

Supporting Information for:

Comparison of Gasoline Direct-Injection (GDI) and Port Fuel Injection (PFI) Vehicle Emissions: Emission Certification Standards, Cold-Start, Secondary Organic Aerosol Formation Potential, and Potential Climate Impacts

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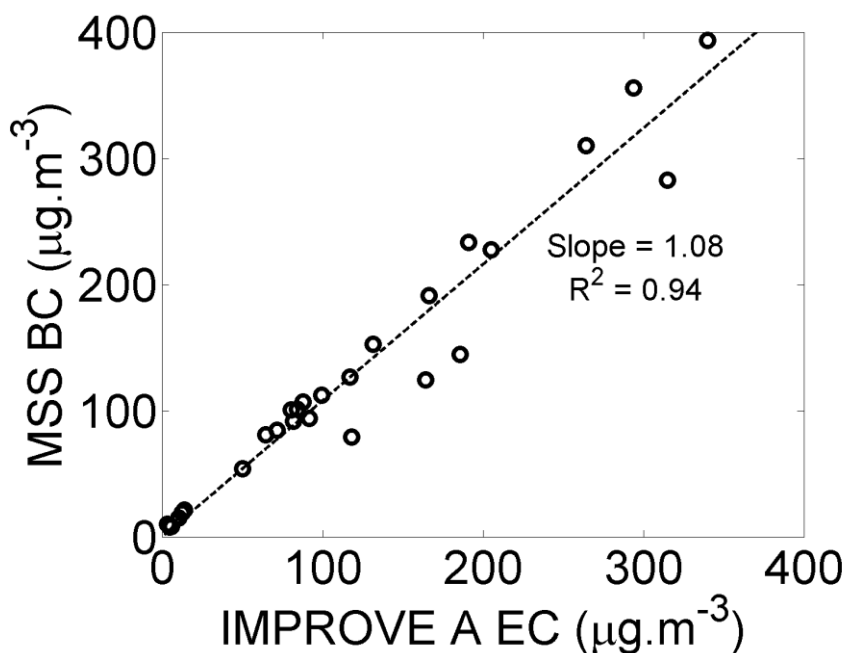
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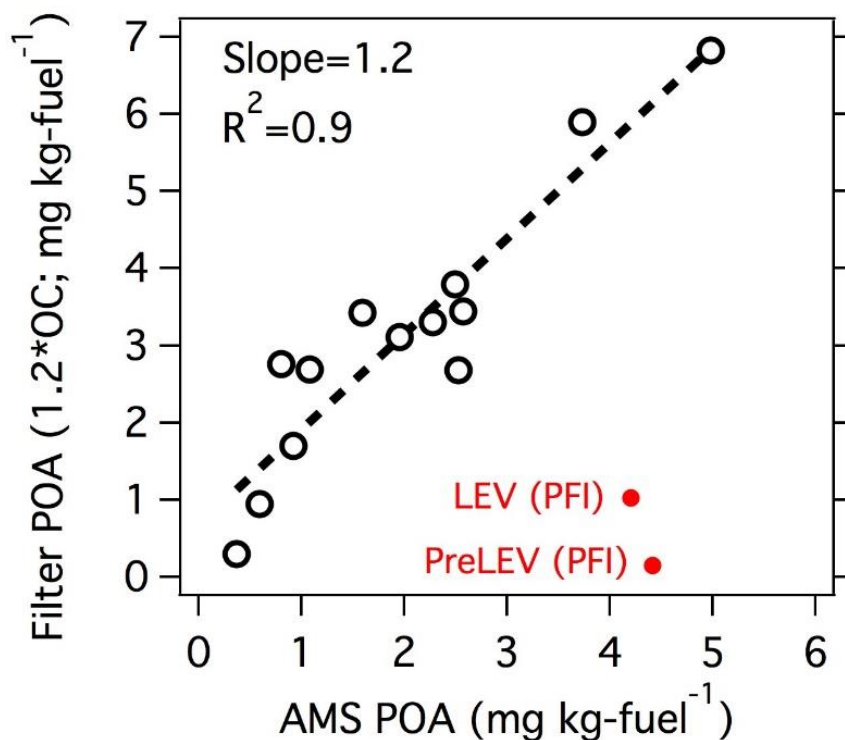
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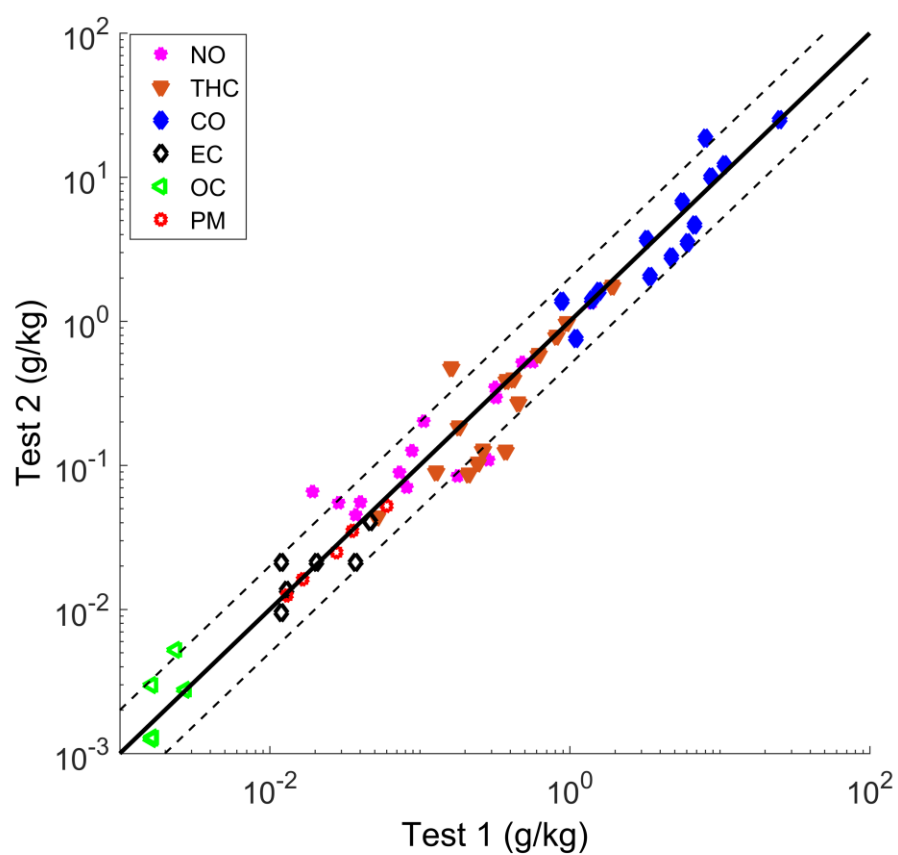
59 S9. Fuel-based emission factors for speciated NMOG



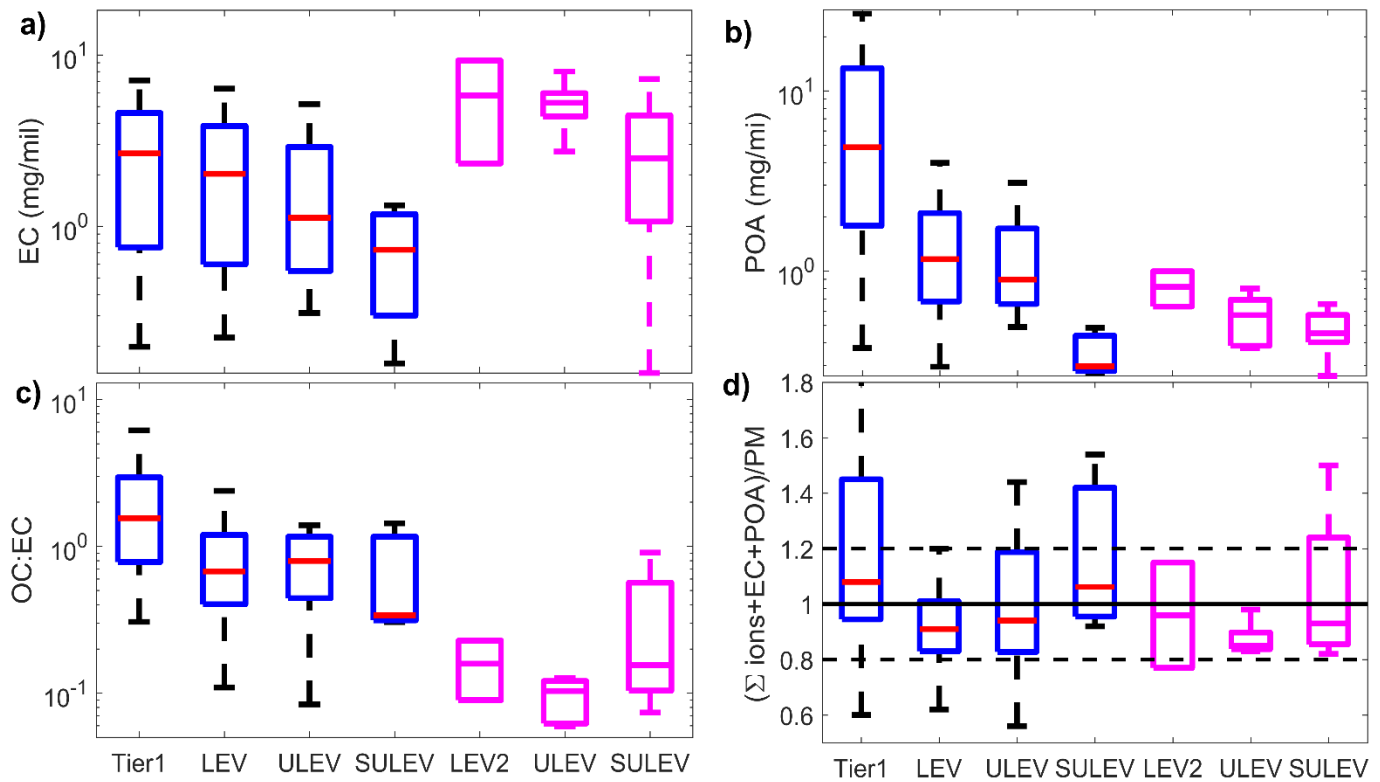
60
 61 Figure S1: Scatter plot of measured filter EC mass concentrations (using the IMPROVE A
 62 protocol) versus micro-soot sensor (MSS) BC mass concentrations averaged over entire UC.



63
 64 Figure S2: Scatter plot of filter measured primary organic aerosol (POA, defined as 1.2 times the
 65 organic carbon) versus AMS POA fuel-based emission factors averaged over the entire UC. Red
 66 data points indicate two apparent outliers that were not included in the linear regression.



67
 68 Figure S3: Scatter plot of gas-phase (NO, CO, and THC) and filter-based particle-phase (PM, EC,
 69 and OC) emissions measured in repeat tests with the same vehicle. The solid black line indicates
 70 the 1:1 line and the two dotted black lines correspond to the 2:1 and 1:2 lines. The data are listed
 71 in Table S6.



73 Figure S4: Particle-phase emission factors for: a) elemental carbon (EC) and b) primary organic
 74 aerosol (POA). Panel c) OC:EC ratio and d) ratio of sum of speciated particulate matter (PM) to
 75 gravimetric PM. POA defined as 1.2 times the OC mass. The solid line in (d) indicates a ratio of
 76 unity (mass closure), and the two dashed lines indicate a 20% deviation from the solid line. For all
 77 graphs, blue and magenta box-whiskers represent vehicles equipped with a PFI and GDI engine
 78 technology respectively. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3%
 79 of the data.

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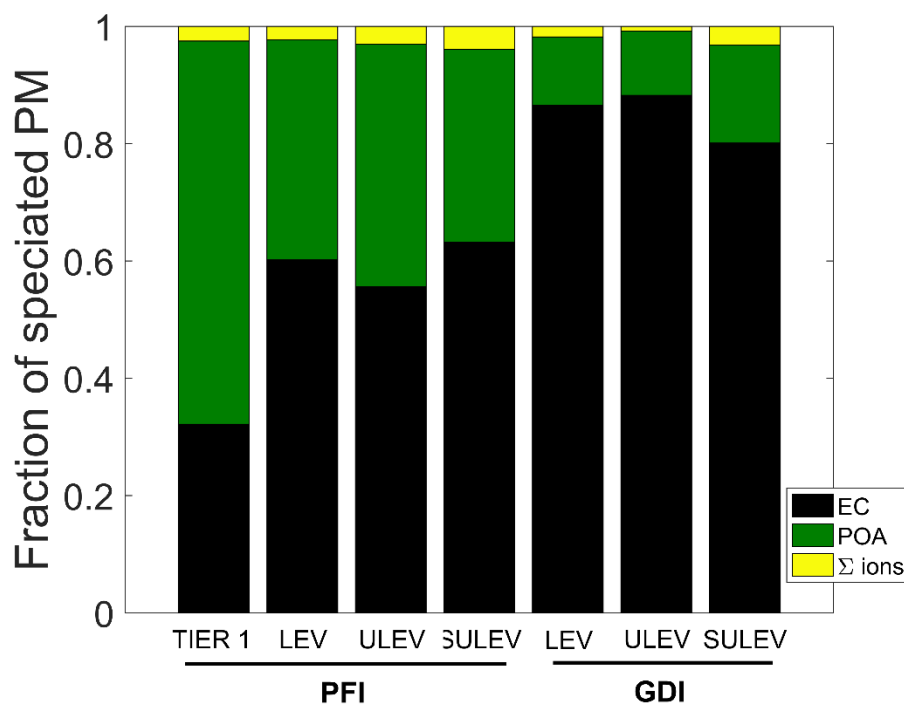


Figure S5: PM composition for different vehicle classes.

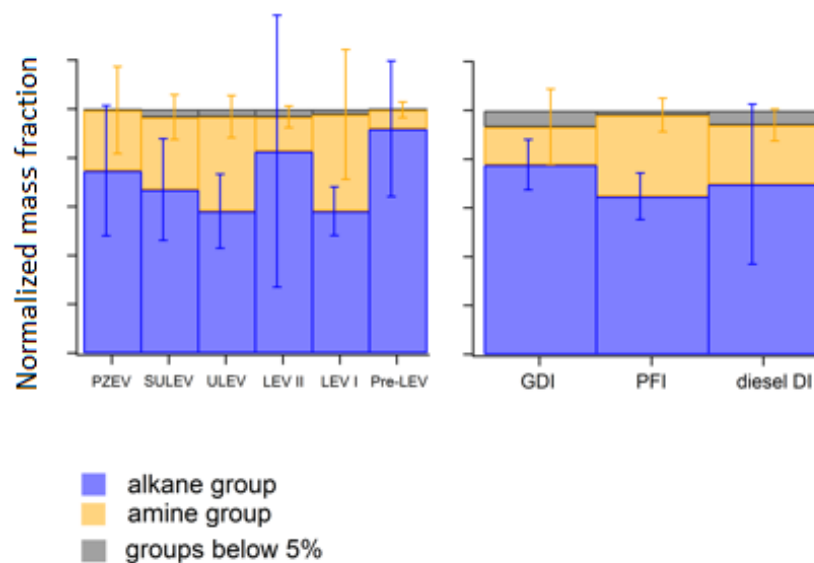


Figure S6: Composition of primary organic aerosol (POA) as a function of emission certification and engine technology measured with FTIR analysis of Teflon filter samples. Alkanes and amines dominate the composition of primary SOA, and POA composition is independent of emission standard and engine technology.

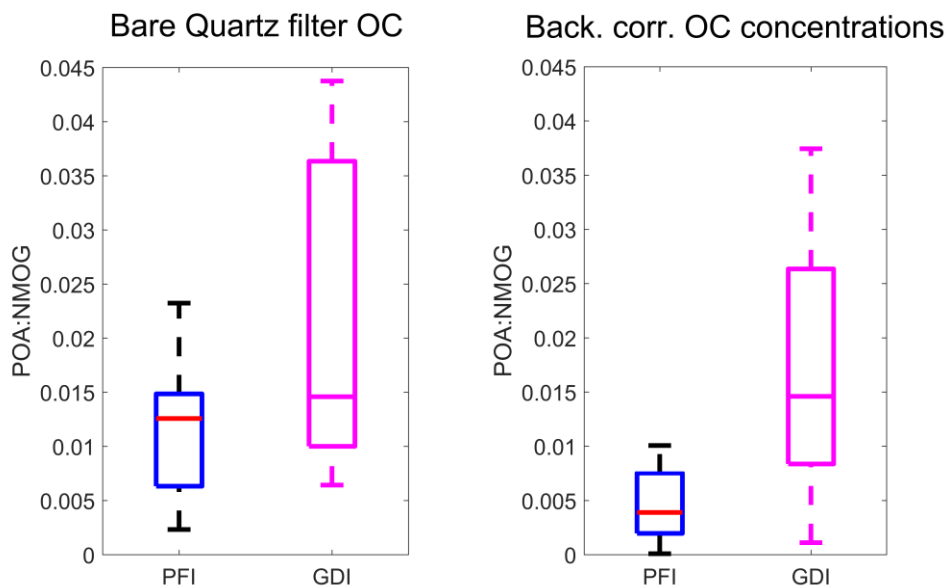


Figure S7: Relative importance of semivolatile to gas-phase organic emissions expressed in terms of the POA-to-NMOG ratio for PFI vehicles certified as LEV2 or newer (N=23) and GDI vehicles certified as LEV2 or newer (N=12). In panel a) the ratios are calculated with the bare quartz filter data for OC (no dynamic blank correction, as reported in main text); in panel b) the POA data are dynamic blank corrected. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the data.

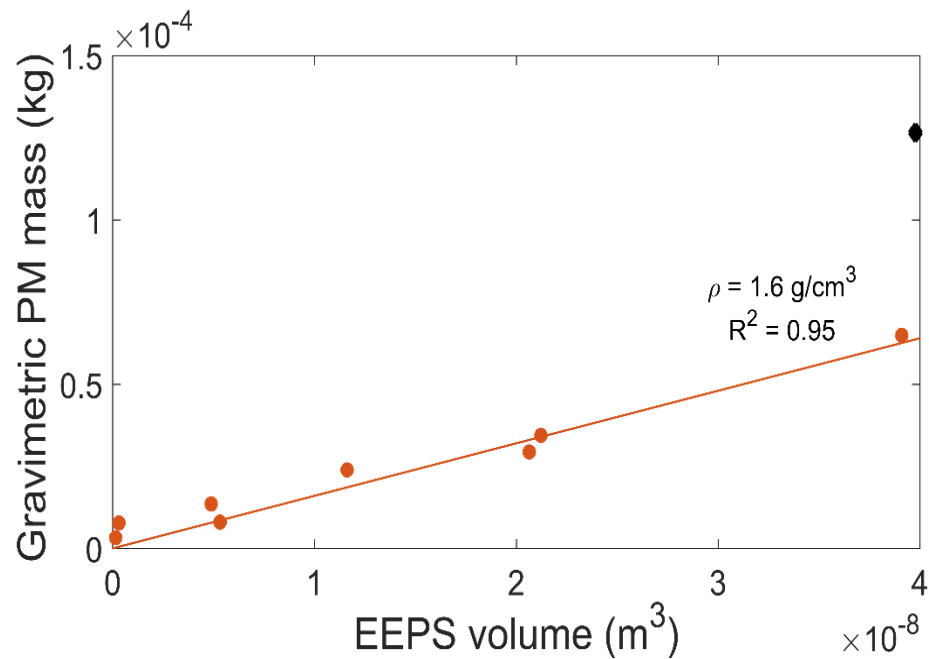


Figure S8: Scatter plot of particle volume (calculated by integrating the EEPS number distribution assuming spherical particles) versus gravimetric PM mass for five PFI vehicles and four GDI vehicles. The solid line is the linear regression (slope = 1.6 g/cm³, R²= 0.95). The black diamond data point (a ULEV GDI) was not included in the regression fit.

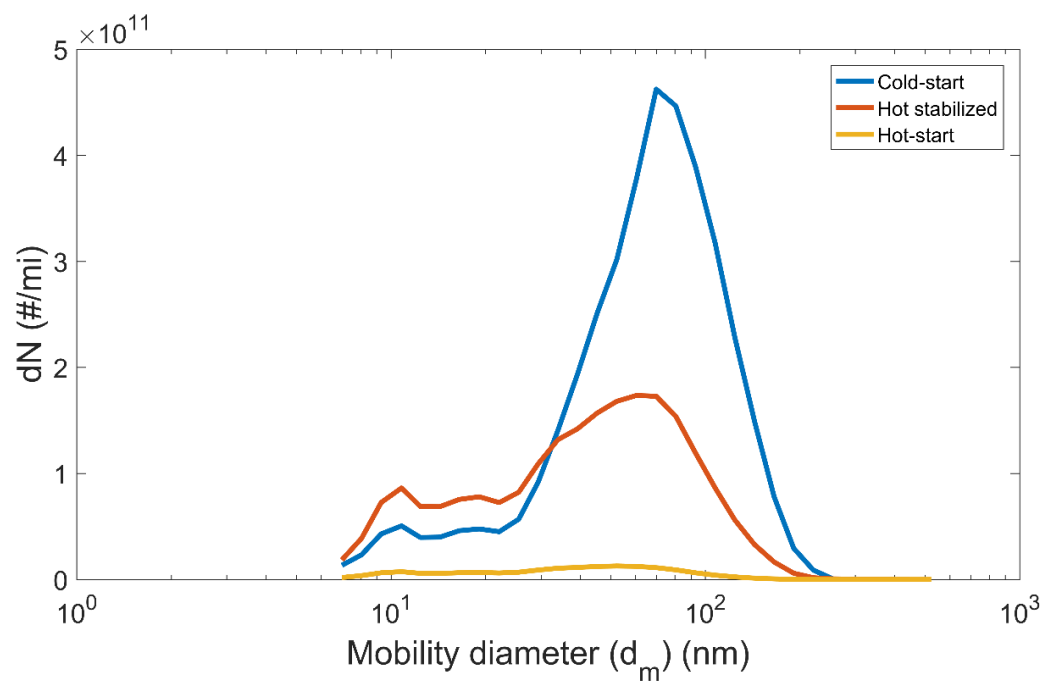
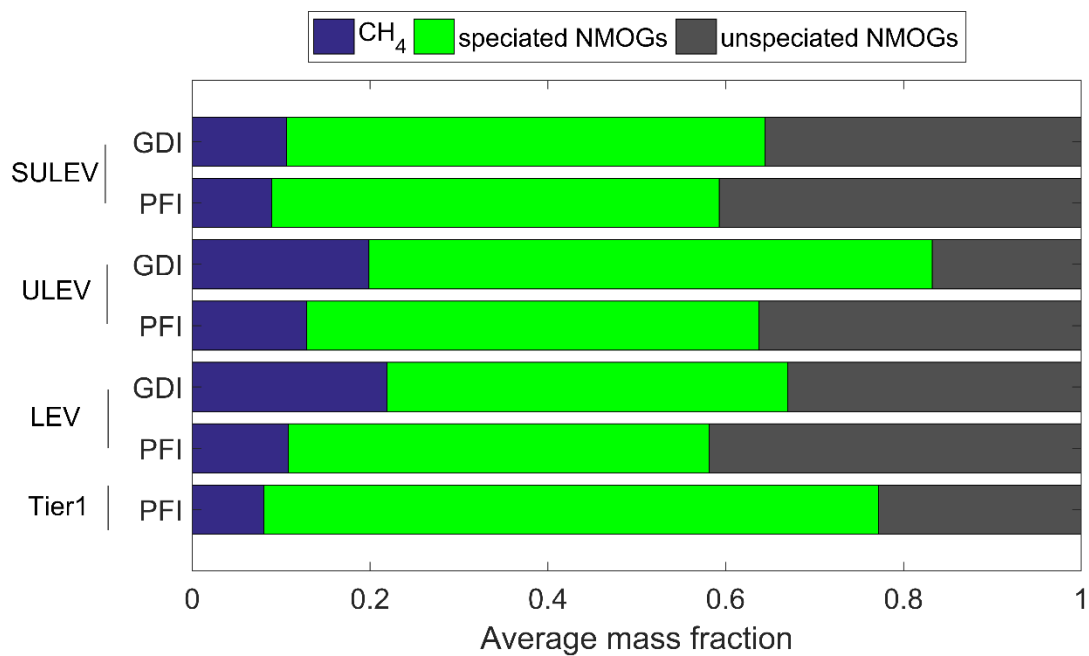


Figure S9: EEPS measured mobility size distributions by UC phase, for a typical experiment.

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106

107 Figure S10: Average mass fraction of methane, speciated non-methane volatile organic
 108 compounds (NMOG) and unspeciated NMOG (defined as the total organic gas minus the sum of
 109 speciated compounds) to total organic gas emissions for different vehicle classes.

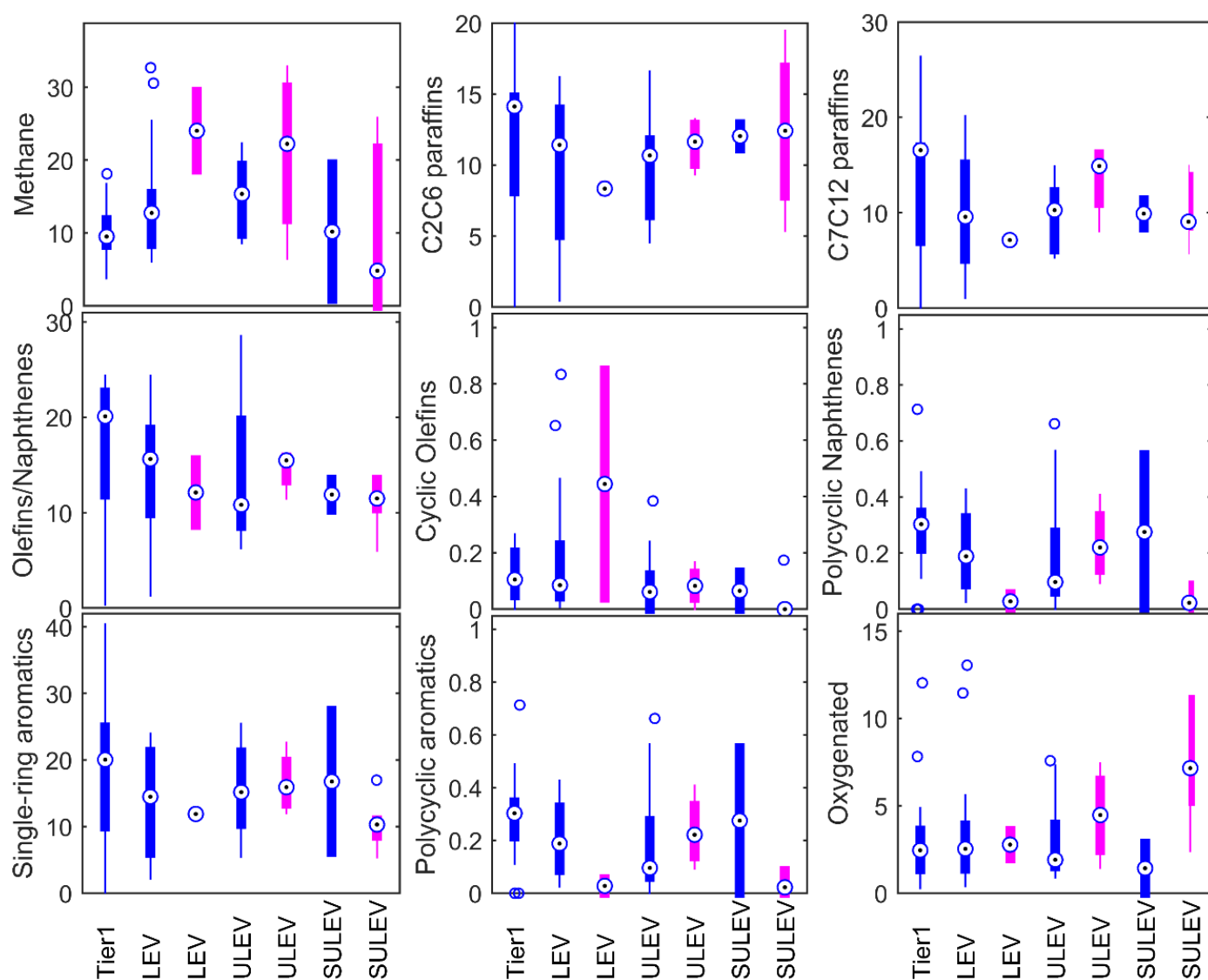
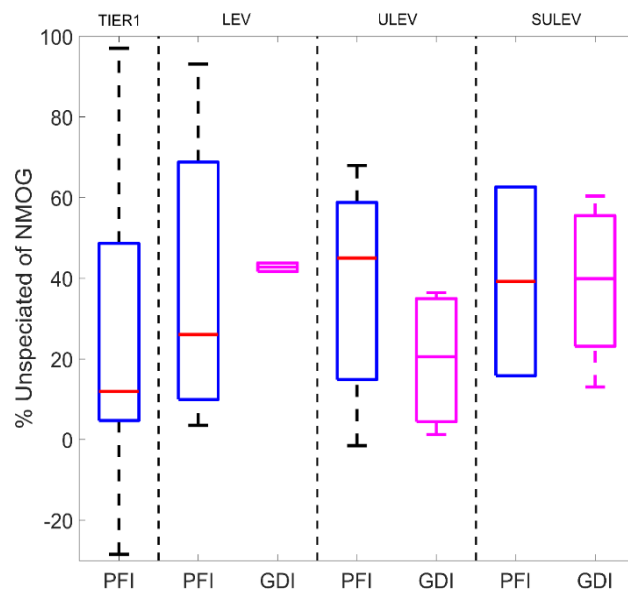
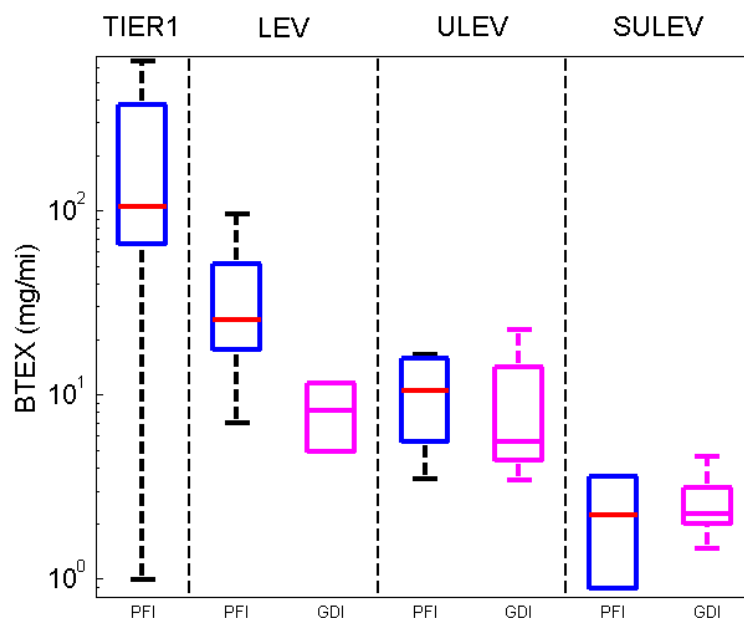


Figure S11: Box-whiskers plots for different organic compound groups presented as a percentage of speciated total organic gas (TOG) emissions. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the data. Data are shown for methane, C2-C6 paraffins, C7-C12 paraffins, olefins/naphthenes, cyclic olefins, polycyclic naphthenes, single-ring aromatics, polycyclic aromatics, and oxygenated compounds. Blue and magenta box whiskers correspond to vehicles equipped with a PFI and GDI engine respectively.



117
 118 Figure S12: Unspeciated NMOGs as a mass percentage of speciated NMOGs for different vehicle
 119 classes. Blue and magenta colors correspond to vehicles equipped with a PFI and GDI engine
 120 respectively. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the data.



121
 122 Figure S13: BTEX (sum of benzene, toluene, ethylbenzenes and xylenes) emission factors for
 123 different vehicle categories. Blue and magenta box-whiskers represent vehicles equipped with a
 124 PFI and a GDI engine respectively. Boxes represent the 25th to 75th percentile and the whiskers
 125 cover 99.3% of the data.

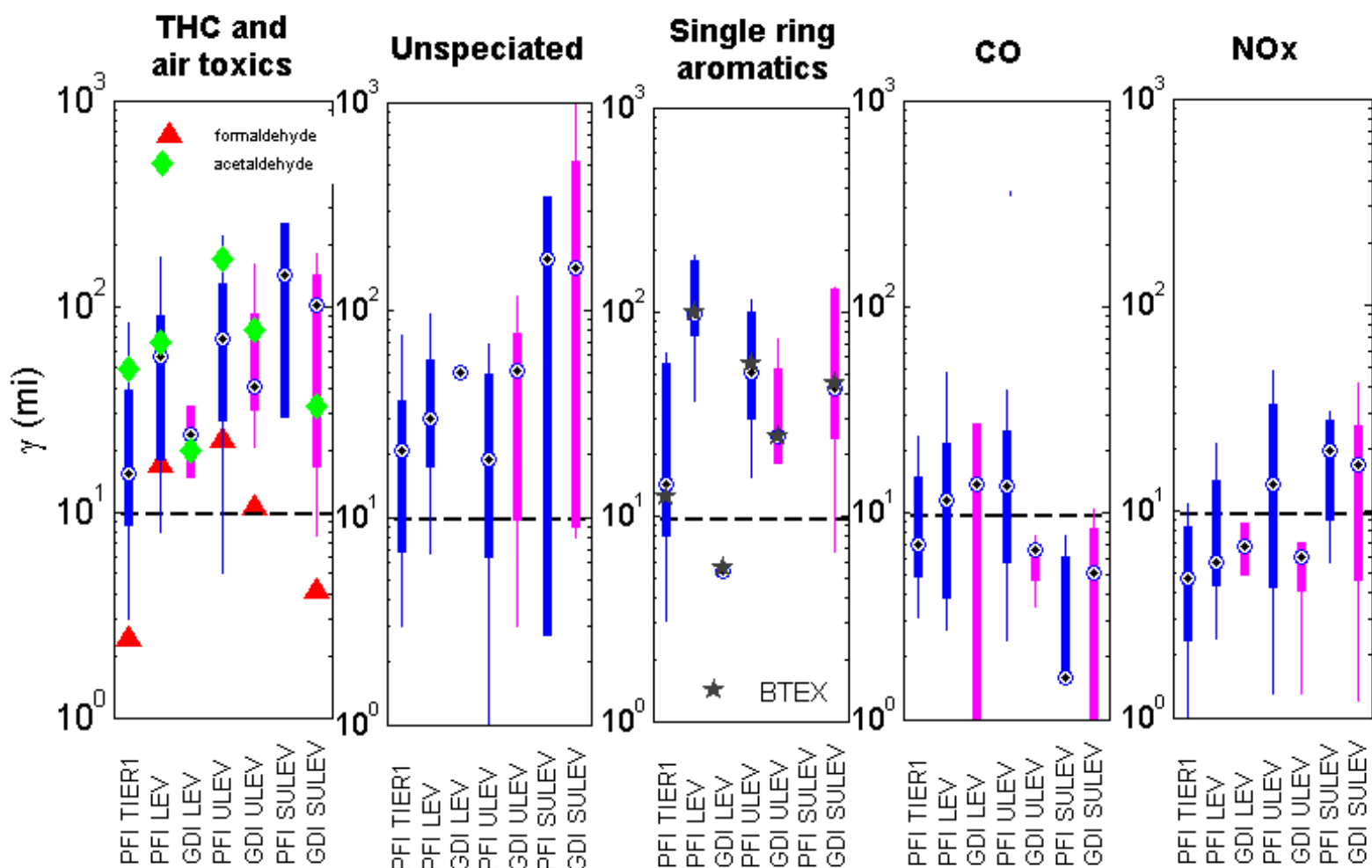
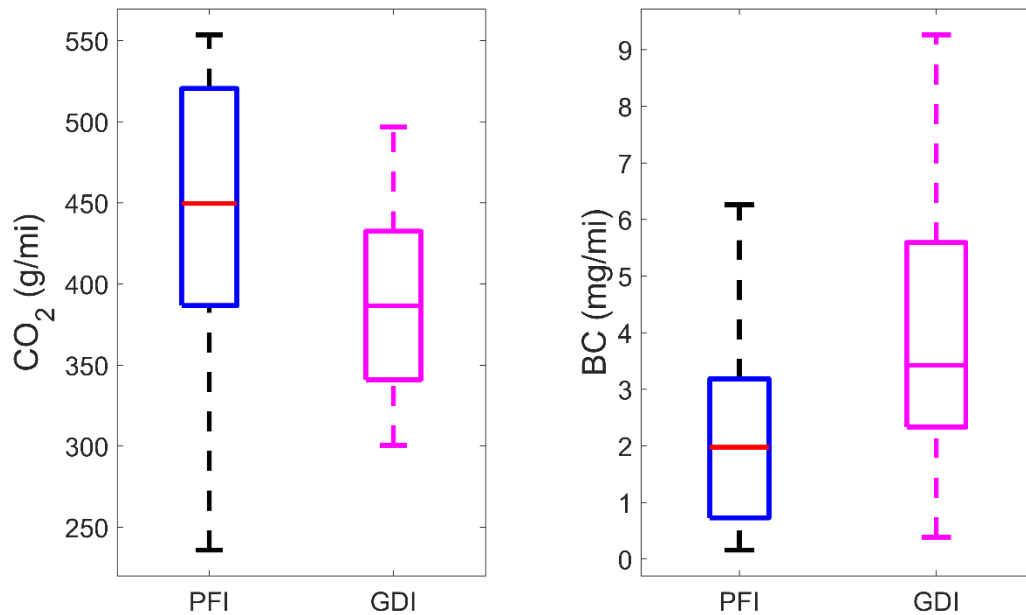
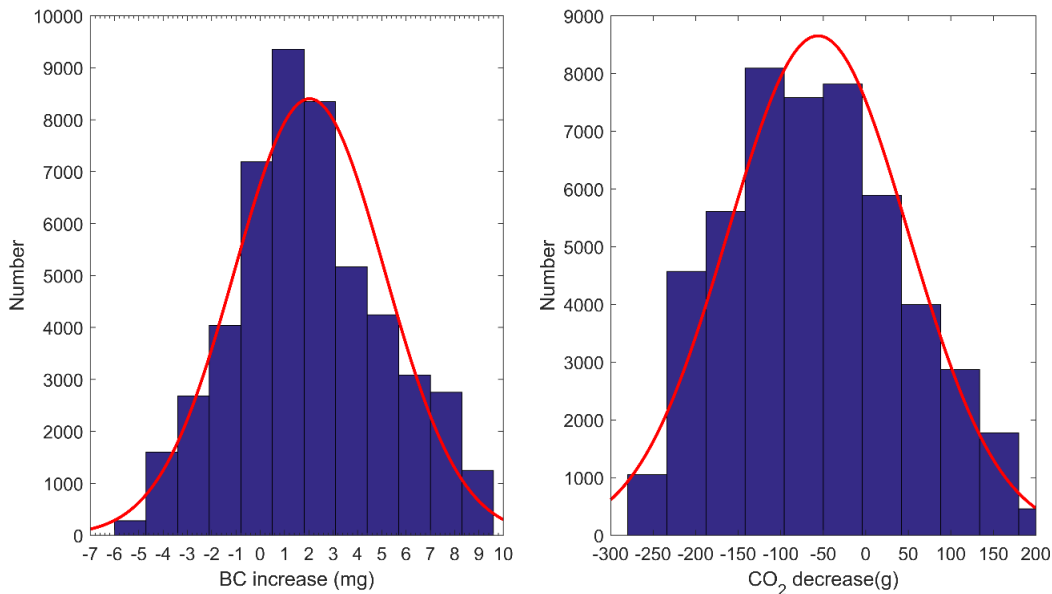


Figure S14: Importance of cold-start importance for different gas-phase pollutants expressed as γ (number of miles of hot-stabilized operations (UC bag 2) to equal cold-start (UC bag 1) emissions) for different vehicle classes. Panel a) THC γ (shown as box-whisker) and median γ for formaldehyde (red triangle) and acetaldehyde (green diamond); b) unspeciated NMOG γ ; c) γ values for single ring aromatics (box-whiskers) and median γ for BTEX (black star); d) CO γ ; and e) NO_x γ . The US average daily trip length of 9.8 miles is shown as the horizontal dashed line. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the data. The dotted circle inside the box-whiskers correspond to the median.



135
 136 Figure S15: CO₂ and BC emission factors for PFI (N=30) and GDI (N=15) vehicles certified as
 137 LEV2 or newer. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the
 138 data.



139
 140 Figure S16: Monte Carlo (N=100000) simulation of data from Figure S15 shown as histograms.
 141 Simulation predicts an average decrease of 57 g/mi in CO₂ emissions and a 2.1 mg/mi increase in
 142 BC emissions when replacing a PFI vehicle by a GDI one. Solid red lines indicate normal
 143 distributions fits to the data.

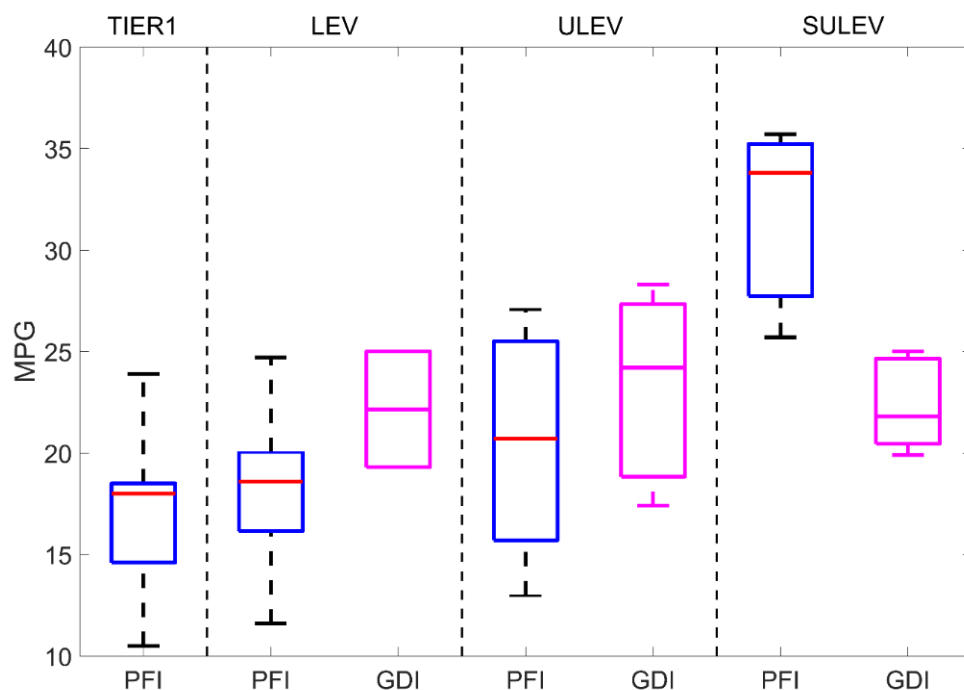


Figure S17: Fuel economy measured during the UC testing expressed in miles per gallon (MPG) for each vehicle category. Boxes represent the 25th to 75th percentile and the whiskers cover 99.3% of the data. MPG was calculated using the amount of fuel burnt, the distance travelled, and the fuel density for each vehicle tested. The data are presented as box-whiskers. Blue and magenta colors correspond to vehicles equipped with a PFI and a GDI engine respectively. SULEV PFI vehicles have higher fuel economy because most of the SULEV PFIs have a hybrid engine.

Tables:

Table S1: List of light-duty gasoline vehicles from 2014 campaign used in this study (WG=wall guided, SG=spray guided)

Test ID	Test Cycle	Vehicle Class	Model Year	Engine Size (L)	Engine technology	Emission Certification	Fuel Economy (mpg)	Odometer (mi)
1038708	UC	PC	2012	2	GDI-WG	SULEV	24.3	36733
1038723	UC	PC	2014	2	GDI-SG	L2SUL	20.2	11378
1038724	UC	PC	2012	2.4	GDI-WG	SULEV	21.5	78310
1038745	UC	PC	2013	1.6	GDI-SG	PZEV	21.0	13452
1038747	UC	PC	2013	1.4	GDI	PZEV	37.5	8902
1038750	UC	PC	2014	3.5	GDI-SG	L2SUL	19.7	11390
1038755	UC	PC	2012	2.5	PFI	PZEV	35.9	30832
1038757	UC	PC	2012	2.4	GDI-WG	SULEV	21.5	78320
1038760	UC	PC	2012	2.5	PFI	PZEV	35.5	30858
1038797	UC	PC	2013	1.4	GDI-WG	PZEV	32.9	8913
1038801	UC	PC	2013	1.6	GDI-WG	ULEV	28.1	18303
1038820	UC	PC	2013	1.6	GDI-WG	ULEV	28.5	18314
1038821	UC	PC	2008	3.9	PFI	L2LEV	16.1	90406
1038822	UC	PC	2013	1.6	GDI-WG	L2ULV	24.4	19802
1038823	UC	PC	2013	2	GDI-WG	ULEV	19.1	23468
1038824	UC	LDT	2013	5.3	PFI	ULEV	13.0	24110
1038825	UC	PC	2012	1.6	GDI-WG	L2LEV	25.0	12943
1038827	UC	PC	2013	2	GDI-WG	L2ULV	27.0	21814
1038848	UC	PC	2008	3.9	PFI	L2LEV	16.1	90417
1038849	UC	PC	2008	3.9	PFI	L2LEV	16.0	90429
1038850	UC	PC	2013	1.6	GDI-WG	L2ULV	24.0	19821
1038853	UC	PC	2014	2.4	GDI-WG	PZEV	28.2	4483
1038862	UC	PC	2013	3.6	GDI-WG	L2SUL	17.3	28121
1038864	UC	PC	2007	1.3	PFI	L2SUL	32.6	105707
1038867	UC	PC	2012	2.4	GDI-WG	PZEV	22.1	13405
1038868	UC	PC	2014	2.4	GDI-WG	PZEV	22.9	4508
1038869	UC	PC	2013	3.6	GDI-WG	L2SUL	17.0	28132
1038885	UC	PC	2007	1.3	PFI	L2SUL	35.0	105639
1038891	UC	M3	2003	5.4	PFI	LEV	11.8	104607
1038901	UC	PC	1990	3.8	PFI	TIER0	18.0	121473
1038909	UC	PC	2013	2	GDI-WG	ULEV	19.7	23514
1038911	UC	M3	2003	5.4	PFI	LEV	11.4	104619
1038912	UC	PC	1990	3.8	PFI	TIER0	17.9	121567
1038915	UC	PC	2013	2	GDI-WG	ULEV	19.2	23494
1038917	UC	LDT	2013	5.3	PFI	ULEV	13.2	24182
1038918	UC	LDT	2013	5.3	PFI	ULEV	13.0	24136
1038920	UC	PC	2014	2.4	GDI-WG	PZEV	23.8	4526
1038945	UC	LDT	2013	5.3	PFI	ULEV	12.9	24170
1038947	UC	PC	2013	1.6	GDI-WG	L2ULV	24.2	19840
1038952	UC	PC	2013	3.6	GDI-WG	L2SUL	17.8	28152

Table S2: List of light-duty gasoline vehicles tested by May et al.¹

Test ID	Test Cycle	Vehicle Class	Model Year	Engine Size (L)	Emission Certification	Fuel economy (mpg)	Odometer (mi)
1027790, 1027837, 1027841, 1027847, 1027859	Cold UC	PC	1996	2.7	Tier 1	20.3	
1032302, 1032304, 1032473	Cold UC	PC	1997	3.0	LEV 1	19.3	130462
1032346, 1032347, 1032348, 1032362	Cold UC	PC	1998	3.0	LEV 1	18.5	90614
1032393	Cold UC	PC	1999	2.0	LEV 1	23.6	118294
1027862, 1027904, 107915	Cold UC	PC	2000	2.2	ULEV	23.0	
1027881, 1027917, 1027918	Cold UC	PC	2003	3.5	LEV 1	17.3	
1027909	Cold UC	PC	1999	3.0	LEV 1	19.9	
1027976	Cold UC	PC	1994	1.9	LEV 1	21.7	
1028025	Cold UC	T2	1995	4.0	LEV 1	15.5	
1027870	Cold UC	M2	1997	5.4	Tier 1	11.5	
1027968	Cold UC	PC	1997	4.6	LEV 1	16.2	
1027972	Cold UC	PC	1997	2.3	Tier 1	20.3	
1027871	Cold UC	PC	1998	2.3	ULEV	22.2	
1028027	Cold UC	PC	1998	1.8	LEV 1	27.3	
1027975	Cold UC	T2	1999	4.0	LEV 1	16.4	
1027903	Cold UC	PC	1999	1.5	Tier 1	25.6	
1028075	Cold UC	PC	2000	3.5	LEV 1	20.1	
1027832	Cold UC	PC	2001	2.2	LEV 1	20.0	
1032388, 1032436	Cold UC	PC	2001	2.2	LEV 1	21.8	53245
1028024	Cold UC	PC	2001	2.8	LEV 1	16.3	
1028030	Cold UC	M2	2002	5.3	ULEV	14.1	
1028023	Cold UC	PC	2003	3.0	LEV 1	17.3	
1027970	Cold UC	PC	2003	1.8	ULEV	26.8	

Test ID	Test Cycle	Vehicle Class	Model Year	Engine Size (L)	Emission Certification	Fuel economy (mpg)	Odometer (mi)
1027789, 1027865, 1027879, 1027958, 1027961, 1027967	Cold UC	M3	2007	3.9	LEV 2	16.1	
1028022	Cold UC	LDT	2008	4.2	LEV 2	15.4	
1032268, 1032283, 1032359, 1032360	Cold UC	PC	2008	3.5	LEV 2	19.6	35731
1027852, 1027971	Cold UC	T2a	2010	3.6	ULEV	15.7	
1032342, 1032351, 1032321	Cold UC	PC	2011	2.0	ULEV	21.7	10899
1032282, 1032309, 1032343, 1032345	Cold UC	PC	2011	3.6	L2ULV	15.9	29196
1032382	Cold UC	PC	2012	2.0	PZEV	25.7	16053
1027908	Cold UC	PC	2004	2.2	LEV 2	24.7	
1027867	Cold UC	PC	2004	2.4	L2ULV	21.0	
1027978	Cold UC	T2	2005	2.7	LEV 2	19.3	
1027973	Cold UC	PC	2005	1.8	L2ULV	26.2	
1027962	Cold UC	PC	2006	2.7	LEV 2	21.5	
1027863	Cold UC	PC	2008	1.6	L2ULV	25.5	
1027833	Cold UC	PC	2008	3.5	LEV 2	19.3	
1027977	Cold UC	PC	2008	2.7	LEV 2	17.8	
1027906	Cold UC	PC	2008	3.6	LEV 2	18.6	
1027848	Cold UC	T2	2009	5.3	L2ULV	14.0	
1028021	Cold UC	T2	2009	5.7	LEV 1	13.8	
1027905	Cold UC	PC	2009	2.0	L2ULV	19.8	
1027907	Cold UC	PC	2009	2.4	L2ULV	18.8	
1027840	Cold UC	PC	2009	1.6	L2ULV	27.1	
1027808	Cold UC	PC	2009	2.0	L2ULV	26.4	
1032310	Cold UC	PC	2011	n/a	L2ULV	20.4	31006
1032383	Cold UC	M3	2012	3.6	ULEV	15.2	14792

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Test ID	Test Cycle	Vehicle Class	Model Year	Engine Size (L)	Emission Certification	Fuel economy (mpg)	Odometer (mi)
1032322	Cold UC	PCa	2012	3.6	ULEV	17.4	9563
1032442	Cold UC	PC	1987	4.1	Tier I	14.6	197631
1032440, 1032444	Cold UC	PC	1988	1.6	Tier I	23.9	224758
1032303, 1032389, 1032426	Cold UC	M3	1990	5.0	Tier I	13.0	58586
1032392	Cold UC	PC	1989	1.3	Tier I	27.2	123085
1032320	Cold UC	PC	1991	3.8	LEV	19.4	118050
1028060	Cold UC	PC	1990	3.0	Tier I	18.5	
1027853	Cold UC	PC	1990	2.3	Tier I	18.1	
1027920	Cold UC	PC	1991	3.8	Tier I	18.5	
1032443	Cold UC	PC	1991	4.0	Tier I	16.4	144000
1028023	Cold UC	PC	1992	3.4	Tier I	15.7	
1027921	Cold UC	PC	1992	3.8	Tier I	18.0	
1028026	Cold UC	PC	1992	3.8	Tier I	18.4	
1027922	Cold UC	LDT	1992	5.7	Tier I	10.5	
1027872	Cold UC	PC	1993	4.9	Tier I	13.1	
1032445	Cold UC	T2	1993	4.3	Tier I	15.0	161476

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Table S3 : Tailpipe emissions Standards, FTP-75 (g/mi), 100,000 miles/10 years

Category	NMOG	CO	NO _x	PM	HCHO
Tier 1	0.31	4.2	0.6	0.08*	-
LEV 1	0.09	4.2	0.3	0.08	0.018
ULEV	0.055	2.1	0.3	0.04	0.011
LEV 2 [†]	0.09	4.2	0.07	0.01	0.018
L2ULV [†]	0.055	2.1	0.07	0.01	0.011
SULEV/PZEV [†]	0.01	1.0	0.02	0.01	0.004

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*Standard based on 50,000 miles/5 years

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[†]Standard based on 120,000 miles/11 years

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191 Table S4: Number of vehicles and range of model years (MY) in each engine-technology/emission-
 192 certification-standard group.

	PM and gases except for NO _x					NO _x				
	PFI		GDI			PFI		GDI		
	#	MY**	#	MY**		#	MY**	#	MY**	
Tier1	17	1988-1997	0	-		Tier1	17	1989-1997	0	-
LEV	30	1991-2008	2	2008-2012		LEV1	20	1991-2009	0	-
						LEV2	10	2004-2008	2	2008-2012
ULEV	17	1998-2013	5	2013		ULEV	17	1998-2013	5	2013
SULEV	3	2007-2012	8	2012-2014		SULEV	3	2007-2012	8	2012-2014
Total	67		15			Total	67		15	

193 **Certification standards for each group are listed in Table S3

Table S5: Gasoline fuel property and composition data

Property/ Fuel component	Units	Median Mass Value (%)	Method
Density	g/mL	0.748	
Reid Vapor Pressure	psi	7.14	ASTM D5191
T10	(°F)	134	ASTM D86
T50	(°F)	202	ASTM D86
T90	(°F)	313	ASTM D86
C4 paraffins	wt %	0.50	
C5 paraffins	wt %	10.31	
C6 paraffins	wt %	9.86	
C7 paraffins	wt %	10.42	
C8 paraffins	wt %	10.41	
C9 paraffins	wt %	3.47	
C10 paraffins	wt %	1.37	
C11+ paraffins	wt %	2.40	
Σ paraffins	wt %	48.74	
C6 aromatics	wt %	0.74	
C7 aromatics	wt %	5.13	
C8 aromatics	wt %	8.00	
C9 aromatics	wt %	6.65	
C10 aromatics	wt %	3.61	
C11+ aromatics	wt %	0.93	
Σ aromatics	wt %	25.06	ASTM D5580
Olefins	wt %	14.34	ASTM 6550
C5 cyclic olefins	wt %	0.06	
C6 cyclic olefins	wt %	0.32	
C7 cyclic olefins	wt %	0.43	
C8 cyclic olefins	wt %	0.23	
C9 cyclic olefins	wt %	0.05	
Σ cyclic olefins	wt %	1.09	
Polycyclic naphthenes	wt %	0.00	
MTBE	wt %	0.00	
Ethanol	wt %	10.77	ASTM 4815
TAME	wt %	0.00	
Sulfur	ppm	6.3	ASTM D5453

198 Table S6: Median test-to-test variability for different pollutants based on repeat experiments of the same
 199 vehicle.

Emission certification	Variability as %RSD					
	CO	NO _x	THC	PM	EC	OC
SULEV	26%	25%	57%	7.8%	21%	48%
ULEV	9.4%	28%	13%	5.3%	13%	9.2%
LEV	36%	5.5%	3.5%	1.7%	3.6%	18%
Tier1	9.1%	2.4%	6.4%	n/a	n/a	n/a

221 Table S7: Light-duty gasoline vehicle emissions. Gas phase emissions in (g/mi), particle phase emissions (mg/mi)

Test ID	Certifi- cation.	Engine tech.	Test Cycle	kg- Fuel /mi	MPG	CO ₂ (g/mi)	CO (g/mi)	NO _x (mg/mi)	NO (mg/mi)	CH ₄ (mg/mi)	NMHC (mg/mi)	EC (mg/mi)	OC (mg/mi)	PM (mg/mi)	Σions (mg/mi)
1038708	SULEV	GDI	UC	0.11	23.6	340.97	5.54	14.82	9.80	8.82	19.21	1.73	0.39	2.92	0.19
1038723	L2SUL	GDI	UC	0.14	19.6	420.27	0.21	7.80	5.05	0.39	28.12	0.38	0.35	0.70	0.05
1038724	SULEV	GDI	UC	0.13	20.8	393.80	0.77	15.88	10.39	1.75	29.08	7.24	0.53	9.65	0.12
1038745	PZEV	GDI	UC	0.13	20.4	402.16	0.93	15.20	9.94	1.75	5.67	1.76	0.32	2.35	0.06
1038747	PZEV	GDI	UC	0.07	36.4	225.61	0.35	19.98	12.94	2.39	24.67	0.13	0.21	0.26	0.01
1038750	L2SUL	GDI	UC	0.14	19.1	430.96	0.22	9.76	6.26	0.13	11.91	n/a	n/a	n/a	n/a
1038755	PZEV	PFI	UC	0.08	34.9	235.88	0.08	2.20	1.46	0.19	19.83	0.15	0.23	0.30	0.03
1038757	SULEV	GDI	UC	0.13	20.9	394.05	0.44	13.53	8.92	1.06	12.08	n/a	n/a	n/a	n/a
1038760	PZEV	PFI	UC	0.08	34.5	238.79	0.06	7.61	5.02	0.74	9.03	n/a	n/a	n/a	n/a
1038797	PZEV	GDI	UC	0.08	32.0	257.18	0.23	10.72	6.96	1.41	8.96	n/a	n/a	n/a	n/a
1038801	ULEV	GDI	UC	0.10	27.3	301.06	0.32	47.66	31.20	2.71	37.90	8.04	0.48	10.46	0.05
1038820	ULEV	GDI	UC	0.10	27.7	296.86	0.35	42.97	28.12	3.08	34.92	n/a	n/a	n/a	n/a
1038821	L2LEV	PFI	UC	0.17	15.6	520.92	4.25	147.5	95.89	54.26	107.64	2.19	0.21	2.81	0.04
1038822	L2ULV	GDI	UC	0.11	23.7	346.35	0.76	15.16	9.90	8.47	42.17	5.22	0.31	6.70	0.03
1038823	ULEV	GDI	UC	0.14	18.5	432.44	7.76	64.40	41.00	30.39	58.12	8.61	0.88	11.51	0.09
1038824	ULEV	PFI	UC	0.21	12.6	648.56	1.18	8.79	6.00	12.20	67.15	2.49	3.82	7.41	0.08
1038825	L2LEV	GDI	UC	0.11	24.3	334.34	3.28	23.29	15.18	11.80	27.83	9.26	0.83	13.54	0.19
1038827	L2ULV	GDI	UC	0.10	26.2	310.56	2.16	6.61	4.38	13.80	58.72	2.72	0.32	3.63	0.04
1038848	L2LEV	PFI	UC	0.17	15.7	518.46	4.24	135.9	88.00	52.59	112.25	2.29	0.28	2.73	0.02
1038849	L2LEV	PFI	UC	0.17	15.5	520.93	5.49	150.1	97.12	55.80	122.22	n/a	n/a	n/a	n/a
1038850	L2ULV	GDI	UC	0.11	23.3	352.29	0.53	21.63	14.30	7.85	22.92	n/a	n/a	n/a	n/a
1038853	PZEV	GDI	UC	0.1	27.4	300.48	0.33	7.55	3.88	0.00	13.01	3.60	0.51	n/a	0.13
1038862	L2SUL	GDI	UC	0.16	16.8	489.11	0.14	17.72	11.49	0.00	8.43	3.20	0.47	4.37	0.07

Test ID	Certification	Engine tech.	Test Cycle	kg-Fuel/mi	MPG	CO2 (g/mi)	CO (g/mi)	NOx (mg/mi)	NO (g/mi)	CH4 (mg/mi)	NMHC (mg/mi)	EC (mg/mi)	OC (mg/mi)	PM (mg/mi)	Σ ions (mg/mi)
1038864	L2SUL	PFI	UC	0.08	31.6	259.34	0.73	13.39	8.87	2.09	11.45	1.36	0.42	2.18	0.13
1038867	PZEV	GDI	UC	0.12	21.5	379.19	2.86	25.36	16.62	5.21	13.73	5.59	0.55	7.23	0.09
1038868	PZEV	GDI	UC	0.12	22.3	369.42	0.24	9.88	6.60	0.00	11.07	n/a	n/a	n/a	n/a
1038869	L2SUL	GDI	UC	0.16	16.5	498.58	0.22	21.84	14.25	0.00	7.28	n/a	n/a	n/a	n/a
1038885	L2SUL	PFI	UC	0.08	34.0	241.15	0.78	24.42	15.68	2.86	34.15	n/a	n/a	n/a	n/a
1038891	LEV	PFI	UC	0.23	11.4	717.65	1.85	115.9	73.61	14.66	173.4	0.52	0.43	1.24	0.09
1038901	TIER 0	PFI	UC	0.15	17.5	466.83	1.62	324.72	209.4	36.59	253.4	0.33	0.31	0.73	0.07
1038909	ULEV	GDI	UC	0.14	19.1	424.90	3.21	23.00	15.07	23.29	57.95	2.06	0.22	2.67	0.01
1038911	LEV	PFI	UC	0.24	11.0	738.44	4.46	135.34	83.07	21.10	167.3	n/a	n/a	n/a	n/a
1038912	TIER 0	PFI	UC	0.15	17.3	471.44	1.86	321.84	204.61	31.58	236.0	n/a	n/a	n/a	n/a
1038915	ULEV	GDI	UC	0.14	18.6	441.44	0.85	62.56	40.06	10.02	39.76	n/a	n/a	n/a	n/a
1038917	ULEV	PFI	UC	0.21	12.8	638.85	1.39	17.08	11.26	12.62	67.37	1.95	0.27	2.67	0.03
1038918	ULEV	PFI	UC	0.21	12.6	650.48	1.48	20.43	13.18	14.52	79.88	2.23	0.35	2.62	0.04
1038920	PZEV	GDI	UC	0.11	23.1	355.74	0.13	7.13	4.58	0.00	17.79	2.42	0.27	3.12	0.04
1038945	ULEV	PFI	UC	0.21	12.5	655.54	1.38	22.62	14.81	13.17	56.33	4.47	0.98	7.41	0.12
1038947	L2ULV	GDI	UC	0.11	23.5	349.73	0.46	27.39	17.89	7.52	27.09	4.56	0.31	5.88	0.02
1038952	L2SUL	GDI	UC	0.15	17.3	476.62	0.15	12.11	8.07	0.00	13.83	3.24	0.25	3.82	0.03

Table S8 : Measured and EMFAC predicted PM emission factors (mg/mi). SE is the standard error in measurements. EMFAC predictions are performed for 2014, using aggregated speeds, gasoline fuel, and considering light-duty vehicles only. The South Coast AQMD was the region of the simulation.

avg. MY	MY range	Measured (mg/mi)				Fleet average from measurements			EMFAC predictions
		avg. PM PFI	SE	avg. PM GDI	SE	avg. GDI market share (%)	avg. fleet PM (mg/mi)	SE	avg. EMFAC PM (mg/mi) [†]
1990	1990	17.6	6	0	0	0	17.6	6.0	22.2
1992	[1991-1993]	12.1	3.6	0	0	0	12.1	3.6	12.7
1994.5	[1994-1995]	10.7	1.6	0	0	0	10.7	1.6	12.7
1998	[1997-1999]	3.77	1.3	0	0	0	3.8	1.3	4.2
2001.5	[2000-2003]	6.2	2	0	0	0	6.2	2.0	4.2
2005	[2004-2006]	4.5	2	0	0	0	4.5	2.0	0.2
2008	[2007-2009]	3.5	0.5	7.9**	1.8	2.1	3.6	0.5	0.3
2011	[2010-2012]	3.5	1.5	7.9	1.8	14.3	4.1	1.3	0.6
2013.5	[2013-2014]	3.5*	1.5	4.2	1.1	39.4	3.8	1.0	1.5

[†] EMFAC PM is calculated using the following formula:

$EMFAC_PM (mg/mi) = \{ [PM_RUNEX (mg/mi)] * 9.8 \text{ mi} + [PN_STREX (mg/start) / 0.506 (mi/start)] * 1.2 \text{ mi} \} / 11 \text{ mi}$. PM_RUNEX is the model output for running exhaust PM emissions and PM_STREX is the model output for cold-start PM emissions. 9.8 mi correspond to bag 2 and bag 3 lengths (hot running and hot-start) and 1.2 mi correspond to the length of bag 1 (cold-start). The factor 0.506 is used to convert UC bag 1 emission rate into a cold start emission rate.

* The same PM emission factors were used as PFI vehicles from the previous MY range ([2010-2012]) due to lack of data

** The same PM emission factors were used as GDI vehicles from the following MY range ([2010-2012]) due to lack of data

237 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
238 fuel)

TEST_ID	Test Cycle	(1-ME)benzene	(1-Mpropyl)benzene	(2-Mpropyl)benzene	1,2,3,4-tetraMbenzene	1,2,3,5-tetraMbenzene	1,2,3-triMbenzene	1,2,4,5-tetraMbenzene	1,2,4-triMCPentane
1038708	UC	0.00	0.00	0.10	0.00	0.00	0.21	0.00	0.15
1038723	UC	0.00	0.00	0.10	0.00	0.00	0.12	0.00	0.16
1038747	UC	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.27
1038755	UC	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.22
1038801	UC	0.14	0.00	0.14	0.00	0.14	1.18	0.00	0.38
1038821	UC	0.28	0.00	0.19	0.11	0.23	1.88	0.14	0.91
1038822	UC	0.19	0.00	0.12	0.00	0.15	0.55	0.12	0.43
1038824	UC	0.23	0.00	0.23	0.08	0.17	1.08	0.10	0.50
1038825	UC	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.15
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.37	0.00	0.27	0.09	0.71	2.65	0.20	1.41
1038862	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.23
1038891	UC	0.78	0.21	0.25	0.33	1.18	4.30	0.76	1.12
1038901	UC	1.45	0.28	2.38	0.51	2.47	7.32	1.32	3.33
1038909	UC	0.48	0.31	0.00	0.00	0.29	2.42	0.21	1.01
1038917	UC	0.23	0.00	0.36	0.07	0.20	1.22	0.14	0.42
1038920	UC	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.20
1038945	UC	0.15	0.00	0.50	0.00	0.18	0.86	0.10	0.37
1038947	UC	0.00	0.00	0.31	0.00	0.00	0.28	0.00	0.00
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	1.13	0.00	0.00	0.00	0.00	0.00

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240 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
241 fuel)

TEST_ID	Test Cycl e	1,2,4- triMben zene	1,2- butadie ne	1,2- diEbenz ene	1,2- diM-3- Ebenze ne	1,2- diM-4- Ebenze ne	1,2- propadie ne	1,3,5- triMCYhe xane	1,3,5- triMbenz ene
1038708	UC	1.83	0.00	0.00	0.00	0.00	0.19	0.00	0.31
1038723	UC	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.23
1038747	UC	3.22	0.00	0.00	0.00	0.19	0.00	0.00	1.11
1038755	UC	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.28
1038801	UC	5.81	0.00	0.00	0.00	0.22	0.00	0.17	0.74
1038821	UC	8.08	0.13	0.00	0.00	0.31	1.69	0.16	0.14
1038822	UC	4.73	0.00	0.00	0.00	0.29	0.00	0.20	1.30
1038824	UC	5.94	0.07	0.00	0.00	0.32	0.90	0.00	1.98
1038825	UC	2.19	0.00	0.00	0.00	0.00	0.00	0.00	0.66
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	10.47	0.13	0.00	0.08	0.47	1.38	0.21	3.42
1038862	UC	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.24
1038891	UC	18.58	0.15	0.27	0.19	1.63	0.00	0.56	5.22
1038901	UC	30.70	0.27	0.49	0.32	3.04	3.68	1.17	9.44
1038909	UC	9.93	0.00	0.00	0.00	0.56	0.00	0.51	3.14
1038917	UC	6.71	0.07	0.00	0.00	0.44	0.00	0.12	2.00
1038920	UC	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.64
1038945	UC	4.52	0.00	0.00	0.00	0.29	0.86	0.07	1.48
1038947	UC	2.41	0.00	0.00	0.00	0.00	0.45	0.00	0.45
1038952	UC	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.09
1038980	UC	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-fuel)

TEST_ID	Test Cycle	1,3-CYpenta diene	1,3-butadiene	1,3-butadiene	1,3-di-n-propylbenzene	1,3-diEbenzene	1,3-diM-2-Ebenzene	1,3-diM-4-Ebenzene	1,3-diM-5-Ebenzene
1038708	UC	0.00	1.49	0.00	0.00	0.00	0.00	0.00	0.00
1038723	UC	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
1038747	UC	0.00	0.30	0.00	0.00	0.00	0.00	0.19	0.33
1038755	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038801	UC	0.00	1.26	0.00	0.00	0.00	0.00	0.19	0.36
1038821	UC	0.00	4.35	0.12	0.00	0.20	0.11	0.65	1.00
1038822	UC	0.00	1.59	0.00	0.00	0.17	0.00	0.24	0.46
1038824	UC	0.00	1.94	0.00	0.06	0.23	0.18	0.31	0.78
1038825	UC	0.00	1.02	0.00	0.00	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.00	3.87	0.00	0.08	0.30	0.19	0.85	1.46
1038862	UC	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
1038891	UC	0.00	5.02	0.00	0.21	0.87	0.35	1.30	2.25
1038901	UC	0.00	13.48	0.16	0.44	1.49	1.04	2.52	4.59
1038909	UC	0.00	1.23	0.00	0.00	0.33	0.10	0.48	0.91
1038917	UC	0.00	1.69	0.00	0.00	0.30	0.09	0.36	0.74
1038920	UC	0.00	0.33	0.00	0.00	0.00	0.57	0.00	0.19
1038945	UC	0.00	2.10	0.00	0.00	0.20	0.09	0.26	0.55
1038947	UC	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.19
1038952	UC	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

265 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
266 fuel)

TEST_ID	Test Cycl e	1,4- diEbenz ene	1,4- diM-2- Ebenze ne	1- (diME)- 2- Mbenze ne	1-(diME)- 3,5- diMbenze ne	1-E-2-n- propylben zene	1-E- tert- butyl- ether	1-M-2- (1- ME)benz ene	1-M-2- Ebenze ne
1038708	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10
1038723	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19
1038747	UC	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.81
1038755	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
1038801	UC	0.00	0.22	0.00	0.00	0.00	0.00	0.00	1.57
1038821	UC	0.25	0.00	0.00	0.00	0.00	0.00	0.34	2.28
1038822	UC	0.17	0.29	0.00	0.00	0.00	0.00	0.12	1.08
1038824	UC	0.13	0.36	0.00	0.00	0.00	0.00	0.14	1.73
1038825	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.36	0.00	0.00	0.00	0.00	0.00	0.30	3.01
1038862	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
1038867	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
1038891	UC	0.74	1.57	0.00	0.19	0.12	0.00	0.50	4.44
1038901	UC	2.20	3.16	0.23	0.28	0.19	0.00	0.91	9.08
1038909	UC	0.29	0.62	0.00	0.00	0.00	0.00	0.27	2.67
1038917	UC	0.18	0.43	0.00	0.00	0.00	0.00	0.13	1.85
1038920	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45
1038945	UC	0.11	0.29	0.00	0.00	0.00	0.00	0.10	1.44
1038947	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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277 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
278 fuel)

TEST_I D	Test Cycle	1-M-2- n- butylbe nzene	1-M-2-n- propylbenz ene	1-M-3- (1- ME)benz ene	1-M-3- Ebenz ene	1-M-3-n- propylbenz ene	1-M-4- (1- ME)benz ene	1-M-4- ECYhe xane	1-M-4- Ebenz ene
1038708	UC	0.00	0.00	0.00	1.63	0.00	0.00	0.00	0.36
1038723	UC	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.12
1038747	UC	0.00	0.00	0.00	1.78	0.30	0.00	0.00	0.81
1038755	UC	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.32
1038801	UC	0.00	0.00	0.00	3.66	0.22	0.00	0.00	1.38
1038821	UC	0.00	0.14	0.11	4.68	0.36	0.00	0.00	2.08
1038822	UC	0.00	0.00	0.00	2.96	0.29	0.00	0.00	0.96
1038824	UC	0.00	0.10	0.10	4.20	0.28	0.00	0.00	1.94
1038825	UC	0.00	0.00	0.00	1.13	0.00	0.00	0.00	0.14
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.00	0.22	0.14	5.85	0.53	0.00	0.00	2.57
1038862	UC	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00
1038867	UC	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.15
1038891	UC	0.46	0.66	0.37	10.67	1.51	0.23	0.13	4.69
1038901	UC	0.49	1.07	0.70	20.15	3.09	0.35	0.00	8.82
1038909	UC	0.16	0.29	0.25	5.90	0.73	0.14	0.24	2.67
1038917	UC	0.09	0.13	0.09	4.90	0.38	0.00	0.08	2.09
1038920	UC	0.00	0.00	0.00	0.94	0.14	0.00	0.00	0.42
1038945	UC	0.00	0.08	0.06	3.05	0.27	0.00	0.00	1.36
1038947	UC	0.00	0.00	0.00	1.17	0.00	0.00	0.00	0.45
1038952	UC	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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289 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
290 fuel)

TEST_ID	Test Cycle	1-M-4-n-propylbenzene	1-MCYpentene	1-buten-3-yne	1-butene	1-butyne	1-heptene	1-hexene	1-nonene
1038708	UC	0.12	0.00	0.00	1.09	0.00	0.00	0.00	0.00
1038723	UC	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00
1038747	UC	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00
1038755	UC	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00
1038801	UC	0.00	0.14	0.00	1.13	0.00	0.00	0.14	0.00
1038821	UC	0.00	0.08	0.08	3.63	0.00	0.00	0.26	0.08
1038822	UC	0.00	0.12	0.00	2.13	0.00	0.00	0.15	0.00
1038824	UC	0.00	0.12	0.14	4.29	0.00	0.00	0.23	0.08
1038825	UC	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.00	0.00	0.12	5.85	0.00	0.00	0.34	0.11
1038862	UC	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
1038867	UC	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00
1038891	UC	0.48	0.23	0.20	5.25	0.00	0.00	0.24	0.26
1038901	UC	0.00	0.43	0.25	14.86	0.00	0.11	2.76	0.48
1038909	UC	0.12	0.00	0.00	1.84	0.00	0.00	0.14	0.20
1038917	UC	0.00	0.00	0.14	4.59	0.00	0.00	0.20	0.07
1038920	UC	0.00	0.14	0.00	0.52	0.00	0.00	0.00	0.00
1038945	UC	0.00	0.00	0.00	3.63	0.00	0.00	0.21	0.09
1038947	UC	0.00	0.46	0.00	1.25	0.00	0.00	0.00	0.00
1038952	UC	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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301 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
302 fuel)

TEST_I D	Test Cycl e	1- octe ne	1- penten e	1- propy ne	1a,2a,3b- triMCYpent ane	2,2,3- triMbuta ne	2,2,4- triMhepta ne	2,2,4- triMhexa ne	2,2,4- triMpenta ne
1038708	UC	0.00	0.15	0.00	0.22	0.00	0.00	0.00	3.87
1038723	UC	0.00	0.35	0.00	0.00	0.00	0.00	0.00	4.24
1038747	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.10
1038755	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.89
1038801	UC	0.00	0.29	0.00	0.20	0.00	0.00	0.00	10.41
1038821	UC	0.08	0.55	2.32	0.33	0.18	0.00	0.00	17.69
1038822	UC	0.00	0.35	0.00	0.23	0.18	0.00	0.00	7.68
1038824	UC	0.00	0.47	0.73	0.22	0.17	0.14	0.10	7.18
1038825	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.10
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.10	0.70	1.42	0.38	0.12	0.00	0.00	20.61
1038862	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43
1038867	UC	0.00	0.11	0.00	0.00	0.00	0.00	0.00	3.84
1038891	UC	0.00	0.99	0.99	0.63	0.22	0.00	0.81	23.19
1038901	UC	0.64	3.02	4.38	1.17	0.00	0.58	0.00	53.38
1038909	UC	0.00	0.28	0.00	0.55	0.00	0.00	0.14	13.81
1038917	UC	0.00	0.44	0.00	0.26	0.13	0.00	0.00	7.94
1038920	UC	0.00	0.00	0.00	0.12	0.00	0.00	0.00	4.22
1038945	UC	0.00	0.36	0.61	0.17	0.08	0.00	0.07	6.03
1038947	UC	0.00	0.22	0.52	0.00	0.00	0.00	0.00	2.92
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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314 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
315 fuel)

TEST_I D	Test Cycle	2,2,5- triMhe ptane	2,2,5- triMhexa ne	2,2- diM- octan e	2,2- diMbuta ne	2,2- diMhexa ne	2,2- diMpenta ne	2,2- diMpropa ne	2,3,3- triMpenta ne
1038708	UC	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00
1038723	UC	0.00	0.91	0.00	0.36	0.00	0.19	0.00	0.00
1038747	UC	0.00	1.74	0.00	0.00	0.00	0.00	0.00	0.00
1038755	UC	0.00	0.90	0.00	0.23	0.00	0.00	0.00	0.00
1038801	UC	0.00	3.11	0.00	0.82	0.00	0.00	0.00	0.00
1038821	UC	0.00	4.39	0.13	0.81	0.00	0.00	0.00	0.00
1038822	UC	0.00	2.11	0.00	0.73	0.00	0.00	0.00	0.00
1038824	UC	0.00	2.61	0.12	0.32	0.08	0.15	0.00	0.00
1038825	UC	0.00	1.56	0.00	0.23	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.00	5.33	0.20	1.03	0.00	0.33	0.00	0.00
1038862	UC	0.00	0.35	0.00	0.00	0.00	0.68	0.00	0.00
1038867	UC	0.00	0.98	0.00	0.44	0.00	0.00	0.00	0.00
1038891	UC	0.00	7.87	0.13	0.69	0.00	0.00	0.00	0.00
1038901	UC	0.00	16.17	0.67	2.16	0.50	0.26	0.00	9.22
1038909	UC	0.00	5.56	0.33	2.52	0.00	0.25	0.00	0.00
1038917	UC	0.00	2.61	0.08	0.25	0.00	0.00	0.00	0.00
1038920	UC	0.00	1.18	0.00	0.40	0.00	0.00	0.00	0.00
1038945	UC	0.00	1.87	0.07	0.19	0.00	0.08	0.00	0.00
1038947	UC	0.00	0.76	0.00	0.38	0.00	0.00	0.00	0.00
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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325 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
326 fuel)

TEST_ID	Test Cycle	2,3,4-triMpentane	2,3,5-triMhexane	2,3-diM-1-buten e	2,3-diM-2-penten e	2,3-diM-octan e	2,3-diMbuta ne	2,3-diMhepta ne	2,3-diMhexa ne
1038708	UC	0.84	0.13	0.00	0.15	0.00	1.37	0.00	0.51
1038723	UC	1.06	0.15	0.00	0.00	0.00	1.25	0.00	0.46
1038747	UC	1.82	0.32	0.00	0.00	0.00	1.23	0.00	0.83
1038755	UC	1.02	0.00	0.00	0.00	0.00	1.82	0.00	0.64
1038801	UC	3.19	0.32	0.00	0.00	0.00	2.89	0.00	1.30
1038821	UC	5.05	0.50	0.15	0.18	0.36	6.71	0.00	2.72
1038822	UC	2.47	0.33	0.15	0.00	0.00	2.41	0.00	1.26
1038824	UC	2.11	0.41	0.19	0.16	0.30	2.53	0.21	1.36
1038825	UC	1.55	0.00	0.00	0.00	0.00	1.71	0.00	0.44
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	5.78	0.61	0.20	0.20	0.53	7.27	0.00	3.19
1038862	UC	0.40	0.00	0.00	0.00	0.00	0.57	0.00	0.18
1038867	UC	1.00	0.16	0.00	0.00	0.00	1.45	0.00	0.60
1038891	UC	7.90	1.43	0.28	0.00	0.39	6.63	0.00	4.33
1038901	UC	15.95	2.93	0.81	0.44	1.91	18.18	0.11	1.78
1038909	UC	5.39	1.01	0.12	0.00	0.18	3.93	0.00	2.67
1038917	UC	2.27	0.42	0.15	0.00	0.07	2.43	0.00	1.25
1038920	UC	1.21	0.18	0.00	0.00	0.00	1.67	0.00	0.65
1038945	UC	1.52	0.28	0.15	0.12	0.22	1.90	0.00	0.83
1038947	UC	0.91	0.13	0.00	0.00	0.00	1.02	0.00	0.41
1038952	UC	0.30	0.00	0.00	0.00	0.00	0.49	0.00	0.13
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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337 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
 338 fuel)

TEST_ID	Test Cycle	2,3-diMpentane	2,4,4-triM-1-pentene	2,4,4-triM-2-pentene	2,4,4-triMhexane	2,4-diM-1-pentene	2,4-diM-2-pentene	2,4-diM-octane	2,4-diMheptane
1038708	UC	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.18
1038723	UC	2.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038747	UC	4.17	0.00	0.00	0.00	0.19	0.00	0.00	0.20
1038755	UC	3.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038801	UC	7.64	0.00	0.20	0.00	0.00	0.00	0.00	0.21
1038821	UC	15.52	0.08	0.00	0.18	0.00	0.00	0.40	0.35
1038822	UC	5.84	0.00	0.25	0.18	0.00	0.00	0.00	0.23
1038824	UC	6.76	0.19	0.00	0.15	0.07	0.00	0.23	0.25
1038825	UC	4.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	17.65	0.00	0.00	0.25	0.00	0.00	0.55	0.43
1038862	UC	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	3.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038891	UC	20.59	0.39	0.69	0.48	0.17	0.22	0.18	0.77
1038901	UC	45.81	0.62	0.13	0.95	0.20	0.00	0.52	2.35
1038909	UC	11.08	0.00	0.71	0.35	0.00	0.00	0.12	0.57
1038917	UC	6.88	0.00	0.26	0.17	0.00	0.00	0.00	0.54
1038920	UC	3.13	0.00	0.17	0.00	0.00	0.15	0.00	0.13
1038945	UC	5.25	0.00	0.00	0.12	0.07	0.00	0.15	0.19
1038947	UC	2.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038952	UC	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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349 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
350 fuel)

TEST_ID	Test Cycle	2,4-diMhexane	2,4-diMpentane	2,5-diM-octane	2,5-diMhexane	2,6-diM-octane	2,6-diMheptane	2-M-1,3-butadiene	2-M-1-butene
1038708	UC	0.58	1.67	0.00	0.66	0.00	0.13	0.19	0.35
1038723	UC	0.71	1.61	0.00	0.71	0.00	0.00	0.00	0.22
1038747	UC	1.35	2.02	0.00	1.11	0.00	0.20	0.00	0.35
1038755	UC	0.72	1.97	0.00	0.98	0.00	0.00	0.18	0.30
1038801	UC	2.43	4.15	0.00	2.25	0.00	0.00	0.56	0.61
1038821	UC	3.94	8.50	0.13	3.65	0.15	0.41	0.09	0.85
1038822	UC	1.86	3.23	0.00	1.73	0.00	0.13	0.69	0.78
1038824	UC	1.73	3.38	0.11	1.73	0.10	0.32	0.62	1.42
1038825	UC	1.10	2.45	0.00	1.05	0.00	0.00	0.15	0.25
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	4.73	9.31	0.22	4.26	0.17	0.84	0.30	2.10
1038862	UC	0.31	0.00	0.00	0.29	0.00	0.00	0.10	0.11
1038867	UC	0.79	1.63	0.00	0.72	0.00	0.00	0.00	0.23
1038891	UC	6.34	10.16	0.37	5.52	0.24	0.42	0.65	2.29
1038901	UC	12.76	23.56	0.43	11.55	0.59	1.98	0.94	3.30
1038909	UC	3.87	5.69	0.12	3.66	0.18	0.29	0.22	0.73
1038917	UC	1.86	3.85	0.08	1.80	0.00	0.15	0.49	1.24
1038920	UC	0.91	1.84	0.00	0.78	0.00	0.00	0.19	0.27
1038945	UC	1.25	2.83	0.07	1.22	0.07	0.22	0.63	1.01
1038947	UC	0.69	1.25	0.00	0.61	0.00	0.00	0.31	0.47
1038952	UC	0.22	0.56	0.00	0.24	0.00	0.00	0.09	0.09
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-fuel)

TEST_ID	Test Cycle	2-M-1-pentene	2-M-2-butene	2-M-2-hexene	2-M-2-pentene	2-M-indan	2-M-octane	2-M-t-3-hexene	2-Mbutane
1038708	UC	0.12	0.42	0.00	0.15	0.00	0.00	0.00	7.83
1038723	UC	0.00	2.92	0.00	0.14	0.00	0.00	0.00	7.78
1038747	UC	0.00	0.54	0.00	0.19	0.00	0.00	0.00	5.24
1038755	UC	0.00	0.85	0.00	0.19	0.00	0.00	0.00	11.40
1038801	UC	0.20	1.01	0.00	0.41	0.00	0.00	0.00	18.50
1038821	UC	0.20	0.89	0.00	0.54	0.12	0.00	0.00	39.63
1038822	UC	0.28	1.16	0.00	0.46	0.00	0.00	0.15	14.09
1038824	UC	0.22	1.89	0.00	0.51	0.11	0.00	0.31	13.80
1038825	UC	0.00	0.48	0.00	0.23	0.00	0.00	0.00	8.37
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.26	1.05	0.00	0.59	0.17	0.00	0.00	43.84
1038862	UC	0.00	0.22	0.00	0.00	0.00	0.00	0.00	3.43
1038867	UC	0.00	0.30	0.00	0.14	0.00	0.00	0.00	9.07
1038891	UC	0.54	3.13	0.13	0.95	0.71	0.00	0.22	31.40
1038901	UC	0.99	2.47	0.00	1.65	1.28	0.00	0.39	91.32
1038909	UC	0.16	1.07	0.20	0.38	0.17	0.00	0.00	19.09
1038917	UC	0.25	1.76	0.00	0.57	0.18	0.00	0.07	10.48
1038920	UC	0.00	0.49	0.00	0.22	0.00	0.00	0.00	9.86
1038945	UC	0.16	1.31	0.00	0.39	0.11	0.00	0.00	8.05
1038947	UC	0.00	0.60	0.00	0.17	0.00	0.00	0.00	7.13
1038952	UC	0.00	0.18	0.00	0.00	0.00	0.00	0.00	3.11
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07

373 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
374 fuel)

TEST_ID	Test Cycle	2-Mheptane	2-Mhexane	2-Mnonane	2-Mpentane	2-Mpropene	2-butyne	3,3-diM-1-butene	3,3-diM-octane
1038708	UC	1.41	1.10	0.43	3.27	3.85	0.00	0.00	0.00
1038723	UC	0.64	2.00	0.35	3.01	1.43	0.00	0.00	0.00
1038747	UC	1.07	2.14	1.26	3.38	1.67	0.00	0.00	0.00
1038755	UC	0.68	1.97	0.38	4.44	1.67	0.00	0.00	0.00
1038801	UC	2.11	4.61	2.09	7.29	3.52	0.00	0.00	0.00
1038821	UC	3.52	7.87	2.68	16.99	9.93	0.00	0.10	0.17
1038822	UC	1.67	3.54	1.16	6.42	4.33	0.00	0.00	0.15
1038824	UC	1.72	3.81	1.63	6.47	7.69	0.00	0.07	0.15
1038825	UC	0.44	2.15	0.76	3.83	2.83	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	4.28	9.39	3.65	18.52	12.92	0.00	0.16	0.27
1038862	UC	0.24	0.66	0.00	1.93	0.54	0.00	0.00	0.00
1038867	UC	0.72	1.70	0.35	4.41	0.85	0.00	0.00	0.00
1038891	UC	5.32	11.17	4.66	17.31	13.04	0.00	0.19	0.48
1038901	UC	10.47	23.58	9.68	45.38	28.38	0.00	0.70	1.17
1038909	UC	3.89	7.37	2.54	11.24	5.13	0.00	0.00	0.31
1038917	UC	1.69	3.82	1.67	6.88	7.07	0.00	0.00	0.14
1038920	UC	0.75	1.84	0.55	4.18	1.21	0.00	0.00	0.00
1038945	UC	1.49	2.86	1.40	4.80	6.30	0.00	0.09	0.09
1038947	UC	0.58	1.50	0.46	2.53	2.77	0.00	0.00	0.00
1038952	UC	0.21	0.67	0.00	1.22	0.49	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00

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385 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
386 fuel)

TEST_ID	Test Cycle	3,3-diMhexane	3,3-diMpentane	3,4-diM-1-pentene	3,4-diMhexane	3,5-diMheptane	3-E-2-pentene	3-Epentane	3-M-1-butene
1038708	UC	0.000	0.00	0.00	0.15	0.18	0.00	0.00	0.12
1038723	UC	0.000	0.10	0.00	0.10	0.17	0.00	0.00	0.12
1038747	UC	0.000	0.20	0.00	0.20	0.36	0.00	0.20	0.00
1038755	UC	0.000	0.00	0.00	0.19	0.00	0.00	0.00	0.00
1038801	UC	0.000	0.24	0.00	0.27	0.41	0.00	0.30	0.23
1038821	UC	0.000	0.38	0.15	0.60	0.83	0.00	0.48	0.47
1038822	UC	0.000	0.28	0.13	0.33	0.54	0.00	0.34	0.38
1038824	UC	0.000	0.34	0.08	0.39	0.58	0.00	0.33	0.49
1038825	UC	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.13
1038827	UC	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.000	0.47	0.15	0.58	1.39	0.00	0.58	0.65
1038862	UC	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	0.000	0.14	0.00	0.19	0.16	0.00	0.14	0.11
1038891	UC	0.000	0.00	0.00	1.12	1.93	0.19	0.93	0.86
1038901	UC	0.000	2.29	0.55	2.82	3.57	0.11	2.27	2.66
1038909	UC	0.185	0.45	0.14	0.93	1.31	0.00	0.60	0.30
1038917	UC	0.125	0.25	0.07	0.35	0.61	0.00	0.32	0.56
1038920	UC	0.000	0.00	0.00	0.23	0.20	0.00	0.15	0.12
1038945	UC	0.000	0.18	0.00	0.22	0.41	0.00	0.23	0.37
1038947	UC	0.000	0.15	0.00	0.00	0.15	0.00	0.13	0.17
1038952	UC	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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397 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
398 fuel)

TEST_I D	Test Cycle	3-M-1- hexene	3-M-1- pentene	3-M-c- 2- hexene	3-M-c- 2- pentene	3-M- octane	3-M-t- 2- pentene	3-M-t- 3- hexene	3- MCYpenten e
1038708	UC	0.00	0.00	0.00	0.00	0.30	0.12	0.00	0.00
1038723	UC	0.00	0.00	0.00	0.10	0.17	0.00	0.00	0.00
1038747	UC	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00
1038755	UC	0.00	0.00	0.00	0.22	0.23	0.00	0.00	0.00
1038801	UC	0.00	0.00	0.00	0.14	0.77	0.00	0.00	0.00
1038821	UC	0.00	0.34	0.00	0.37	1.81	0.00	0.00	0.38
1038822	UC	0.00	0.15	0.00	0.20	0.95	0.13	0.00	0.00
1038824	UC	0.00	0.30	0.00	1.11	0.93	0.00	0.07	0.41
1038825	UC	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.00	0.46	0.00	0.39	2.20	0.00	0.00	0.45
1038862	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038867	UC	0.00	0.11	0.00	0.00	0.30	0.00	0.00	0.00
1038891	UC	0.00	0.24	0.30	0.45	3.07	0.28	0.11	0.00
1038901	UC	0.51	0.75	0.00	5.61	5.75	0.00	0.17	1.06
1038909	UC	0.00	0.00	0.14	0.32	2.18	0.14	0.00	0.00
1038917	UC	0.00	0.12	0.12	0.16	1.01	0.19	0.00	0.00
1038920	UC	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00
1038945	UC	0.00	0.25	0.00	0.28	0.60	0.00	0.00	0.31
1038947	UC	0.00	0.00	0.00	0.12	0.28	0.00	0.00	0.15
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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409 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
 410 fuel)

TEST_ID	Test Cycle	3-Mheptane	3-Mhexane	3-Mpentane	4-M-1-pentene	4-M-c-2-pentene	4-M-indan	4-M-octane	4-M-t-2-hexene
1038708	UC	0.76	1.72	2.29	0.00	0.00	0.00	0.41	0.00
1038723	UC	0.77	1.54	2.07	0.00	0.00	0.00	0.31	0.00
1038747	UC	1.23	2.22	2.23	0.00	0.00	0.00	1.03	0.00
1038755	UC	0.91	1.97	2.96	0.00	0.00	0.00	0.30	0.00
1038801	UC	2.45	4.85	4.85	0.00	0.00	0.00	1.88	0.00
1038821	UC	4.72	8.96	11.50	0.16	0.00	0.00	2.48	0.00
1038822	UC	1.80	3.77	4.27	0.13	0.00	0.00	1.36	0.00
1038824	UC	2.27	3.68	4.33	0.11	0.00	0.00	1.30	0.11
1038825	UC	0.41	2.32	2.33	0.00	0.00	0.00	0.28	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	5.70	9.94	12.32	0.23	0.00	0.00	3.14	0.00
1038862	UC	0.29	0.00	1.01	0.00	0.00	0.00	0.13	0.00
1038867	UC	0.95	1.80	2.91	0.00	0.00	0.00	0.46	0.00
1038891	UC	6.35	11.91	11.88	0.22	0.00	0.16	4.25	0.17
1038901	UC	14.21	24.59	30.95	0.97	0.00	0.26	7.71	0.44
1038909	UC	4.46	7.77	7.80	0.18	0.00	0.00	3.04	0.00
1038917	UC	1.93	4.06	4.71	0.00	0.00	0.00	1.41	0.00
1038920	UC	0.86	2.43	2.67	0.00	0.00	0.00	0.60	0.00
1038945	UC	1.78	2.92	3.68	0.08	0.00	0.00	0.77	0.00
1038947	UC	0.79	1.50	2.27	0.00	0.00	0.00	0.33	0.00
1038952	UC	0.22	0.56	0.86	0.00	0.00	0.00	0.09	0.00
1038980	UC	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00

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421 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
 422 fuel)

TEST_ID	Test Cycle	4-M-t-2-pentene	4-Mheptane	5-M-indan	CYhexane	CYhexene	CYpentane	CYpentene	ECYhexane
1038708	UC	0.00	0.23	0.00	0.40	0.00	0.20	0.00	0.00
1038723	UC	0.00	0.15	0.00	0.53	0.00	0.29	0.00	0.00
1038747	UC	0.00	0.44	0.00	0.86	0.00	0.27	0.00	0.00
1038755	UC	0.00	0.26	0.00	0.74	0.00	0.44	0.00	0.00
1038801	UC	0.00	0.53	0.00	0.00	0.00	0.55	0.23	0.17
1038821	UC	0.18	1.41	0.11	2.89	0.16	1.63	0.46	0.28
1038822	UC	0.00	0.64	0.14	0.00	0.15	0.56	0.34	0.25
1038824	UC	0.15	0.66	0.11	1.35	0.13	0.59	1.10	0.22
1038825	UC	0.13	0.18	0.00	0.00	0.00	0.23	0.15	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.18	1.70	0.15	3.43	0.18	1.80	0.87	0.36
1038862	UC	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
1038867	UC	0.00	0.30	0.00	0.62	0.00	0.34	0.00	0.00
1038891	UC	0.95	2.11	0.69	0.00	0.34	1.49	0.52	0.65
1038901	UC	1.28	4.20	1.17	8.52	1.00	5.53	1.73	1.10
1038909	UC	0.00	1.60	0.19	2.53	0.10	0.83	0.39	0.61
1038917	UC	0.12	0.67	0.18	1.20	0.11	0.56	1.36	0.25
1038920	UC	0.00	0.33	0.00	0.00	0.00	0.32	0.14	0.00
1038945	UC	0.11	0.43	0.13	0.81	0.08	0.37	0.92	0.15
1038947	UC	0.00	0.23	0.00	0.55	0.00	0.27	0.15	0.00
1038952	UC	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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433 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
 434 fuel)

TEST_ID	Test Cycle	ECYpentane	Ebenzene	Ethane	M-tert-butyl-ether	MCYhexane	MCYpentane	MEketone	Methane
1038708	UC	0.00	1.56	7.17	0.00	0.65	1.95	0.00	0.00
1038723	UC	0.00	0.60	3.47	0.00	0.69	1.57	0.64	0.00
1038747	UC	0.00	2.21	2.49	0.00	0.86	2.02	1.38	0.00
1038755	UC	0.00	0.95	3.93	0.00	0.93	2.59	0.00	0.00
1038801	UC	0.00	4.17	6.28	0.00	1.36	4.15	0.56	0.00
1038821	UC	0.00	6.22	47.13	0.00	4.58	10.08	0.73	0.00
1038822	UC	0.00	3.23	9.54	0.00	1.75	3.59	0.36	0.00
1038824	UC	0.00	5.64	12.45	0.00	1.88	4.03	0.41	0.00
1038825	UC	0.00	1.34	6.43	0.00	0.56	2.03	0.61	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
1038849	UC	0.00	7.72	49.03	0.00	4.96	10.58	0.60	0.00
1038862	UC	0.00	0.27	1.37	0.00	0.32	0.83	0.00	0.00
1038867	UC	0.00	0.76	2.11	0.00	0.87	2.01	0.48	0.00
1038891	UC	0.22	11.97	14.29	0.00	4.95	11.57	0.61	0.00
1038901	UC	0.00	22.94	46.50	0.00	11.35	27.40	1.60	0.00
1038909	UC	0.14	6.59	8.97	0.00	4.38	6.15	0.96	0.00
1038917	UC	0.00	6.71	12.29	0.00	1.55	4.03	0.29	0.00
1038920	UC	0.00	1.33	1.75	0.00	0.96	1.98	0.95	0.00
1038945	UC	0.00	4.52	11.94	0.00	1.36	3.07	0.38	0.00
1038947	UC	0.00	1.18	7.90	0.00	0.85	1.52	0.69	0.00
1038952	UC	0.00	0.24	1.11	0.00	0.18	0.64	0.21	0.00
1038980	UC	0.00	0.00	11.99	0.00	0.00	0.00	0.35	0.00

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445 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
446 fuel)

TEST_I D	Test Cycle	Mpro pane	acetaldehy de	aceto ne	acrole in	benzaldehy de	benze ne	butyraldehy de	c-1,2- diMCIYhe xane
1038708	UC	0.12	4.17	2.10	0.30	0.00	15.10	0.00	0.00
1038723	UC	0.34	5.32	4.77	0.28	0.00	2.22	0.27	0.00
1038747	UC	0.24	9.38	3.11	0.00	0.00	5.18	0.00	0.00
1038755	UC	0.23	0.00	0.00	0.00	0.00	2.85	0.00	0.00
1038801	UC	0.24	5.07	2.56	0.00	0.51	12.31	0.08	0.23
1038821	UC	0.86	11.49	4.79	0.39	1.77	36.97	0.39	0.21
1038822	UC	0.34	7.45	6.01	0.00	0.81	14.65	0.34	0.30
1038824	UC	0.26	9.47	2.61	0.00	0.16	18.01	0.21	0.15
1038825	UC	0.05	3.70	2.97	0.00	0.27	16.62	0.17	0.00
1038827	UC	0.00	5.73	2.01	0.00	0.98	0.00	0.33	0.00
1038849	UC	0.87	13.26	3.97	0.32	1.81	47.78	0.32	0.25
1038862	UC	0.19	1.48	0.00	0.00	0.00	1.70	0.00	0.00
1038867	UC	0.31	4.27	2.10	0.00	0.00	3.28	0.00	0.00
1038891	UC	0.13	15.11	7.46	1.89	1.90	31.84	0.45	1.01
1038901	UC	0.63	43.44	11.02	4.66	5.79	45.92	1.05	0.81
1038909	UC	0.17	6.00	4.03	0.00	0.65	27.54	0.00	0.69
1038917	UC	0.18	6.93	1.59	0.00	0.31	19.44	0.00	0.34
1038920	UC	0.15	3.26	4.10	0.00	0.00	5.80	0.00	0.12
1038945	UC	0.11	7.04	1.27	0.00	0.53	15.53	0.00	0.09
1038947	UC	0.16	5.58	2.05	0.00	0.00	6.96	0.00	0.00
1038952	UC	0.00	0.55	0.27	0.00	0.00	1.63	0.00	0.00
1038980	UC	0.17	0.35	0.40	0.00	0.00	0.16	0.00	0.00

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457 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
458 fuel)

TEST_ID	Test Cycle	c-1,3-diMCYhexane	c-1,3-diMCYpentane	c-1-M-3-ECYpentane	c-2-butene	c-2-heptene	c-2-hexene	c-2-octene	c-2-pentene
1038708	UC	0.17	0.37	0.00	0.30	0.00	0.00	0.00	0.00
1038723	UC	0.16	0.39	0.00	0.31	0.00	0.00	0.00	0.16
1038747	UC	0.27	0.51	0.00	0.27	0.00	0.00	0.00	0.00
1038755	UC	0.22	0.59	0.00	0.41	0.00	0.00	0.00	0.26
1038801	UC	0.49	0.81	0.00	0.46	0.00	0.00	0.00	0.23
1038821	UC	1.32	2.57	0.00	1.51	0.10	0.15	0.00	0.54
1038822	UC	0.61	0.99	0.00	0.91	0.00	0.00	0.00	0.30
1038824	UC	0.61	1.11	0.00	2.81	0.08	0.15	0.00	0.49
1038825	UC	0.13	0.33	0.00	0.25	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	1.51	2.81	0.00	2.63	0.11	0.18	0.00	0.64
1038862	UC	0.09	0.18	0.00	0.11	0.00	0.00	0.00	0.00
1038867	UC	0.25	0.50	0.00	0.18	0.00	0.00	0.00	0.14
1038891	UC	1.96	3.09	0.00	2.09	0.30	0.00	0.00	0.76
1038901	UC	3.82	7.27	0.00	6.04	0.57	0.70	0.00	2.09
1038909	UC	1.64	1.76	0.00	1.17	0.12	0.00	0.00	0.28
1038917	UC	0.64	1.01	0.00	2.94	0.00	0.41	0.00	0.42
1038920	UC	0.30	0.44	0.00	0.25	0.00	0.15	0.00	0.12
1038945	UC	0.41	0.77	0.00	2.44	0.07	0.13	0.00	0.35
1038947	UC	0.22	0.42	0.00	0.50	0.00	0.00	0.00	0.17
1038952	UC	0.00	0.18	0.00	0.11	0.00	0.00	0.97	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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469 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
 470 fuel)

TEST_ID	Test Cycle	c-3-hexene	crotonaldehyde	ethanol	ethene	ethyne	formaldehyde	hexanal	indan
1038708	UC	0.00	0.00	0.00	21.15	1.14	84.81	0.00	0.16
1038723	UC	0.00	0.00	0.00	9.76	0.00	6.74	0.00	0.00
1038747	UC	0.00	0.00	0.00	8.40	0.69	5.35	0.00	0.33
1038755	UC	0.00	0.00	0.00	9.93	0.17	0.00	0.00	0.00
1038801	UC	0.20	0.00	0.00	18.18	3.74	5.84	0.00	0.33
1038821	UC	0.00	0.00	27.11	71.35	25.97	12.42	0.00	0.62
1038822	UC	0.23	0.00	0.00	37.59	10.74	12.94	0.00	0.40
1038824	UC	0.00	0.00	15.87	50.47	5.53	4.38	0.00	0.70
1038825	UC	0.00	0.00	0.00	15.46	0.80	4.54	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	7.27	0.00	0.00
1038849	UC	0.00	0.00	23.90	86.19	12.16	12.21	0.00	1.29
1038862	UC	0.00	0.00	0.00	4.88	0.10	0.00	0.00	0.00
1038867	UC	0.00	0.00	0.00	5.24	0.30	2.51	0.00	0.00
1038891	UC	0.30	0.00	76.29	63.21	14.21	49.86	0.00	1.90
1038901	UC	0.00	0.63	46.31	153.96	34.63	23.47	0.00	3.31
1038909	UC	0.12	0.00	14.46	38.23	3.43	6.82	0.00	1.41
1038917	UC	0.00	0.00	13.23	52.52	4.20	5.07	0.00	0.96
1038920	UC	0.00	0.00	0.00	8.48	0.46	9.97	0.00	0.16
1038945	UC	0.00	0.00	9.52	45.04	5.15	5.07	0.00	0.56
1038947	UC	0.00	0.00	0.00	23.84	9.33	22.92	0.00	0.14
1038952	UC	0.00	0.00	0.00	4.58	0.22	0.87	0.00	0.00
1038980	UC	0.00	0.00	0.00	1.11	0.00	2.00	0.00	0.00

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482 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
483 fuel)

TEST_ID	Test Cycle	m-tolualdehyde	m-xylene	methacrolein	methanol	n-butane	n-decane	n-dodecane	n-heptane
1038708	UC	0.00	3.29	0.00	21.92	0.50	0.00	0.00	0.71
1038723	UC	0.00	1.57	0.55	0.00	0.51	0.00	0.00	0.92
1038747	UC	0.00	6.77	1.50	0.00	0.40	0.28	0.00	1.51
1038755	UC	0.00	2.00	0.00	0.00	0.88	0.00	0.00	1.13
1038801	UC	0.00	10.06	0.00	0.00	1.71	0.26	0.00	3.13
1038821	UC	0.00	16.71	0.63	0.00	3.51	0.31	0.00	5.50
1038822	UC	0.00	8.33	0.49	0.00	2.23	0.26	0.00	2.30
1038824	UC	0.00	12.12	0.00	0.00	0.84	0.32	0.07	2.46
1038825	UC	0.00	4.25	0.71	0.00	0.82	0.00	0.00	1.25
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	0.31	20.37	0.85	0.00	3.39	0.74	0.00	6.38
1038862	UC	0.00	0.71	0.00	0.00	0.22	0.00	0.00	0.40
1038867	UC	0.00	2.32	0.39	0.00	0.73	0.00	0.00	1.17
1038891	UC	0.35	29.22	1.44	0.00	2.82	0.99	0.15	8.14
1038901	UC	2.91	52.65	4.78	14.97	4.96	2.29	0.28	15.68
1038909	UC	0.00	17.37	0.49	0.00	0.37	0.66	0.00	5.58
1038917	UC	0.00	13.76	0.36	0.00	1.50	0.26	0.00	2.79
1038920	UC	0.00	3.98	0.19	0.00	5.47	0.13	0.00	1.31
1038945	UC	0.00	9.63	0.41	0.00	0.43	0.16	0.00	1.86
1038947	UC	0.00	3.57	0.50	0.00	0.75	0.15	0.00	0.89
1038952	UC	0.00	0.62	0.00	0.00	0.44	0.63	0.00	0.34
1038980	UC	0.00	0.00	0.00	0.00	2.06	0.00	0.00	0.00

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494 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
495 fuel)

TEST_ID	Test Cycl e	n- hexan e	n- nonan e	n- octan e	n- pentan e	n- pentylbenzen e	n- propylbenzen e	n- undecan e	naphthalen e
1038708	UC	2.34	0.23	0.41	3.07	0.00	0.12	0.30	0.00
1038723	UC	2.03	0.21	0.42	2.59	0.00	0.00	0.00	0.00
1038747	UC	2.67	0.47	0.95	2.61	0.00	0.37	0.00	0.00
1038755	UC	2.96	0.00	0.45	4.74	0.00	0.00	0.00	0.00
1038801	UC	5.00	0.38	1.61	6.19	0.00	0.36	0.00	0.49
1038821	UC	11.45	1.13	2.55	16.51	0.00	0.68	0.12	0.65
1038822	UC	4.16	0.51	1.24	5.00	0.00	0.39	0.13	0.73
1038824	UC	4.73	0.59	1.31	4.92	0.00	0.53	0.14	0.17
1038825	UC	2.57	0.00	0.28	2.91	0.00	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	12.67	1.61	3.40	18.92	0.00	0.98	0.20	0.88
1038862	UC	0.97	0.00	0.16	1.16	0.00	0.00	0.00	0.00
1038867	UC	2.25	0.16	0.51	3.62	0.00	0.00	0.00	0.00
1038891	UC	13.30	1.91	4.44	11.56	0.19	2.32	0.61	0.67
1038901	UC	31.62	3.86	8.35	32.41	0.28	4.27	1.62	0.28
1038909	UC	6.49	1.27	2.92	6.18	0.00	1.14	0.18	0.76
1038917	UC	4.96	0.57	1.33	4.63	0.00	0.58	0.17	0.15
1038920	UC	2.72	0.30	0.60	3.64	0.00	0.16	0.00	0.00
1038945	UC	3.47	0.39	0.91	3.53	0.00	0.41	0.15	0.07
1038947	UC	1.73	0.25	0.43	2.41	0.00	0.00	0.00	0.67
1038952	UC	0.84	0.00	0.13	1.02	0.00	0.00	0.00	0.00
1038980	UC	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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506 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
507 fuel)

TEST_ID	Test Cycle	o-xylene	p-xylene	propane	propene	propionaldehyde	styrene	t-1,2-diMCYpentane	t-1,3-diMCYhexane
1038708	UC	2.28	1.73	0.52	8.10	0.37	0.79	0.25	0.17
1038723	UC	0.95	0.79	0.76	3.45	0.50	0.09	0.27	0.10
1038747	UC	3.27	3.47	0.50	3.77	0.00	0.25	0.51	0.19
1038755	UC	1.23	1.02	0.45	4.48	0.00	0.00	0.41	0.19
1038801	UC	5.60	5.08	0.42	8.71	0.55	1.01	0.70	0.38
1038821	UC	9.89	8.38	1.38	28.61	0.70	2.21	1.84	0.95
1038822	UC	4.56	4.17	0.64	12.55	0.71	0.80	0.81	0.46
1038824	UC	6.55	6.08	0.57	24.20	0.46	1.01	0.82	0.41
1038825	UC	2.15	2.12	0.78	6.65	0.13	0.84	0.25	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00
1038849	UC	11.67	10.20	1.66	35.77	0.60	1.86	2.07	1.07
1038862	UC	0.37	0.40	0.43	1.58	0.00	0.00	0.00	0.00
1038867	UC	1.08	1.16	0.30	2.59	0.12	0.00	0.37	0.16
1038891	UC	16.54	14.64	0.70	34.33	1.34	2.28	2.61	1.19
1038901	UC	30.80	26.29	1.73	89.52	2.06	5.86	5.12	2.71
1038909	UC	9.76	8.68	0.47	14.45	0.47	0.84	1.54	0.97
1038917	UC	8.08	6.87	0.46	24.22	0.45	0.90	0.87	0.44
1038920	UC	1.82	1.95	0.00	3.26	0.00	0.16	0.40	0.12
1038945	UC	5.43	4.84	0.36	19.90	0.52	0.89	0.57	0.28
1038947	UC	2.12	1.82	0.60	7.71	0.37	0.32	0.30	0.20
1038952	UC	0.35	0.31	0.06	1.48	0.04	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.95	0.00	0.08	0.00	0.00	0.00

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519 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
520 fuel)

TEST_ID	Test Cycle	t-1,3-diMCYpentane	t-1,3-pentadiene	t-1,4-diMCYhexane	t-1-M-3-ECYpentane	t-2-butene	t-2-heptene	t-2-hexene	t-2-octene
1038708	UC	0.30	0.00	0.12	0.15	0.37	0.00	0.00	0.00
1038723	UC	0.53	0.00	0.00	0.12	0.39	0.00	0.00	0.00
1038747	UC	0.54	0.00	0.00	0.27	0.35	0.00	0.00	0.00
1038755	UC	0.48	0.00	0.00	0.00	0.70	0.00	0.00	0.00
1038801	UC	0.90	0.00	0.20	0.35	0.64	0.00	0.00	0.14
1038821	UC	2.25	0.00	0.31	0.57	1.93	0.00	0.31	0.15
1038822	UC	1.04	0.15	0.23	0.40	1.09	0.00	0.00	0.18
1038824	UC	0.97	0.09	0.22	0.41	2.91	0.07	0.26	0.14
1038825	UC	0.35	0.00	0.00	0.00	0.43	0.00	0.00	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	2.47	0.00	0.38	0.64	3.30	0.00	0.34	0.00
1038862	UC	0.20	0.00	0.00	0.00	0.16	0.00	0.00	0.00
1038867	UC	0.41	0.00	0.11	0.16	0.23	0.00	0.00	0.00
1038891	UC	3.35	0.17	0.63	1.25	2.87	0.22	0.58	0.37
1038901	UC	6.26	0.30	1.57	2.56	7.81	0.46	1.34	0.73
1038909	UC	1.74	0.00	0.67	0.79	1.49	0.00	0.22	0.26
1038917	UC	1.12	0.07	0.22	0.42	2.60	0.07	0.27	0.14
1038920	UC	0.47	0.00	0.15	0.17	0.37	0.00	0.12	0.00
1038945	UC	0.68	0.09	0.16	0.28	2.17	0.00	0.20	0.09
1038947	UC	0.35	0.97	0.00	0.15	0.57	0.00	0.00	0.00
1038952	UC	0.15	0.00	0.00	0.00	0.15	0.00	0.00	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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531 Table S9: Light-duty gasoline vehicle speciated NMOG emissions. Values are reported as fuel-based emission factors (mg/kg-
532 fuel)

TEST_ID	Test Cycle	t-2-pentene	t-3-heptene	t-3-hexene	t-4-octene	toluene	valeraldehyde
1038708	UC	0.20	0.00	0.00	0.00	9.19	0.00
1038723	UC	0.29	0.00	0.00	0.00	4.41	0.00
1038747	UC	0.23	0.00	0.23	0.00	11.52	0.00
1038755	UC	0.37	0.00	0.00	0.00	5.91	0.00
1038801	UC	0.43	0.00	0.00	0.00	19.01	0.00
1038821	UC	0.98	0.00	0.20	0.00	39.80	0.37
1038822	UC	0.51	0.00	0.13	0.23	18.18	0.00
1038824	UC	0.82	0.16	0.16	0.00	25.78	0.00
1038825	UC	0.18	0.00	0.00	0.00	11.14	0.00
1038827	UC	0.00	0.00	0.00	0.00	0.00	0.00
1038849	UC	1.01	0.00	0.21	0.00	47.36	0.00
1038862	UC	0.11	0.00	0.00	0.00	2.46	0.00
1038867	UC	0.25	0.00	0.00	0.00	5.34	0.00
1038891	UC	1.32	0.39	0.00	0.19	54.23	0.00
1038901	UC	3.66	0.60	1.01	0.00	102.70	0.00
1038909	UC	0.44	0.00	0.00	0.00	35.45	0.00
1038917	UC	0.71	0.16	0.16	0.11	29.86	0.00
1038920	UC	0.22	0.00	0.00	0.00	7.76	0.00
1038945	UC	0.55	0.00	0.12	0.00	21.97	0.00
1038947	UC	0.32	0.00	0.00	0.00	8.26	0.00
1038952	UC	0.11	0.00	0.00	0.00	1.89	0.00
1038980	UC	0.00	0.00	0.00	0.00	0.23	0.00

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