Organic Gas Speciation Profiles for Catalyzed Gasoline-Powered Vehicle Stabilized Running Exhaust—E6 Fuel (OG2303 & OG2304)

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1 Introduction

This memo addresses an update to the current gasoline vehicle stabilized exhaust profiles using proposed profiles OG2303 (Catalyzed gasoline vehicle stabilized exhaust running summer-grade E6 fuel) and OG2304 (Catalyzed gasoline vehicle stabilized exhaust running winter-grade E6 fuel). The new profiles will be used to replace the existing profiles OG2104 through OG2109 (Catalyzed gasoline vehicle stabilized exhaust SSD ethanol 2% oxygen MTBE phase-out) for the related categories for calendar years 2004 to 2009 during which E6 gasoline fuel (i.e. 6% vol ethanol or 2% wt oxygen) was used in California. It should be noted that profiles OG2104 through OG2104 through OG2109 were not obtained from actual source testing data. Rather, they were derived by adjusting the stabilized exhaust profile for MTBE-based fuel (i.e. California Reformulated Gasoline Phase 2) for each specific calendar year (e.g. OG2104 is for year 2004, OG2105 is for year 2005, and so on) [1]. Both the previous and proposed profiles are applied to categories of catalyzed gasoline vehicle stabilized exhaust. The catalyzed gasoline vehicle idle exhaust categories are also mapped to these profiles (see Appendix 1).

The updated stabilized exhaust profiles proposed in this memo, OG2303 (for E6 summer fuel) and OG2304 (for E6 winter fuel), are based on source testing results. In 2005 and 2006, CARB conducted the Seventeenth Light-Duty Gasoline Vehicle Surveillance Program (VSP17) to measure criteria pollutant emissions and speciated TOG emissions for vehicles representative of the California vehicle fleet after the transition to ethanol-containing fuels from MTBE-containing fuels. Under VSP17, a total of forty-two in-use vehicles (see Appendix 2 for vehicle information) were randomly selected for exhaust organic gas speciation tests. Twenty-five of these vehicles (all equipped with catalytic converters) were fueled with summer-grade E6 gasoline; and the other seventeen (sixteen equipped with catalyst converter and one without catalyst coverter) were fueled with winter-grade E6 gasoline.

2 Methodology

In the VSP17 speciation tests, the organic gases from tailpipe exhausts were sampled as the vehicles were running on the unified cycle (UC), which was developed by CARB as a dynamometer driving schedule for light-duty vehicles in 1992 [2, 3]. The UC test cycle has a three-phase (bag) structure and it consists of the following segments (Figure 1):

- Cold start phase (Bag 1): 300 seconds and 1.2 miles
- Stabilized phase (Bag 2): 1135 seconds and 8.6 miles
- Hot soak: 10 minutes



• Hot start phase (Bag 3): a duplicate of Bag 1, 300 seconds and 1.2 miles

Figure 1. Unified Cycle

Phase 1 (i.e. Bag 1) and Phase 2 (i.e. Bag 2) are run consecutively, followed by a ten minute hot soak, then Phase 3 (i.e. Bag 3) which is a duplicate of Phase 1 (i.e. Bag 1). The emissions from a start generally end after one or two minutes of vehicle operation. Therefore, the samples collected in Bag 1 actually consists of cold start exhaust (about the first 100 sec) and running exhaust (about the last 200 sec); while samples in Bag 3 include hot start exhaust and running exhaust. The samples collected in Bag 2 consist solely of hot stabilized running emissions, so the analytical test results of Bag 2 samples are used to generate the new stabilized OG profiles discussed in this memo.

Tedlar bags were used to collect organic gas samples from each phase for GC speciation analysis (MLD SOP#102/103) [4]. Aldehyde and ketone compounds in the exhaust were sampled to 2,4-dinitrophenylhydrazine (DNPH) impregnated cartridges and analyzed by using HPLC (MLD SOP#104) [5]. The methanol and ethanol in the exhaust were obtained by flowing exhaust through deionized water contained in glass impingers and analyzed by using GC (MLD SOP#101) [6].

Over two hundred organic compounds were detected in the Bag 2 samples. For each test vehicle, the speciation profile was calculated by dividing the emissions of each species by the sum of total organic gas emissions. The new profile OG2303 was obtained by averaging the twenty-five speciation profiles for catalyzed gasoline vehicles running with summer-grade E6 fuel. Similarly, the new profile OG2304 was obtained by averaging the sixteen speciation profiles for catalyzed gasoline with winter-grade E6 fuel. The non-catalyzed vehicle was excluded from the calculation.

3 Results

The speciation profiles OG2303 (for E6 summer) and OG2304 (for E6 winter) are tabulated in Appendix 3. The ratios of TOG/THC (total organic gases/total hydrocarbon) are 1.083 for OG2303 and 1.108 for OG2304. This ratio can be used to convert THC emission mass to actual weight TOG. The ROG/TOG ratios are 0.6853 and 0.5988 for OG2303 and OG2304, respectively.

• Comparison of summer (OG2303) and winter (OG2304) profiles

Methane is the dominant species in the two stabilized profiles: 27.7% in summer profile OG2303, and 36.9% in winter profile OG2304 (Figure 2). Toluene, benzene, ethylene, and isopentane are major species besides methane, and each species weighs about 3-5% of the TOG. Butane is 3.0% in the winter profile (OG2304), nine times higher than in the summer profile (OG2303). However, the winter profile (OG2304) has about 1/3 the amount of 2,2,4-trimethylpentane than in the summer profile (OG2303). The winter versus summer differences of butane and 2,2,4-trimethylpentane in these two running exhaust profiles are consistent with the differences between the E6 winter fuel (OG682) and summer fuel (OG681) profiles, which were developed based on the fuel test results in April 2013. The E6 winter fuel (OG682) consists of more butane but less 2,2,4-trimethylpentane than the E6 summer fuel (OG681), which is due to the change of Reid Vapor Pressure (RVP) [7].



Figure 2. Comparison between new summer and new winter stabilized exhaust profiles by major species

• New (OG2303 & OG2304) vs. current (OG2104 – OG2109)

The previous study conducted by Allen et al. [8] concluded from the summer 1994 ARB Surveillance test data that the percentage of exhaust methane increased with decreasing organic gas emissions. As the in-use fleet emission rates have decreased over the years the methane percentage has increased; therefore, the exhaust speciation profiles were developed for each calendar year. In 1999, a series of stabilized profiles, OG2104 through OG2109, were created for vehicles burning ethanol fuel for years 2004 to 2009, respectively. However, these profiles were made by adjusting the MTBE-based fuel stabilized exhaust profiles, not through original source testing [1].

The new profiles proposed in this work are based on actual testing data obtained in VSP17. However, the data analysis does not show the previously observed relationship between methane and TOG or THC emissions as Allen et al. noticed from the 1994 Surveillance project. Therefore, the profiles proposed in this memo, OG2303 (for E6 summer fuel) and OG2304 (for E6 winter fuel), are not created for each specific calendar year. Both of these two profiles are applied to years 2004 through 2009, the period for which E6 was used in California.

The comparisons between the new and current profiles are plotted in Figures 3 and 4. Compared to the current profiles (OG2104-OG2109), the new profiles (OG2303 and OG2304) have higher percentages of C1 (mainly methane), C9 and C10+compounds, but lower percentages of C5- and C6-compounds (Figure 3). The new profiles consist of a much higher methane fraction than the current profiles (28-37% vs. 18-22%). Figure 4 illustrates that alkanes are fairly consistent among both the new and old profiles at 60%, while the new profiles have more aromatics but less alkenes than the current ones.



Figure 3. Comparison between current and new stabilized exhaust profiles by carbon number



Figure 4. Comparison between current and new stabilized exhaust profiles by compound group

4 Estimated Impacts of the Profile Update on the Emission Inventory

The newly-developed profiles, OG2303 and OG2304, will replace the current profiles OG2104 through OG2109 for years 2004 to 2009, respectively. The new profiles will be used for categories associated with on-road gasoline vehicle hot stabilized exhaust and idle exhaust as E6 fuel was in use during that time period. The summer-grade profile GO2303 will be used during the months of RVP regulatory control periods, while the winter-grade profile OG2304 will be used for different air basins [9]. The related EIC/SCC codes for the related emission categories are summarized in Appendix 1.

The impacts of the proposed profile update on emissions are estimated for year 2008 as an example in this memo. Based on the 2009 Almanac, statewide annual average TOG emissions from the emission categories to which these profiles are assigned for calendar year 2008 are 136.45 tons/day, which is 19.7% of the total statewide on-road mobile source TOG emissions, and 1.6% of the grand total statewide TOG emissions [10]. Based on the ROG/TOG ratios derived from the new profiles OG2303 and OG2304, the statewide 2008 ROG would be 93.51 and 81.71 tons/day for burning summer and winter fuel, respectively, which is 11.8% and 22.9% lower than the ROG estimated based on the current profile OG2108 (ROG/TOG=0.7767); however, the replacement of the current profile OG2108 with the new summer (OG2303) and winter (OG2304) profiles would cause an increase in benzene emissions by 62.4% and 50.8%, respectively. For toluene emissions, the same profile replacement would cause a decrease of 14.7% (with new summer profile OG2303) and 29.7% (with new winter profile OG2304) (Table 1). The ozone forming potential (OFP) calculated based on the SAPRC07 mechanism [11] is

3.01 for OG2303 and 2.81 for OG2304, lower than the 3.210FP of the current stabilized profile (OG2108).

 Table 1. Emission and reactivity changes resulting from new E6 catalyst gasoline-vehicle stabilized exhaust an idle exhaust categories (2008)

		Current Profile	New Profile	Change		
		OG2108 (tons/day)	OG2303— summer (tons/day)	Emissions (tons/day)	Percentage	
Statewide Annual Average Emissions	ROG		105.98	93.51	-12.47	-11.8%
	E .	Benzene	3.27	5.31	+2.04	+62.4%
	Emissions 10	TOXICS	Toluene	7.61	6.49	-1.12
Ozone forming potential, MIR (g O3/g ORG)		3.21	3.01	-0.20	-6.2%	

(a)	OG2303 (New E6 summer)	vs. OG2108 (Current E6 summe	r/winter for	vear 2008)
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(b) OG2304 (New E6 winter) vs. OG2108 (Current E6 summer/winter for year 2008)

		Current Profile	New Profile	Change		
		OG2108 (tons/day)	OG2304— winter (tons/day)	Emissions (tons/day)	Percentage	
Statewide Annual Average Emissions	ROG		105.98	81.71	-24.27	-22.9%
	Toxics	Benzene	3.27	4.93	+1.66	+50.8%
		Toluene	7.61	5.35	-2.26	-29.7%
Ozone forming potential, MIR (g O3/g ORG)		3.21	2.81	-0.40	-12.5%	

5 Version Control

This section will be completed after management approval and after the CEIDARS FRACTION table and ORGPROFILE table are updated. Version information from CEIDARS FRACTION table will be copied here.

References:

- 1. Croes, B., et al., *Air Quality Impacts of the Use of Ethanol in California Reformulated Gasoline*, 1999, California Air Resources Board.
- 2. *Speed versus Time Data for California's Unified Driving Cycle*. 1996; Available from: <u>www.arb.ca.gov/msprog/obdprog/uccycle.doc</u>.
- 3. Maldonado, H., *Test Cycles Descriptions*, Personal Communication with W. Yang, 2009.
- 4. CARB, Standard Operating Procedure No. MLD 102 / 103 (Version 2.2): Procedure for the Determination of C2 to C12 Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography, 2007: El Monte, CA.
- 5. CARB, Standard Operating Procedure No. MLD 104 (Revision 3.0): Procedure for the Determination of Aldehyde and Ketone Compound in Automotive Source Samples by High Performace Liquid Chromatography, 2006: El Monte, CA.
- 6. CARB, Standard Operating Procedure No. MLD 101 (Revision 2.2): Procedure for the Analysis of Automotive Exhaust for Methanol and Ethanol, 2005: El Monte, CA.
- 7. California Code of Regulations, The California Refomulated Gasoline Regulations, Title 13, , Sections 2250-2273.5: California Air Resources Board.
- 8. Allen, P., et al., *Speciation of Organic Gas Emissions California Light-Duty Vehicle Exhaust*, 1998, California Air Resources Board: Sacramento, CA.
- 9. Title 13, California Code of Regulations, The California Reformulated Gasoline Regulations, Sections 2250-2273.5.
- 10. *CEPAM*, 2013, California Air Resources Board.
- 11. Titel 17, California Code of Regulations, Division 3, Chapter 1, Subchapter 8.6, Article 1. Maximum Incremental Reactivity Values, Sections 94700-94701.

EIC/SCC	Names						
3	EMFAC/DTIM	GASOLINE, ALL VEHICLES	CATALYST RUNNING EXHAUST				
15	EMFAC/DTIM	GASOLINE, ALL VEHICLES	CATALYST BUSES				
18	EMFAC/DTIM	GASOLINE, ALL VEHICLES	CATALYST IDLE				
203	EMFAC/DTIM	GASOLINE, LIGHT-MED DUTY (LMV)	CATALYST RUNNING EXHAUST				
215	EMFAC/DTIM	GASOLINE, LIGHT-MED DUTY (LMV)	CATALYST BUSES				
218	EMFAC/DTIM	GASOLINE, LIGHT-MED DUTY (LMV)	CATALYST IDLE				
303	EMFAC/DTIM	GASOLINE, HEAVY DUTY VEH (HDV)	CAT RUNNING EXHAUST				
315	EMFAC/DTIM	GASOLINE, HEAVY DUTY VEH (HDV)	CATALYST BUSES				
318	EMFAC/DTIM	GASOLINE, HEAVY DUTY VEH (HDV)	CATALYST IDLE				
45807	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	HOT START				
45948	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	STABILIZED				
47175	ON-ROAD VEHICLES	LIGHT DUTY TRUCKS	HOT START				
82552	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST STABILIZED				
82586	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST STABILIZED				
83154	ON-ROAD VEHICLES	HEAVY GAS TRUCKS	CATALYST STABILIZED				
84160	ON-ROAD VEHICLES	LIGHT DUTY TRUCKS-1	CATALYST STABILIZED				
84376	ON-ROAD VEHICLES	MEDIUM DUTY TRUCKS	CATALYST STABILIZED				
84525	ON-ROAD VEHICLES	LIGHT HEAVY DUTY TRUCKS-1	CATALYST STABILIZED				
84673	ON-ROAD VEHICLES	MEDIUM HEAVY GAS TRUCKS	CATALYST STABILIZED				
86231	ON-ROAD VEHICLES	LT. DUTY TRUCKS-2	CATALYST HOT STABILIZED				
86421	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-1	CATALYST IDLE EXHAUST				
86546	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-2	CATALYST HOT STABILIZED				
86553	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-2	CATALYST IDLE EXHAUST				
86652	ON-ROAD VEHICLES	MEDIUM HEAVY DUTY GAS	CATALYST IDLE EXHAUST				
86777	ON-ROAD VEHICLES	HEAVY HEAVY DUTY GAS	CATALYST HOT STABILIZED				
86785	ON-ROAD VEHICLES	HEAVY HEAVY DUTY GAS	CATALYST IDLE EXHAUST				
86975	ON-ROAD VEHICLES	MOTORCYCLES (MCY)	CATALYST HOT STABILIZED				
87155	ON-ROAD VEHICLES	HEAVY DUTY GAS URBAN	CATALYST HOT STABILIZED				
87320	ON-ROAD VEHICLES	SCHOOL BUSES (SB)	CATALYST HOT STABILIZED				
87536	ON-ROAD VEHICLES	MOTOR HOMES (MH)	CATALYST HOT STABILIZED				
71073411000000	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST STABILIZED				
72073411000000	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST IDLE EXHAUST				
72273411000000	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST STABILIZED				
72373411000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS-1	CATALYST STABILIZED				
72473411000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS-1	CATALYST IDLE EXHAUST				
73073411000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS-2	CATALYST HOT STABILIZED				

Appendix 1. EICs/SCCs associated with catalyzed gasoline-powered vehicle stabilized running exhaust speciation profiles

73273411000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS-2	CATALYST IDLE EXHAUST
73273511000000	ON-ROAD VEHICLES	MEDIUM TRUCKS	CATALYST STABILIZED
73373411000000	ON-ROAD VEHICLES	MEDIUM TRUCKS	CATALYST IDLE EXHAUST
73373511000000	ON-ROAD VEHICLES	HEAVY GAS TRUCKS	CATALYST STABILIZED
73473411000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-1	CATALYST STABILIZED
73473511000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-1	CATALYST IDLE EXHAUST
73673411000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-2	CATALYST HOT STABILIZED
73673511000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS-2	CATALYST IDLE EXHAUST
75073411000000	ON-ROAD VEHICLES	MED. HVY. DTY TRUCKS	CATALYST STABILIZED
76273411000000	ON-ROAD VEHICLES	MED. HVY. DTY TRUCKS	CATALYST IDLE EXHAUS
77073411000000	ON-ROAD VEHICLES	HVY. HVY. DTY TRUCKS	CATALYST HOT STABILIZED
77073511000000	ON-ROAD VEHICLES	HVY. HVY. DTY TRUCKS	CATALYST IDLE EXHAUST
77173411000000	ON-ROAD VEHICLES	MOTORCYCLES (MCY)	CATALYST HOT STABILIZED
77173511000000	ON-ROAD VEHICLES	MOTORCYCLES (MCY)	CATALYST IDLE EXHAUST
77673411000000	ON-ROAD VEHICLES	HVY. GAS URBAN BUSES	CATALYST HOT STABILIZED
77673511000000	ON-ROAD VEHICLES	HVY. GAS URBAN BUSES	CATALYST IDLE EXHAUST
77773411000000	ON-ROAD VEHICLES	SCHOOL BUSES (SB)	CATALYST HOT STABILIZED
77773511000000	ON-ROAD VEHICLES	SCHOOL BUSES (SB)	CATALYST IDLE EXHAUST
78073411000000	ON-ROAD VEHICLES	SCHOOL BUSES GASOLINE (SBG)	CATALYST HOT STABILIZED
78073511000000	ON-ROAD VEHICLES	SCHOOL BUSES GASOLINE (SBG)	CATALYST IDLE EXHAUST

Vehicle No.	Model_Year	Manufacturer	Model_Type	Equipped with Catalvzed Converter	Fuel_Type
218	2000	GM	LS2	Yes	
219	1987	NISS	P/U	Yes	
220	1992	MITS	PU	Yes	
221	1997	NISS	QUEST XE	Yes	
222	1998	CHRY	GRANDVOYAGER	Yes	
223	1996	TOTA	CAMRY LE	Yes	
224	1994	NISS	G20	Yes	
225	2002	HOND	ACCORD LX	Yes	
226	1999	VOLK	NEW BEETLE	Yes	
227	1994	FORD	VILLAGER LS	Yes	
228	1998	FORD	CONTOUR	Yes	Summor
229	1995	GM	SUBURBAN LT	Yes	Commercial
230	1991	MB	300SEL	Yes	Phase 3
231	2001	GM	MALIBU	Yes	Gasoline
233	1998	MAZD	PROTEGE	Yes	
235	2002	FORD	MUSTANG	Yes	
242	1996	GM	CAVALIER	Yes	
244	1998	FORD	NAVIGATOR	Yes	
246	1996	GM	TAHOE	Yes	
247	2000	TOTA	CELICA GT-S	Yes	
248	1994	GM	CAVALIER	Yes	
251	1994	CHRY	GRAND CHEROKEE	Yes	
254	1998	FORD	MUSTANG SALEEN	Yes	
259	1999	HOND	CIVIC CX	Yes	
260	2000	CHRY	NEON	Yes	
265	1994	FORD	RANGER	Yes	
266	1984	CHRY	ARIES	Yes	
271	2001	VOLK	GTI	Yes	
272	1988	HOND	INTEGRA	Yes	
274	2001	SAAB	95 SE	Yes	
277	1996	FORD	WINDSTAR GL	Yes	
278	1999	NISS	FRONTIER XE	Yes	
280	1998	HOND	CIVIC DX	Yes	Winter
281	2001	GM	LUMINA	Yes	Commercial Phase 3
282	1999	GM	GRAND PRIX GT	Yes	Gasoline
*284	1980	GM	P/U	No	Cusonin
286	1991	FORD	ESCORT GT	Yes]
292	1992	CHRY	ACCLAIM	Yes]
294	1998	CHRY	SEBRING	Yes]
299	1996	FORD	TAURUS GL	Yes]
301	1998	FORD	RANGER XLT	Yes]
302	1985	HOND	CIVIC CRX	Yes	1

Appendix 2. Test vehicle and fuel information

*The test results of this non-catalyzed vehicle were not included in the profile development for catalyzed vehicles.

		Weight Percentage, %		
	SAROAD	OG2303 OG2304		
Species Name		Catalyzed Gasoline-Powered	Catalyzed Gasoline-Powered	
		Vehicle Stabilized Exhaust	Vehicle Stabilized Exhaust	
		(E6 Summer)	(E6 Winter)	
(2-methylpropyl)benzene	45235	0.081527	0.007325	
1-(1,1-dimethylethyl)-3,5-dimethylbenzene	45256	0.046830	0.004371	
1,2,3,4-tetramethylbenzene	91109	0.040088	0.026153	
1,2,3,5-tetramethylbenzene	91104	0.253842	0.251723	
1,2,3-trimethylbenzene	45225	0.728718	0.542883	
1,2,4,5-tetramethylbenzene	91103	0.162907	0.145122	
1,2,4-trimethylbenzene	45208	3.159537	2.005976	
1,2,4-trimethylcyclopentane	43400	0.054036	0.047408	
1,2-butadiene (methylallene)	43221	0.000777	0.012689	
1,2-diethylbenzene (ortho)	98154	0.003134	0.006997	
1,2-dimethyl-3-ethylbenzene	45254	0.014124	0.005431	
1,2-dimethyl-4-ethylbenzene	45252	0.321799	0.293271	
1,2-propadiene	43208	0.055392	0.029722	
1,3,5-trimethylbenzene	45207	0.674134	0.456899	
1,3,5-trimethylcyclohexane	98061	0.020355	0.017572	
1,3-butadiene	43218	0.242726	0.198716	
1,3-butadiyne	43222		0.004576	
1,3-diethylbenzene (meta)	45113	0.055441	0.033481	
1,3-dimethyl-2-ethylbenzene	45253	0.046948	0.012537	
1,3-dimethyl-4-ethylbenzene	45251	0.217076	0.122260	
1,3-dimethyl-5-ethylbenzene	45257	0.434780	0.310653	
1,3-dipropylbenzene	45237	0.058326	0.068665	
1,4-diethylbenzene (para)	45114	0.082855	0.074276	
1,4-dimethyl-2-ethylbenzene	45250	0.246598	0.194426	
1-butene	43213	0.174689	0.257032	
1-ethyl-2n-propylbenzene	98179	0.001392	0.004469	
1-ethyl-4-methylcyclohexane	92001	0.023413	0.005295	
1-hexene	43245	0.005398	0.026631	
1-methyl-2-ethylbenzene	99915	0.398895	0.335250	
1-methyl-2-isopropylbenzene	91096	0.020631	0.016281	
1-methyl-2-n-butylbenzene	45243	0.026293	0.016823	
1-methyl-2-n-propylbenzene	98178	0.072985	0.040204	
1-methyl-3-ethylbenzene	99912	1.449800	1.154466	
1-methyl-3-isopropylbenzene	98153	0.010753	0.006845	
1-methyl-3-n-propylbenzene	98152	0.328589	0.267025	
1-methyl-4-ethylbenzene	99914	0.461214	0.408819	
1-methyl-4-isopropylbenzene	91094	0.003956	0.003401	
1-methyl-4-n-propylbenzene	98182	0.008961	0.021633	
1-methylcyclopentene	92000	0.015453	0.238498	
1-nonene	43267		0.005167	
1-octene	43265		0.001142	
1-pentene	43224	0.020651	0.071340	
1-tert-butyl-2-methylbenzene	45244	0.003587	0.003345	
2,2,3-trimethylbutane	43160	0.003480	0.003810	
2,2,4-trimethylheptane	98174	0.025870	0.005339	
2,2,4-trimethylhexane	45222	0.025154	0.001202	

Appendix 3. OG speciation profiles for catalyzed gasoline-powered vehicle stabilized running exhaust burning E6 summer and winter fuels

		Weight Percentage, %		
		OG2303	OG2304	
Species Name	SAROAD	Catalyzed Gasoline-Powered	Catalyzed Gasoline-Powered	
		Vehicle Stabilized Exhaust	Vehicle Stabilized Exhaust	
		(E6 Summer)	(E6 Winter)	
2,2,4-trimethylpentane	43276	3.769925	1.355051	
2,2,5-trimethylheptane	43252	0.164013	0.041986	
2,2,5-trimethylhexane	98033	1.660483	0.156472	
2,2-dimethylbutane	43291	0.402086	0.281424	
2,2-dimethylhexane	98138		0.008767	
2,2-dimethyloctane	98175	0.030777	0.009457	
2,2-dimethylpentane	90042		0.004274	
2,3,3-trimethylpentane	43280		0.019611	
2,3,4-trimethylpentane	43279	1.349811	0.367775	
2,3,5-trimethylhexane	98141	0.048677	0.013036	
2,3-dimethyl-1-butene	43234		0.033323	
2,3-dimethylbutane	98001	0.792349	0.637659	
2,3-dimethylhexane	98139	0.476031	0.076832	
2,3-dimethyloctane	98183	0.021097	0.009355	
2,3-dimethylpentane	43274	1.225835	0.821724	
2,4,4-trimethyl-2-pentene	98055	0.021763	0.000789	
2,4,4-trimethylhexane	45223	0.068837	0.010488	
2,4-dimethyl-1-pentene	90063		0.002412	
2,4-dimethylheptane	98142	0.108185	0.077641	
2.4-dimethylhexane	43277	0.567796	0.223548	
2.4-dimethyloctane	98149	0.063893	0.006733	
2.4-dimethylpentane	43271	0.867762	0.496317	
2.5-dimethylhexane	43278	0.483680	0.301937	
2.5-dimethyloctane	98176	0.013695	0.007305	
2.6-dimethylheptane	98157	0.050398	0.015919	
2.6-dimethyloctane	98177	0.003323	0.005792	
2-methyl-1-butene	43225	0.061190	0.148018	
2-methyl-1-pentene	98040	0.016644	0.005008	
2-methyl-2-butene	43228	0.137153	0.197808	
2-methyl-2-hexene	90028	0.002821		
2-methyl-2-pentene	98004	0.014020	0.003156	
2-methyl-2-propenal	43506	0.008895	0.019617	
2-methylheptane	98140	0.300165	0.330821	
2-methylhexane	43275	0.850466	0.614310	
2-methylindan	91108	0.155142	0.168540	
2-methylnonane	90047	0.398006	0.137356	
2-methylpentane	43229	1.581986	1.381234	
2-methyl-trans-3-hexene	91006	0.000940	0.001052	
3.3-dimethyl-1-butene	98169	0.086677	0.074413	
3.3-dimethylhexane	98171	0.002678	0.002131	
3.3-dimethyloctane	98184	0.015631	0.007284	
3.3-dimethylpentane	90040	0.028383	0.032832	
3.4-dimethyl-1-pentene	90075		0.002665	
3.4-dimethylhexane	98150	0.030505	0.016673	
3.5-dimethylheptane	98144	0.059068	0.048229	
3-ethyl-2-pentene	98007	0.132919	0.01022	
3-ethylpentane	43300	0.029724	0.134874	
3-methyl-1-butene	43223	0.007412	0.017423	
		0.00,111	01017120	

Species Name OC2303 Carabyzed Gasoline-Powerd Vehicle Stabilized Exhaust (E6 Summer) Carabyzed Gasoline-Powerd Vehicle Stabilized Exhaust (E6 Summer) Carabyzed Gasoline-Powerd Vehicle Stabilized Exhaust (E6 Summer) 3-methyl-i-pentene 90030 0.004082 0.00530 3-methyl-i-spentene 99029 0.0068495 0.002310 3-methyl-i-spentene 98163 0.006648 0.00411 3-methyl-i-spentene 43228 0.399430 0.323467 3-methyl-i-spentene 43230 1.044662 0.850120 3-methyl-i-spentene 43272 0.123591 0.007367 3-methyl-i-pentene 43270 0.017263 0.007367 4-methyl-i-pentene 43297 0.01744 0.051383 4-methyl-i-pentene 98173 0.321994 0.17938 4-methyl-indan 91107 0.002882 0.05954 4-methyl-indan 91107 0.002882 0.017938 4-methyl-indan 91106 0.110123 0.150955 accatylene 43206 0.562078 0.313300 cortioni 43501 0		SAROAD	Weight Percentage, %		
Species Name SAROAD Catabyzed Gasoline-Powered Vehicle Stabilized Exhaust (E6 Summer) Catabyzed Gasoline-Powered Vehicle Stabilized Exhaust (E6 Winter) 3-methyl-i-pentene 90030 0.004082 0.005630 3-methyl-isp-2-hexene 90029 0.0068895 0.000530 3-methyl-isp-2-pentene 98163 0.006648 0.004121 3-methylexplopentene 43272 0.005991 0.002310 3-methylexplopentene 43295 0.884752 0.58113 3-methylpotane 43230 1.044662 0.850120 3-methylpotane 43237 0.017263 0.007593 4-methylhoptane 43297 0.071748 0.05183 4-methylhoptane 43297 0.071748 0.05183 4-methylhoptane 43293 0.027489 0.004947 4-methylhoptane 91107 0.002682 0.01332 4-methylindan 91106 0.110123 0.15994 4-methylindan 91106 0.101123 0.15095 5 0.027489 0.0044917 5 5-methyl			OG2303	OG2304	
Vehice Stabilized Exhaust (E6 Summer) Vehice Stabilized Exhaust (E6 Winter) 3-methyl-1-bexene 9000 0.052516 3-methyl-ics2-hexene 90029 0.068895 3-methyl-cis2-hexene 98163 0.006644 0.00411 3-methyl-cipopentene 43272 0.005991 0.002310 3-methyl-cipopentene 43298 0.399430 0.323467 3-methyl-cipopentene 43292 0.123591 0.007367 3-methyl-texane 48172 0.123591 0.007367 3-methyl-tentane 43270 0.017263 0.007367 4-methyl-teptane 43135 0.007367 4.methylinghane 43297 4-methyl-tarba 98173 0.321497 0.017263 0.007367 4-methyl-tarba 98173 0.321994 0.175938 4.methylindhane 91107 0.002682 0.01594 4-methyl-tarba 98173 0.321994 0.175938 4.methylindhane 91106 0.110123 0.15995 a-methyl-tarba 2.methyl-tarba 90031 0.002482 0.015930	Species Name		Catalyzed Gasoline-Powered	Catalyzed Gasoline-Powered	
Jonethyl-1-bexene 00030 (E6 Winter) 3-methyl-1-peratene 43211 0.004082 0.005530 3-methyl-cis-2-bexene 90029 0.068895 - 3-methyl-cis-2-pentene 98163 0.006648 0.004121 3-methyl-peratene 43227 0.005991 0.002310 3-methylpeprane 43295 0.884752 0.581113 3-methylpextane 43227 0.017263 0.007348 3-methylpextane 43227 0.017263 0.007367 4-methyll-pentane 43227 0.017263 0.0073767 4-methylloptane 43297 0.071748 0.015383 4-methylloptane 43297 0.071748 0.015934 4-methylloptane 98173 0.321994 0.175938 4-methylloptane 98133 0.321994 0.175938 4-methylloptane 93233 0.027489 0.004917 5-methyllopdu 43505 0.06278 0.737721 accolare 43521 0.85005 0.622981 accolare			Vehicle Stabilized Exhaust	Vehicle Stabilized Exhaust	
3-methyl-l-bexene 90030 0.052516 3-methyl-cis-2-bexene 90029 0.068895 3-methyl-cis-2-pentene 98163 0.006648 0.004121 3-methyl-cyclopentene 43272 0.005991 0.002310 3-methyl-topentene 43272 0.0399430 0.323467 3-methyl-bexane 43298 0.399430 0.323467 3-methyl-bexane 43220 0.144662 0.88173 3-methyl-trans-2-pentene 43230 1.044662 0.850120 3-methyl-trans-2-pentene 43270 0.017263 0.007367 4-methylicptane 43297 0.071748 0.005783 4-methylicptane 43293 0.027449 0.01793 4-methylictane 98173 0.321994 0.17938 4-methylictane 98173 0.321994 0.01332 4-methyl-trans-2-pentene 43293 0.027449 0.049197 5-methylindan 91106 0.110123 0.150695 accataldehyde 43505 0.0001418 0.005590			(E6 Summer)	(E6 Winter)	
3-methyl-is-2-hexene 90029 0.006885 3-methyl-is-2-hexene 98163 0.006648 0.004121 3-methyl-cis-2-pentene 43272 0.005991 0.002310 3-methylpeytapiane 43295 0.3844752 0.531437 3-methylperane 43295 0.884752 0.581113 3-methylocane 98172 0.123591 0.007364 3-methylocane 43270 0.017263 0.007367 4-methyl-pentene 43297 0.071748 0.05733 4-methyloghane 43297 0.071748 0.01593 4-methyloghane 43297 0.071748 0.01593 4-methyloghane 43297 0.071748 0.01593 4-methyloghane 91107 0.000862 0.01594 4-methyloghane 91107 0.000862 0.01312 4-methyloghane 91233 0.027489 0.004917 5-methylindan 91106 0.110123 0.150695 acetaldehyde 43505 0.001418 0.005599 acetaldehyde	3-methyl-1-hexene	90030		0.052516	
3-methyl-cis-2-hexanc 90029 0.068895 3-methyl-cis-2-pentene 98163 0.000648 0.001210 3-methyl-cyclopentene 43272 0.005991 0.02310 3-methyl-bytanc 43298 0.399430 0.323467 3-methyl-bytanc 43295 0.884752 0.058113 3-methyl-pentane 43230 1.044662 0.8850120 3-methyl-pentane 43270 0.017263 0.007367 4-methyl-trans-2-pentene 43270 0.017148 0.05133 4-methyl-trans-2-pentene 98173 0.321994 0.15954 4-methyl-trans-2-pentene 98173 0.321994 0.15954 4-methyl-trans-2-pentene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methyl-trans-2-pentene 43206 0.562078 0.373721 accolone 43551 0.85055 0.622981 accolone 43505 0.00112 1.639909 accolone 43505 0.001418 0.00555	3-methyl-1-pentene	43211	0.004082	0.005630	
3-methyl-cis-2-pentene 98163 0.006648 0.004121 3-methylhextane 43272 0.00591 0.002310 3-methylhextane 43295 0.884752 0.58113 3-methylpentane 43230 1.044662 0.850120 3-methyloctane 98172 0.017263 0.007367 4-methyl-pentene 48320 1.044662 0.850120 4-methyl-pentene 98135 0.007367 0.007367 4-methylindan 91107 0.002682 0.015934 4-methylindan 91107 0.002682 0.01332 4-methylindan 91106 0.110123 0.150943 4-methylindan 91106 0.110123 0.15095 acetaldehyde 43503 0.000112 1.639909 acetone 43551 0.850055 0.622981 acetylene 43505 0.001418 0.005559 benzzine 91055 0.097780 0.124814 cis-1.2-dimethylcyclonexane 91038 0.01332 0.024789 cis-1.2-	3-methyl-cis-2-hexene	90029	0.068895		
3-methyleyclopentene 43272 0.005991 0.002310 3-methylbexane 43298 0.399430 0.323467 3-methylbexane 43295 0.884752 0.581113 3-methylpentane 43230 1.044662 0.850120 3-methylpentane 43270 0.017263 0.007367 4-methylheytane 43270 0.071748 0.005793 4-methylheytane 43297 0.071748 0.005734 4-methyloctane 98135 0.002682 0.01583 4-methyloctane 98173 0.321994 0.175938 4-methyloctane 98173 0.321994 0.175938 4-methylotane 98173 0.321994 0.175938 4-methylotane 91107 0.002682 0.01332 4-methylotane 9106 0.110123 0.150595 acctane 93551 0.80055 0.622981 acetylene 43206 0.562078 0.73721 acrolein 43505 0.001418 0.005599 benzaldehyde	3-methyl-cis-2-pentene	98163	0.006648	0.004121	
3-methylhexane 43298 0.39430 0.323467 3-methylhexane 43295 0.884752 0.581113 3-methyloctane 98172 0.123591 0.075348 3-methyl-tanes-2-pentene 43230 1.044662 0.850120 3-methyl-tanes-2-pentene 43270 0.017263 0.007367 4-methyl-1-pentene 98135 0.002682 0.01833 4-methyl-tane 98173 0.321994 0.175934 4-methyl-tane 98173 0.321994 0.015934 4-methyl-tans-2-bxene 90031 0.0002682 0.01332 4-methyl-tans-2-bxene 90031 0.000806 0.001332 4-methyl-tans-2-bxene 90031 0.000806 0.001312 acctaldehyde 43503 0.00112 1.639009 acctaldehyde 43503 0.00112 1.63900 acctaldehyde 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.31330 benzaldehyde 45501 0.196768 0.31330	3-methylcyclopentene	43272	0.005991	0.002310	
3-methylbexane 43295 0.884752 0.581113 3-methylpertane 98172 0.123591 0.075348 3-methylpertane 43230 1.044662 0.850120 3-methylpertane 43270 0.017263 0.007534 4-methyl-pretne 98135 0.007573 0.0075793 4-methyl-pretne 98173 0.321994 0.175938 4-methyl-trans-2-bexene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methylindan 91106 0.110123 0.150695 acctolachyde 43303 0.900112 1.639909 acctolachyl-trans-2-pentene 43206 0.562078 0.737721 acctolachyde 43505 0.02788 0.737721 acctolachyde 43510 0.278587 0.163300 benzaldehyde 45501 0.196768 0.31300 benzaldehyde 4510 0.278587 0.163300 cis-1.3-dimethylcyclopentane 91038 0.019335 0.020406	3-methylheptane	43298	0.399430	0.323467	
3-methyloctane 98172 0.123591 0.075348 3-methyl-trans-2-pentene 43230 1.044662 0.850120 3-methyl-trans-2-pentene 98135 0.0077867 4-methyl-1-pentene 98135 0.007784 4-methyl-1-pentene 98135 0.0071748 0.051383 4-methyl-trans-2-bexene 90031 0.000806 0.001312 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methyl-trans-2-pentene 433503 0.900112 1.639909 acetaldehyde 43503 0.900112 1.639909 acetone 433505 0.027489 0.737721 acrolein 43305 0.001418 0.00555 berzadehyde 45501 0.196768 0.313300 berzadehyde 43510 0.278587 0.165390 cis-1.3-dimethylcyclohexane 91035 0.00406 0.057920 cis-1.3-dimethylcyclohexane 91038 0.1097780 0.124814 butyraldehyde 43217 0.05264 0.07820 <	3-methylhexane	43295	0.884752	0.581113	
3-methylpentane 43230 1.044662 0.850120 3-methyl-trans-2-pentene 43270 0.017263 0.007367 4-methyl-pentene 98135 0.005793 0.01748 0.051933 4-methylloptane 98173 0.321994 0.017938 4.015938 4-methylottane 98173 0.321994 0.175938 4.015938 4-methyl-trans-2-pentene 43293 0.027489 0.0014917 5-methylindan 91106 0.110123 0.150695 acctole 43551 0.850055 0.622981 acctylene 43206 0.562078 0.737721 acrolein 433505 0.001418 0.00559 benzaldehyde 45501 0.196768 0.313300 benzaldehyde 45201 3.890986 3.614598 butyraldehyde 91055 0.077780 0.124814 cis-1.2-dimethylcyclopentane 91018 0.160312 0.150317 cis-1.2-dimethylcyclopentane 91038 0.019335 0.024662 cis-1.2-methylcyclopentane<	3-methyloctane	98172	0.123591	0.075348	
3-methyl-trans-2-pentene 43270 0.017263 0.007367 4-methyl-I-pentene 98135 0.005793 0.005793 4-methylheptane 43297 0.017148 0.05593 4-methylndan 91107 0.002682 0.015954 4-methyloctane 98173 0.321994 0.175938 4-methyl-trans-2-hexene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methylindan 91106 0.110123 0.15955 acetaldehyde 43503 0.900112 1.639909 acetolene 43351 0.850055 0.622981 acetylene 43505 0.001418 0.00559 benzaldehyde 45501 0.196768 0.31300 benzene 45201 3.890986 3.614598 butyraldehyde 91055 0.097780 0.124814 cis-1.3-dimethylcyclopentane 91018 0.100406 0.057920 cis-1.4methylcyclopentane 91018 0.016331 0.012482 <td>3-methylpentane</td> <td>43230</td> <td>1.044662</td> <td>0.850120</td>	3-methylpentane	43230	1.044662	0.850120	
4-methyl-1-pentene 98135 0.007793 4-methylindan 91107 0.002682 0.015954 4-methylindan 91107 0.022682 0.015954 4-methylindan 91107 0.002682 0.01329 4-methyl-trans-2-hexene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methylindan 91106 0.110123 0.150955 acetole 43551 0.850055 0.622981 acetolene 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 benzaldehyde 45501 0.278587 0.165390 cis-1.2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1.2-dimethylcyclohexane 91018 0.160312 0.15390 cis-1.3-dimethylcyclopentane 91038 0.019335 0.020406 cis-2-heytene 43227 0.05224 0.072855 cis-2-heytene 91038 0.0104347 cis-2-hexene 9835	3-methyl-trans-2-pentene	43270	0.017263	0.007367	
4-methylheptane 43297 0.071748 0.051383 4-methylloctane 91107 0.002682 0.015954 4-methylloctane 98173 0.321994 0.175938 4-methylloctane 98173 0.321994 0.001332 4-methylloctane 43293 0.027489 0.004917 5-methyllindan 91106 0.110123 0.150695 acetaldehyde 43503 0.900112 1.639909 acetone 43351 0.850055 0.622981 acetylene 43306 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzene 45201 3.890986 3.614598 butyraldehyde 43510 0.278587 0.165390 cis-1.3-dimethylcyclohexane 98180 0.10406 0.057920 cis-1.3-dimethylcyclopentane 91038 0.012335 0.024562 cis-2-beptene 91028 0.0169312 0.150317 cis-1-asethyl-sethylcyclopentane 90080 0.0238571 0.024562 <t< td=""><td>4-methyl-1-pentene</td><td>98135</td><td></td><td>0.005793</td></t<>	4-methyl-1-pentene	98135		0.005793	
4-methylindan91107 0.022682 0.015954 4-methyl-trans-2-bexene90031 0.000806 0.00132 4-methyl-trans-2-pentene43293 0.027489 0.004917 5-methylindan91106 0.110123 0.150695 acetaldehyde43551 0.850055 0.622981 acetaldehyde43551 0.850055 0.622981 acetylene43206 0.562786 0.737721 acrolein43505 0.001181 0.000559 benzaldehyde45501 0.196768 0.313300 butyraldehyde43510 0.278587 0.165390 cis-1.2-dimethylcyclohexane91055 0.097780 0.124814 cis-1.3-dimethylcyclopentane91018 0.100312 0.150317 cis-1.3-dimethylcyclopentane91038 0.019335 0.024662 cis-2-breate93035 0.0024662 0.027825 cis-2-breate91028 0.016994 0.004142 cis-2-breate98186 0.0169347 0.024562 cis-2-breate98126 0.016994 0.004142 cis-2-breate98035 0.016994 0.004142 cis-2-breate98126 0.016332 0.012825 cis-2-breate98136 0.016934 0.012454 cyclopentane43227 0.019228 0.002466 cis-2-breate98035 0.016994 0.004122 cis-2-breate98136 0.016337 0.024562 cis-2-breate98156 0.0163047 0.072454 <	4-methylheptane	43297	0.071748	0.051383	
4-methyl-trans-2-hexene 98173 0.321994 0.175938 4-methyl-trans-2-pentene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methylindan 91106 0.110123 0.150695 acetone 43503 0.900112 1.639909 acetore 43206 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 benzene 445201 3.890986 3.614598 butyraldehyde 45510 0.278587 0.165390 cis-1,2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1,2-dimethylcyclopentane 91018 0.160312 0.150317 cis-1-methyl-3-ethylcyclopentane 9108 0.01935 0.024462 cis-2-butene 43217 0.052624 0.072855 cis-2-butene 91028 0.016940 0.004142 cis-2-betene 91028 0.016630 0.115658	4-methylindan	91107	0.002682	0.015954	
4-methyl-trans-2-hexene 90031 0.000806 0.001332 4-methyl-trans-2-pentene 43293 0.027489 0.004917 5-methylindan 91106 0.110123 0.150695 acetaldehyde 43503 0.900112 1.639909 acetone 43551 0.850055 0.622981 acetylene 43206 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 butyraldehyde 43510 0.278587 0.165390 cis-1,2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1,3-dimethylcyclohexane 91038 0.100406 0.057920 cis-1,3-dimethylcyclopentane 91038 0.010335 0.020466 cis-2-butene 43217 0.052624 0.072857 cis-2-butene 91028 0.010694 0.014142 cis-2-hexene 98035 0.004417 0.52624 0.072852 cis-2-hexene 98035 0.004347	4-methyloctane	98173	0.321994	0.175938	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	4-methyl-trans-2-hexene	90031	0.000806	0.001332	
5-methylindan 91106 0.110123 0.150695 acetone 43551 0.850055 0.622981 acetylene 43206 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.166768 0.313300 benzene 45201 3.800986 3.614598 butyraldehyde 43510 0.278587 0.165390 cis-1,2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1,3-dimethylcyclopentane 91018 0.100406 0.057920 cis-1,3-dimethylcyclopentane 91038 0.019335 0.020466 cis-2-hextene 94080 0.023877 0.024562 cis-2-hextene 94035 0.016994 0.004142 cis-2-hextene 98035 0.0104347 0.024562 cis-2-hextene 98035 0.016994 0.004142 cis-2-hextene 98035 0.016630 0.115638 cyclohexane 43242 0.006391 0.0172454	4-methyl-trans-2-pentene	43293	0.027489	0.004917	
acetaldehyde 43503 0.900112 1.639909 acetone 43551 0.850055 0.622981 acetylene 43206 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 benzene 45201 3.890986 3.614598 butyraldehyde 43510 0.278587 0.165390 cis-1,2-dimethylcyclohexane 98180 0.100406 0.057920 cis-1,3-dimethylcyclopentane 91035 0.019335 0.020406 cis-1,3-dimethylcyclopentane 91038 0.019335 0.020406 cis-2-butene 43266 0.019335 0.024814 cis-2-heptene 91028 0.019335 0.02466 cis-2-butene 43266 0.004347 0.024862 cis-2-betene 98035 0.019228 0.052091 cis-2-pentene 43242 0.004347 0.024562 cis-2-pentene 43242 0.003879 0.072454 cyclop	5-methylindan	91106	0.110123	0.150695	
acetone 43551 0.850055 0.622981 acrolein 43206 0.562078 0.737721 acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 benzene 43510 0.278587 0.163390 cis-1,2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1,3-dimethylcyclohexane 91018 0.160312 0.150317 cis-1,3-dimethylcyclopentane 91018 0.160312 0.150317 cis-1,artmyl-3-ethylcyclopentane 91038 0.019335 0.024864 cis-2-butene 43217 0.052624 0.072825 cis-2-bettene 91028 0.016994 0.004142 cis-2-bettene 98035 0.004347 0.052624 0.0123818 cis-2-otetne 43227 0.019228 0.052091 0.072454 cis-2-otetne 43242 0.0003879 0.072454 cyclopexane 43242 0.090558 0.0172454 cyclopexane 43242 0.0003879 <td< td=""><td>acetaldehyde</td><td>43503</td><td>0.900112</td><td>1.639909</td></td<>	acetaldehyde	43503	0.900112	1.639909	
acetylene43206 0.562078 0.737721 acrolein43505 0.001418 0.005559 benzaldehyde45501 0.196768 0.313300 benzene45201 3.890986 3.614598 butyraldehyde43510 0.278587 0.165390 cis-1,2-dimethylcyclohexane91055 0.097780 0.124814 cis-1,3-dimethylcyclohexane91018 0.160312 0.150317 cis-1,3-dimethylcyclopentane91018 0.160312 0.027852 cis-1,3-dimethylcyclopentane91028 0.019335 0.024462 cis-2-butene43217 0.052624 0.072825 cis-2-betene91028 0.016994 0.004142 cis-2-otene43266 0.004347 0.004412 cis-2-otene43227 0.019228 0.0052091 crotonaldehyde98156 0.016630 0.115658 cyclohexane43242 0.0003879 0.072454 cyclopentane43222 0.006391 0.018761 cyclopentane43202 2.27162 2.611943 ethanol43202 2.927162 2.611943 ethanol43203 3.397285 4.702096 formuldehyde98057 0.043304 ethyleneethylene43203 3.397285 4.702096 formuldehyde98057 0.043304 ethyleneethylene43203 3.397285 4.702096 formuldehyde98159 0.365898 0.17929 indan98044 0.10	acetone	43551	0.850055	0.622981	
acrolein 43505 0.001418 0.005559 benzaldehyde 45501 0.196768 0.313300 benzene 45201 3.80986 3.614598 butyraldehyde 43510 0.278587 0.165390 cis-1,2-dimethylcyclohexane 91055 0.097780 0.124814 cis-1,3-dimethylcyclohexane 98180 0.100406 0.057920 cis-1,3-dimethylcyclopentane 91018 0.160312 0.150317 cis-1,rans-2,3-trimethylcyclopentane 91038 0.019335 0.0024060 cis-1,rans-2,3-trimethylcyclopentane 90080 0.023877 0.024562 cis-2-butene 43217 0.052624 0.072825 cis-2-betene 98035 0.004142 0.004142 cis-2-hexene 98035 0.004412 cis-2-betene 432266 0.004347 cis-2-pentene 43248 0.309910 0.324518 cyclohexane 43242 0.003879 0.072454 cyclopentane 43202 2.927162 2.611943 ethanol 43302 0.052671 1.055577 ethanol 43203 3.397285 4.702096 fethane 43203 3.397285 4.702096 formaldehyde 98057 0.044304 ethylcyclopentaneethylcyclopentane 98057 0.043304 ethylcyclopentane 98057 0.043304 ethylcyclopentane 98057 0.043304 ethylcyclopentane 98057 0.0443304 ethylcyclopentane	acetylene	43206	0.562078	0.737721	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	acrolein	43505	0.001418	0.005559	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	benzaldehyde	45501	0.196768	0.313300	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	benzene	45201	3.890986	3.614598	
$\begin{array}{c} \hline cis-1,2-dimethylcyclohexane & 91055 & 0.097780 & 0.124814 \\ \hline cis-1,3-dimethylcyclohexane & 98180 & 0.100406 & 0.057920 \\ \hline cis-1,3-dimethylcyclopentane & 91018 & 0.160312 & 0.150317 \\ \hline cis-1,trans-2,3-trimethylcyclopentane & 91038 & 0.019335 & 0.020406 \\ \hline cis-1-methyl-3-ethylcyclopentane & 90080 & 0.023877 & 0.024562 \\ \hline cis-2-butene & 43217 & 0.052624 & 0.072825 \\ \hline cis-2-butene & 91028 & 0.016994 & 0.004142 \\ \hline cis-2-hexene & 98035 & 0.004412 \\ \hline cis-2-octene & 43266 & 0.004347 \\ \hline cis-2-pentene & 43227 & 0.019228 & 0.052091 \\ \hline crotonaldehyde & 98156 & 0.016630 & 0.115658 \\ \hline cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclohexane & 43242 & 0.003879 & 0.072454 \\ \hline cyclopentane & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylcyclohexane & 43288 & 0.03297 & 0.031740 \\ \hline ethylcyclopentane & 98057 & 0.043304 \\ \hline ethylene & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 98159 & 0.365898 & 0.179629 \\ \hline rotonaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline rotonaldehyde & 98057 & 0.043304 \\ \hline ethylene & 43202 & 2.927162 & 2.611943 \\ \hline rotonaldehyde & 98057 & 0.043304 \\ \hline rotonaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline rotonaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline rotonaldehyde & 98057 & 0.043304 \\ \hline rotonaldehy$	butyraldehyde	43510	0.278587	0.165390	
$\begin{array}{c} \hline cis-1,3-dimethylcyclohexane & 98180 & 0.100406 & 0.057920 \\ \hline cis-1,3-dimethylcyclopentane & 91018 & 0.160312 & 0.150317 \\ \hline cis-1,trans-2,3-trimethylcyclopentane & 91038 & 0.019335 & 0.020406 \\ \hline cis-1-methyl-3-ethylcyclopentane & 90080 & 0.023877 & 0.024562 \\ \hline cis-2-butene & 43217 & 0.052624 & 0.072825 \\ \hline cis-2-butene & 91028 & 0.016994 & 0.004142 \\ \hline cis-2-hexene & 98035 & 0.004412 \\ \hline cis-2-pentene & 43266 & 0.004347 \\ \hline cis-2-pentene & 43227 & 0.019228 & 0.052091 \\ \hline crotonaldehyde & 98156 & 0.016630 & 0.115658 \\ \hline cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclohexane & 43242 & 0.090558 & 0.072454 \\ \hline cyclopentane & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylbenzene & 43288 & 0.032297 & 0.031740 \\ \hline ethylcyclopentane & 98057 & 0.043304 \\ \hline ethylene & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline indan & 98044 & 0.107456 & 0.166211 \\ \hline \end{array}$	cis-1,2-dimethylcyclohexane	91055	0.097780	0.124814	
$\begin{array}{c} \hline cis-1,3-dimethylcyclopentane & 91018 & 0.160312 & 0.150317 \\ \hline cis-1,trans-2,3-trimethylcyclopentane & 91038 & 0.019335 & 0.020406 \\ \hline cis-1-methyl-3-ethylcyclopentane & 90080 & 0.023877 & 0.024562 \\ \hline cis-2-butene & 43217 & 0.052624 & 0.072825 \\ \hline cis-2-betene & 91028 & 0.016994 & 0.004142 \\ \hline cis-2-hexene & 98035 & 0.004412 \\ \hline cis-2-cotene & 43266 & 0.004347 & 0.004412 \\ \hline cis-2-pentene & 43227 & 0.019228 & 0.052091 \\ \hline crotonaldehyde & 98156 & 0.016630 & 0.115658 \\ \hline cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclohexene & 43273 & 0.003879 & 0.072454 \\ \hline cyclopentene & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylbenzene & 43288 & 0.032297 & 0.031740 \\ \hline ethylcyclohexane & 43288 & 0.032297 & 0.031740 \\ \hline ethylene & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline indan & 98044 & 0.107456 & 0.166211 \\ \hline \end{array}$	cis-1,3-dimethylcyclohexane	98180	0.100406	0.057920	
$\begin{array}{c} \hline cis-1,trans-2,3-trimethylcyclopentane \\ 91038 \\ 0.019335 \\ 0.023877 \\ 0.024562 \\ \hline cis-1-methyl-3-ethylcyclopentane \\ 90080 \\ 0.023877 \\ 0.024562 \\ \hline cis-2-butene \\ 91028 \\ 0.016994 \\ 0.004142 \\ \hline cis-2-hexene \\ 98035 \\ \hline cis-2-hexene \\ 98035 \\ \hline cis-2-otene \\ 43266 \\ 0.004347 \\ \hline cis-2-pentene \\ 43227 \\ 0.019228 \\ 0.006301 \\ 0.016630 \\ 0.115658 \\ \hline cyclohexane \\ 43248 \\ 0.309910 \\ 0.324518 \\ \hline cyclohexene \\ 43242 \\ 0.0003879 \\ 0.072454 \\ \hline cyclopentane \\ 43242 \\ 0.0003879 \\ 0.072454 \\ \hline cyclopentane \\ 43202 \\ \hline cyclohexane \\ 43202 \\ \hline cyclohexene \\ 43202 \\ \hline cyclohexene \\ 43202 \\ \hline cyclopentane \\ \hline 43203 \\ \hline cyclohexane \\ \hline cyclopentane \\ \hline 43203 \\ \hline cyclohexane \\ \hline cyclopentane \\ \hline cyclopentane \\ \hline cyclopentane \\ \hline 43203 \\ \hline cyclohexane \\ \hline cyclopentane \\ \hline cyclopenta$	cis-1,3-dimethylcyclopentane	91018	0.160312	0.150317	
$\begin{array}{c} \hline cis-1-methyl-3-ethylcyclopentane & 90080 & 0.023877 & 0.024562 \\ \hline cis-2-butene & 43217 & 0.052624 & 0.072825 \\ \hline cis-2-heptene & 91028 & 0.016994 & 0.004142 \\ \hline cis-2-hexene & 98035 & 0.004412 \\ \hline cis-2-octene & 43266 & 0.004347 & \\ \hline cis-2-pentene & 43227 & 0.019228 & 0.052091 \\ \hline crotonaldehyde & 98156 & 0.016630 & 0.115658 \\ \hline cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclopentane & 43242 & 0.090558 & 0.072454 \\ \hline cyclopentane & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylbenzene & 43288 & 0.032297 & 0.031740 \\ \hline ethylcyclohexane & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline indan & 98044 & 0.107456 & 0.166211 \\ \hline \end{array}$	cis-1,trans-2,3-trimethylcyclopentane	91038	0.019335	0.020406	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	cis-1-methyl-3-ethylcyclopentane	90080	0.023877	0.024562	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	cis-2-butene	43217	0.052624	0.072825	
$\begin{array}{c cccc} \hline cis-2-hexene & 98035 & 0.004412 \\ \hline cis-2-octene & 43266 & 0.004347 \\ \hline cis-2-pentene & 43227 & 0.019228 & 0.052091 \\ \hline crotonaldehyde & 98156 & 0.016630 & 0.115658 \\ \hline cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclohexene & 43273 & 0.003879 & 0.072454 \\ \hline cyclopentane & 43242 & 0.090558 & 0.075484 \\ \hline cyclopentene & 43292 & 0.006391 & 0.018761 \\ \hline ethane & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylbenzene & 43288 & 0.032297 & 0.031740 \\ \hline ethylcyclohexane & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 98159 & 0.365898 & 0.179029 \\ \hline indan & 98044 & 0.107456 & 0.166211 \\ \hline \end{array}$	cis-2-heptene	91028	0.016994	0.004142	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	cis-2-hexene	98035		0.004412	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	cis-2-octene	43266	0.004347		
crotonaldehyde981560.0166300.115658cyclohexane432480.3099100.324518cyclohexene432730.0038790.072454cyclopentane432420.0905580.075484cyclopentene432920.0063910.018761ethane432022.9271622.611943ethanol433020.0522671.055577ethylbenzene452031.1191040.802767ethylcyclohexane432880.0322970.031740ethylene432033.3972854.702096formaldehyde435022.1485242.163643hexaldehyde981590.3658980.179029indan980440.1074560.166211	cis-2-pentene	43227	0.019228	0.052091	
$\begin{array}{c c} cyclohexane & 43248 & 0.309910 & 0.324518 \\ \hline cyclohexane & 43273 & 0.003879 & 0.072454 \\ \hline cyclopentane & 43242 & 0.090558 & 0.075484 \\ \hline cyclopentene & 43292 & 0.006391 & 0.018761 \\ \hline ethane & 43202 & 2.927162 & 2.611943 \\ \hline ethanol & 43302 & 0.052267 & 1.055577 \\ \hline ethylbenzene & 45203 & 1.119104 & 0.802767 \\ \hline ethylcyclohexane & 43288 & 0.032297 & 0.031740 \\ \hline ethylcyclopentane & 98057 & 0.043304 \\ \hline ethylene & 43203 & 3.397285 & 4.702096 \\ \hline formaldehyde & 43502 & 2.148524 & 2.163643 \\ \hline hexaldehyde & 98059 & 0.365898 & 0.179029 \\ \hline indan & 98044 & 0.107456 & 0.166211 \\ \hline \end{array}$	crotonaldehyde	98156	0.016630	0.115658	
cyclohexene432730.0038790.072454cyclopentane432420.0905580.075484cyclopentene432920.0063910.018761ethane432022.9271622.611943ethanol433020.0522671.055577ethylbenzene452031.1191040.802767ethylcyclohexane432880.0322970.031740ethylcyclohexane980570.043304ethylene432033.3972854.702096formaldehyde981590.3658980.179029indan980440.1074560.166211	cyclohexane	43248	0.309910	0.324518	
cyclopentane432420.0905580.075484cyclopentene432920.0063910.018761ethane432022.9271622.611943ethanol433020.0522671.055577ethylbenzene452031.1191040.802767ethylcyclohexane432880.0322970.031740ethylcyclopentane980570.043304ethylene432033.3972854.702096formaldehyde435022.1485242.163643hexaldehyde981590.3658980.179029indan980440.1074560.166211	cyclohexene	43273	0.003879	0.072454	
cyclopentene 43292 0.006391 0.018761 ethane 43202 2.927162 2.611943 ethanol 43302 0.052267 1.055577 ethylbenzene 45203 1.119104 0.802767 ethylcyclohexane 43203 0.032297 0.031740 ethylene 98057 0.043304 ethylene 43203 3.397285 4.702096 formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	cyclopentane	43242	0.090558	0.075484	
ethane 43202 2.927162 2.611943 ethanol 43302 0.052267 1.055577 ethylbenzene 45203 1.119104 0.802767 ethylcyclohexane 43288 0.032297 0.031740 ethylene 98057 0.043304 ethylene 43203 3.397285 4.702096 formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	cyclopentene	43292	0.006391	0.018761	
ethanol433020.0522671.055577ethylbenzene452031.1191040.802767ethylcyclohexane432880.0322970.031740ethylcyclopentane980570.043304ethylene432033.3972854.702096formaldehyde435022.1485242.163643hexaldehyde981590.3658980.179029indan980440.1074560.166211	ethane	43202	2.927162	2.611943	
ethylbenzene452031.1191040.802767ethylcyclohexane432880.0322970.031740ethylcyclopentane980570.043304ethylene432033.3972854.702096formaldehyde435022.1485242.163643hexaldehyde981590.3658980.179029indan980440.1074560.166211	ethanol	43302	0.052267	1.055577	
ethylcyclohexane 43288 0.032297 0.031740 ethylcyclopentane 98057 0.043304 ethylene 43203 3.397285 4.702096 formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	ethylbenzene	45203	1.119104	0.802767	
ethylcyclopentane 98057 0.043304 ethylene 43203 3.397285 4.702096 formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	ethylcyclohexane	43288	0.032297	0.031740	
ethylene 43203 3.397285 4.702096 formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	ethylcyclopentane	98057	0.043304		
formaldehyde 43502 2.148524 2.163643 hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	ethylene	43203	3.397285	4.702096	
hexaldehyde 98159 0.365898 0.179029 indan 98044 0.107456 0.166211	formaldehvde	43502	2.148524	2.163643	
indan 98044 0.107456 0.166211	hexaldehyde	98159	0.365898	0.179029	
	indan	98044	0.107456	0.166211	

		Weight Percentage, %		
		OG2303	OG2304	
Species Name	SAROAD	Catalyzed Gasoline-Powered	Catalyzed Gasoline-Powered	
		Vehicle Stabilized Exhaust	Vehicle Stabilized Exhaust	
		(E6 Summer)	(E6 Winter)	
isobutane	43214	0.097842	0.498401	
isobutylene	43215	1.021746	0.985936	
isopentane	98132	3.066590	3.225566	
isoprene	43243	0.066677	0.023082	
isopropylbenzene (cumene)	98043	0.020091	0.020470	
methane	43201	27.691971	36.889619	
methyl alcohol	43301	0.020460	0.063320	
methyl ethyl ketone (mek)	43552	0.150660	0.106671	
methyl t-butyl ether (mtbe)	43378	0.467993	0.004079	
methylcyclohexane	43261	0.730725	0.303706	
methylcyclopentane	43262	0.841109	0.861391	
m-xylene	45205	2.267152	2.090324	
naphthalene	98046	0.368544	0.136460	
n-butane	43212	0.316705	2.997849	
n-decane	43238	0.344923	0.293857	
n-dodecane	43255	0.127582	0.050781	
n-heptane	43232	0.638928	0.447108	
n-hexane	43231	0.777615	0.759503	
n-nonane	43235	0.644852	0.124780	
n-octane	43233	0.213755	0.254167	
n-pentane	43220	0.943338	1.312607	
n-pentylbenzene	45255	0.007359	0.017655	
n-propylbenzene	45209	0.227370	0.078954	
n-undecane	43241	0.136448	0.070378	
n-valeraldehyde	98200	0.105116	0.034767	
o-xylene	45204	1.611576	1.174892	
propane	43204	0.632941	0.558541	
propionaldehyde	43504	0.189806	0.157532	
propylene	43205	2.197042	2.098877	
p-xylene	45206	1.195047	1.019910	
styrene	45220	0.218529	0.094347	
tolualdehyde	45502	0.109363	0.090498	
toluene	45202	4.754084	3.922254	
trans-1,2-dimethylcyclopentane	91021	0.118821	0.145395	
trans-1,3-dimethylcyclohexane	98059	0.038340	0.031176	
trans-1,3-dimethylcyclopentane	91019	0.171939	0.159661	
trans-1,3-pentadiene	90100		0.002773	
trans-1,4-dimethylcyclohexane	98181	0.036009	0.036042	
trans-1-methyl-3-ethylcyclopentane	91044	0.050472	0.043790	
trans-2-butene	43216	0.100621	0.144476	
trans-2-heptene	91026	0.095426	0.007939	
trans-2-hexene	98034	0.014036	0.034343	
trans-2-octene	43263	0.008692	0.005939	
trans-2-pentene	43226	0.060527	0.270345	
trans-3-heptene	98006	0.000672	0.003994	
trans-3-hexene	98136	0.020823	0.006454	
trans-4-octene	43250		0.004339	
Total		100.000000	100.000000	