**Documentation for Portable Fuel Containers – 2014**

There are several sources of emissions associated with portable fuel containers (PFC) used for gasoline. These sources include vapor displacement and spillage while refueling the gas can at the pump, spillage during transport, permeation and evaporation from the gas can during transport and storage, and vapor displacement and spillage while refueling equipment. Vapor displacement and spillage while refueling nonroad equipment from PFCs are included in the nonroad inventory. This section describes how other types of PFC emissions are accounted for in the NEI.

PFC emissions are impacted by a 2007 regulation controlling emissions of hazardous pollutants from mobile sources (MSAT2 rule). In this rule EPA promulgated requirements to control VOC emissions from gas cans. The methodology used to develop emission inventories for gas cans was initially described in the regulatory impact analysis for the rule and in an accompanying technical support document.[[1]](#endnote-1),[[2]](#endnote-2) The inventory development approach used for the NEI is still based on the analyses done for this rule.

Below, data and methods are described for development of portable fuel container (PFC) inventories in the 2014 National Emissions Inventory (NEI).

**VOC Allocation**

PFC inventories in the MSAT2 rule were developed for different emissions scenarios in several calendar years (1990, 2005, 2010, 2015, 2020, and 2030) at the State level for 6 categories of emissions: 1) vapor displacement while refilling containers at the pump, 2) spillage while refilling at the pump, 3) spillage during transport, 4) vapor displacement while refueling equipment, 5) spillage while refueling equipment, and 6) permeation and evaporation.

For the NEI, emissions had to separate into commercial and residential fuel container emissions. Total state level PFC emissions were allocated to the categories by using national level residential and commercial emission splits from the MSAT2 rule for each of the categories using the following equations:

(1)

(2)

, where E was the emissions of the category being split, XXXX was year, YY was state, and Res and Com were the national residential and commercial PFC emissions.

Permeation and evaporation were also separated as follows:

(3)

(4)

The fraction 0.3387 represents the fraction of combined permeation and evaporative emissions attributable to permeation, based on data from the California Air Resources Board.

Once the state VOC emissions were allocated to the residential and commercial components of the categories, they were assigned SCC codes. These codes are shown in Table 1.

**Table 1.** SCC codes for PFC sources.

|  |  |
| --- | --- |
| **SCC code** | **Description** |
| 2501011011 | Storage and Transport; Petroleum and Petroleum Product Storage; Residential Portable Gas Cans; Permeation |
| 2501011012 | Storage and Transport; Petroleum and Petroleum Product Storage; Residential Portable Gas Cans; Evaporation |
| 2501011013 | Storage and Transport; Petroleum and Petroleum Product Storage; Residential Portable Gas Cans; Spillage During Transport |
| 2501011014 | Storage and Transport; Petroleum and Petroleum Product Storage; Residential Portable Gas Cans; Refilling at the Pump - Vapor Displacement |
| 2501011015 | Storage and Transport; Petroleum and Petroleum Product Storage; Residential Portable Gas Cans; Refilling at the Pump - Spillage |
| 2501012011 | Storage and Transport; Petroleum and Petroleum Product Storage; Commercial Portable Gas Cans; Permeation |
| 2501012012 | Storage and Transport; Petroleum and Petroleum Product Storage; Commercial Portable Gas Cans; Evaporation |
| 2501012013 | Storage and Transport; Petroleum and Petroleum Product Storage; Commercial Portable Gas Cans; Spillage During Transport |
| 2501012014 | Storage and Transport; Petroleum and Petroleum Product Storage; Commercial Portable Gas Cans; Refilling at the Pump - Vapor Displacement |
| 2501012015 | Storage and Transport; Petroleum and Petroleum Product Storage; Commercial Portable Gas Cans; Refilling at the Pump - Spillage |

Finally, state emissions were allocated to the counties using the ratio of county to State fuel consumption:

(5)

, where EXXXX,YYYYY,AAA,SCC were the emissions for year XXXX, county with FIPS code YYYYY, emission scenario AAA, and SCC shown in Table 1, EXXXX,YY,AAA,SCC were the state level emissions for year XXXX, state YY, emission scenario AAA, and SCC in Table 1, ConsumptionYYYY was the county fuel consumption and ConsumptionYY was the state fuel consumption.

Below are descriptions of how 2014 PFC inventories for various types of pollutants were developed for the 2014 NEI, for different groups of SCCs.

**VOCs**

Permeation and Evaporation

These emissions are represented by the following SCCs

2501011011 – Residential Portable Fuel Containers: Permeation

2501011012 – Residential Portable Fuel Containers: Evaporation

2501012011 – Commercial Portable Fuel Containers: Permeation

2501012012 – Commercial Portable Fuel Containers: Evaporation

Emissions from these SCCs are impacted by 2007 MSAT rule standards limiting evaporation and permeation emissions from these containers to 0.3 grams of hydrocarbons per day. [[3]](#endnote-3) Inventory estimates developed for calendar year 2018 in EPA’s Tier 3 vehicle rule modeling platform[[4]](#endnote-4) reflect the impact of these standards, as well as impacts of RVP and oxygenate use. These Tier 3 inventories were interpolated from earlier 2015 and 2020 MSAT2 rule inventories and assumed 100% E10. They were judged to be reasonable approximations of the 2014 inventory, although increases in activity between 2014 and 2018 means emissions will be overestimated in the 2014 NEI.

Vapor Displacement

Vapor displacement emissions occur while refueling containers at the pump. These emissions are represented by the following SCCs:

25010111014 – Residential Portable Fuel Containers: Refilling at the Pump: Vapor Displacement

25010112014 – Commercial Portable Fuel Containers: Refilling at the Pump: Vapor Displacement

These emissions are not impacted by MSAT2 rule standards, but are impacted by RVP and oxygenate use. Inventory estimates developed for calendar year 2018 in EPA’s Tier 3 vehicle rule modeling platform were judged to be reasonable approximations of the 2014 inventory, although increases in activity between 2014 and 2018 means emissions will be overestimated in the 2014 NEI.

Spillage

Spillage occurs during transport and refilling at the pump. These emissions are represented by the following SCCs:

2501011013 – Residential Portable Fuel Containers: Spillage During Transport

2501011015 -- Residential Portable Fuel Containers: Refilling at the Pump: Spillage

2501012013 – Commercial Portable Fuel Containers: Spillage During Transport

2501012015 -- Commercial Portable Fuel Containers: Refilling at the Pump: Spillage

These emissions are not impacted by MSAT2 standards or RVP. However, composition of the emissions are impacted by oxygenate. VOC emissions for these SCCs are carried forward from 2011.

**Air Toxics**

Permeation, Evaporation and Vapor Displacement

MSATs found in liquid gasoline will be present as a component of VOC emissions. These MSATs include benzene, ethanol, and naphthalene. For vapor displacement, toxic to VOC ratios were obtained from headspace vapor profiles from EPAct test fuels.[[5]](#endnote-5) For permeation emissions, vehicle permeation speciation data from Coordinating Research Council (CRC) technical reports E-77-2b and E-77-2c were used.[[6]](#endnote-6),[[7]](#endnote-7) We relied on three day diurnal profiles from the CRC data. For evaporative emissions resulting from changes in ambient temperatures, speciation data from the Auto/Oil program were used for E0 and E10.[[8]](#endnote-8) Table 2 lists the toxic to VOC ratios for each type of PFC emission.

**Table 2.** Toxic to VOC ratios for PFCs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pollutant** | **Process** | **Speciation Surrogate** | **E0** | **E10** |
| Benzene | Vapor Displacement | Vehicle Headspace | 0.0077 | 0.0087 |
| Permeation | Vehicle Permeation | 0.0250 | 0.0227 |
| Evaporation | Vehicle Evap | 0.0336 | 0.0340 |
| Naphthalene | Vapor Displacement | Vehicle Headspace | 0.0000 | 0.0000 |
| Permeation | Vehicle Permeation | 0.0004 | 0.0004 |
| Evaporation | Vehicle Evap | 0.0004 | 0.0004 |
| Ethanol | Vapor Displacement | Vehicle Headspace | 0 | 0.0645 |
| Permeation | Vehicle Permeation | 0 | 0.2020 |
| Evaporation | Vehicle Evap | 0 | 0.1190 |

Emissions of other air toxics for permeation, evaporation, and vapor displacement were all estimated from the EPAct headspace vapor displacement profile for E10 (SPECIATE profile 8870). Toxic to VOC ratios are provided in Table 3.

**Table 3.** Toxic to VOC ratios for Other HAPs (Vapor Displacement, Permeation and Evaporation).

|  |  |
| --- | --- |
| **Pollutant** | **Toxic to VOC Ratio** |
| Ethylbenzene | 0.0068 |
| Hexane | 0.0616 |
| Toluene | 0.0521 |
| Xylenes (o,m,p) | 0.0300 |
| 2,2,4-Trimethylpentane | 0.0540 |

Spillage

Since spillage emissions were carried forward from the 2011 NEI, the HAP estimation approach for these emissions reflects the methods used for that inventory. The methods used in the 2011 NEI are described below.

To calculate the benzene emissions for each PFC SCC in each county the following formulas was used:

(6)

, where XXXX was the year, YYYYY was the FIPS code of the county, and SCC was an SCC code shown in Table 1.

In the equations the factor 0.36 represents an adjustment based on the nationwide percentage of benzene in gasoline vapor from gasoline distribution with an RVP of 10 psi at 60˚F.[[9]](#endnote-9) This factor is based on the ratio of the percentage of benzene in gasoline vapor from gasoline distribution of 0.27%, divided by the percentage of benzene in vehicle refueling emissions of 0.74% benzene in vehicle refueling emissions.[[10]](#endnote-10)

For all other HAPs, the PFC emissions were created by multiplying the PFC VOC emissions by the county level ratio of HAP LDGV evaporative emissions by the VOC LDGV evaporative emissions for the county or:

(7)

, where the subscripts are as denoted previously. Using the LDGV evaporative emissions means only HAPs in the onroad inventory with LDGV evaporative emissions would have PFC emissions. Naphthalene was also multiplied by a factor of 0.0054, based on data from the same study used to adjust benzene, where the where the percentage of naphthalene in VOC from gasoline distribution vapor emissions was 0.00027, in contrast to about 0.05% naphthalene in vehicle refueling emissions from highway vehicles.

One modification was made to spillage estimates from the 2011 NEI. The 2011 inventory did not account for impacts of the fuel benzene standard implemented in 2011 as a result of the 2007 mobile source air toxics rule.1 This rule established a 0.62% volume standard for benzene, whereas the national average benzene content standard prior to the rule was about 1.0%. Thus PFC benzene emissions for these SCCs were scaled by a ratio of 0.62/1 to account for impacts of this rule.

1. U. S. EPA. 2007. Final Regulatory Impact Analysis: Control of Hazardous Air Pollutants from Mobile Sources; EPA420-R-07-002; Office of Transportation and Air Quality, Ann Arbor, MI. http://www.epa.gov/otaq/toxics.htm [↑](#endnote-ref-1)
2. Landman, L. C. (2007) Estimating Emissions Associated with Portable Fuel Containers (PFCs). U. S. EPA, Assessment and Standards Division, National Vehicle and Fuel Emissions Laboratory, Ann Arbor, MI, Report No. EPA420-R-07-001. http://www.epa.gov/otaq/toxics.htm [↑](#endnote-ref-2)
3. Federal Register. 2007. Control of Hazardous Air Pollutants from Mobile Sources. 72 (37): 8428-8570. [↑](#endnote-ref-3)
4. U.S. EPA. 2014. Emissions Modeling Technical Support Document: Tier 3 Motor Vehicle and Emission and Fuel Standards. Office of Air Quality Planning and Standards, Research Triangle Park, NC, Report No. EPA-454/R-13-003, February 2014. Available at: <http://www3.epa.gov/otaq/documents/tier3/454r14003.pdf> [↑](#endnote-ref-4)
5. U. S. EPA. 2011. Hydrocarbon Composition of Gasoline Vapor Emissions from Enclosed Fuel Tanks. Office of Research and Development and Office of Transportation and Air Quality. Report No. EPA-420-R-11-018. EPA Docket EPA-HQ-OAR-2011-0135. [↑](#endnote-ref-5)
6. U. S. EPA. 2010. Evaporative Emissions from In-Use Vehicles: Test Fleet Expansion (CRC E-77-2b). Prepared by Harold Haskew and Associates for Assessment and Standards Division, Office of Transportation and Air Quality, October, 2010. http://www.epa.gov/otaq/emission-factors-research/420r10025.pdf [↑](#endnote-ref-6)
7. Coordinating Research Council. 2010. Study to Determine Evaporative Emission Breakdown, Including Permeation Effects and Diurnal Emissions, Using E20 Fuels on Aging Enhanced Evaporative Emissions Certified Vehicles. Report No. E-77-2c. http://www.crcao.org/reports/recentstudies2011/E-77-2c/E-77-2c%20Final%20Report%20for%20sure%201-28-11.pdf. [↑](#endnote-ref-7)
8. Auto/Oil Air Quality Improvement Research Program. 1996. Phase I and II Test Data. Prepared by Systems Applications International, Inc. [↑](#endnote-ref-8)
9. Hester, Charles. 2006. Review of Data on HAP Content in Gasoline. Memorandum from MACTEC to Steve Shedd, U. S. EPA, March 23, 2006. This document is available in Docket EPA-HQ-OAR-2003-0053. [↑](#endnote-ref-9)
10. U. S. EPA. 2007. Final Regulatory Impact Analysis: Control of Hazardous Air Pollutants from Mobile Sources; EPA420-R-07-002; Office of Transportation and Air Quality, Ann Arbor, MI. http://www.epa.gov/otaq/toxics.htm [↑](#endnote-ref-10)