Organic Gas Speciation Profile for Off-Highway Recreational Vehicle Evaporative Emissions (OG2311)

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1 Introduction

Off-highway recreational vehicle (OHRV) engines are defined as 4-stroke or 2-stroke, gasoline, diesel, or alternate-fuel powered engines or electric motors that are designed for powering off-road recreational vehicles. OHRVs primarily include off-highway motorcycles (OHMCs), all-terrain vehicles (ATVs), minibikes, golf carts and specialty vehicle carts. OHRVs are frequently used in occupational disciplines that include, but are not limited to, agricultural, building and trades, landscape maintenance, and law enforcement.

Due to the lack of source testing data, the categories of OHRV evaporative emissions are assigned with profiles for gasoline headspace vapor. For example, in CARB's current inventory, OG691 (*headspace vapor of summer-grade E10*) and OG695 (*headspace vapor of winter-grade E10*) are applied for OHRV evaporation for 2010 and later years consistent with 10% ethanol gasoline fuel used in California [1]. Evaporative emissions generally occur due to the permeation of fuel through plastic and rubber components of the engine and fuel delivery system of a vehicle; therefore, the gasoline headspace vapor profiles may not truly characterize the composition of the evaporative emissions.

CARB's inventory indicates that most of the OHRVs in the state are equipped with spark ignition (SI) engines running on gasoline fuel rather than compression ignition (CI) engines running on diesel fuel, thus developing speciation profiles for gasoline-powered OHRV is the focus of this work. Project 2R1404 was performed at CARB's Haagen-Smit Laboratory (HSL) in El Monte, CA in 2014. The primary objective of this project was to conduct exhaust and evaporative emissions testing for OHRVs. As part of the project, organic gas (OG) speciation tests were conducted on evaporation from four OHMCs, and a new OG profile was generated based on the testing data. The profile, *OG2311: Off-highway recreational vehicle evaporation (E10),* will replace the currently-in-use OG691 and OG695 for OHRV evaporative emissions for 2010 and later years.

2 Methodology

The specific focus of Project 2R1404 was OHMC. A total of eighteen OHMCs were recruited for the test through a combination of CARB fleet vehicles, CARB standard procurement contracts through rental agencies and private owners, and vehicle purchasing. Four different makes and models were selected for the evaporation speciation testing. Their makes and models are listed in Table 1.

Table 1. Four test motorcycles in Project 2R1404.

Vehicle Make/Model	*Vehicle Model Year*	*Engine Type*	*Fuel Delivery System*	*Engine Displacement*
YAMAHA/WR450FF	2015	4-Stroke	EFI*	490 cc
KTM/250XC-FW	2013	4-Stroke	EFI*	249 cc
KAWASAKI/KX250Y	2012	4-Stroke	EFI*	250 cc
HONDA/CRF150R	2013	4-Stroke	Carbureted	150 cc

Note: *EFI: Electronic Fuel Injection

All test vehicles were filled with California Phase III certification gasoline fuel containing 10% ethanol by volume, i.e., E10. The evaporation testing was conducted in a sealed housing for evaporative determination (SHED) enclosure located at the HSL testing facility. The speciation tests were performed for diurnal evaporation, which represents the total evaporative emissions resulting from the daily cycle of ambient temperatures. Tedlar bags were used to directly collect organic gas samples from the enclosure for GC speciation analysis (MLD SOP#102/103) [2]. The alcohols in the evaporation were obtained by flowing exhaust through deionized water contained in glass impingers and analyzed by using GC (MLD SOP#101) [3].

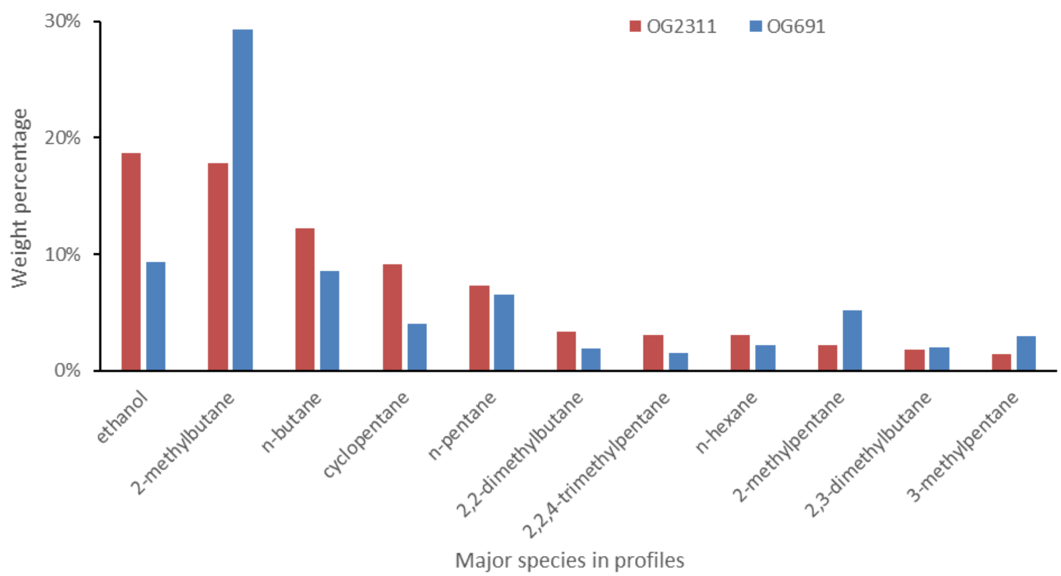
Over one hundred organic compounds were measured in the evaporation samples. Emissions from three diurnal evaporation periods (0-24 hr period, 24-48 hr period, and 48-72 hr period) were collected and analyzed for each test vehicle. The emissions of individual species from the three diurnal evaporation periods were averaged, and the speciation profile for each vehicle was calculated by dividing the emission of each species by the total emissions of all the species generated from the same test vehicle. The speciation profile consists of the weight percent of total organic gas (TOG) for each compound. Because the gas concentrations collected from the 2013 HONDA/CRF150R in the SHED were too high to be measured, there was no test data reported for this carbureted OHMC. Therefore, only three individual speciation profiles were obtained from the evaporation test. The profiles are for the 2015 YAMAHA MC, the 2013 KTM MC and the 2012 KAWASAKI MC, respectively. It has to be noted that all three profiles are for engines equipped with an Electronic Fuel Injection (EFI) system (Table 1). Since the diurnal processes are similar in carbureted and EFI systems, and the OHRVs with EFI system are dominating the market, the profile OG2311 are applied for OHRVs with either carburetor or EFI systems.

3 Results and Discussion

The evaporative emissions are separated into three processes: diurnal, hot soak, and running loss; however, for off-road engines, the diurnal evaporation is much more important than hot soak and running loss due to their limited operating time. In addition, CARB's inventory doesn't specify the OHRV evaporation by process and the relevant categories are all generally classified as "evaporation". Therefore, the new profile OG2311 will be used to represent all evaporative emissions from OHRV (Appendix-Table 1) although it was made based on diurnal testing data. Also, since the test fuel was not specified as summer-grade or winter-grade E10, the new profile will replace both OG691 and OG695 for all seasons. The details of the new profile are provided in the Appendix-Table 2.

Ethanol and 2-methylbutane are the two dominant species in OG2311, and they are both close to 20% of the evaporation TOG. The contribution of n-pentane, cyclopentane and n-butane to the evaporative emissions varies from 9 to 12% in the new profile. Figure 1 compares the new profile OG2311 and the currently-in-use profiles OG691 (E10 summer headspace vapor) and OG695 (E10 winter headspace vapor) by major species. The diurnal evaporation and headspace vapor have the same major contributors, such as ethanol, 2-methylbutane, n-butane and n-pentane. Compared to OG691 and OG695, OG2311 has lower 2-methylbutane, but higher ethanol.

a.



b.

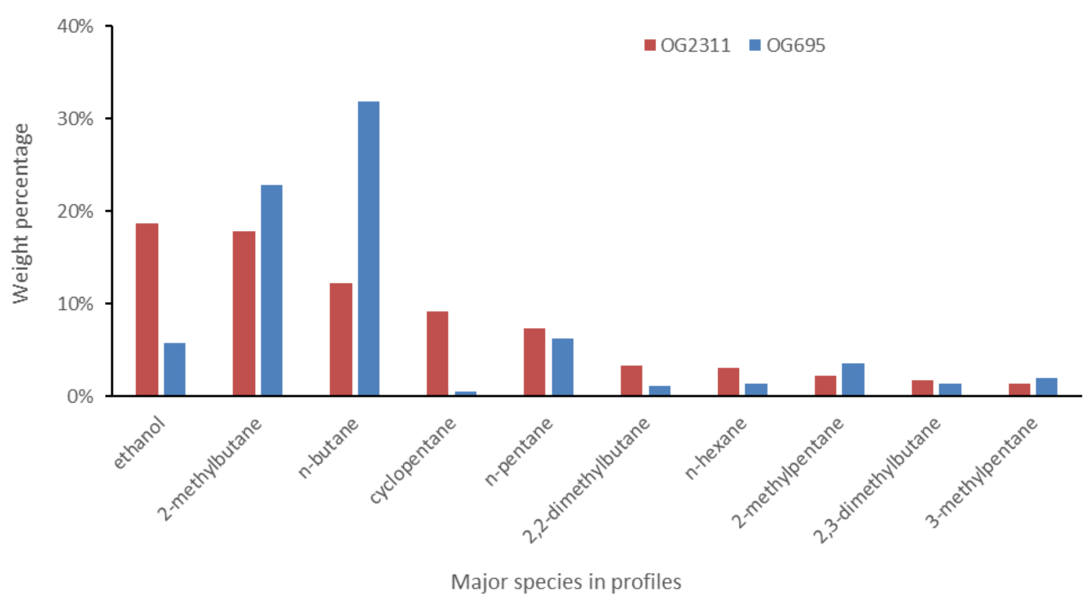


Figure 1. Major species comparison (a) OG2311 vs. OG691 and (b) OG2311 vs. OG695.

The ROG/TOG (reactive organic gas/total organic gas) ratio of OG2311 is very close to the current profiles: 0.998 for OG2311, and 1.00 for OG691 and OG695. The ozone forming potential (OFP) of the new profile is 1.98 g O3/g organics, based on SAPRC07.

4 Estimated Impacts of the Profile Update on the Emission Inventory

OG2311 will replace OG691 and OG695 for the OHRV evaporation categories for 2010 and later years. The affected EICs are summarized in the Appendix-Table 1. Implementation of the new profile for the related categories will impact the estimation of their ROG and toxic emissions. The OFP contributed by these categories will also be affected. Using 2016 emissions as an example, the statewide annual average TOG emissions of OHRV evaporation are about 7.18 tons/day based on CEPAM (version 1.05): 2016 SIP Baseline Emission Projection for year 2016 [4]. Using the new profile OG2311, the corresponding ROG of these OHRV evaporative emissions will be 7.17 tons/day, which is 0.14% lower than the ROG emissions estimated based on the current profiles OG691 or OG695. If the new profile is applied, the calculated OFP of these categories will be 18.88% lower than the estimation using the current profile OG691 but 1.50% higher than using OG695. For toxic species, the emissions of benzene and toluene will increase 50% and 170% with the application of the new profiles compared to the values calculated based on OG691; the increase will be 200% and 350% when compared to OG695.

Table 2. Changes on emissions of organic gas species for OHRV evaporation related categories (2016).

a. OG2311 vs. OG691

Statewide Annual Ave. Emissions		*Current OG691 (tons/day)*	*New OG2311 (tons/day)*	*Change*	
				Emissions (tons/day)	*Percentage*
ROG		7.18	7.17	-0.01	-0.14%
Ozone forming potential		17.53	14.22	-3.31	-18.88%
Toxics	Benzene	0.04	0.06	+0.02	+50.00%
	Toluene	0.10	0.27	+0.17	+170.00%

b. OG2311 vs. OG695

Statewide Annual Ave. Emissions		*Current OG695 (tons/day)*	*New OG2311 (tons/day)*	*Change*	
				Emissions (tons/day)	*Percentage*
ROG		7.18	7.17	-0.01	-0.14%
Ozone forming potential		14.01	14.22	+0.21	+1.50%
Toxics	Benzene	0.02	0.06	+0.04	+200.00%
	Toluene	0.06	0.27	+0.21	+350.00%

References:

1. *California Air Resources Board Main Speciation Profiles*, 2018, California Air Resources Board, *Accessed*: May 18, 2018.
2. 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.
3. 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.
4. *CEPAM*, 2018, California Air Resources Board, *Accessed*: Feb 2, 2018.

Appendix

Table 1. OHRV evaporative emission related categories.

SCC/EIC	Category Name			
85087011006253	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G2-25-Evap.
85087011006255	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G4-25-Evap.
85087011006553	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G2-50-Evap.
85087011006555	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G4-50-Evap.
85087011006653	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G2-120-Evap.
85087011006655	OFF-ROAD RECREATIONAL VEHICLES	SNOWMOBILES	GASOLINE (UNSPECIFIED)	Snowmobiles -G4-120-Evap.
85087111000021	OFF-ROAD RECREATIONAL VEHICLES	RECREATIONAL EQUIPMENT	GASOLINE (UNSPECIFIED)	TWO-STROKE EVAPORATIVE
85087111000041	OFF-ROAD RECREATIONAL VEHICLES	RECREATIONAL EQUIPMENT	GASOLINE (UNSPECIFIED)	FOUR-STROKE EVAPORATIVE
85087211004053	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G2-5-Evap.
85087211004055	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G4-5-Evap.
85087211004153	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G2-15-Evap.
85087211004155	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G4-15-Evap.
85087211004253	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G2-25-Evap.
85087211004255	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G4-25-Evap.
85087211004553	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G2-50-Evap.

SCC/EIC	Category Name			
85087211004555	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G4-50-Evap.
85087211004653	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G2-120-Evap.
85087211004655	OFF-ROAD RECREATIONAL VEHICLES	OFF-ROAD MOTORCYCLES	GASOLINE (UNSPECIFIED)	Off-Road Motorcycles -G4-120-Evap.
85087311003053	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	Minibikes -G2-5-Evap.
85087311003055	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	Minibikes -G4-5-Evap.
85087311003253	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	Minibikes -G2-15-Evap.
85087311003255	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	Minibikes -G4-15-Evap.
85087311003453	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	Minibikes -G2-25-Evap.
85087311003455	OFF-ROAD RECREATIONAL VEHICLES	MINIBIKES	GASOLINE (UNSPECIFIED)	MINIBIKES -G4-25-EVAP.
85087411000953	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G2-5-Evap.
85087411000955	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G4-5-Evap.
85087411001053	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G2-15-Evap.
85087411001055	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G4-15-Evap.
85087411001253	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G2-25-Evap.
85087411001255	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G4-25-Evap.
85087411001553	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G2-50-Evap.

SCC/EIC	Category Name			
85087411001555	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G4-50-Evap.
85087411001653	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G2-120-Evap.
85087411001655	OFF-ROAD RECREATIONAL VEHICLES	ALL-TERRAIN VEHICLES (ATV'S)	GASOLINE (UNSPECIFIED)	All-Terrain Vehicles (ATVs)-G4-120-Evap.
85087511002153	OFF-ROAD RECREATIONAL VEHICLES	GOLF CARTS	GASOLINE (UNSPECIFIED)	Golf Carts -G2-15-Evap.
85087511002155	OFF-ROAD RECREATIONAL VEHICLES	GOLF CARTS	GASOLINE (UNSPECIFIED)	Golf Carts -G4-15-Evap.
85087711005153	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G2-5-Evap.
85087711005155	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G4-5-Evap.
85087711005253	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G2-15-Evap.
85087711005255	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G4-15-Evap.
85087711005353	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G2-25-Evap.
85087711005355	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G4-25-Evap.
85087711005453	OFF-ROAD RECREATIONAL VEHICLES	SPECIALTY VEHICLES CARTS	GASOLINE (UNSPECIFIED)	Specialty Vehicles Carts -G2-15-Evap.

Table 2. OG speciation profiles for OHRV evaporation (OG2311).

Species Name	*SAROAD*	*Weight Percentage, %*
(1a,2a,3b)-1,2,3-trimethylcyclopentane	91038	0.003315
(1-methylethyl)benzene	98043	0.008129
(2-methylpropyl)benzene	45235	0.018657
1,2,3,5-tetramethylbenzene	91104	0.002450
1,2,3-trimethylbenzene	45225	0.077365
1,2,4,5-tetramethylbenzene	91103	0.001280
1,2,4-trimethylbenzene	45208	0.489326
1,2,4-trimethylcyclopentane	43400	0.011086
1,2-dimethyl-4-ethylbenzene	45252	0.008445
1,3,5-trimethylbenzene	45207	0.142245
1,3-diethylbenzene	45113	0.004234
1,3-dimethyl-2-ethylbenzene	45253	0.002264
1,3-dimethyl-4-ethylbenzene	45251	0.005601
1,3-dimethyl-5-ethylbenzene	45257	0.015839
1,4-dimethyl-2-ethylbenzene	45250	0.007779
1-butyne	98131	0.004561
1-hexene	43245	4.426566
1-methyl-2-(1-methylethyl)benzene	91096	0.004332
1-methyl-2-ethylbenzene	99915	0.094022
1-methyl-2-n-propylbenzene	98178	0.005612
1-methyl-3-(1-methylethyl)benzene	98153	0.005908
1-methyl-3-ethylbenzene	99912	0.136931
1-methyl-3-n-propylbenzene	98152	0.026154
1-methyl-4-(1-methylethyl)benzene	91094	0.001378
1-methyl-4-ethylbenzene	99914	0.234104
1-methyl-4-ethylcyclohexane	92001	0.007513
1-methyl-4-n-propylbenzene	98182	0.004629
1-nonene	43267	0.001235
1-pentene	43224	0.001852
2,2,3-trimethylbutane	43160	0.056285
2,2,4-trimethylheptane	98174	0.001149
2,2,4-trimethylpentane	43276	3.060372
2,2,5-trimethylheptane	43252	0.002921
2,2,5-trimethylhexane	98033	0.141916
2,2-dimethylbutane	43291	3.314205
2,2-dimethylhexane	98138	0.003862
2,2-dimethyloctane	98175	0.001671
2,2-dimethylpentane	90042	0.077852
2,2-dimethylpropane	98130	0.198581
2,3,3-trimethylpentane	43280	0.041249
2,3,4-trimethylpentane	43279	0.711631
2,3,5-trimethylhexane	98141	0.008677
2,3-dihydroindene	98044	0.023635
2,3-dimethyl-1-butene	43234	0.018410
2,3-dimethyl-2-pentene	90061	0.326297

Species Name	*SAROAD*	*Weight Percentage, %*
2,3-dimethylbutane	98001	1.777287
2,3-dimethylheptane	98145	0.001882
2,3-dimethylhexane	98139	0.126199
2,3-dimethyloctane	98183	0.004174
2,3-dimethylpentane	43274	0.421376
2,4,4-trimethyl-2-pentene	98055	0.052913
2,4,4-trimethylhexane	45223	0.010353
2,4-dimethyl-2-pentene	90062	0.021533
2,4-dimethylheptane	98142	0.026860
2,4-dimethylhexane	43277	0.340985
2,4-dimethyloctane	98149	0.002712
2,4-dimethylpentane	43271	0.730367
2,5-dimethylhexane	43278	0.272672
2,5-dimethyloctane	98176	0.002924
2,6-dimethylheptane	98157	0.002090
2-methyl-1,3-butadiene	43243	0.030766
2-methyl-1-butene	43225	0.004527
2-methyl-2-butene	43228	0.009819
2-methyl-2-pentene	98004	0.004527
2-methylbutane	98132	17.792220
2-methylheptane	98140	0.064145
2-methylhexane	43275	0.394544
2-methylindan	91108	0.002004
2-methylnonane	90047	0.128222
2-methylpentane	43229	2.194442
2-methylpropene	43215	0.002881
2-methyl-trans-3-hexene	91006	0.004114
3,3-dimethyl-1-butene	98169	0.001235
3,3-dimethylhexane	98171	0.001362
3,3-dimethyloctane	98184	0.013887
3,3-dimethylpentane	90040	0.016793
3,4-dimethylhexane	98150	0.030930
3,5-dimethylheptane	98144	0.006384
3-ethylpentane	43300	0.004408
3-methyl-1-hexene	90030	0.008022
3-methyl-1-pentene	43211	0.001956
3-methyl-cis-2-hexene	90029	0.000721
3-methyl-cis-2-pentene	98163	0.001235
3-methylcyclopentene	43272	0.001808
3-methylheptane	43298	0.053136
3-methylhexane	43295	0.297758
3-methyloctane	98172	0.013357
3-methylpentane	43230	1.416478
3-methyl-trans-2-pentene	43270	0.003085
4-methyl-1-pentene	98135	0.001028
4-methyl-cis-2-pentene	98170	0.005348
4-methylheptane	43297	0.020807

Species Name	*SAROAD*	*Weight Percentage, %*
4-methyloctane	98173	0.007941
4-methyl-trans-2-pentene	43293	0.011724
5-methylindan	91106	0.000873
acetylene	43206	0.003732
benzene	45201	0.797125
cis-1,2-dimethylcyclohexane	91055	0.003294
cis-1,3-dimethylcyclohexane	98180	0.027012
cis-1,3-dimethylcyclopentane	91018	0.029984
cis-2-butene	43217	0.153858
cis-2-hexene	98035	0.000618
cis-2-octene	43266	0.003294
cis-2-pentene	43227	0.002675
cyclohexane	43248	0.823681
cyclohexene	43273	0.020426
cyclopentane	43242	9.122861
ethane	43202	0.004348
ethanol	43302	18.645343
ethene	43203	0.005622
ethylbenzene	45203	0.261529
ethylcyclohexane	43288	0.002983
ethylcyclopentane	98057	0.023243
isobutane	43214	0.369299
m- & p-xylene	45205	0.829297
methane	43201	0.195371
Methanol	43301	0.070985
methylcyclohexane	43261	0.283281
methylcyclopentane	43262	0.714529
n-butane	43212	12.266533
n-decane	43238	0.018889
n-dodecane	43255	0.001110
n-heptane	43232	0.348749
n-hexane	43231	3.026093
n-nonane	43235	0.044559
n-octane	43233	0.102574
n-pentane	43220	7.284972
n-propylbenzene	45209	0.026654
n-undecane (hendecane)	43241	0.003335
o-xylene	45204	0.291267
propane	43204	0.218355
propene	43205	0.002902
styrene	45220	0.013232
toluene	45202	3.741244
trans-1,2-dimethylcyclopentane	91021	0.041822
trans-1,3-dimethylcyclohexane	98059	0.003829
trans-1,3-dimethylcyclopentane	91019	0.038268
trans-1,3-pentadiene	90100	0.002198
trans-1,4-dimethylcyclohexane	98181	0.014862

Species Name	*SAROAD*	*Weight Percentage, %*
trans-1-methyl-3-ethylcyclopentane	91044	0.001235
trans-2-hexene	98034	0.010287
trans-2-octene	43263	0.002882
trans-2-pentene	43226	0.005556
trans-3-hexene	98136	0.005864
Total		*100.000000*