2020 National Emissions Inventory Technical Support Document: Portable Fuel Containers

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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
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14.1 Sector Descriptions and Overview

There are several sources of emissions associated with portable fuel containers (PFC) used for storage of 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, and spillage during transport and at the pump are included in the nonroad inventory. This section describes how the nonpoint data category PFC emissions (permeation, evaporation, and vapor displacement at the pump) are accounted for in the NEI. This source category is one of many components in the Miscellaneous Non-industrial sector.

Table 14-1 shows the SCCs covered by this source category, and those for which we generate nonpoint estimates. EPA will likely retire the PFC SCCs that are included in the MOVES model [ref 1], and hence nonroad data category, prior to the 2023 NEI. The SCC level 3 and 4 descriptions are also provided. The leading SCC description is "Storage and Transport; Petroleum Product Storage" for all SCCs.

Table 14-1: Portable Fuel Container SCCs in the 2020 NEI, with nonpoint flagged

Estimated for the Nonpoint NEI?	SCC	Description
Yes	2501011011	Residential Portable Gas Cans; Permeation
Yes	2501011012	Residential Portable Gas Cans; Evaporation (includes Diurnal losses)
No	2501011013	Residential Portable Gas Cans; Spillage During Transport
Yes	2501011014	Residential Portable Gas Cans; Refilling at the Pump - Vapor Displacement
No	2501011015	Residential Portable Gas Cans; Refilling at the Pump - Spillage
Yes	2501012011	Commercial Portable Gas Cans; Permeation
Yes	2501012012	Commercial Portable Gas Cans; Evaporation (includes Diurnal losses)
No	2501012013	Commercial Portable Gas Cans; Spillage During Transport
Yes	2501012014	Commercial Portable Gas Cans; Refilling at the Pump - Vapor Displacement
No	2501012015	Commercial Portable Gas Cans; Refilling at the Pump - Spillage

14.2 EPA-developed estimates

For the 2020 NEI, where states did not submit their own data, we relied on an inventory developed for the Tier 3 motor vehicle and fuel standards rule [ref 2]. This inventory assumed all fuel dispensed from PFCs was E10, with an average RVP of 8.7 psi. Use of ethanol in gasoline fuels can increase evaporative emissions from PFCs, relative to E0, for several reasons. First, if E10 fuels have higher volatility than corresponding E0 fuels, that can increase evaporation and vapor displacement. Second, ethanol in gasoline increases permeation of fuel through gas can materials. Finally, the lower energy content of

ethanol fuels leads to more frequent refueling, and, thus, greater emissions from spillage and displacement while filling the gas can at the pump.

The use of ethanol also changes the mix of hydrocarbons in the evaporated fuel. In particular, it can change the fraction of several hazardous air pollutants as well as ethanol.

As part of the 2007 regulation controlling emissions of hazardous pollutants from mobile sources (MSAT2 rule), EPA promulgated requirements to control VOC emissions from gas cans. The methodology we used to develop emission inventories for gas cans was developed for that regulation and is described in the regulatory impact analysis for the rule and in an accompanying technical support document [ref 3, ref 4]. However, while that regulation included estimates for spillage emissions occur when refueling equipment, most of these emissions is already included in the nonroad equipment inventory. Thus, we did not include these emissions in the PFC inventory for the NEI. Vapor displacement for nonroad equipment container refueling was also subtracted from vapor displacement in the PFC inventory to avoid double counting these emissions.

14.2.1 VOC allocation

For the NEI, emissions were separated 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:

$$E_{residential,XXXX,YY} = E \times \left(\frac{\mathrm{Res}}{\mathrm{Res} + Com} \right) \quad (1)$$

$$E_{commercial,XXXX,YY} = E \times \left(\frac{Com}{\mathrm{Res} + Com} \right) \quad (2)$$

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:

$$E_{AAA,XXXX,YY,perm} = E_{AAA,XXXX,YY,perm\&evap} \times 0.3387 \quad (3)$$

$$E_{AAA,XXXX,YY,evap} = E_{AAA,XXXX,YY,perm\&evap} \times (1 - 0.3387) \quad (4)$$

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.

14.2.2 VOC emissions

VOC emissions estimates are based on gasoline volumes for calendar year 2018, calculated with NONROAD2005 for the Tier 3 rule. Nonroad gasoline consumption estimates from the newer MOVES3 model are used to update the NONROAD2005 gasoline volume estimates; these updated values are then

adjusted to calendar year 2020. PFC emissions from permeation and evaporation are developed separately from PFC emissions from vapor displacement.

Permeation and evaporation estimated for year 2018 from Tier 3 rule

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 [ref 5]. Inventory estimates developed for calendar year 2018 in EPA's Tier 3 vehicle rule modeling platform [ref 6] 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.

Vapor Displacement estimated for year 2018 from Tier 3 rule

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

- 2501011014 – Residential Portable Fuel Containers: Refilling at the Pump: Vapor Displacement
- 2501012014 – 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 were developed for calendar year 2018 in EPA's Tier 3 vehicle rule modeling platform.

14.2.3 Hazardous air pollutants

Hazardous air pollutants found in liquid gasoline will be present as a component of VOC emissions. These MSATs include benzene, ethyl benzene, toluene, hexane, xylenes, 2,2,4-trimethylpentane, and naphthalene. For vapor displacement emissions of benzene and naphthalene, toxic to VOC ratios were obtained from headspace vapor profiles from EPAct test fuels [ref 7]. For permeation emissions of these pollutants, vehicle permeation speciation data from Coordinating Research Council (CRC) technical reports E-77-2b and E-77-2c were used [ref 8, ref 9]. 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 [ref 10]. Table -2 lists the toxic to VOC ratios for each type of PFC emission.

Table -2: Toxic to VOC ratios for benzene and naphthalene from PFCs

Pollutant	Process	Speciation Surrogate	E10
Benzene	Vapor Displacement	Vehicle Headspace	0.0087
	Permeation	Vehicle Permeation	0.0227
	Evaporation	Vehicle Evap	0.0340
Naphthalene	Vapor Displacement	Vehicle Headspace	0.0000
	Permeation	Vehicle Permeation	0.0004
	Evaporation	Vehicle Evap	0.0004

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

14.2.4 Changes in the 2020 NEI and looking forward to the 2023 NEI

Inventories for the 2017 NEI were based on gasoline volumes for year 2018 using the NONROAD2005 estimates. These 2018 estimates were then adjusted to account for the differences in gasoline volumes used for PFCs in MOVES3 versus NONROAD2005. Next, MOVES3 was run to estimate nonroad fuel consumption for year 2020, and these adjustments were applied between year 2018 and 2020 MOVES3 consumption estimates.

It is important to note that this PFC methodology does not account for current levels of non-compliance; this will be an improvement sought for the 2023 NEI PFC estimates.

14.3 References

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4. 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.
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9. 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.
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