

Organic Gas Speciation Profile for Gasoline-Powered Vehicles Hot Soak Evaporations—E10 Summer Fuel (OG2315)

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1 Introduction

Vehicle hot soak losses are produced from fuel evaporation as a result of the fuel tank and fuel system being heated above ambient temperatures after a hot engine is turned off. This work addresses the development of the new organic gas speciation profile, OG2315, for hot soak evaporations from gasoline-powered vehicles running on summer-grade E10 (10% vol ethanol) fuel.

This profile was created based on the hot soak SHED (Sealed Housing for Evaporative Determination) testing data, which were collected as a part of the 19th CARB Vehicle Surveillance Program (VSP-19) in 2013 and 2014 at the Haagen-Smit Laboratory in El Monte, California. The new profile OG2315 will replace the current profile OG692 (summer-grade E10 gasoline profile) to characterize the chemical composition of hot soak evaporative emissions for 2010 and later years when E10 is in use in California. Running losses are evaporative emissions that emanate from hoses, fittings or canisters, while the vehicle is being operated. Because no source testing data are available for running losses, the new hot soak profile OG2315 will be used for the categories of running losses as well [1, 2] (Appendix 1).

2 Methodology

The VSP-19 was conducted by CARB staff in order to measure criteria pollutant emissions and speciated TOG emissions for in-use California light-duty vehicles after the transition from E6 to E10 fuels in 2013 and 2014. Twenty vehicles fueled with summer-grade E10 gasoline were randomly selected for the SHED tests (Appendix 2). The hot soak emissions were collected during the one-hour period after the engines were shut down [3].

Methane was measured using flame ionization detection (FID) (MLD Method 119) [4]. C₂-C₁₂ hydrocarbons collected in Tedlar bags from the SHED were analyzed using gas chromatography (MLD Methods 1002/1003) [5, 6]. Methanol and ethanol were collected by flowing gas samples through cold deionized water contained in glass impingers. The solutions were analyzed using gas chromatography (GC) (MLD Method 1001) [7]. Over one hundred organic compounds were identified in the hot soak samples.

The speciation profile for each test vehicle was obtained by dividing the emission of each chemical species by the total emissions of all quantified compounds. The new profile OG2315 was composited by averaging the 20 speciation profiles developed from the individual tests of vehicles running on summer-grade E10 fuel.

3 Results

The details of profile OG2315 are presented in Appendix 3. The ratio of TOG/THC (total organic gases/total hydrocarbon) calculated from the profile is 1.063. Laboratories commonly measure THC using FID rather than TOG directly for combustion and evaporative emissions, and this ratio can be used to convert THC emission mass to actual weight TOG. The ROG/TOG (reactive organic gases/total organic gases) ratio calculated from the profile is 0.8076.

- **E10 summer hot soak profile (OG2315) vs. E6 summer hot soak profile (OG2305)**

The most abundant species is ethanol in both profiles. Figure 1 shows a little less ethanol content in the E10 profile (OG2315) than in the E6 profile (OG2305). In the E10 profile, methane is the second most abundant species which is about 19.2% of TOG. It is about five times the methane percentage in the E6 profile. Figure 1 also shows that toluene and m-xylene are lower in the E10 profile than in the E6 profile.

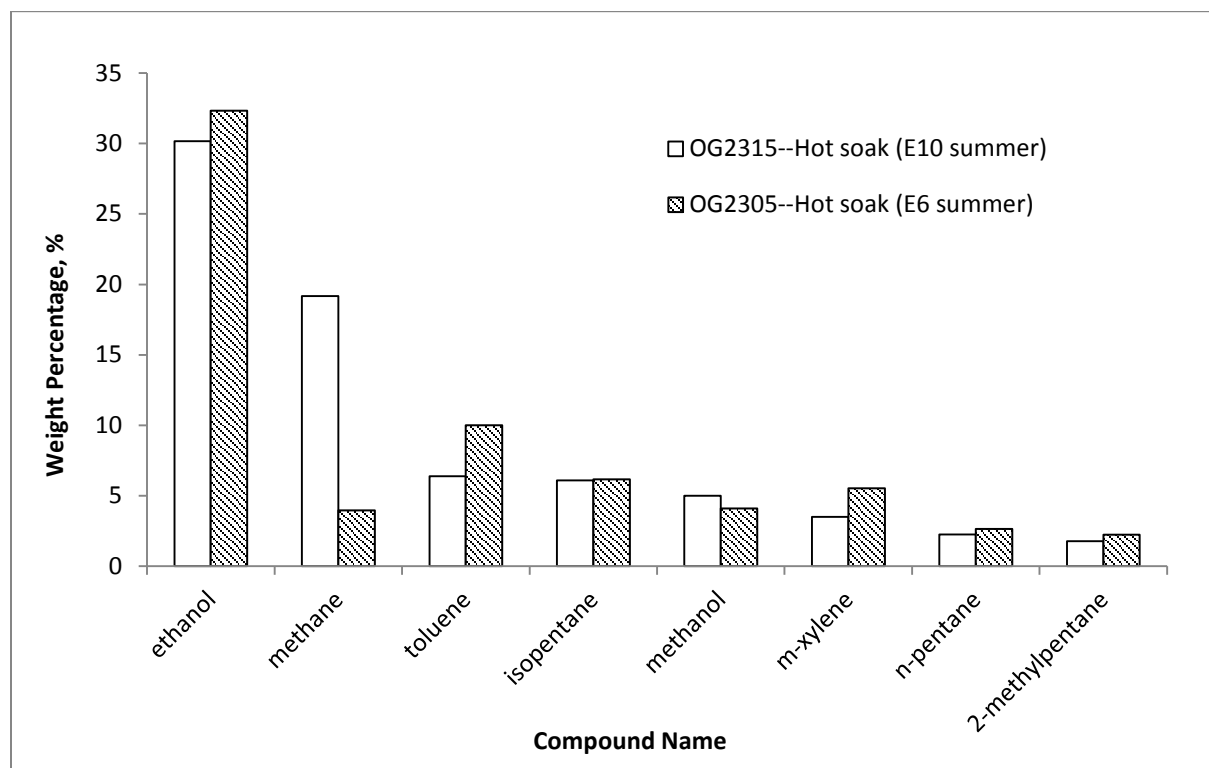


Figure 1. Profile comparison of selected species for OG2315 and OG2305

- **New E10 summer hot soak profile (OG2315) vs. current E10 summer fuel profile (OG692)**

As mentioned earlier, the categories of hot soak evaporations and running losses are associated with the E10 liquid fuel profile OG692 for 2010 and later years. Compared with the fuel profile (OG692), the hot soak profile (OG2315) has much higher alcohol contents (30.2% vs. 10.3% for ethanol, and 5.0% vs. 0 for methanol). In addition, the hot soak profile consists of 19.2% of methane while none is reported in the fuel profile.

4 Estimated Impacts of the Profile Update on the Emission Inventory

The newly-developed profile OG2315 will be assigned to the categories of on-road gasoline vehicle hot soak and running losses for 2010 and later years by replacing the currently used OG692. It should be noted that OG2315 will be used during the months of RVP regulatory control periods, and the control period varies for different air basins [8]. The related EICs/SCCs (Emission Inventory Code/Source Classification Code) for these emission processes are summarized in Appendix 1.

Based on CEPAM [9] data (California 2016 Ozone SIP Baseline Emission Projection, Version 1.00), statewide 2012 annual average TOG emissions for the on-road hot soak and running losses categories are 171.29 tons/day, 3.0% of the grand total statewide TOG emissions (natural sources are excluded) [9]. According to the ROG/TOG ratio derived from the new profile OG2315, the statewide 2012 ROG emissions will be 138.33 tons/day, 19.24% lower than the ROG obtained based on OG692 (ROG/TOG=1.0000). The ozone forming potential (OFP) calculated according to SAPRC07 mechanism [10] is 2.21 for OG2315. It is 26.33% lower than the OFP of OG692. However, the use of the new hot soak profiles OG2315 will result in 105.71% more benzene emissions and 10.00% more toluene emissions (Table 1).

Table 1. Changes in 2012 emissions of organic gas species for gasoline-vehicle hot soak and running losses categories

Statewide Annual Ave. Emissions		OG692 [Current profile] (tons/day)	OG2315 [New profile] (tons/day)	Change	
				Emission (tons/day)	Percentage
ROG		171.29	138.33	-32.96	-19.24%
Ozone forming potential, MIR (g O ₃ /g ORG)		3.00	2.21	-0.79	-26.33%
Toxics	Benzene	1.20	2.47	+1.27	+105.71%
	Toluene	9.93	10.93	+0.99	+10.00%

References:

1. Croes, B., et al., *Air Quality Impacts of the Use of Ethanol in California Reformulated Gasoline*, 1999, California Air Resources Board.
2. Hsu, Y., *Methodology for Speciation of Organic Gas Hot Soak Emissions California Light-Duty Vehicles*, 2003, California Air Resources Board.
3. CARB, *California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles*, 2012: El Monte, CA.
4. *Procedure for the Direct Determination of Total Non-methane Hydrocarbons and Methane in Motor Vehicle Exhaust Using Cryogenic Preconcentration and Flame*

- Ionization Detection: SOP MLD 119 (Ver 2.1)*, 2001, California Air Resources Board: El Monte, California.
5. *Method 1002: Determination of C₂ to C₅ Hydrocarbons in Automotive Source Samples by Gas Chromatography in Part D of California Non-methane Organic Gas Test Procedures*2002, California Air Resources Board: El Monte, California.
 6. *Method 1003: Determination of C₆ to C₁₂ Hydrocarbons in Automotive Source Samples by Gas Chromatography in Part E of California Non-methane Organic Gas Test Procedures*2002, California Air Resources Board: El Monte, California.
 7. *Method 1001: Determination of Alcohols in Automotive Source Samples by Gas Chromatography in Part C of California Non-methane Organic Gas Test Procedures*2002, California Air Resources Board: El Monte, California.
 8. *Title 13, California Code of Regulations, The California Reformulated Gasoline Regulations, Sections 2250-2273.5.*
 9. *CEPAM*, 2015, California Air Resources Board, Accessed: February 12, 2015.
 10. *Titel 17, California Code of Regulations, Division 3, Chapter 1, Subchapter 8.6, Article 1. Maximum Incremental Reactivity Values, Sections 94700-94701.*

Appendix 1. EICs/SCCs to be associated with hot soak speciation profile.

<i>EIC/SCC</i>	<i>Category Name</i>
6	EMFAC/DTIM-HOT SOAK-GASOLINE-ALL VEHICLES
9	EMFAC/DTIM-RUNNING EVAPORATIVES-GASOLINE-ALL VEHICLES
206	EMFAC/DTIM-HOT SOAK-GASOLINE-LIGHT-MED DUTY (LMV)
209	EMFAC/DTIM-RUNNING EVAPS-GASOLINE-LIGHT-MED DUTY (LMV)
306	EMFAC/DTIM-HOT SOAK-GASOLINE-HEAVY DUTY VEH (HDV)
309	EMFAC/DTIM-RUNNING EVAPORATIVES-GASOLINE-HEAVY DUTY VEH (HDV)
46508	LIGHT DUTY PASSENGER-HOT SOAK-1000 VEHICLE TRIPS
47506	LIGHT DUTY TRUCKS-HOT SOAK-1000 VEHICLE TRIPS
48025	MOTORCYCLES-HOT SOAK--1000 VEHICLE TRIPS
48041	HD GAS TRUCKS-HOT SOAK-1000 VEHICLE TRIPS
54239	MEDIUM DUTY TRUCKS-HOT SOAK-1000 VEHICLE TRIPS
82693	LIGHT DUTY PASSENGER-CAT HOT SOAK--1000 VEHICLE TRIPS
82701	LIGHT DUTY PASSENGER-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
82719	LIGHT/MEDIUM TRUCKS-CAT HOT SOAK--1000 VEHICLE TRIPS
82727	LIGHT/MEDIUM TRUCKS-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
83113	HEAVY GAS TRUCKS-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
83162	HEAVY GAS TRUCKS-CAT HOT SOAK--1000 VEHICLE TRIPS
83386	LIGHT DUTY PASSENGER-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83394	LIGHT DUTY PASSENGER-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83402	LIGHT/MEDIUM TRUCKS-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83410	LIGHT/MEDIUM TRUCKS-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83428	HD GAS TRUCKS-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83436	HD GAS TRUCKS-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
83444	MOTORCYCLES-RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84087	LT. DUTY TRUCKS-1-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84103	LT. DUTY TRUCKS-1-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
84178	LT. DUTY TRUCKS-1-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84194	LT. DUTY TRUCKS-1-CAT HOT SOAK--1000 VEHICLE TRIPS
84293	MEDIUM TRUCKS-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84319	MEDIUM TRUCKS-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
84384	MEDIUM TRUCKS-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84400	MEDIUM TRUCKS-CAT HOT SOAK--1000 VEHICLE TRIPS
84459	LT.HVY.DTY TRUCKS-1-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84475	LT.HVY.DTY TRUCKS-1-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
84533	LT.HVY.DTY TRUCKS-1-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84558	LT.HVY.DTY TRUCKS-1-CAT HOT SOAK--1000 VEHICLE TRIPS
84608	MED HVY GAS TRUCKS-NON-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84624	MED HVY GAS TRUCKS-NON-CAT HOT SOAK--1000 VEHICLE TRIPS
84681	MED HVY GAS TRUCKS-CAT RUNNING EVAP--1000 VEHICLE MILES TRAVEL
84707	MED HVY GAS TRUCKS-CAT HOT SOAK--1000 VEHICLE TRIPS
86157	LT. DUTY TRUCKS-2-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86173	LT. DUTY TRUCKS-2-NON-CAT HOT SOA--1000 VEHICLE TRIPS
86249	LT. DUTY TRUCKS-2-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86264	LT. DUTY TRUCKS-2-CAT HOT SOAK--1000 VEHICLE TRIPS

<i>EIC/SCC</i>	<i>Category Name</i>
86462	LT.HVY.DTY TRUCKS-2-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86488	LT.HVY.DTY TRUCKS-2-NON-CAT HOT SOA--1000 VEHICLE TRIPS
86561	LT.HVY.DTY TRUCKS-2-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86587	LT.HVY.DTY TRUCKS-2-CAT HOT SOAK--1000 VEHICLE TRIPS
86694	HEAVY HEAVY DUTY GAS-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86710	HEAVY HEAVY DUTY GAS-NON-CAT HOT SOA--1000 VEHICLE TRIPS
86793	HEAVY HEAVY DUTY GAS-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
86819	HEAVY HEAVY DUTY GAS-CAT HOT SOAK--1000 VEHICLE TRIPS
86983	MOTORCYCLES(MCY)-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87007	MOTORCYCLES(MCY)-CAT HOT SOAK--1000 VEHICLE TRIPS
87072	HEAVY DUTY GAS URBAN-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87098	HEAVY DUTY GAS URBAN-NON-CAT HOT SOA--1000 VEHICLE TRIPS
87163	HEAVY DUTY GAS URBAN-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87189	HEAVY DUTY GAS URBAN-CAT HOT SOAK--1000 VEHICLE TRIPS
87247	SCHOOL BUSES(SB)-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87262	SCHOOL BUSES(SB)-NON-CAT HOT SOA--1000 VEHICLE TRIPS
87338	SCHOOL BUSES(SB)-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87353	SCHOOL BUSES(SB)-CAT HOT SOAK--1000 VEHICLE TRIPS
87452	MOTOR HOMES (MH)-NON-CAT EVAPORA-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87478	MOTOR HOMES (MH)-NON-CAT HOT SOA--1000 VEHICLE TRIPS
87544	MOTOR HOMES (MH)-CAT EVAPORATIVE-RUNNING LOSSES-1000 VEHICLE MILES TRAVEL
87569	MOTOR HOMES (MH) -CAT HOT SOAK--1000 VEHICLE TRIPS
71070811000000	LIGHT DUTY PASSENGER (LDA)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
71071211000000	LIGHT DUTY PASSENGER (LDA)-NON-CAT HOT SOAK-GASOLINE
71073611000000	LIGHT DUTY PASSENGER (LDA)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
71074011000000	LIGHT DUTY PASSENGER (LDA)-CAT HOT SOAK-GASOLINE
72070811000000	LIGHT AND MEDIUM DUTY TRUCKS-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72071211000000	LIGHT AND MEDIUM DUTY TRUCKS-NON-CAT HOT SOAK-GASOLINE
72073611000000	LIGHT AND MEDIUM DUTY TRUCKS-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72074011000000	LIGHT AND MEDIUM DUTY TRUCKS-CAT HOT SOAK-GASOLINE
72270811000000	LIGHT DUTY TRUCKS-1 (LDT1)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72271211000000	LIGHT DUTY TRUCKS-1 (LDT1)-NON-CAT HOT SOAK-GASOLINE
72273611000000	LIGHT DUTY TRUCKS-1 (LDT1)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72274011000000	LIGHT DUTY TRUCKS-1 (LDT1)-CAT HOT SOAK-GASOLINE
72370811000000	LIGHT DUTY TRUCKS-2 (LDT2)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72371211000000	LIGHT DUTY TRUCKS-2 (LDT2)-NON-CAT HOT SOAK-GASOLINE
72373611000000	LIGHT DUTY TRUCKS-2 (LDT2)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72374011000000	LIGHT DUTY TRUCKS-2 (LDT2)-CAT HOT SOAK-GASOLINE
72470811000000	MEDIUM DUTY TRUCKS (MDV)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72471211000000	MEDIUM DUTY TRUCKS (MDV)-NON-CAT HOT SOAK-GASOLINE
72473611000000	MEDIUM DUTY TRUCKS (MDV)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
72474011000000	MEDIUM DUTY TRUCKS (MDV)-CAT HOT SOAK-GASOLINE
73070811000000	HEAVY DUTY GAS TRUCKS (ALL)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73071211000000	HEAVY DUTY GAS TRUCKS (ALL)-NON-CAT HOT SOAK-GASOLINE
73073611000000	HEAVY DUTY GAS TRUCKS (ALL)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73074011000000	HEAVY DUTY GAS TRUCKS (ALL)-CAT HOT SOAK-GASOLINE
73270811000000	LIGHT HEAVY DUTY GAS TRUCKS-1 (LHDV1)-NON-CAT EVAP RUNNING LOSSES-GASOLINE

<i>EIC/SCC</i>	<i>Category Name</i>
73271211000000	LIGHT HEAVY DUTY GAS TRUCKS-1 (LHDV1)-NON-CAT HOT SOAK-GASOLINE
73273611000000	LIGHT HEAVY DUTY GAS TRUCKS-1 (LHDV1)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73274011000000	LIGHT HEAVY DUTY GAS TRUCKS-1 (LHDV1)-CAT HOT SOAK-GASOLINE
73370811000000	LIGHT HEAVY DUTY GAS TRUCKS-2 (LHDV2)-NON-CAT EVAP RUNNING LOSSES-GASOLINE
73371211000000	LIGHT HEAVY DUTY GAS TRUCKS-2 (LHDV2)-NON-CAT HOT SOAK-GASOLINE
73373611000000	LIGHT HEAVY DUTY GAS TRUCKS-2 (LHDV2)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73374011000000	LIGHT HEAVY DUTY GAS TRUCKS-2 (LHDV2)-CAT HOT SOAK-GASOLINE
73470811000000	MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)-NON-CAT EVAP RUNNING LOSSES-GASOLINE
73471211000000	MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)-NON-CAT HOT SOAK-GASOLINE
73473611000000	MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73474011000000	MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)-CAT HOT SOAK-GASOLINE
73670811000000	HEAVY HEAVY DUTY GAS TRUCKS (HHDV)-NON-CAT EVAP RUNNING LOSSES-GASOLINE
73671211000000	HEAVY HEAVY DUTY GAS TRUCKS (HHDV)-NON-CAT HOT SOAK-GASOLINE
73673611000000	HEAVY HEAVY DUTY GAS TRUCKS (HHDV)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
73674011000000	HEAVY HEAVY DUTY GAS TRUCKS (HHDV)-CAT HOT SOAK-GASOLINE
75070811000000	MOTORCYCLES (MCY)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
75071211000000	MOTORCYCLES (MCY)-NON-CAT HOT SOAK-GASOLINE
75073611000000	MOTORCYCLES (MCY)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
75074011000000	MOTORCYCLES (MCY)-CAT HOT SOAK-GASOLINE
76270811000000	HEAVY DUTY GAS URBAN BUSES (UB)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
76271211000000	HEAVY DUTY GAS URBAN BUSES (UB)-NON-CAT HOT SOAK-GASOLINE
76273611000000	HEAVY DUTY GAS URBAN BUSES (UB)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
76274011000000	HEAVY DUTY GAS URBAN BUSES (UB)-CAT HOT SOAK-GASOLINE
77070811000000	SCHOOL BUSES (SB)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77071211000000	SCHOOL BUSES (SB)-NON-CAT HOT SOAK-GASOLINE
77073611000000	SCHOOL BUSES (SB)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77074011000000	SCHOOL BUSES (SB)-CAT HOT SOAK-GASOLINE
77170811000000	SCHOOL BUSES-GAS (SBG)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77171211000000	SCHOOL BUSES-GAS (SBG)-NON-CAT HOT SOAK-GASOLINE
77173611000000	SCHOOL BUSES-GAS (SBG)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77174011000000	SCHOOL BUSES-GAS (SBG)-CAT HOT SOAK-GASOLINE
77670811000000	OTHER BUSES (OB)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77671211000000	OTHER BUSES (OB)-NON-CAT HOT SOAK-GASOLINE
77673611000000	OTHER BUSES (OB)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77674011000000	OTHER BUSES (OB)-CAT HOT SOAK-GASOLINE
77770811000000	OTHER BUSES-GAS (OBG)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77771211000000	OTHER BUSES-GAS (OBG)-NON-CAT HOT SOAK-GASOLINE
77773611000000	OTHER BUSES-GAS (OBG)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
77774011000000	OTHER BUSES-GAS (OBG)-CAT HOT SOAK-GASOLINE
78070811000000	MOTOR HOMES (MH)-NON-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
78071211000000	MOTOR HOMES (MH)-NON-CAT HOT SOAK-GASOLINE
78073611000000	MOTOR HOMES (MH)-CAT EVAPORATIVE RUNNING LOSSES-GASOLINE
78074011000000	MOTOR HOMES (MH)-CAT HOT SOAK-GASOLINE

Appendix 2. Test vehicles from VSP-19

<i>Vehicle No.</i>	<i>Model Year</i>	<i>Manufacturer</i>	<i>Model Type</i>	<i>Vehicle Class</i>
70	2006	CHRY PT CRUSIER	PT CRUSIER	PC
71	2007	TOTA	SCION TC	PC
77	2001	GM	MALIBU	PC
80	2011	HYND	SONATA	PC
81	2003	TOTA	TACOMA TRD P/U	T2
82	2003	TOTA	COROLLA S	PC
85	2002	HOND	ACCORD	PC
90	2008	VOLK	JETTA	PC
94	2008	VOLV	XC90	PC
102	2010	NISS	ALTIMA S	PC
103	1999	VOLK	JETTA	PC
107	2007	GM	IMPALA	PC
109	2000	CHRY	DURANGO	M2
110	1994	TOTA	4 RUNNER	PC
111	1998	MB	C280	PC
113	2005	GM	TRAIL BLAZER	T2
147	2003	FORD	TAURUS SE	PC
149	2004	HOND	ACCORD DX	PC
151	1994	HOND	ACCORD DX	PC
153	1995	TOTA	CAMRY LE	PC

Appendix 3. OG speciation profile for hot soak evaporations from gasoline-powered vehicles burning summer-grade E10 fuel---OG2315

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>
(2-methylpropyl)benzene	45235	0.025602
1,2,3,4-tetramethylbenzene	91109	0.000232
1,2,3,5-tetramethylbenzene	91104	0.001626
1,2,3-trimethylbenzene	45225	0.243092
1,2,4-trimethylbenzene	45208	1.028932
1,2,4-trimethylcyclopentane	43400	0.004613
1,2-dimethyl-4-ethylbenzene	45252	0.006925
1,3,5-trimethylbenzene	45207	0.261746
1,3-diethylbenzene (meta)	45113	0.001162
1,3-dimethyl-2-ethylbenzene	45253	0.041507
1,3-dimethyl-4-ethylbenzene	45251	0.001394
1,3-dimethyl-5-ethylbenzene	45257	0.020986
1,4-diethylbenzene (para)	45114	0.001162
1,4-dimethyl-2-ethylbenzene	45250	0.001626
1-butene	43213	0.003156
1-butyne (ethylacetylene)	98131	0.014970
1-ethyl-1-methylcyclopentane	91046	0.002428
1-hexene	43245	0.014384
1-methyl-2-ethylbenzene	99915	0.195065
1-methyl-2-n-propylbenzene	98178	0.001394
1-methyl-3-ethylbenzene	99912	0.755000
1-methyl-3-n-propylbenzene	98152	0.028670
1-methyl-4-ethylbenzene	99914	0.329132
1-pentene	43224	0.099645
2,2,4-trimethylheptane	98174	0.001724
2,2,4-trimethylpentane	43276	0.787259
2,2,5-trimethylhexane	98033	0.133624
2,2-dimethylbutane	43291	0.242350
2,2-dimethylhexane	98138	0.731289
2,2-dimethyloctane	98175	0.001724
2,2-dimethylpentane	90042	0.003221
2,2-dimethylpropane	98130	0.006540
2,3,4-trimethylpentane	43279	0.314006
2,3,5-trimethylhexane	98141	0.001480
2,3-dimethyl-1-butene	43234	0.023058
2,3-dimethyl-2-pentene	90061	0.046747
2,3-dimethylbutane	98001	0.694186
2,3-dimethylhexane	98139	0.184313
2,3-dimethylpentane	43274	0.840637
2,4,4-trimethylhexane	45223	0.004687

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>
2,4-dimethylheptane	98142	0.002220
2,4-dimethylhexane	43277	0.165451
2,4-dimethyloctane	98149	0.069604
2,4-dimethylpentane	43271	0.571542
2,5-dimethylhexane	43278	0.173096
2,6-dimethylheptane	98157	0.001727
2-methyl-1-butene	43225	0.340159
2-methyl-1-pentene	98040	0.112891
2-methyl-2-butene	43228	0.947563
2-methyl-2-hexene	90028	0.005098
2-methyl-2-pentene	98004	0.056671
2-methylheptane	98140	0.208693
2-methylhexane	43275	0.721626
2-methylindan	91108	0.001144
2-methylnonane	90047	0.059822
2-methylpentane	43229	1.763246
2-methyl-trans-3-hexene	91006	0.152869
3,3-dimethyl-1-butene	98169	0.077335
3,3-dimethylpentane	90040	0.002478
3,4-dimethyl-1-pentene	90075	0.001214
3,4-dimethylhexane	98150	0.001730
3,5-dimethylheptane	98144	0.160801
3-methyl-1-butene	43223	0.025007
3-methyl-1-pentene	43211	0.003156
3-methyl-cis-2-hexene	90029	0.001214
3-methyl-cis-2-pentene	98163	0.042500
3-methylcyclopentene	43272	0.007820
3-methylheptane	43298	0.237338
3-methylhexane	43295	0.765425
3-methyloctane	98172	0.039466
3-methylpentane	43230	1.131350
3-methyl-trans-2-pentene	43270	0.017292
4-methyl-1-pentene	98135	0.001942
4-methyl-cis-2-pentene	98170	0.016796
4-methylheptane	43297	0.032412
4-methyloctane	98173	0.101514
4-methyl-trans-2-pentene	43293	0.051844
acetylene	43206	0.085850
benzene	45201	1.443289
cis-1,2-dimethylcyclohexane	91055	0.240093
cis-1,3-dimethylcyclohexane	98180	0.063646
cis-1,3-dimethylcyclopentane	91018	0.184833

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>
cis-1,trans-2,3-trimethylcyclopentane	91038	0.002428
cis-2-butene	43217	0.031115
cis-2-hexene	98035	0.013763
cis-2-pentene	43227	0.270087
cis-3-hexene	98003	0.001214
cyclohexane	43248	0.472882
cyclohexene	43273	0.001185
cyclopentane	43242	0.219019
cyclopentene	43292	0.051590
ethane	43202	0.071336
ethanol	43302	30.168493
ethylbenzene	45203	0.934256
ethylcyclohexane	43288	0.001214
ethylcyclopentane	98057	0.018649
ethylene	43203	0.051843
indan	98044	0.190341
isobutane	43214	0.063997
isobutylene	43215	0.008048
isopentane	98132	6.099902
isoprene	43243	0.000707
isopropylbenzene (cumene)	98043	0.001156
methane	43201	19.172742
methyl alcohol	43301	4.998575
methylcyclohexane	43261	0.879184
methylcyclopentane	43262	1.244244
m-xylene	45205	3.508049
n-butane	43212	0.605908
n-decane	43238	0.054824
n-dodecane	43255	0.133449
n-heptane	43232	0.782160
n-hexane	43231	1.061817
n-nonane	43235	0.014361
n-octane	43233	0.170769
n-pentane	43220	2.255864
n-propylbenzene	45209	0.070241
n-undecane	43241	0.001476
o-xylene	45204	1.260498
propane	43204	0.211147
propylene	43205	0.017887
styrene	45220	0.002028
toluene	45202	6.383125
trans-1,2-dimethylcyclopentane	91021	0.036968

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>
trans-1,3-dimethylcyclopentane	91019	0.146074
trans-1,4-dimethylcyclohexane	98181	0.016182
trans-1-methyl-3-ethylcyclopentane	91044	0.003399
trans-2-butene	43216	0.029790
trans-2-heptene	91026	0.001214
trans-2-hexene	98034	0.061056
trans-2-pentene	43226	0.985247
trans-3-hexene	98136	0.027436
<i>Total</i>		<i>100.000000</i>