ETH-Zurich	BUWAL - Switzerland, BBW - Switzerland, EUROTRAC
152	Lehrle, R.S.; H. West; M.L. Wyszynski	On-line mass spectrometric characterization of hydrocarbons in engine exhaust gases		Proceedings of the Institution of Mechanical Engineers, Part D: J. Automobile Engineering	1995	209		307-324	University of Birmingham	UK Science and Engineering Research Council, Jaguar Cars plc, Castrol Limited
153	Kayes, David and Simone Hochgreb	Time, Space, and Species Resolved Measurements of Engine-Out Hydrocarbon Emissions from Spark-Ignited Engines		Combustion Science and Technology	1997	127		333-362	Massachusetts Institute of Technology	Department of Energy
154	Stump, Fred D.; Kenneth T. Knapp; William D. Ray	Seasonal Impact of Blending Oxygenate Organics with Gasoline on Motor Vehicle Tailpipe and Evaporative Emissions		J. Air & Waste Management Association	1990	40	6	872-880	US EPA	US EPA
156	Norbeck, Joseph M.; Thomas D. Durbin; Timothy J. Truex	Measurement of Primary Particulate Matter Emissions from Light-Duty Motor Vehicles	CRC Project E-24-2		1998					Coordinating Research Council, South Coast Air Quality Management District
157	Knapp, Kenneth; Steven H. Cadle; Silvestre Tejada; Douglas R. Lawson; Richard Snow	Central Carolina Vehicle Particulate Emissions Study	CRC Project E-54		2000				US EPA, General Motors R&D, National Renewable Energy Laboratory, Clean Air Vehicle Technology Corp.	Coordinating Research Council, US DOE NREL

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158	Zielinska, Barbara; John Sagebiel; Jacob McDonald	Analysis of Selected Sample Collected in the Central Carolina Vehicle Particulate Emissions Study	CRC Project E-54		2000				Desert Research Institute	Coordinating Research Council, US DOE NREL
159	Cadle, Stephen H.; Patricial Mulawa; Peter Groblicki; Chris Laroo; Ronald A. Ragazzi; Ken Nelson; Gerald Gallagher; Barbara Zielinska	In-Use Light Duty Gasoline Vehicle Particulate Matter Emissions on the FTP, REP05, and UC Cycles	CRC Project E-46		1999				General Motors R&D, Colorado Department of Public Health, Desert Research Institute	Coordinating Research Council
160	Tancell, Paul J.; Michael M. Rhead; Robin D. Pemberton; Jim Braven	Survival of Polycyclic Aromatic Hydrocarbons during Diesel Combustion		Environmental Science & Technology	1995	29	11	2871-2876	University of Plymouth	Engineering and Physical Sciences Research Council - UK
161	Harley, Robert A.; Michael P. Hannigan; Glen R. Cass	Respeciation of Organic Gas Emissions and the Detection of Excess Unburned Gasoline in the Atmosphere		Environmental Science & Technology	1992	26	12	2395-2408	California Institute of Technology	x
162	Westerholm, Roger; Almen, Jacob; Li, Hang; Rannug, Ulf; Egeback, Karl-Erik; and Kerstin Gragg	Chemical and Biological Characterization of Particulate-, Semivolatile-, and Gas-Phase-Associated Compounds in Diluted Heavy-Duty Diesel Exhausts: A Comparison of Three Different Semivolatile-Phase Samplers		Environmental Science & Technology	1991	25	2	332-338	Stockholm University, The National Environmental Protection Board - Sweden	x
163	Tsai, Jium-Horng; Chiang, Hung-Lung; Hsu, Yi-Chun; Weng, Hung-Cheng; Yang, Chang-Yu	The speciation of volatile organic compounds (VOCs) from motorcycle engine exhaust at different driving modes		Atmospheric Environment	2003	37		2485-2496	National Cheng-Kung University, Fooyin University, Kun Shan University of Technology	x
164	Bagley, Susan, Linda D. Gratz, David G. Leddy and John.H. Johnson	Characterization of Particle- and Vapor-Phase Organic Fraction Emissions from a Heavy-Duty Diesel Engine Equipped with a Particle Trap and Regeneration Controls	HEI 56		1993				Michigan Technological University	Health Effects Institute
165	Bagley, Susan, Kirby J. Baumgard, Linda D. Gratz, John.H. Johnson, and David G. Leddy	Characterization of Fuel and Aftertreatment Device Effects on Diesel Emissions	HEI 76		1996				Michigan Technological University	Health Effects Institute

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167	Kohoutek, Peter	Characterization of Passenger Car Emissions	HEI Communications 7	In "Diesel Workshop: Building a Reasearch Strategy to Improve Risk Assessment"	1999			102-114	Volkswagen AG	x
172	Hare, C.T.; J.J. White	Toward the Environmentally-Friendly Small Engine: Fuel, Lubricant, and Emission Measurement Issues	SwRi 911222						Southwest Research Institute	
174	Kuljukka, T., K. Savela, K. Peltonen; S. Mikkonen, L. Rantanen	Effect of Fuel Reformulation on Diesel Particulate Emissions – Application of DNA Adduct Test	982650	Society of Automotive Engineers	1998			33-42	Finnish Institute of Occupational Health; Neste Oyj	Society of Automotive Engineers
178	Norbeck, J., T.D. Durbin, T.J. Truex	Measurement of Primary Particulate Matter Emissions from Light-Duty Motor Vehicles			1998				Center for Environmental Research and Technology, U.C. Riverside, CA	Coordinating Research Council, Inc; South Coast Air Quality Management District; National Renewable Energy Laboratory
181	Smith, J.A., D.L. Endicott and R.R. Graze	Biodiesel Engine Performance and Emissions Testing – Final Report – Caterpillar 3406E Engine			1998				Caterpillar	National Biodiesel Board
182	Tanaka, S., H. Takizawa, T. Shimizu, K. Sanse	Effect of Fuel Compositions on PAH in Particulate matter DI Diesel Engine	982648	Society of Automotive Engineers	1998			1-11	Cosmo Research Institute	Society of Automotive Engineers
185	Cooper, D.A.	Exhaust emissions from high speed passenger ferries		Atmospheric Environment	2001	35		4189-4200	Swedish Environmental Research Institute	Swedish Transport and Communciation Ressearch Board (KFB)

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186	Cooper, D.A.	Exhaust emissions from ships at berth		Atmospheric Environment	2003	37		3817-3830	Swedish Environmental Research Institute	Port of Gothenburg, Stena Line, DFDS Seaways, Swedish Maritime Administration, Swedish Agency for Innovation Systems and Swedish Environmental Department
194	Terry L. Ullman, Lawrence R. Smith, and Joseph W. Anthony;Warren J. Slodowske, Bill Trestrail, Angelita L. Cook, and William B. Bunn;Charles A. Lapin;Kenneth J. Wright and Charles R. Clark	Comparison of Exhaust Emissions, Including Toxic Air Contaminants, From School Buses in Compressed Natural Gas, Low Emitting Diesel, and Conventional Diesel Engine Configurations			2003				Southwest Research Institute; International Truck and Engine Corporation; Lapin and Associates; ConocoPhillips	
195	Graham, Lisa; Welburn, Colin	Gaseous and Particulate Matter Emissions from Two In-Use Urban Transit Bus	ERMD Report #00-37		2003				Environmental Technology Centre, Emissions Research And Measurement Division, Environment Canada	
196	Durbin, Thomas D.; Norbeck, Joseph M.	Comparison of Emissions for Medium-Duty Diesel Trucks Operated on California In-Use Diesel, ARCO's EC-Diesel, and ARCO EC-Diesel with a Diesel Particulate Filter			2002				CE-CERT, UC Riverside	National Renewable Energy Laboratory; Ford Motor Company