

# **Organic Gas Speciation Profiles for Catalyzed Gasoline-Powered Vehicle Start Exhaust—E6 Fuel (OG2301 & OG2302)**

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## **1 Introduction**

This memo addresses an update of the current gasoline vehicle start exhaust profile assigned to 2004 through 2009 calendar year inventories (OG664) with new two new profiles, OG2301 (summer-grade E6 fuel) and OG2302 (winter-grade E6 fuel). The current profile was derived for E6 gasoline fuel by adjusting the start exhaust profile for MTBE-based fuel [1]; it was not based on source testing measurements. The new profiles are based on measurements. Minor to moderate percentage changes in toxic emission estimates (i.e. benzene and toluene) result from this update.

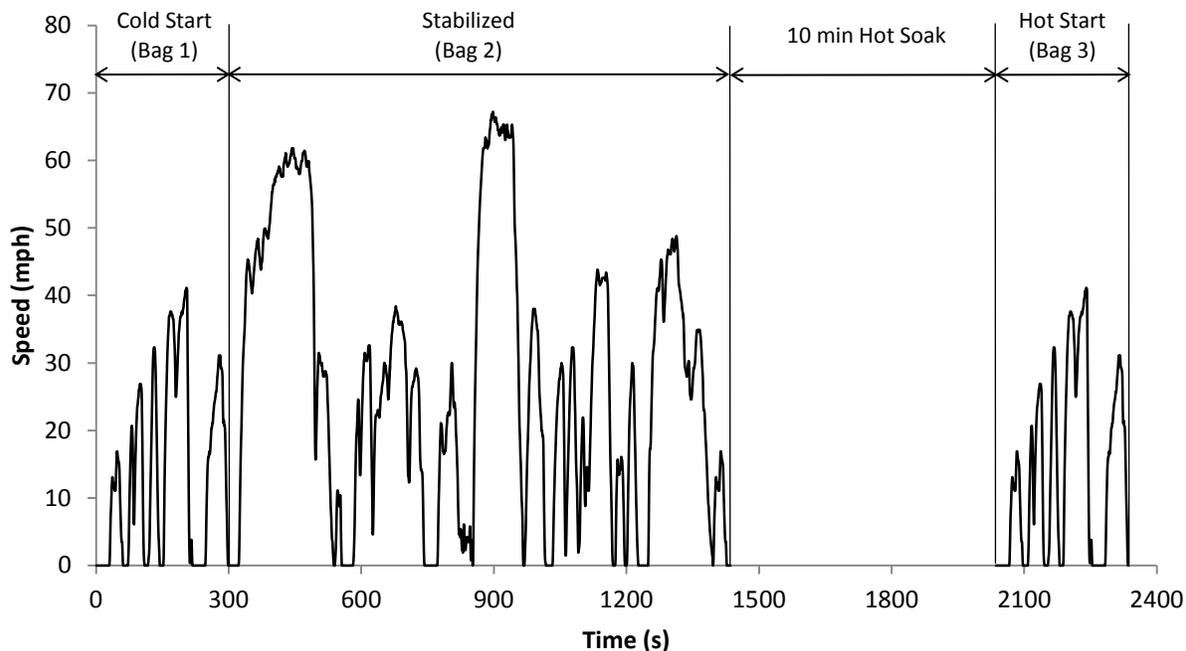
The updated start profiles proposed in this memo, OG2301 (Catalyzed gasoline vehicle start exhaust—summer-grade E6 fuel) and OG2302 (Catalyzed gasoline vehicle start exhaust—winter-grade E6 fuel), are based on source testing results. In 2005 and 2006, CARB conducted the Seventeenth Vehicle Surveillance program (VSP-17) 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 VSP-17, a total of forty-two in-use vehicles were randomly selected for exhaust organic gas speciation tests. Twenty-five of these vehicles (all equipped with catalyst converter) were fueled with summer grade E6 gasoline; and the other seventeen (sixteen equipped with catalyst converter) were fueled with winter grade E6 gasoline.

## **2 Methodology**

In the VSP-17 speciation tests, the organic gases from tailpipe exhaust were sampled as the vehicles were running on the unified cycle (UC), which was developed by CARB in 1992 as a dynamometer driving schedule for light-duty vehicles.

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 sample collected in Bag 1 actually consists of cold start (about the first 100 s) exhaust and running (about the last 200 s) exhaust; while the sample in Bag 3 includes hot start (about the first 100 s) exhaust and running (about the last 200 s) exhaust. Thus, the differences between Bag 1 and Bag 3 are emissions generated from start operations only. Because the processes of cold start and hot start are not specified in the CARB emission inventory, the general start exhaust speciation profile is discussed in this work.

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

Over two hundred organic compounds were detected in the Bag 1 and Bag 3 samples. For each test vehicle, the differences between Bag 1 and Bag 3 emissions were calculated for each organic gas species with negative values set to zero. The speciation profile for each vehicle was then obtained by dividing the emissions of each species by the sum of all emissions. The new profile OG2301 was calculated by averaging the twenty-five speciation profiles for catalyzed gasoline vehicles running with summer-grade E6 fuel; and the new profile OG2302 was calculated by averaging the sixteen speciation profiles for catalyzed gasoline vehicles running with winter-grade E6 fuel.

### 3 Results

The details of profiles OG2301 (E6 summer) and OG2302 (E6 winter) are tabulated in Appendix 1. The ratios of TOG/THC (total organic gases/total hydrocarbon) are 1.044 for OG2301 and 1.054 for OG2302. This ratio can be used to convert THC emission mass to actual weight TOG. The ROG/TOG ratios are 0.9133 and 0.8811 for OG2301 and OG2302, respectively.

- **Summer (OG2301) vs. winter (OG2302)**

The most abundant species in the two profiles include: ethylene (about 8%), toluene (about 8%), methane (7-10%), and propene (4-5%). The summer profile (OG2301) has 3.6% less methane and 1.4% less butane than the winter profile (OG2302); but the content of 2,2,4-trimethylpentane in the summer profile (OG2301) is 2.2% more than in the winter profile (OG2302). The differences of butane and 2,2,4-trimethylpentane in these two start exhaust profiles are consistent with the differences between summer and winter fuel profiles (i.e. as a consistency check comparison). The E6 summer fuel (OG681) consists of 3.0% less butane but 2.8% more 2,2,4-trimethylpentane than the E6 winter fuel (OG682), which is due to the change of Reid Vapor Pressure (RVP).

- **New (OG2301 & OG2302) vs. current (OG664)**

The current start profile used for 2004 and later years is OG664. This profile was not based on source testing measurements; rather, it was created for E6 gasoline fuel by adjusting the start exhaust profile for MTBE-based fuel [1]. However, the two new start profiles OG2301 and OG2302 are based on real testing data. Compared with OG664, the new profiles have higher methane (7-10% vs. 5%), ethylene (8% vs. 7%), and propylene (4-5% vs. 3%). The content of m-xylene, ethanol, C5 alkanes (e.g. n-pentane and isopentane), C6 alkanes (e.g. 2-methylpentane and 3-methylpentane) and methylcyclopentane are about 1-2% less in the new profiles than in OG664. The fraction of 2,2,4-trimethylpentane is about 2% less in OG2301 than in OG664 (Figure 1).

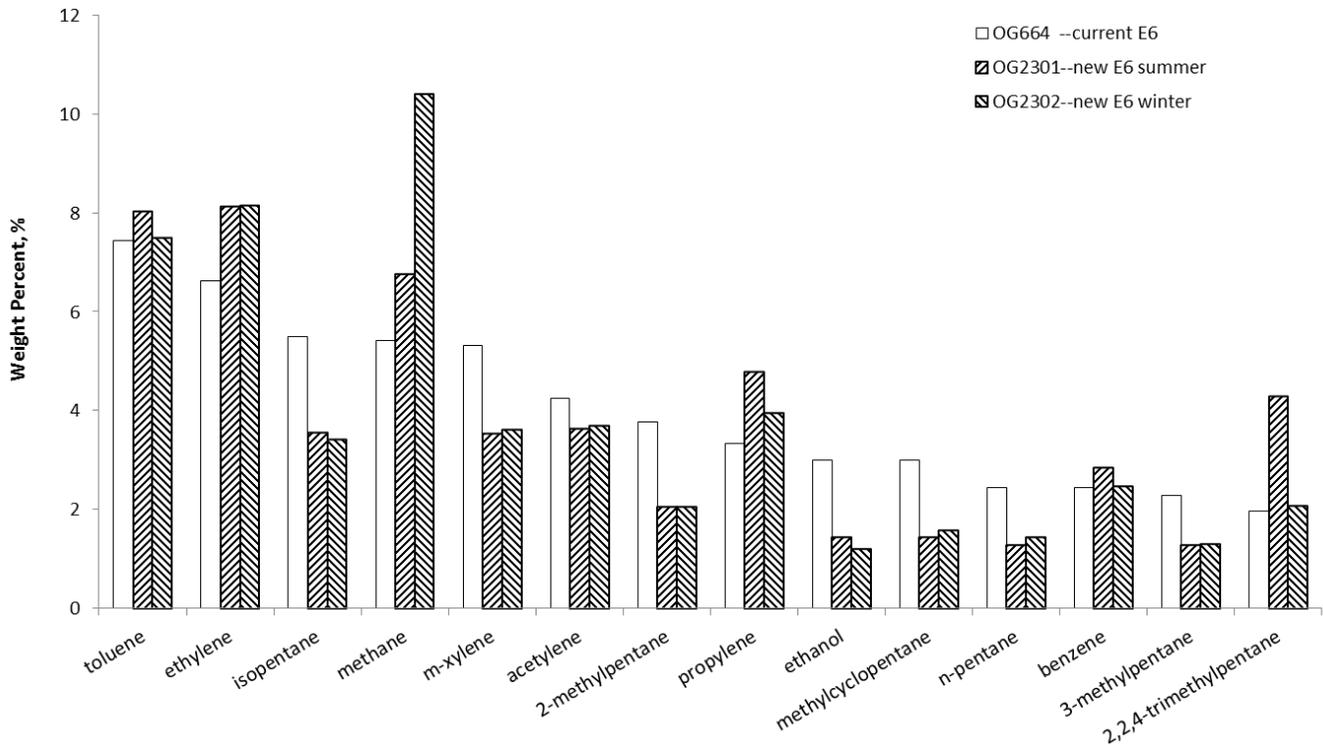


Figure 2. Comparison of selected species between OG664 and OG2301/OG2302

#### 4 Estimated Impacts of the Profile Update on the Emission Inventory

The newly-developed profiles, OG2301 and OG2302, will replace the current profile OG664 for categories associated with on-road gasoline vehicle start emissions for years 2004 to 2009 as E6 fuel was in use during this time period. The summer-grade profile (OG2301) will be used during the months of RVP regulatory control periods; while the winter-grade profile (OG2302) will be used for other months of the year. It should be noted that the control period varies for different air basins [2]. The related EIC/SCC codes for these emission processes are summarized in Appendix 2.

Based on the 2009 Almanac, statewide annual average TOG emissions for calendar year 2008 from the emission categories to which these profiles will be assigned are 128.10 tons/day, which is 18.5% of the total statewide on-road mobile source TOG emissions, and 1.5% of the grand total statewide TOG emissions [3]. Based on the ROG/TOG ratios derived from the new profiles OG2301 and OG2302, the statewide 2008 ROG will be 116.99 and 112.87 tons/day for summer and winter, respectively, which is 2.3 and 5.8% lower than the ROG estimated based on the current profile OG664 (ROG/TOG=0.9349); however, the replacement of the current OG664 with the new summer (OG2301) and winter (OG2302) profiles will cause a 16.3% and 1.6% increase in benzene emissions and 7.9% and 0.7% increase in toluene emissions, respectively (Table 1). The ozone forming potential (OFP) calculated based on the SAPRC07 mechanism [4] is 4.33 for OG2301 and 4.22 for OG2302, which are higher than the OFP of the current start profile (OG664) 4.05.

**Table 1. Changes in 2008 emissions of organic gas species for catalyst gasoline-vehicle start exhaust categories (a) OG2301 (New E6 summer) vs. OG664 (Current E6)**

Statewide Annual Ave. Emissions		OG664 Current E6 (tons/day)	OG2301 New E6 Summer (tons/day)	Change	
				Emission (tons/day)	Percentage
ROG		119.76	116.99	-2.77	-2.3%
Ozone forming potential, MIR (g O3/g ORG)		4.05	4.33	+0.28	+6.9%
Toxics	Benzene	3.12	3.63	+0.51	+16.3%
	Toluene	9.53	10.28	+0.75	+7.9%

**(b) OG2302 (New E6 winter) vs. OG664 (Current E6)**

Statewide Annual Ave. Emissions		OG664 Current E6 (tons/day)	OG2302 New E6 Winter (tons/day)	Change	
				Emission (tons/day)	Percentage
ROG		119.76	112.87	-6.89	-5.8%
Ozone forming potential, MIR (g O3/g ORG)		4.05	4.22	+0.17	+4.2%
Toxics	Benzene	3.12	3.17	+0.05	+1.6%
	Toluene	9.53	9.60	+0.07	+0.7%

## 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. *Title 13, California Code of Regulations, The California Reformulated Gasoline Regulations, Sections 2250-2273.5.*
3. *CEPAM*, 2013, California Air Resources Board.
4. *Titel 17, California Code of Regulations, Division 3, Chapter 1, Subchapter 8.6, Article 1. Maximum Incremental Reactivity Values, Sections 94700-94701.*

**Appendix 1. OG speciation profiles for catalyzed gasoline-powered vehicle start exhaust burning E6 summer and winter fuels**

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>	
		<i>OG2301 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Summer)</i>	<i>OG2302 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Winter)</i>
(1a,2a,3b)-1,2,3-trimethylcyclopentane	91038	0.089733	0.094376
(1-methylethyl)benzene	98043	0.088174	0.090257
(2-methylpropyl)benzene	45235	0.048577	0.019629
1-(1,1-dimethylethyl)-2-methylbenzene	45244	0.012500	0.004415
1-(1,1-dimethylethyl)-3,5-dimethylbenzene	45256	0.028366	0.017568
1,2,3,4-tetramethylbenzene	91109	0.037107	0.021025
1,2,3,5-tetramethylbenzene	91104	0.131098	0.137987
1,2,3-trimethylbenzene	45225	0.399651	0.423476
1,2,4,5-tetramethylbenzene	91103	0.090073	0.096339
1,2,4-trimethylbenzene	45208	1.894830	2.018221
1,2,4-trimethylcyclopentane	43400	0.149508	0.158752
1,2-butadiene	43221	0.017368	0.062350
1,2-diethylbenzene	98154	0.015900	0.024003
1,2-dimethyl-3-ethylbenzene	45254	0.089727	0.024083
1,2-dimethyl-4-ethylbenzene	45252	0.197150	0.246594
1,2-propadiene	43208	0.141279	0.195041
1,3,5-trimethylbenzene	45207	0.616244	0.674683
1,3,5-trimethylcyclohexane	98061	0.085037	0.063941
1,3-butadiene	43218	0.709925	0.586457
1,3-butadiyne	43222	0.008719	0.023900
1,3-diethylbenzene	45113	0.103212	0.119672
1,3-dimethyl-2-ethylbenzene	45253	0.053778	0.047800
1,3-dimethyl-4-ethylbenzene	45251	0.157191	0.175542
1,3-dimethyl-5-ethylbenzene	45257	0.276527	0.279776
1,3-di-n-propylbenzene	45237	0.026111	0.019345
1,4-diethylbenzene	45114	0.107060	0.104723
1,4-dimethyl-2-ethylbenzene	45250	0.191814	0.195673
1-buten-3-yne	98134	0.019968	
1-butene	43213	0.705141	0.726753
1-butyne	98131	0.000450	0.002242
1-ethyl-2-n-propylbenzene	98179	0.011624	0.013047
1-ethyl-tert-butyl-ether	99998	0.000992	
1-hexene	43245	0.068046	0.075799
1-methyl-2-(1-methylethyl)benzene	91096	0.076082	0.061953
1-methyl-2-ethylbenzene	99915	0.430488	0.458361
1-methyl-2-n-butylbenzene	45243	0.021207	0.026077
1-methyl-2-n-propylbenzene	98178	0.082760	0.072360
1-methyl-3-(1-methylethyl)benzene	98153	0.058378	0.031747
1-methyl-3-ethylbenzene	99912	1.271630	1.384503
1-methyl-3-n-propylbenzene	98152	0.260473	0.261875
1-methyl-4-(1-methylethyl)benzene	91094	0.026227	0.017737
1-methyl-4-ethylbenzene	99914	0.543483	0.594561
1-methyl-4-ethylcyclohexane	92001	0.053647	0.069157

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>	
		<i>OG2301 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Summer)</i>	<i>OG2302 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Winter)</i>
1-methyl-4-n-propylbenzene	98182	0.003781	0.044681
1-methylcyclopentene	92000	0.001092	0.146453
1-nonene	43267	0.040463	0.042031
1-octene	43265	0.063034	0.013233
1-pentene	43224	0.146317	0.175609
1-propyne	43209	0.017558	0.070632
2,2,3-trimethylbutane	43160	0.039696	0.003965
2,2,4-trimethylheptane	98174	0.037342	0.049033
2,2,4-trimethylhexane	45222	0.048410	0.020902
2,2,4-trimethylpentane	43276	4.296141	2.075336
2,2,5-trimethylheptane	43252	0.214932	0.141610
2,2,5-trimethylhexane	98033	0.675574	0.368097
2,2-dimethylbutane	43291	0.298101	0.358723
2,2-dimethylhexane	98138	0.012068	0.051277
2,2-dimethyloctane	98175	0.075335	0.051919
2,2-dimethylpentane	90042	0.006405	0.054377
2,2-dimethylpropane	98130	0.001320	0.001997
2,3,3-trimethylpentane	43280	0.001789	0.046850
2,3,4-trimethylpentane	43279	1.457128	0.831796
2,3,5-trimethylhexane	98141	0.079541	0.080762
2,3-dihydroindene (indan)	98044	0.183994	0.210934
2,3-dimethyl-1-butene	43234	0.004053	0.032921
2,3-dimethyl-2-pentene	90061	0.006982	0.024785
2,3-dimethylbutane	98001	0.828650	0.600380
2,3-dimethylheptane	98145	0.009483	0.017128
2,3-dimethylhexane	98139	0.476855	0.295937
2,3-dimethyloctane	98183	0.073742	0.038564
2,3-dimethylpentane	43274	1.554008	1.333478
2,4,4-trimethyl-1-pentene	98054	0.003857	0.034870
2,4,4-trimethyl-2-pentene	98055	0.032287	0.003099
2,4,4-trimethylhexane	45223	0.028176	0.046543
2,4-dimethyl-1-pentene	90063	0.003011	0.003065
2,4-dimethyl-2-pentene	90062	0.004391	0.001204
2,4-dimethylheptane	98142	0.113238	0.066066
2,4-dimethylhexane	43277	0.716445	0.516195
2,4-dimethyloctane	98149	0.085046	0.057147
2,4-dimethylpentane	43271	0.970185	0.677485
2,5-dimethylhexane	43278	0.701497	0.487418
2,5-dimethyloctane	98176	0.075224	0.065886
2,6-dimethylheptane	98157	0.156461	0.118913
2,6-dimethyloctane	98177	0.037706	0.030804
2-methyl-1,3-butadiene	43243	0.125220	0.113470
2-methyl-1-butene	43225	0.307814	0.250884
2-methyl-1-pentene	98040	0.054727	0.056415
2-methyl-2-butene	43228	0.416337	0.340760
2-methyl-2-hexene	90028	0.028763	0.009976
2-methyl-2-pentene	98004	0.124452	0.127171
2-methylbutane	98132	3.551859	3.412237

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>	
		<i>OG2301 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Summer)</i>	<i>OG2302 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Winter)</i>
2-methylheptane	98140	0.511690	0.580107
2-methylhexane	43275	1.056571	1.114728
2-methylindan	91108	0.076360	0.096097
2-methylnonane	90047	0.358978	0.332334
2-methylpentane	43229	2.055310	2.052084
2-methylpropene	43215	1.908143	1.204810
2-methyl-trans-3-hexene	91006	0.020070	0.006799
3,3-dimethyl-1-butene	98169	0.028468	0.012678
3,3-dimethylhexane	98171	0.025366	0.010837
3,3-dimethyloctane	98184	0.067675	0.072333
3,3-dimethylpentane	90040	0.114339	0.091570
3,4-dimethyl-1-pentene	90075	0.005281	0.006181
3,4-dimethylhexane	98150	0.127653	0.114000
3,5-dimethylheptane	98144	0.177986	0.191733
3-ethyl-2-pentene	98007	0.007490	0.004442
3-ethylpentane	43300	0.091290	0.086924
3-methyl-1-butene	43223	0.117435	0.086659
3-methyl-1-hexene	90030	0.000799	0.001431
3-methyl-1-pentene	43211	0.054793	0.036422
3-methyl-cis-2-hexene	90029	0.016181	0.002608
3-methyl-cis-2-pentene	98163	0.057995	0.065937
3-methylcyclopentene	43272	0.061340	0.047265
3-methylheptane	43298	0.574003	0.674444
3-methylhexane	43295	1.115241	1.184676
3-methyloctane	98172	0.270559	0.316217
3-methylpentane	43230	1.280880	1.297075
3-methyl-trans-2-pentene	43270	0.042809	0.030619
3-methyl-trans-3-hexene	90032	0.009054	0.004576
4-methyl-1-pentene	98135	0.001943	0.033780
4-methylheptane	43297	0.182920	0.209190
4-methylindan	91107	0.012046	0.020125
4-methyloctane	98173	0.395437	0.439479
4-methyl-trans-2-hexene	90031	0.017836	0.008610
4-methyl-trans-2-pentene	43293	0.078615	0.052163
5-methylindan	91106	0.065762	0.086908
acetaldehyde	43503	0.951349	1.275166
acetone (2-propanone)	43551	0.330498	0.388951
acrolein (propenal)	43505	0.006929	0.004070
benzaldehyde	45501	0.217376	0.292173
benzene	45201	2.835520	2.472889
butyraldehyde (butanal)	43510	0.033725	0.091580
cis-1,2-dimethylcyclohexane	91055	0.071466	0.064237
cis-1,3-dimethylcyclohexane	98180	0.257902	0.272220
cis-1,3-dimethylcyclopentane	91018	0.318122	0.351731
cis-1-methyl-3-ethylcyclopentane	90080	0.104866	0.115387
cis-2-butene	43217	0.323769	0.285669
cis-2-heptene	91028	0.037283	0.013929
cis-2-hexene	98035	0.007550	0.038691

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>	
		<i>OG2301 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Summer)</i>	<i>OG2302 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Winter)</i>
cis-2-octene	43266	0.013735	0.001060
cis-2-pentene	43227	0.144155	0.158512
cis-3-hexene	98003	0.000799	0.006824
crotonaldehyde	98156	0.102024	0.141192
cyclohexane	43248	0.607256	0.683235
cyclohexene	43273	0.045857	0.054053
cyclopentane	43242	0.201746	0.219907
cyclopentene	43292	0.148202	0.113865
ethane	43202	1.562321	1.090819
ethanol	43302	1.427873	1.196625
ethene	43203	8.132314	8.146528
ethylbenzene	45203	1.417089	1.463958
ethylcyclohexane	43288	0.109312	0.116524
ethylcyclopentane	98057	0.033697	0.001168
ethyne	43206	3.631952	3.702233
formaldehyde	43502	1.541993	1.834332
hexanal	98159	0.079838	0.048667
methacrolein	43506	0.067429	0.044645
methane	43201	6.772481	10.414614
methanol	43301		0.067184
methylcyclohexane	43261	0.776712	0.738456
methylcyclopentane	43262	1.439598	1.580386
methylethylketone	43552	0.083883	0.126155
methylpropane	43214	0.053451	0.369197
methyl-tert-butyl-ether	43378	0.049519	0.014658
m-tolualdehyde	45502	0.086408	0.084306
m-xylene	45205	3.530378	3.611055
naphthalene	98046	0.063994	0.026462
n-butane	43212	0.422002	1.838861
n-decane	43238	0.226963	0.138895
n-dodecane	43255	0.108532	0.014520
n-heptane	43232	0.697704	0.799063
n-hexane	43231	1.044985	1.237502
n-nonane	43235	0.242230	0.256629
n-octane	43233	0.367226	0.417043
n-pentane	43220	1.273893	1.433924
n-pentylbenzene	45255	0.012699	0.021803
n-propylbenzene	45209	0.285716	0.319829
n-undecane (hendecane)	43241	0.111498	0.061037
o-xylene	45204	1.953450	1.951193
propane	43204	0.080814	0.127862
propene	43205	4.787746	3.942810
propionaldehyde (propanal)	43504	0.109996	0.159442
p-xylene	45206	1.766653	1.805014
styrene	45220	0.282979	0.283079
toluene	45202	8.025091	7.495735
trans-1,2-dimethylcyclopentane	91021	0.260478	0.308809
trans-1,3-dimethylcyclohexane	98059	0.150750	0.158954

<i>Species Name</i>	<i>SAROAD</i>	<i>Weight Percentage, %</i>	
		<i>OG2301 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Summer)</i>	<i>OG2302 Catalyzed Gasoline-Powered Vehicle Start Exhaust (E6 Winter)</i>
trans-1,3-dimethylcyclopentane	91019	0.338556	0.374234
trans-1,3-pentadiene	90100	0.018921	0.026548
trans-1,4-dimethylcyclohexane	98181	0.099721	0.096305
trans-1-methyl-3-ethylcyclopentane	91044	0.125158	0.132920
trans-2-butene	43216	0.434688	0.379370
trans-2-heptene	91026	0.024531	0.029815
trans-2-hexene	98034	0.099295	0.104896
trans-2-octene	43263	0.041412	0.043108
trans-2-pentene	43226	0.267402	0.266926
trans-3-heptene	98006	0.042040	0.040558
trans-3-hexene	98136	0.057795	0.061369
trans-4-octene	43250	0.018411	0.026974
valeraldehyde	98200	0.024231	0.021001
<i>Total</i>		<i>100.000000</i>	<i>100.000000</i>

**Appendix 2. EICs/SCCs to be associated with catalyzed gasoline-powered vehicle start exhaust speciation profiles**

<i>EIC/SCC</i>	<i>Names</i>		
2	EMFAC/DTIM	CATALYST START EXHAUST	GASOLINE, ALL VEHICLES
202	EMFAC/DTIM	CATALYST START EXHAUST	GASOLINE, LMV
302	EMFAC/DTIM	CATALYST START EXHAUST	GASOLINE, HDV
43075	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	COLD START
46920	ON-ROAD VEHICLES	LIGHT DUTY TRUCKS	COLD START
82339	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST COLD START
82362	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST COLD START
82446	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST HOT START
82479	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST HOT START
84020	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST STARTS
84152	ON-ROAD VEHICLES	LT. DUTY TRUCKS - 1	CATALYST STARTS
84368	ON-ROAD VEHICLES	MEDIUM TRUCKS	CATALYST STARTS
86223	ON-ROAD VEHICLES	LT. DUTY TRUCKS - 2	CATALYST STARTS
86413	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS- 1	CATALYST STARTS
86538	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS- 2	CATALYST STARTS
86645	ON-ROAD VEHICLES	MEDIUM HEAVY DUTY GAS	CATALYST STARTS
86769	ON-ROAD VEHICLES	HEAVY HEAVY DUTY GAS	CATALYST STARTS
86967	ON-ROAD VEHICLES	MOTORCYCLES (MCY)	CATALYST STARTS
87148	ON-ROAD VEHICLES	HEAVY DUTY GAS URBAN	CATALYST STARTS
87312	ON-ROAD VEHICLES	SCHOOL BUSES (SB)	CATALYST STARTS
87528	ON-ROAD VEHICLES	MOTOR HOMES (MH)	CATALYST STARTS
71073011000000	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST COLD START
71073111000000	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST STARTS
71073211000000	ON-ROAD VEHICLES	LIGHT DUTY PASSENGER	CATALYST HOT START
72073011000000	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST COLD START
72073211000000	ON-ROAD VEHICLES	LIGHT/MEDIUM TRUCKS	CATALYST HOT START
72273111000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS – 1	CATALYST STARTS
72373111000000	ON-ROAD VEHICLES	LT. DUTY TRUCKS – 2	CATALYST STARTS
72473111000000	ON-ROAD VEHICLES	MEDIUM TRUCKS	CATALYST STARTS
73273111000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS- 1	CATALYST STARTS
73373111000000	ON-ROAD VEHICLES	LT.HVY.DTY TRUCKS- 2	CATALYST STARTS
73473111000000	ON-ROAD VEHICLES	MED. HVY. DTY TRUCKS	CATALYST STARTS
73673111000000	ON-ROAD VEHICLES	HVY. HVY. DTY TRUCKS	CATALYST STARTS
75073111000000	ON-ROAD VEHICLES	MOTORCYCLES (MCY)	CATALYST STARTS
76273111000000	ON-ROAD VEHICLES	HVY. GAS URBAN BUSES	CATALYST STARTS
77073111000000	ON-ROAD VEHICLES	SCHOOL BUSES (SB)	CATALYST STARTS
77173111000000	ON-ROAD VEHICLES	SCHOOL BUSES GAS	CATALYST STARTS
77673111000000	ON-ROAD VEHICLES	OTHER BUSES	CATALYST STARTS
77773111000000	ON-ROAD VEHICLES	OTHER BUSES GAS	CATALYST STARTS
78073111000000	ON-ROAD VEHICLES	MOTOR HOMES (MH)	CATALYST STARTS