Development of a County Level Portable Fuel Container (PFC) Emission Inventory for VISTAS Based on the U.S. EPA National PFC Inventory

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ABSTRACT

This paper discusses the approach used by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) Regional Planning Organization (RPO) to develop a county level portable fuel containers emission inventory based on the State level estimates provided in the "Estimating Emissions Associated with Portable Fuel Containers (PFCs), Draft Report, Office of Transportation and Air Quality, United States Environmental Protection Agency, Report #EPA420-D-06-003, February 2006". PFC emissions were felt to be an important component of VOC emissions that had not previously been included in earlier versions of the VISTAS base year or projection year inventories. The paper discusses how the State level emissions presented in the report were allocated to the county level and projected to the years 2009 and 2018. Fuel usage values derived from NONROAD 2005 runs completed for VISTAS for the years 2002, 2009 and 2018 were used in conjunction with the "spillage" data file to develop allocation factors used to assign emissions to each county. The allocation scheme is based on using the "spillage" file that is part of the U.S. EPA's NONROAD model along with estimated fuel usage in each year.

INTRODUCTION

Over the past few years as areas strive to come into compliance with air quality standards, in particular regional haze and ozone standards, State, local and regional air quality planning groups have looked increasingly at smaller more diffuse area sources for potential controls. This close examination of these source types is driven largely by two factors, first the overall emission levels of the sources and second the inability to institute more significant control levels on larger more easily controlled sources since many of these sources are already subject to fairly strenuous control programs.

Portable fuel containers (PFCs, or gas cans) are consumer products used to refuel a wide variety of gasoline-powered equipment. In 2001, California established an emissions control program for gas cans. Since that time, some other states have adopted the California requirements or instituted similar control programs. In 2005, California adopted a revised program. The U.S. EPA is planning to propose standards to control VOCs as an ozone precursor and also to minimize exposure to VOC-based toxics such as benzene and toluene. Since gasoline is highly volatile and evaporates easily from containers that are not sealed or closed properly, PFCs are being evaluated for potential controls similar to the California program. While an individual gas can is a relatively modest emission source, the cumulative VOC emissions from an estimated population of 80 million gas cans could be quite significant. Left uncontrolled, the evaporative emissions from a gas can are up to 60 times the VOC of a new Tier 2 vehicle evaporative control system. PFC emissions largely result from one of three areas: evaporative emissions from unsealed or open containers; permeation emissions from gasoline passing through the walls of the plastic containers; and evaporative emissions from gasoline spillage during use.

The Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional planning organization (RPO) is interested in emission sources that can contribute to regional haze and fine particulates. Since VOC emissions can result in secondary organic aerosols (SOAs) which can contribute to regional haze and fine particulates, and since several of the northern Virginia counties/independent cities are also part of the Ozone Transport Commission (OTC) which has a PFC control rule in effect (Rule 4-42), VISTAS was interested in developing a county-level base and future year inventories for PFCs as part of their Base G modeling inventory update. PFCs were not included in modeling inventories used by VISTAS prior to Base G. As a consequence, MACTEC (under contract with VISTAS) was tasked to prepare a 2002 base year and 2009 and 2018 future year projection inventories for PFCs in the VISTAS region.

This paper describes the method used to develop the county-level emission inventories required for VISTAS Base G updates.

METHODS

MACTEC's approach to creation of a county-level PFC inventory was to make the development as straightforward as possible, yet produce an inventory that was tied to national estimates and could be produced with minimal effort since the timeframe for development to make it into VISTAS Base G inventory was short.. MACTEC initiated our approach by determining that there was no existing county-level inventory for PFCs that could be scaled or modified to provide what VISTAS needed. The only national data that MACTEC found was a national inventory developed by the U.S. EPA and published in a draft report entitled "Estimating Emissions Associated with Portable Fuel Containers (PFCs)".[1] The inventory in that publication was provided on a State-level for two years, 1990 and 2005. In the inventory prepared by EPA, they used the NONROAD model (NONROAD2004 version) to estimate the seasonal (nonroad) consumption of gasoline by source classification code (SCC) for each state plus the District of Columbia. Within the NONROAD model, each SCC code has a unique usage (commercial versus residential), a unique ratio of the percent of fuel dispensed from PFCs (versus from fuel pumps), and a unique spillage rate (grams per gallon). In the NONROAD2004 model, the spillage (from PFCs) is assumed to be a constant 17 grams for each refueling event. Since the fuel tank capacity varies for different pieces of equipment, the spillage rate (in terms of grams per gallon of dispensed gasoline) also varies greatly. Thus, by combining those two outputs of NONROAD2004, EPA was able to estimate (by state) the total quantity of gasoline supplied from PFCs as well as the total spillage (from using the PFCs to refuel the individual pieces of equipment) for residential usage and for commercial usage.

VISTAS base year is 2002. Although both 1990 and 2002 were available, VISTAS decided to use the 2005 values as surrogates for 2002 and then perform the allocation to the county-level for the base year and projections.

State-level emission estimates for 2005 were derived from Appendix Table B-2 (recreated in Table 1) of the PFC report which was used as the starting point for developing 2002 county-level emissions estimates. State emissions were derived from that table by using all of the emission estimates in that table with the exception of values for vapor displacement and spillage from refueling operations. Those components of the State emissions were left out of the State-level emissions to avoid double counting refueling emissions in the non-road sector.

One of the modifications made to the Base G VISTAS inventory was to re-calculate non-road emissions using the NONROAD05 model which had been released in December 2005. Prior to

those calculations, refueling emissions (vapor displacement and spillage) for on-road and non-road vehicles and engines had been estimated separately and included in the area source component of the inventory. Effective with the Base G inventory, refueling estimates were included in the on-road and non-road estimates made with the MOBILE and NONROAD models respectively. Thus to avoid double counting, MACTEC removed the equipment refueling displacement and spillage component of the State-level inventory created by EPA and only used the State-level emission estimates from the following categories: vapor displacement and spillage from refilling the PFC at the pump, spillage during transport and permeation plus evaporation.

Table 1. State-level emissions from the EPA PFC report.

State	Refilling PFC at Pump		Spillage During Transport	Refueling Equipment		Permeation Plus Evaporation
	Vapor Displacement	Spillage		Vapor Displacement	Spillage	
AL	**192.7**	**15.9**	**482.8**	**192.7**	**944.9**	**4,685.2**
AK	25.3	2.1	68.7	25.3	99.4	844.4
AZ	310.6	26.7	749.9	310.6	1,739.0	3,562.7
AR	113.8	9.0	285.6	113.8	473.8	3,472.1
CA	1,825.0	154.9	3,693.2	1,825.0	3,959.6	8,331.9
CO	242.5	19.7	566.8	242.5	1,241.5	3,705.4
CT	169.0	14.6	419.8	169.0	928.7	2,612.1
DE	38.1	3.5	99.9	38.1	219.3	535.0
DC	6.5	0.6	20.8	6.5	38.7	197.6
FL	**931.4**	**82.1**	**2,308.8**	**931.4**	**5,232.2**	**12,159.4**
GA	**356.8**	**34.0**	**986.9**	**356.8**	**2,088.3**	**5,229.9**
HI	58.4	4.4	124.2	58.4	284.8	1,072.4
ID	54.3	5.7	172.0	54.3	333.2	933.4
IL	441.1	45.6	1,325.5	441.1	2,822.1	5,225.5
IN	247.2	23.9	705.9	247.2	1,483.8	3,666.8
IA	124.2	11.2	335.7	124.2	665.8	2,297.1
KS	109.1	10.7	315.6	109.1	650.4	1,945.2
KY	**131.0**	**12.4**	**384.5**	**131.0**	**704.9**	**2,931.8**
LA	163.8	13.6	424.4	163.8	753.8	4,895.5
ME	57.6	5.0	153.3	57.6	315.7	1,243.1
MD	281.9	24.4	689.2	281.9	1,596.0	3,502.4
MA	262.9	23.0	668.3	262.9	1,443.0	3,951.7
MI	528.7	39.1	1,172.5	528.7	2,390.4	12,431.8
MN	185.8	17.6	535.2	185.8	1,009.9	3,343.3
MS	**89.4**	**8.2**	**262.5**	**89.4**	**460.9**	**2,552.4**
MO	229.1	21.3	641.4	229.1	1,260.7	3,957.5
MT	30.8	3.0	95.3	30.8	160.5	707.1
NE	64.1	6.7	199.4	64.1	392.6	986.1
NV	93.0	9.0	251.7	93.0	577.5	905.2
NH	60.3	5.0	149.1	60.3	302.2	1,169.7

NJ	403.0	35.6	1,022.8	403.0	2,208.9	6,008.3
NM	66.7	5.9	176.4	66.7	359.7	1,275.2
NY	563.5	53.6	1,576.6	563.5	3,119.7	8,610.4
NC	**426.4**	**33.1**	**968.7**	**426.4**	**2,047.6**	**7,896.5**
ND	22.1	2.2	67.3	22.1	115.4	458.5
OH	602.8	48.5	1,419.0	602.8	3,043.1	10,429.0
OK	147.5	11.8	361.3	147.5	707.0	3,798.1
OR	195.7	15.8	459.5	195.7	998.0	3,360.7
PA	462.7	45.6	1,366.9	462.7	2,823.8	8,531.5
RI	33.9	3.6	105.7	33.9	227.9	423.8
SC	**185.2**	**16.2**	**471.6**	**185.2**	**1,029.0**	**3,114.2**
SD	23.3	2.4	74.1	23.3	129.0	463.8
TN	**216.1**	**19.7**	**598.3**	**216.1**	**1,156.3**	**4,855.2**
TX	857.2	78.5	2,279.9	857.2	4,890.7	13,282.8
UT	78.4	8.0	240.9	78.4	454.2	1,299.8
VT	26.0	2.4	73.2	26.0	143.6	480.7
VA	**337.3**	**29.9**	**864.4**	**337.3**	**1,937.0**	**5,046.7**
WA	287.7	24.1	701.0	287.7	1,522.2	4,491.8
WV	**67.9**	**5.8**	**188.4**	**67.9**	**309.8**	**2,112.5**
WI	222.8	19.8	597.9	222.8	1,190.1	4,382.3
WY	18.7	1.9	58.0	18.7	100.2	378.8
50-State	12,669.3	1,117.1	31,960.8	12,669.3	63,087.1	193,754.0

States in bold are VISTAS States. Shaded columns were not used in calculating emissions from PFCs since including these emissions could have resulted in double counting.

Allocation to County-Level

Since we had run NONROAD05 as part of our Base G emission inventory preparation, MACTEC had in-hand seasonal outputs from these model runs for every county in the VISTAS region for 2002, 2009 and 2018. Included in these output files was the fuel usage by county, SCC and horsepower (HP) classification. Thus if a linkage could be made between the fuel usage and the fraction of fuel handled by PFCs for each county/SCC/HP classification, then an allocation of the State level emissions from the EPA national inventory could be made to each county based on county fuel usage for engines utilizing PFCs for fueling. The necessary linkage can be found in the NONROAD model SPILLAGE file. The SPILLAGE file, which is a data file that comes with the NONROAD model (normally found in the \nonroad\DATA\EMSFAC directory), contains information related to the method used to fuel each type of nonroad engine by SCC and horsepower classification. An example of a portion of the SPILLAGE file is shown below in Table 2. Of particular interest is the column in the table labeled "filled". This column indicates the refueling fill method (with legitimate entries being PUMP or CONTAINER). MACTEC extracted the SCC, Description, Fill method and minimum and maximum horsepower

information from the SPILLAGE file for all entries having a method of CONTAINER. These entries indicated the nonroad engines and their corresponding horsepower ranges that used containers (e.g., PFCs) for refueling operations.

All of the SCC and horsepower classes using containers that were extracted from the file were cross-referenced with the fuel usage by county for those SCC/horsepower combinations from the appropriate year model runs (2002, 2009 or 2018). Then the fuel usages by county from the NONROAD 2005 runs prepared for VISTAS were summed for those SCCs by county. The county level fuel use was then divided by the State total fuel use for the same SCCs to determine the fraction of total State fuel usage and that fraction was used to allocate the State-level emissions to each county.

As indicated, for the purposes of 2002 emission estimates for Base G, the 2005 values were assumed equal to 2002 values. Thus the 2005 State-level estimates minus the refueling component from Appendix Table B-2 of the report were summed for each State and then allocated to the county-level using the allocation method described above.

Emission Projections

In order to prepare the 2009 and 2018 emission projections MACTEC used the NONROAD05 fuel use data for nonroad engines using fuel containers as fueling devices to create State-level growth factors. The State-level growth factors were developed but determining ratios between the 2002 and projection year NONROAD05 fuel usage. That value was then applied at the State-level to project the 2005 emissions from the U.S. EPA report to the corresponding future year. The future year State-level emissions were then apportioned to the county-level using the fraction of each county-level fuel usage from the projection year.

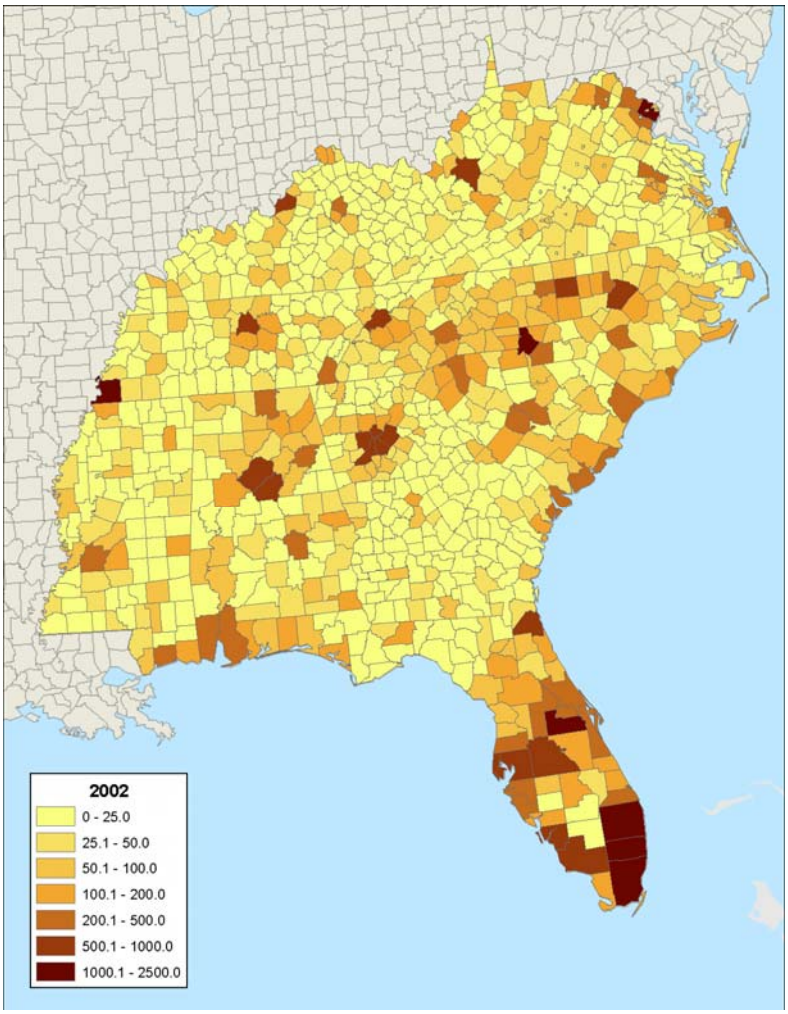
Table 2. Example of NONROAD SPILLAGE file

SCC_code /EMSFAC/	Name	Filled	TnkHp	HPmn	HPmx	Tech	Units
2260001010	2-Str Offroad Motorcycles	CONTAINER	HP	0	9999	ALL	GALLONS
2260001020	2-Str Snowmobiles	PUMP	HP	1	175	ALL	GALLONS
2260001030	2-Str All Terrain Vehicles	CONTAINER	HP	0	9999	ALL	GALLONS
2260001060	2-Str Specialty Vehicle Carts	CONTAINER	HP	0	6	ALL	GALLONS
2260001060	2-Str Specialty Vehicle Carts	PUMP	HP	6	25	ALL	GALLONS
2260001060	2-Str Specialty Vehicle Carts	PUMP	HP	25	40	ALL	GALLONS
2260001060	2-Str Specialty Vehicle Carts	PUMP	HP	40	100	ALL	GALLONS
2260002006	2-Str Tampers/Rammers	PUMP	HP	3	6	ALL	GALLONS
2260002009	2-Str Plate Compactors	PUMP	HP	1	3	ALL	GALLONS
2260002021	2-Str Paving Equipment	PUMP	HP	1	3	ALL	GALLONS
2260002027	2-Str Signal Boards/Light Plants	PUMP	HP	1	3	ALL	GALLONS
2260002039	2-Str Concrete/Industrial Saws	PUMP	HP	1	3	ALL	GALLONS
2260002039	2-Str Concrete/Industrial Saws	PUMP	HP	3	6	ALL	GALLONS

RESULTS

Figures 1 through 3 show the results of the method used to calculate county-level PFC emissions for 2002, 2009, and 2018 respectively.

Figure 1. County allocation of emissions for PFCs for 2002 (all values in tons).



The results for 2002 clearly show that emissions are primarily centered around population centers and that the highest emissions (at both the State and county level) are found in areas with high temperatures and thus high evaporative emissions (FL in particular).

Data for 2009 and 2018 show similar patters but with slightly higher emissions overall (see Figures 2 and 3). Table 3 shows the State-level emissions following the county allocation for each year.

Figure 2. County allocation of emissions for PFCs for 2009 (all values in tons).

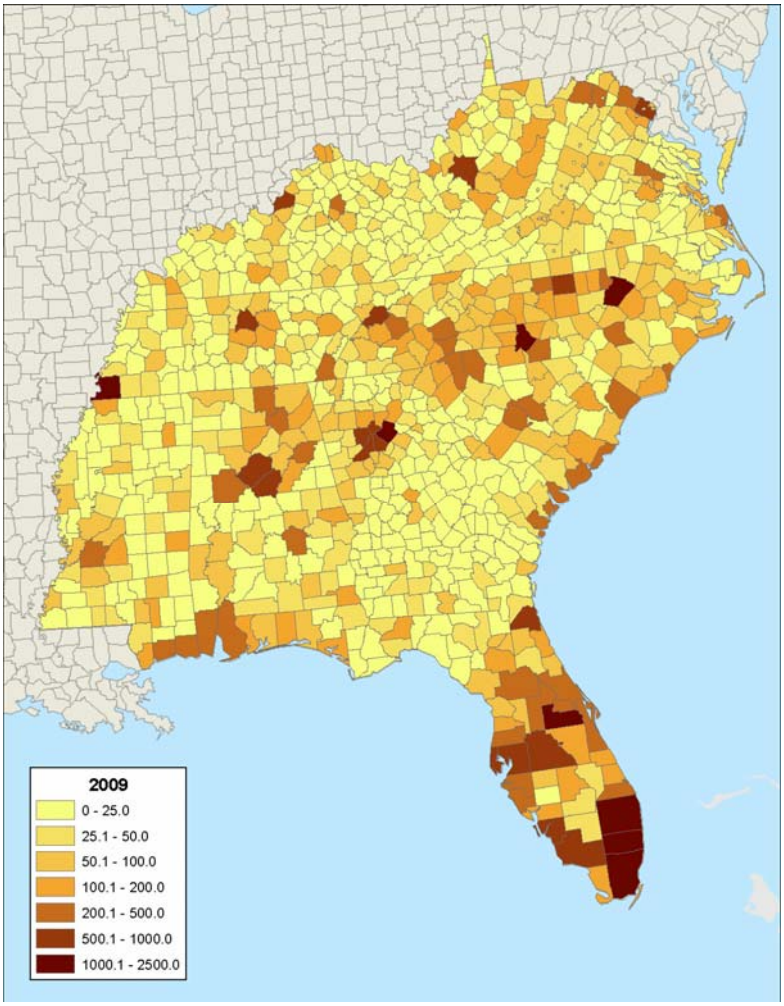


Figure 3. County allocation of emissions for PFCs for 2018 (all values in tons).

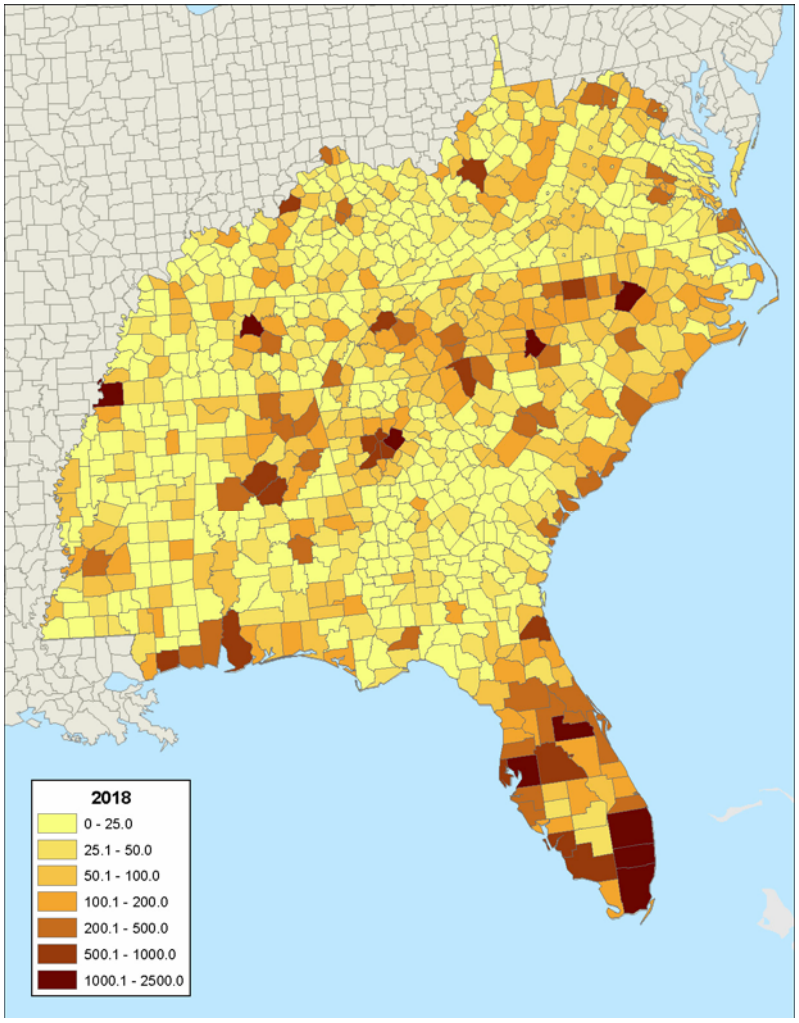


Table 3. PFC emissions by State for 2002, 2009 and 2018.

	2002	2009	2018
AL	5,376.6	6,135.2	7,138.1
FL	15,481.7	16,319.5	18,932.0
GA	6,607.6	7,232.2	8,413.6
KY	3,459.7	4,021.4	4,678.7
MS	2,912.5	3,522.2	4,111.0
NC	9,324.7	10,184.1	11,815.0
SC	3,787.2	4,094.9	4,738.3
TN	5,689.3	6,430.5	7,471.9
VA	6,278.3	5,872.5	5,806.3
WV	2,374.6	2,946.5	3,442.7
Total	**61,292.2**	**66,759.0**	**76,547.6**

REFERENCES

U.S. EPA, 2006, “Estimating Emissions Associated with Portable Fuel Containers (PFCs)” Draft Report, Office of Transportation and Air Quality, United States Environmental Protection Agency, Report #EPA420-D-06-003, February 2006.