**AVIATION GASOLINE DISTRIBUTION – STAGE 1**

***a. Source Category Description***

Aviation gasoline (also called “AvGas”) is the only aviation fuel that contains lead as a knock-out component for small reciprocating, piston-engine crafts in civil aviation.1 Commercial and military aviation rarely use this fuel. AvGas is shipped to airports and is filled into bulk terminals, and then into tanker trucks. These processes fall under the definition of stage 1, displacement vapors during the transfer of gasoline from tank trucks to storage tanks, and vice versa. These processes are subject to EPA’s maximum available control technology (MACT) standards for gasoline distribution.2

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **SCC Level 1** | **SCC Level 2** | **SCC Level 3** | **SCC Level 4** |
| 2501080050 | Storage and Transport | Petroleum and Petroleum Product Storage | Airports : Aviation Gasoline | Stage 1: Total |

***b. Activity Data***

The amount of AvGas consumed by each state in 2014 was obtained from the Energy Information Administration (EIA) State Energy Data System (SEDS).3 This information was used to calculate county-level emissions estimates for one criteria pollutant and ten hazardous air pollutants (HAPs). Assumptions for bulk plant processes are summarized in Table 1.

***c. Emission Factors***

Emission factors were provided by ESD and EIG publications (Tables 2 and 3).1,4,5,6

***d. Emissions***

In general, county-level emissions were calculated by multiplying AvGas consumption by the appropriate emission factors (Tables 2 and 3) and then summing emissions. The county-level AvGas consumption was estimated by multiplying the ratio of county Landing-Take Offs (LTOs) to state LTOs by the total state AvGas consumption. LTO data for turbine-powered airplanes were excluded because turbine-powered planes do not use AvGas.7 In addition, LTOs at airports that do not have AvGas refueling were also excluded.

***e. Sample Calculations***

County-Level Calculations

Amount of AvGas consumed in 2014 (thousand barrels) by Alabama = 57

*Conversion: 1 barrel = 42 gallons*

*1 gallon = 3.78 liters*

*1 kg = 2.205 lb*

*1 kg = 1,000,000 mg*

*1 ton = 2000 lb*

*Step 1 - Convert AvGas consumption into gallons using conversion factors.*

Amount of AvGas consumed in 2014 (gallons) = 57,000 barrels \* 42 gallons/barrel

Amount of AvGas consumed in 2013 (gallons) = 2,394,000

*Step 2 - Calculate the ratio of county to state LTOs.*

Total number of LTOs in Alabama in 2012 = 689,947

Total number of LTOs in Autauga County, Alabama in 2012 = 3,064

Ratio of county/state LTOs in Autauga County, Alabama = 3,064/689,947

Ratio of county/state LTOs in Autauga County, Alabama = 4.44E-3

*Step 3 - Calculate the estimated AvGas consumption at the county level.*

Amount of AvGas consumed in 2014 in Autauga County = 2,394,000gallons \* 4.44E-3

Amount of AvGas consumed in 2014 in Autauga County = 10,633 gallons

*Step 4 - Use the gallons of AvGas consumed and apply the non-fugitive VOC emission factors in Table 2 to calculate non-fugitive VOC estimates*.

Unloading/Tank Filling: tank fill VOC emissions = 9.02E-3 LB/GAL \* 10,633 GAL / 2,000 LB/TON

Unloading/Tank Filling: tank fill VOC emissions = **4.80E-2** tpy

Unloading/Tank Filling: Storage tank VOC emissions = 3.61E-3 LB/GAL \* 10,633 GAL / 2,000 LB/TON

Unloading/Tank Filling: Storage tank VOC emissions = **1.92E-2** tpy

Tank Truck Filling - Composite VOC Emissions = 1.03E-2 LB/GAL \* 10,633 GAL \* / 2,000 LB/TON

Tank Truck Filling - Composite VOC Emissions = **5.48E-2** tpy

Storage Tank - Breathing losses VOC Emissions = 1.69E-3 LB/GAL \* 10,633 GAL \* / 2,000 LB/TON

Storage Tank - Breathing losses VOC Emissions = **9.01E-3** tpy

*Step 5 - Use the assumptions in Table 1 and the fugitive VOC emission factors in Table 2 to generate fugitive VOC emissions.*

Ratio of LTOs in Autauga County to national LTOs = 3,064/28,353,661

Ratio of LTOs in Autauga County to national LTOs = 1.08E-4

AvGas - Fugitive from valves VOC Emissions = (# Bulk Plant Equivalents) \* (#valves/plant) \* EF \* days \* ratio county to national LTOs

AvGas - Fugitive from valves VOC Emissions = (2442 plants) \* (50 valves/plant) \* (5.73E-1 LB/valve/day) \* 300 days \* 1.08E-4 / 2,000 LB/TON

AvGas - Fugitive from valves VOC Emissions = **1.31E0** tpy

AvGas - Fugitive from pumps VOC Emissions = (# Bulk Plant Equivalents) \* (#pumps/plant) \* (#seals/pump) \* EF \* days \* ratio county to national LTOs

AvGas - Fugitive from pumps VOC Emissions = (2442 plants) \* (2 pumps/plant) \* (4 seals/pump) \* (5.95E0 LB/seal/day) \* 300 days \* 1.08E-4 / 2,000 LB/TON

AvGas - Fugitive from pumps VOC Emissions = **1.89E0** tpy

*Step 6 - Sum the fugitive and non-fugitive VOC emissions together for total VOC emissions.*

Total VOC emissions in Autauga County, Alabama = **3.15** tpy

*Step 7 - Apply the speciation emission factors in Table 3 for lead, 2,2,4-trimethylpentane, benzene, cumene, ethylbenzene, hexane, naphthalene, toluene, and xylene to calculate HAP emissions.*

Lead emissions = 3.15 tpy VOC \* 6.27E-6 = **1.98E-5** tpy

2,2,4-Trimethylpentane emissions = 3.15 tpy VOC \* 0.008 = **2.52E-2** tpy

Benzene emissions = 3.15 tpy VOC \* 0.009 = **2.84E-2** tpy

Cumene emissions = 3.15 tpy VOC \* 0.0001 = **3.15E-4** tpy

Ethylbenzene emissions = 3.15 tpy VOC \* 0.0010 = **3.15E-3** tpy

Hexane emissions = 3.15 tpy VOC \* 0.0160 = **5.04E-2** tpy

Naphthalene emissions = 3.15 tpy VOC \* 0.0005 = **1.58E-3** tpy

Toluene emissions = 3.15 tpy VOC \* 0.0130 = **4.10E-2** tpy

Xylene emissions = 3.15 tpy VOC \* 0.005 = **1.58E-2** tpy

*Step 8 - Use the ethylene dichloride emission factor in Table 3 to calculate ethylene dichloride emissions.*

Ethylene dichloride emissions = 10,633 GAL \* 2.17E-6 LB/GAL \* TON/2000 LB = **1.15E-5** tpy

**Table 1 - Assumptions Used For Bulk Terminals Using AvGas**

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Data** | **Reference** |
| Number of Bulk Plant Equivalents (U.S.) | 2,442 plants | 1 |
| Number of valves per bulk plant | 50 valves/plant |
| Number of pumps per bulk plant | 2 pumps/plant |
| Number of seals per bulk plant | 4 seals/pump |
| Number of days per year used | 300 days |

**Table 2 - VOC Emission Factors**

| **Pollutant** | **Emission Source** | **Emission Factor** | **Emission Factor Units** | **Factor Reference** |
| --- | --- | --- | --- | --- |
| VOC | Aviation Gas Unloading/ Tank Filling - tank fill | 9.02E-3 | LB/GAL AvGas | 1 |
| Aviation Gas Unloading/ Tank Filling - Storage tank working | 3.61E-3 |
| Aviation Gas Tank Truck Filling - Composite | 1.03E-2 |
| Aviation Gas Storage Tank - Breathing losses | 1.69E-3 |
| Aviation Gas - Fugitive from valves | 5.73E-1 | LB/valve/day |
| Aviation Gas - Fugitive from pumps | 5.95E0 | LB/seal/day |

**Table 3 - HAP Emission Factors**

| **Pollutant** | **Emission Source** | **Emission Factor** | **Emission Factor Units** | **Factor Reference** |
| --- | --- | --- | --- | --- |
| Ethylene Dichloride | All processes | 2.17E-6 | LB/GAL AvGas | 4 |
| Lead\* | All processes | 6.27E-6 | LB/LB VOC | 1 |
| 2,2,4-Trimethylpentane | All processes | 8.00E-3 | LB/ LB VOC | 5 |
| Benzene | All processes | 9.00E-3 |
| Cumene | All processes | 1.00E-4 | 6 |
| Ethylbenzene | All processes | 1.00E-3 | 5 |
| Hexane | All processes | 1.60E-2 |
| Naphthalene | All processes | 5.00E-4 |
| Toluene | All processes | 1.30E-2 |
| Xylene | All processes | 5.00E-3 |

\*Note: The 2011 NEI included tetraethyl lead (TEL) with an emission factor of 9.78E-6. In 2014, EPA only accounts for the emissions of elemental lead. The TEL emission factor was modified by multiplying by the ratio of the atomic mass of lead to the atomic mass of TEL, or 64.06%.

***f. Changes from 2011 Methodology***

Activity data (AvGas consumption) are derived from EIA's 2014 State Energy Data System. In 2011, the activity data were based on EIA's 2008 Petroleum Annual Supply. The LTO data have been updated from 2009 to 2012. The pollutant code for tetraethyl lead (TEL; 78002) has been retired. In 2014, EPA only accounts for the emissions of elemental lead. The lead emissions factor is derived by multiplying the TEL emission factor by the ratio of the atomic mass of lead to the atomic mass of TEL, or 64.06%, and the pollutant code changed to 7439921.

***g. Puerto Rico and US Virgin Islands Emissions Calculations***

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory’s activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are “EACH”.

***h. References***

1. TRC Environmental Corporation. *Estimation of Alkylated Lead Emissions, Final Report*. Prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. RTP, NC 1993.

2. U.S. Environmental Protection Agency. National Emission Standards for Source Categories: Gasoline Distribution (Stage I). 40 CFR Part 63. Office of Air Quality Planning and Standards. RTP, NC. February 28, 1997. Pages 9087-9093.

3. Energy Information Administration. *State Energy Data System (SEDS): 1960-2014 (Complete)*. Consumption in Physical Units. U.S. Department of Energy. Washington, D.C. July 2016. (Internet address: http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US)

4. U.S. Environmental Protection Agency. *Locating and Estimating Air Emissions from Sources of Ethylene Dichloride*. EPA-450/4-84-007d. RTP, NC. March 1984.

5. Memorandum from Greg LaFlam and Tracy Johnson (PES) to Stephen Shedd (EPA/OAQPS). *Speciated Hazardous Air Pollutants - Baseline Emissions and Emissions Reductions Under the Gasoline Distribution NESHAP*. August 9, 1996.

6. Personal Communication via e-mail from Stephen Shedd (EPA/OAQPS) to Laurel Driver (EPA/OAQPS). E-mail dated May 29, 2002.

7. [LTObyCtyandSCC.mdb], electronic file from Laurel Driver, U.S. Environmental Protection Agency, OAQPS, to U.S. Environmental Protection Agency, OAQPS, April 4, 2013. Aircraft operations data compiled from FAA’s Terminal Area Forecasts (TAF) and 5010 Forms.