MACTEC ALPINE GEOPHYSICS

TECHNICAL MEMORANDUM

To: Julie McDill, MARAMA
From: Gregory Stella, Alpine Geophysics, LLC
Edward Sabo, MACTEC Engineering and Consulting, Inc.
Date: 17 December 2010
Re: MARAMA Work Order #9; SMOKE Auxiliary File Review

INTRODUCTION

The purpose of this work order is to conduct a quality assurance (QA) review of the SMOKE speciation, spatial and temporal allocation files and to perform limited updates to those files to fill in data gaps or improve the profiles for certain categories. We obtained the latest versions of the SMOKE ancillary file data from CHIEF's website[1] relevant to EPA's 2005v4 modeling platform. These data included speciation, spatial and temporal allocation files as well as the cross-reference files necessary to correlate emissions inventory data to these profiles. We also used the final versions of the MANEVU+VA 2007 area, point, and nonroad emission inventories. The MANEVU+VA 2007 onroad inventory was not included in this evaluation.

CHECKS TO MATCH SCCs USED IN THE MANEVU+VA 2007 INVENTORY WITH SMOKE ANCILLARY FILES

We performed QA checks to ensure that all SCCs in the final MARAMA 2007 annual emissions inventories were cross referenced to this ancillary data and when a proper cross reference did not exist, we made recommendations on valid matches.

Speciation Profiles

We conducted a check of the annual emissions inventory data for 2007 area, nonroad, and point source inventories to ensure that appropriate matches were made to the SMOKE speciation profiles and cross-reference files available from EPA. The SMOKE files from the EPA distribution used in this comparison were:

- gsref_cmaq_cb05_soa_2005ck_05b_19mar2009.txt: Speciation cross-reference file using SPECIATE4.0 with some SPECIATE4.2 profiles
- gspro_cmaq_cb05_soa_2005ck_05b_19mar2009.txt: Speciation profiles for CMAQ version 4.7 CB05 with SOA chemical mechanism

For the majority of SCCs and almost all of the domain wide emission totals, SCC-profile matches were found in all cases. A small list of SCCs did not have appropriate matches within the EPA distributed tables. We have recommended speciation profile assignments based on the profiles used for similar SCCs. For example, SCCs 2275050011 (Aircraft/General

[1] http://www.epa.gov/ttn/chief/emch
ancillary_2005v4_smokeformat.zip, dated 05/25/2010
readme_2005v2cap_bafm_haps_anicllary_inputs.txt, dated 07/08/2010

Aviation/Piston) and 2275050012 (Aircraft/General Aviation/Turbine) are subsets of the more general SCC 2275050000 (Aircraft/General Aviation, All Types). The SMOKE speciation profile for 2275050000 was used for both the Piston and Turbine SCCs. Exhibit 1 is attached and summarizes the SCC/pollutant code/speciation profile combinations that need to be added to the GSREF file. The second check made was to insure that each pollutant code/speciation profile in the GSREF file had a match in the GSPRO file. No problems were identified as the result of this check.

Spatial Profiles

We conducted a check of the MANEVU+VA 2007 area and nonroad source inventories to ensure that all SCCs in the inventory had a spatial surrogate match in the SMOKE spatial cross-reference file. Spatial allocation profiles are not used for point sources as the point source inventory has geographic coordinates for each stack. The point source coordinates were reviewed under Work Order 2 of this contract to check the reasonableness of each release point relative to county centroid and minimum/maximum coordinate associated with the FIPS code assigned to each stack.

The spatial allocation files from the EPA distribution used in this comparison were:

- amgref_us_can_mex_revised_11mar2010_v8.txt: Spatial cross-reference for sectors other than othar_hg
- srgdesc_36km_revised_17mar2009_v1.txt: Surrogate code descriptions (36 or 12 km) for all U.S. and non-U.S. sectors other than othar_hg

For the majority of SCCs SCC-profile matches were found. However, a list of SCCs which appear to be unique to MARAMA did not have associations to the EPA spatial cross-reference file. We have recommended spatial profile assignments based on the profiles used for similar SCCs. For example, the was no spatial profile for SCC 2501090050 (Petrol & Petrol Product Storage /Marinas : Gasoline/ Stage 1: Total). We used profile 350 (water area) for this SCC since it is similar to SCC 2282005010 (Pleasure Craft /Gasoline 2-Stroke /Outboard). Exhibit 2 is attached and summarizes the SCC/spatial code combinations that need to be added to the AMGREF file. The second check made was to insure that each spatial allocation profile in the AMGREF file had a match in the SRGDESC file. No problems were identified as the result of this check.

Temporal Profiles

We conducted a check of the 2007 area, nonroad and point source inventories to ensure that appropriate matches were made to the SMOKE temporal cross-reference files available from EPA. The files from the EPA distribution used in this comparison were:

- amptref_v3_3_revised_13mar2009_v1.txt: Temporal cross-reference to use for the "regulatory" (case name 2005ck_05b) simulation
- amptpro_2005_us_can_revised_10mar2009_v0.txt: 2005-specific temporal profiles used for "regulatory" (case name 2005ck_05b)

Several SCCs are unique to the MANEVU+VA 2007 inventory and did not have associations to the EPA temporal cross-reference file. We used our engineering judgment to recommend profile assignments based on the profiles used for similar SCCs. Exhibit 3 is attached and summarizes the SCC/temporal code combinations that need to be added to the AMPTREF file.

AVAILABILITY OF IMPROVED PROFILES FOR KEY CATEGORIES

We reviewed and documented the SMOKE ancillary files used for EPA's 2005v4 modeling platform for several key source categories. We also investigated whether new or improved data were available to improve the temporal or spatial allocation of emissions for each category.

Temporal Profiles for Agricultural Ammonia Emissions

The temporal allocation profiles for agricultural emissions in the EPA SMOKE files vary by State. In particular, the monthly profiles for fertilizer application show a wide variation by State. For example, fertilizer application in the southern part of the region (i.e., Virginia) is allocated primarily to the months of March, April and May. In contrast, fertilizer application in the northern part of the region (i.e., Maine) is allocated primarily to the months of May and June. See Figure 1 for a graphical representation of the temporal profiles or an example SCC. The temporal profiles for ammonia emissions for livestock operations do not vary by State. See Figure 2 for a graphical representation of the temporal profiles or an example SCC.

We contacted Mark Janssen (LADCO) to determine if updated temporal profiles were available from planned work with the ammonia based process model. He referred us to the Eastern Regional Technical Advisory Committee (ERTAC) process, but to date no new work has been published regarding these profiles. For this reason, we consider the agricultural ammonia temporal profiles currently distributed in the latest EPA modeling platform as the most recent available for MARAMA's use.

Temporal Profiles for Residential Wood Combustion (RWC) Emissions

The temporal allocation profiles for RWC emissions vary by county. For example, RWC emissions in the southern part of the region (i.e., Brunswick County, Virginia) are primarily allocated to the winter months. In contrast, RWC emissions in the north (i.e., Addison County, Vermont) are allocated more smoothly throughout the Fall, Winter, and Spring months. See Figure 3 for a graphical representation of the temporal profiles or an example SCC.

The current RWC profiles from EPA's modeling platform appear to be based on a 2004 report generated for MARAMA by E.H. Pechan and Associates, Inc.[2] This report summarizes data collected during the 2002 emission inventory preparation process. Should MARAMA wish to replace these temporal profiles, we recommend an update to the monthly distribution profiles using National Climatic Data Center (NCDC) heating degree day distributions for calendar year 2007[3]. This would allow the emissions modeling to match the meteorological conditions of the chosen episodes (based on a 2007 calendar year meteorological data set).

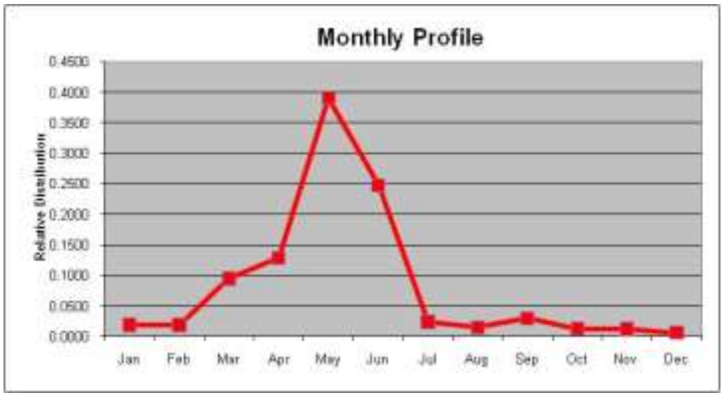
[2] http://marama.org/visibility/ResWoodCombustion/Final_report.pdf

[3] http://www.cpc.noaa.gov/products/analysis_monitoring/cdus/degree_days/

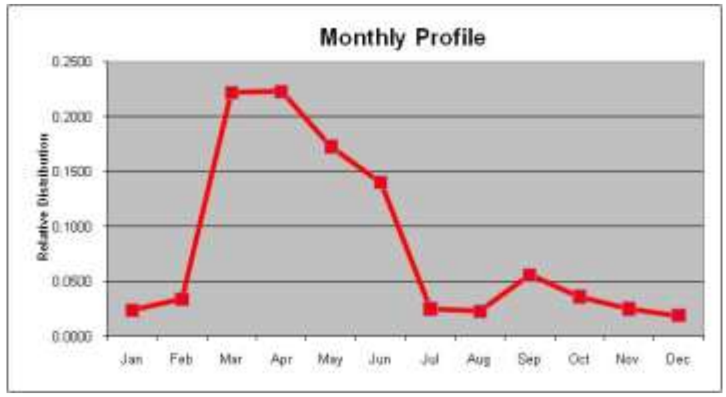
Figure 1 Temporal Profiles for Agricultural Fertilizer Application

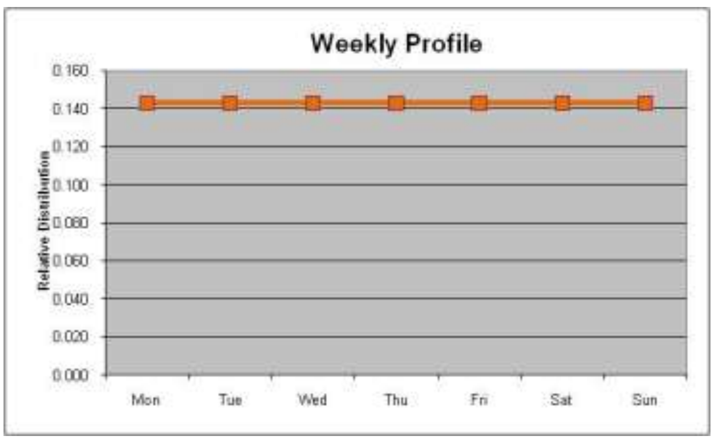
Example SCC:	28-01-700-004 Miscellaneous Area Sources; Agriculture Production - Crops; Fertilizer Application; Urea
Similar SCCs:	All SCCs in 28-01-700-xxx series
Emission Summary:	28-01-700-xxx accounts for 32,688 tons of NH3 per year, about 13% of all NH3 from the point, area, and nonroad sectors.
Geographic Variability?	Varies by State; examples below is for Pennsylvania and Virginia

Maine



Virginia





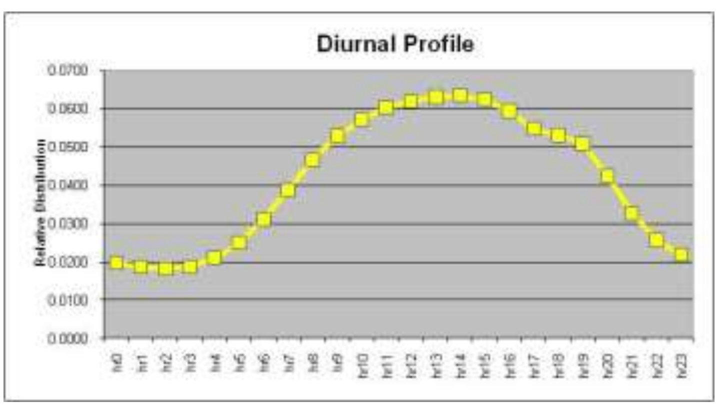


Figure 2 Temporal Profiles for Agricultural Livestock Operations

Example SCC:	28-05-009-100 Miscellaneous Area Sources; Agriculture Production - Livestock; Poultry production - broilers; Confinement
Similar SCCs:	All SCCs in 28-05-xxx-xxx series
Emission Summary:	28-05-xxx-xxx accounts for 179, 248 tons of NH3 per year, about 70% of all NH3 from the point, area, and nonroad sectors.
Geographic Variability?	National Default

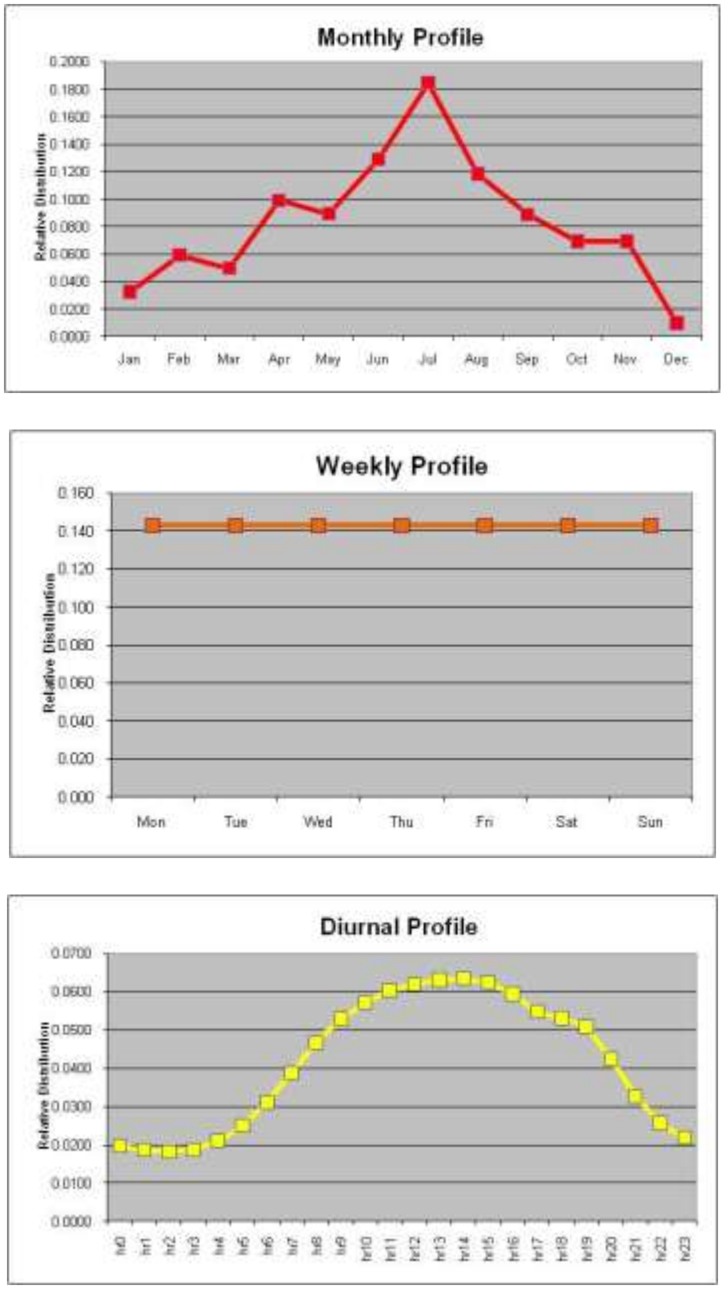
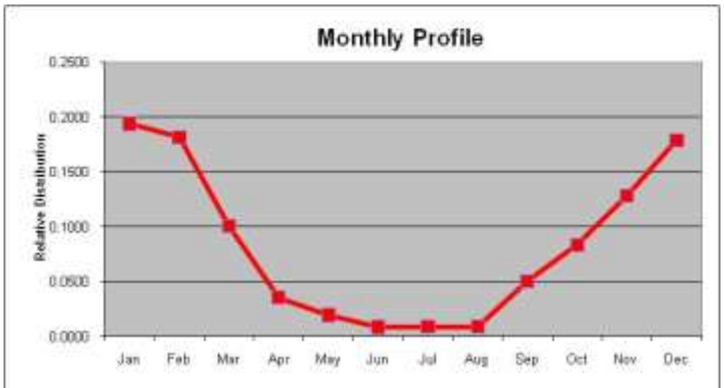


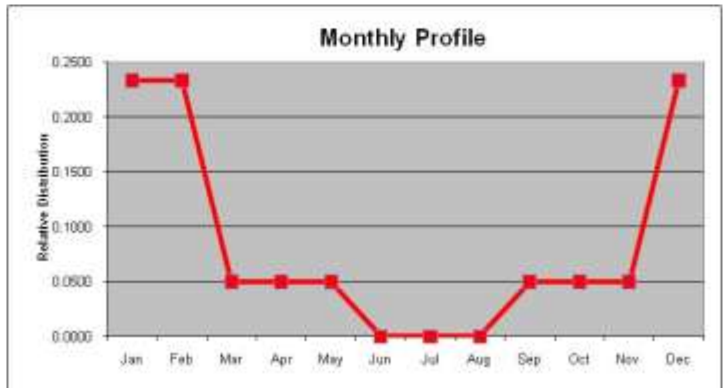
Figure 3 Temporal Profiles for Residential Wood Combustion

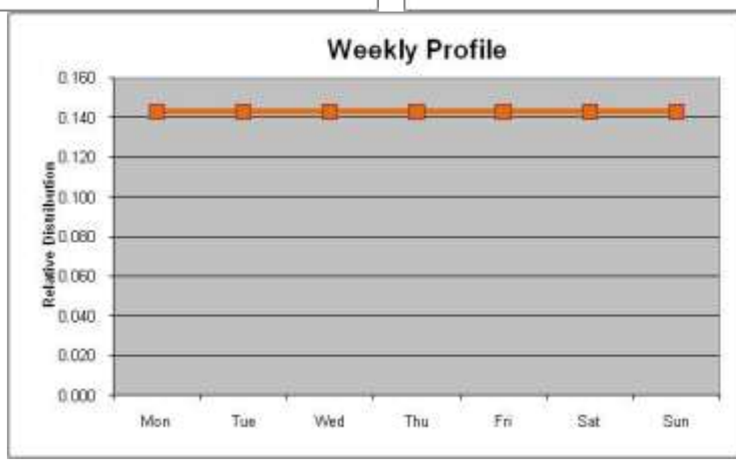
Example SCC:	21-04-008-000 Stationary Source Fuel Combustion; Residential; Wood; Total: Woodstoves and Fireplaces
Similar SCCs:	21-04-008-xxx includes all Res Wood Combustion SCCs
Emission Summary:	21-04-008-xxx accounts for 73, 227 tons of PM2.5 per year, about 18% of all PM2.5 and 162,914 tons of VOC, about 10% of all VOC from the point, area, and nonroad sectors.
Geographic Variability?	Monthly profile varies by county – two examples below

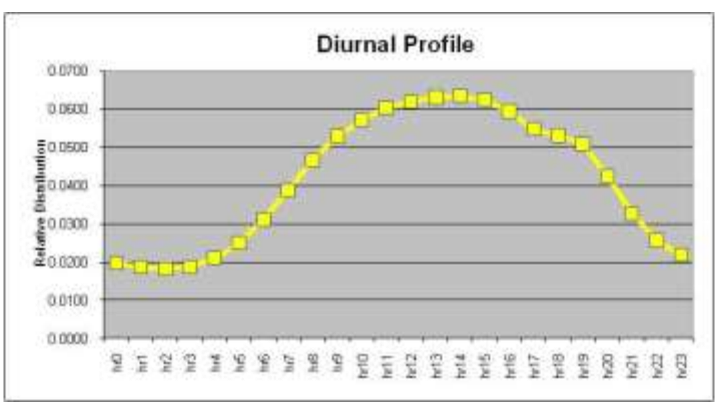
Addison County, Vermont



Brunswick County, Virginia







Temporal Profiles for NMIM Nonroad Sources

Discussions with MARAMA modeling staff confirmed that revised monthly temporal profile data were not necessary for NONROAD/NMIM generated source types. Because the emissions for these sources were generated on a monthly basis by MACTEC, the emissions are already provided with monthly allocation based on NONROAD/NMIM input files. We also confirmed that the SMOKE day of week and hour of day profiles associated with NONROAD/NMIM sources are allocated to most recent NONROAD model profiles available with the model.

Figure 4 provides an example of how using the results of monthly NMIM/NONROAD model runs provides improved monthly temporal allocation over the use of SMOKE defaults. The SMOKE default for pleasure craft (SCCs 22-82-xxx-xxx) is a flat profile, i.e., emissions occur uniformly throughout the year. Since we are using the NMIM/NONROAD monthly profiles instead for the 2007 inventory, a more realistic allocation is used which assigns most of the annual emissions from pleasure craft to the summer months. Another example (not shown graphically) is for snowmobiles (SCC 22-60-001-020) and snowblowers (SCC 22-60-004-035), where the NMIM/NONROAD monthly profile assigns nearly all of the annual emissions to the three month of December, January, and February. Thus, using the monthly NMIM/NONROAD model results provides a significant improvement in the seasonal allocation of nonroad emissions.

Spatial and Temporal Profiles for Airports

Through communication with EPA staff, we determined that the landing and take-off (LTO) data used to allocate county level area source airport emissions to individual airports (using the ARTOPNT module of SMOKE) is based on airport specific information used in the development of EPA's 2005 National Emission Inventory. These LTO data were obtained from airport specific LTO data and Bureau of Transportation Statistics (BTS) geographic information system (GIS) data.

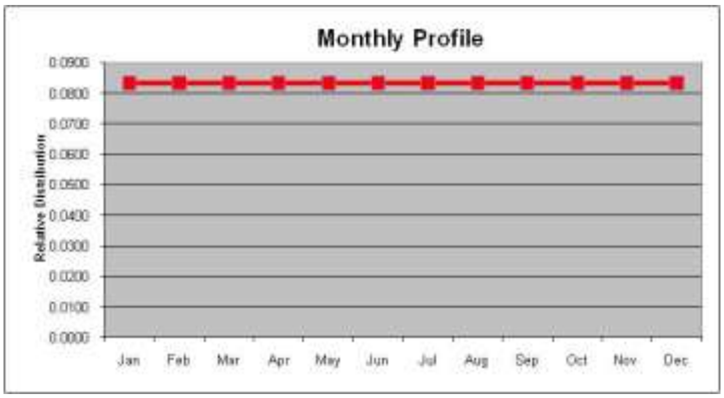
The MANE-VU+VA 2007 airport inventory was developed at the county level. We conducted a quality assurance review of the SMOKE ARTOPNT file to verify that county level emissions were properly allocated to large commercial and military airports. Commercial aircraft account for about 75% of the region-wide airport NOx emissions, while military aircraft account for about 18% of the emissions. The remaining 7% of the region-wide airport NOx emissions result from general aviation, air taxi, and auxiliary power units. We did not QA the spatial allocation of these last three categories.

We prepared a spreadsheet to show how county level commercial aircraft emissions will be allocated to specific locations using the SMOKE ARTOPNT file (see: "Commercial_spatial" tab of Airport_Spatial_Temporal_Allocation.xlsx). The top 20 counties account for 95% of the total commercial aircraft NOx emissions. We verified that there is just one large airport per top 20 county, so that the county-level emissions are being allocated to the location of the large airport. The only exception is Queens County, NY, where LaGuardia and JFK airports are located. The SMOKE ARTOPNT file allocates 60% of the commercial emissions to LaGuardia and 40% of the emissions to JFK. EPA's 2008 airport inventory has 160,043 commercial LTOs for

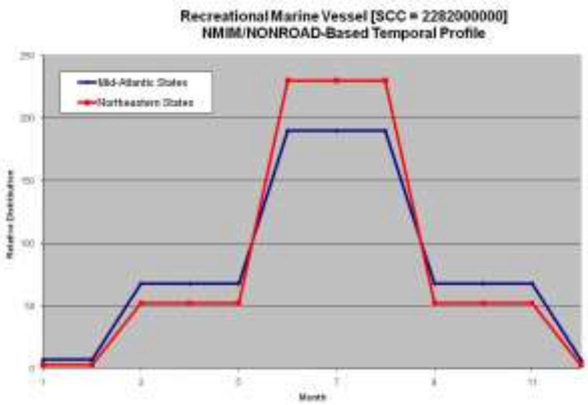
Figure 4 Temporal Profiles for Pleasure Craft

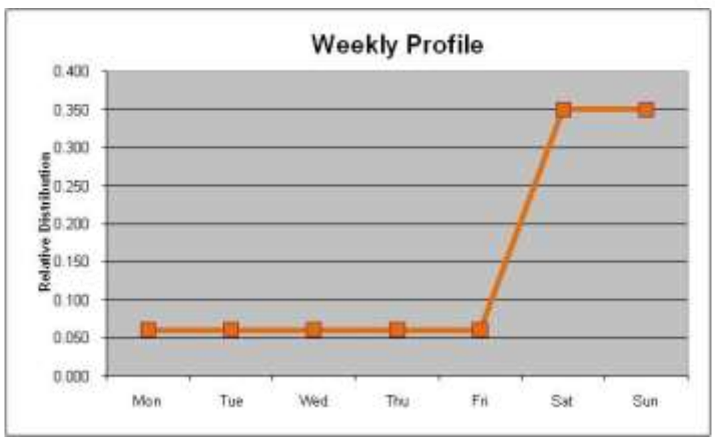
Example SCC:	22-82-005-010 Mobile Sources; Pleasure Craft; Gasoline 2-Stroke; Outboard
Similar SCCs:	All SCCs in 22-85-xxx-xxx series (i.e., no variation by type of railroad)
Emission Summary:	22-85-xxx-xxx accounts for 153,771 tons of VOC per year, about 10% of all VOC from the point, area, and nonroad sectors.
Geographic Variability?	SMOKE is National Default; NMIM/NONROAD is by region

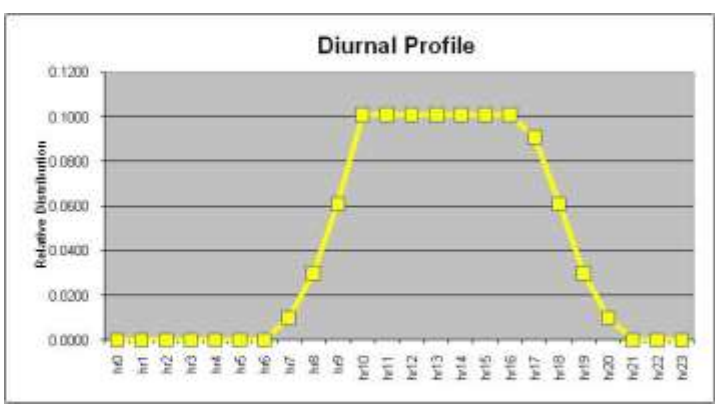
SMOKE Default Monthly Profile



NONROAD/NMIM Monthly Profile
(Used for 2007 MANE-VU+VA)







LaGuardia and 211,922 LTOs for JFK, which suggests that 43% of the commercial emissions should be allocated to LaGuardia and 57% of the emissions allocated to JFK. We recommend that these factors be used in the SMOKE ARTOPNT file for commercial aircraft (SCC 22-75-020-000).

We also prepared a similar spreadsheet for military airport emissions and confirmed that the SMOKE ARTOPNT file reasonably allocates county-level emissions to the location of the military airport (see: "Military_spatial" tab of Airport_Spatial_Temporal_Allocation.xlsx). We also visually verified that the latitude and longitude of the top 20 commercial airports and top 10 military airports were reasonable using an internal MACTEC project locator mapping system.

The SMOKE temporal profiles for commercial aircraft operations are shown in Figure 5. We investigated the availability of alternative data for the temporal profiles for commercial aircraft operations. The BTS Airline On-Time Performance Database contains information on monthly, day-of-week, and hour-of-day air travel (http://www.transtats.bts.gov/DataIndex.asp). These data are reported by US certified air carriers that account for at least one percent of domestic scheduled passenger revenues. We used these data to develop alternative temporal profiles for commercial aircraft operations.

Commercial aircraft uses monthly profile 246, which appears to be a bit odd. Monthly BTS flight data for 2007 is shown below and are plotted alongside the SMOKE profile in Figure 5. The BLS data show a peak in commercial air traffic during the summer months, with secondary peaks in March and October. We recommend that the SMOKE monthly profile for commercial aircraft (SCC 22-75-020-000), ground support equipment, and Auxiliary power units (22-75-070-000) be changed to use the 2007 BLS monthly profile shown below.

	BTS Flights	**BTS Fraction**	**SMOKE Fraction**
Jan	621,559	0.08337	0.08283
Feb	565,604	0.07586	0.08283
Mar	639,209	0.08574	0.07685
Apr	614,648	0.08244	0.07685
May	631,609	0.08472	0.07685
Jun	629,280	0.08441	0.08683
Jul	648,560	0.08699	0.08683
Aug	653,279	0.08762	0.08683
Sep	600,187	0.08050	0.08683
Oct	629,992	0.08450	0.08683
Nov	605,149	0.08117	0.08683
Dec	616,382	0.08268	0.08283
Total	**7,455,458**	**1.0000**	**1.00000**

Commercial aircraft uses day-of-week profile 7, which is uniformly flat. Day-of-week BTS flight data for 2007 is shown below and are plotted alongside the SMOKE profile in Figure 5. The BLS data show a decline in the number of flights on Saturday, but otherwise a relatively flat distribution for the rest of the week. We recommend that the SMOKE monthly profile for commercial aircraft (SCC 22-75-020-000), ground support equipment, and Auxiliary power units (22-75-070-000) be changed to use the 2007 BLS day-of-week profile shown below.

	BTS Flights	BTS Fraction	SMOKE Fraction
Mon	1,112,919	0.1493	0.1430
Tue	1,078,562	0.1447	0.1430
Wed	1,088,858	0.1460	0.1430
Thu	1,097,738	0.1472	0.1430
Fri	1,102,261	0.1478	0.1430
Sat	933,953	0.1253	0.1430
Sun	1,041,167	0.1397	0.1430
Total	**7,455,458**	**1.0000**	**1.0000**

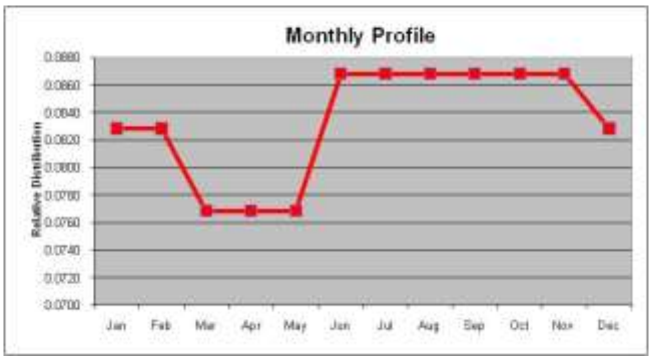
Commercial aircraft uses day-of-week profile 26. Hour-of-day BTS flight data for 2007 is shown below and are plotted alongside the SMOKE profile in Figure 5. The BLS data show very few flights during the overnight hours, with small peaks around 6am and 5pm. We recommend that the SMOKE monthly profile for commercial aircraft (SCC 22-75-020-000), ground support equipment, and Auxiliary power units (22-75-070-000) be changed to use the 2007 BLS day-of-week profile shown below.

	BTS Flights	BTS Fraction	SMOKE Fraction
hr0	10,426	0.00140	0.01980
hr1	10,426	0.00140	0.01860
hr2	10,426	0.00140	0.01820
hr3	10,426	0.00140	0.01870
hr4	10,426	0.00140	0.02100
hr5	10,426	0.00140	0.02500
hr6	523,279	0.07019	0.03110
hr7	512,002	0.06867	0.03880
hr8	510,575	0.06848	0.04670
hr9	486,566	0.06526	0.05279
hr10	467,553	0.06271	0.05709
hr11	494,120	0.06628	0.06039
hr12	461,344	0.06188	0.06199
hr13	486,189	0.06521	0.06309
hr14	459,359	0.06161	0.06349
hr15	451,652	0.06058	0.06239
hr16	482,371	0.06470	0.05939
hr17	501,153	0.06722	0.05479
hr18	437,944	0.05874	0.05309
hr19	437,305	0.05866	0.05089
hr20	297,934	0.03996	0.04250
hr21	250,926	0.03366	0.03270
hr22	91,519	0.01228	0.02570
hr23	41,111	0.00551	0.02180
	7,455,458	**1.00000**	**1.00000**

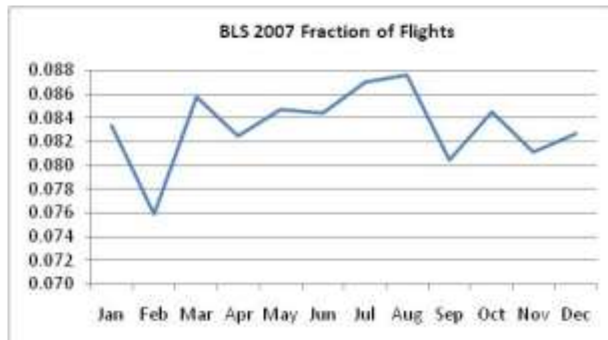
Figure 5 Temporal Profiles for Commercial Aircraft Operations

Example SCC:	22-75-020-000 Mobile Sources; Aircraft; Commercial Aircraft; Total: All Types
Similar SCCs:	Most SCCs in 22-75-xxx-xxx series; General aviation 22-75-050-xxx has a flat monthly profile
Emission Summary:	22-75-xxx-xxx accounts for 25,462 tons of NOx per year, about 2% of all NOx from the point, area, and nonroad sectors.
Geographic Variability?	National Default

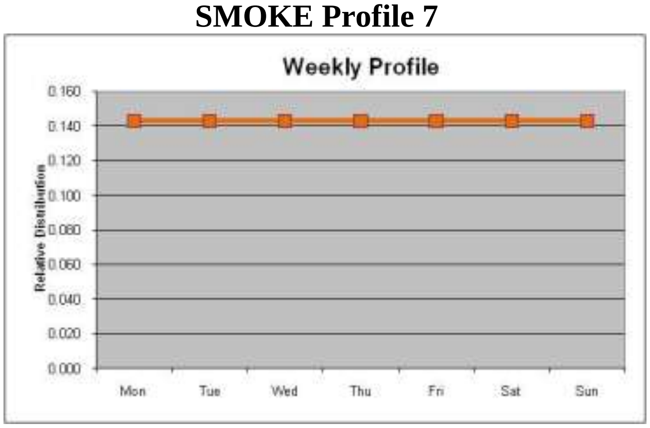
SMOKE Profile 246



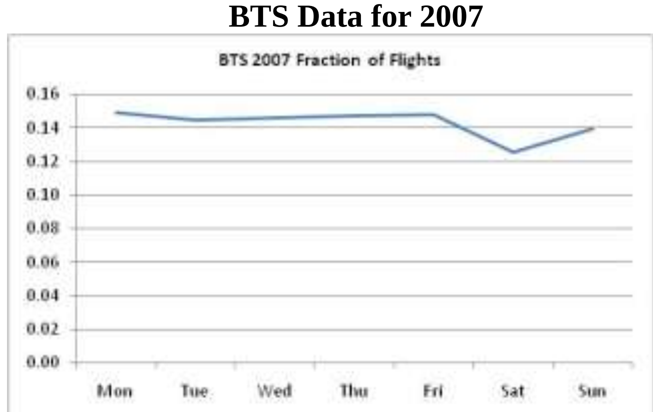
BTS Data for 2007



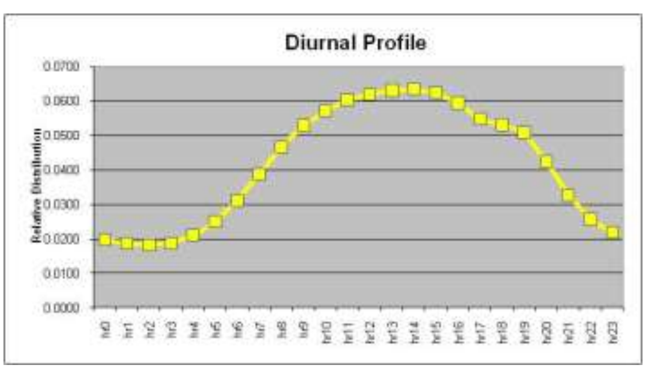
SMOKE Profile 7



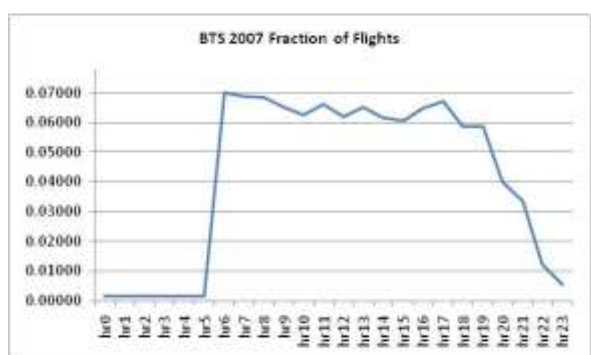
BTS Data for 2007



SMOKE Profile 26



BTS Data for 2007



Spatial and Temporal Profiles for Residual Oil Commercial Marine Vessels (CMV C3)

The following inventory files are available:

- **EPA NEI 2008**. EPA provided a file (2008CountySCCSummary_100429.mdb) used for the NEI with county level emissions for both diesel (C1/C2) and residual oil (C3) engines. The two SCCs used for C3 engines are: below.
  - 22-80-003-100 CMV/Residual (aka Class 3)/Port Emission
  - 22-80-003-200 CMV/Residual (aka Class 3)/Underway Emissions

  EPA NEI Documentation[4] states that the inventory includes "port and interport emissions that occur within the area that extends 200 nautical miles (nm) from the official U.S. baseline." However, it appears that the NEI only assigns emissions to counties to reflect State waters (3–10 nautical miles), not the entire 200 nm area.

- **MANE-VU+VA 2007 Inventory**. States reviewed the EPA inventory and either accepted the EPA inventory or provided their own county-level estimates. In several cases, the State-supplied emissions differ dramatically from the 2008 NEI and the differences cannot be easily explained.

- **EPA Spatially Allocated C3 Emissions (June 2010)**. EPA provided a file with 2007 emissions (ptinv_eca_imo_FINAL_c3_caps_2007_21JUN2010_orl.txt) for C3 vessels in SMOKE Point ORL format which represents shipping lanes as a series of point sources with specific latitude/longitude coordinates. For example, C3 emissions within 200 nm of Sussex County DE are represented by 107 point sources with a total of 3,853 tons of SO2 and 4,162 tons of NOx. The file has annual emissions (i.e., it is not temporally allocated). The EPA point source inventory includes only a single SCC for the C3 marine sources (22-80-003-000 C3 All Vessel types) instead of the two SCCs used in the MANE-VU+VA inventory (2280003100 – C3 Port, 2280003200 – C3 Underway). There are no Class 1/2 SCCs in this file. It appears that the emissions out to 200 nm were assigned to FIPS counties.

- **EPA Spatially Allocated C3 Emissions (October 2010)**. As part of the Transport Rule Final NODA[5], EPA proposed to reduce the boundaries used to allocate C3 CMV emissions to States from 200 nautical miles to reflect State waters (3–12 nautical miles) based on Mineral Management Service State federal boundary data consistent with approaches used for the 2005 and 2008 National Emissions Inventories. For example, C3 emissions within 3-12 nm of Sussex County DE are represented by 5 point sources with a total of 1,332 tons of SO2 and 248 tons of NOx. The total C3 emissions themselves are virtually unchanged from the 21JUN2010 file previously provided to MARAMA, but the county-level emissions change because EPA restricted state FIPS assignments to within 3-12 nm of shore. Emissions beyond the 3-12 nm boundaries are assigned to generic FIPS county codes. EPA provided a 2005 file but has not generated other years yet (ptinv_eca_imo_fixFIPS_US_caps_2005_19OCT2010_orl.txt).

[4] http://www.epa.gov/ttn/chief/net/cmv_report4.pdf
[5] http://www.gpo.gov/fdsys/pkg/FR-2010-10-27/pdf/2010-27171.pdf

NOx and SO2 emissions by county for the MANEV-VU+VA region contained in these four inventories are summarized in the attached spreadsheet (CMV_C3_Emission_Summary.xlsx).

Given the above data availability, the simplest option for spatially allocating MANE-VU+VA CMV C3 emissions may be to try to adjust the October 2010 EPA C3 point source ORL file and replace the EPA calculated emissions with the State-supplied emissions on a county-by-county and SCC-by-SCC basis. Since the October 2010 EPA C3 point source ORL file extends only out to 3-12 nm (roughly the same distance as the State supplied emissions), the point source ORL file emissions could be adjusted by the ratio of the State-supplied county-level emissions to the ORL file county-level emissions, by SCC. There will be a few special cases that would have to be assessed, such as when the State supplied port emissions but the ORL file does not have port emissions, and vice versa, which would have to be worked out. We would only be altering the EPA C3 point source ORL file for emissions that occur within county boundaries; emissions for areas outside the county boundaries (i.e., from 3 to 200 nm) would remain unchanged. We would need EPA to generate a 2007 file for the areas outside of the county boundaries.

Other options exist for spatially allocating the MANE-VU+VA C3 emissions, such as using the approach EPA employed using the above mentioned shape files and the methods identified in the EPA paper[6]. This likely will require much more effort than the approach described in the previous paragraph.

The SMOKE temporal allocation for CMV Residual Port (SCC 22-80-003-100) and CMV Residual Underway (22-80-003-200) emissions are flat on a monthly, day of week and hour of day. However, the monthly profile for CMV/Residual/All Vessel Types (SCC 22-80-003-000) show a seasonal variation, as depicted in Figure 6. The monthly profile (#19531) used for SCC 22-80-003-000 appears to be the same as that used by EPA in their C3 inventory. EPA explained the summer peak possibly being due to the setup for production for peak holiday season consumerism beginning in the fall. We recommend that monthly profile 19531 also be used for SCCs 22-80-003-100 (CMV/Residual/Port) and 22-80-003-200 (CMV/Residual/Underway) which are used in the MANE-VU+VA 2007 inventory.

Spatial and Temporal Profiles for C1/C2 Diesel Commercial Marine Vessels Activities

The section discusses the following two SCCs:

- 22-80-002-100 CMV/Diesel (aka Class I/II)/Port Emissions
- 22-80-002-200 CMV/Diesel (aka Class I/II)/Underway Emissions

(Category 1 and 2 vessels tend to be smaller ships that operate closer to shore, and along inland and intercoastal waterways.)

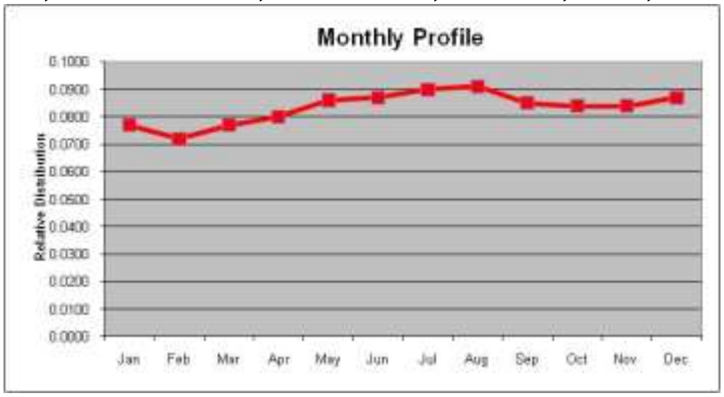
The SMOKE spatial allocation files for assigning county diesel CMV emissions to grid cells are as follows:

- 22-80-002-100 CMV/Diesel/Port uses profile 800 (Marine Ports)
- 22-80-002-200 CMV/Diesel/Underway uses profile 810 (Navigable Waterway Activity)

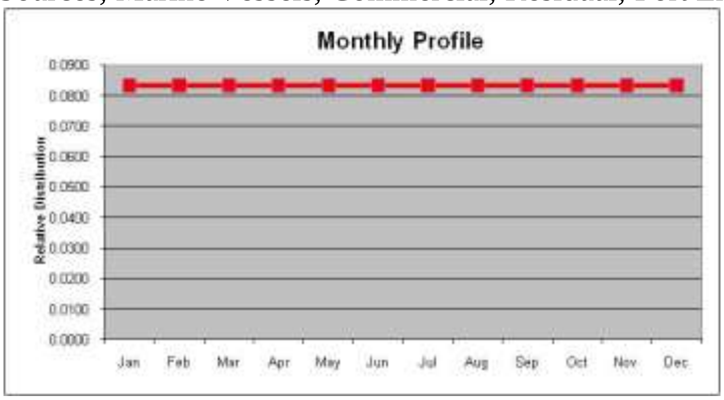
[6](http://www.epa.gov/ttn/chief/conference/ei17/session6/mason.pdf

Figure 3 Temporal Profiles for CMV Residual (Class 3)

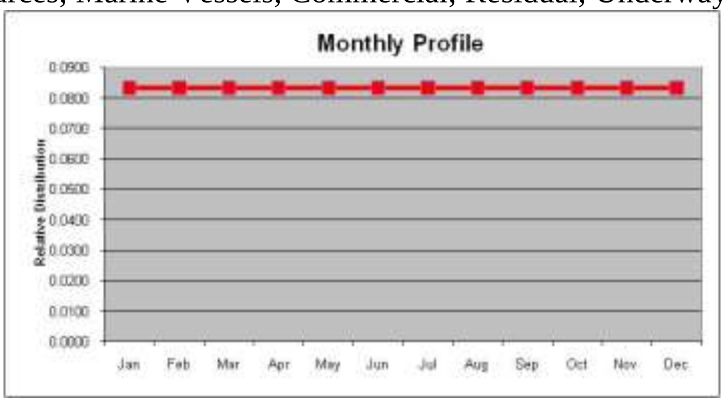
SCC = 22-80-003-000 Monthly Profile 19531
Mobile Sources; Marine Vessels, Commercial; Residual; Total, All Vessel Types



SCC = 22-80-003-100 Monthly Profile 262
Mobile Sources; Marine Vessels, Commercial; Residual; Port Emissions



SCC = 22-80-003-200 Profile Monthly Profile 262
Mobile Sources; Marine Vessels, Commercial; Residual; Underway Emissions



EPA has posted port and CMV shipping lane shape files on their ftp site[7]; port_032310.zip and shipping_lanes_111309.zip). In this EPA effort, spatial accuracy was greatly enhanced via the creation of GIS polygons representing port and waterway boundaries. GIS polygons allowed the estimation/allocation of emissions to defined port, waterway, and coastal areas, leading to improved spatial resolution compared to previous inventories. The shape files are documented in *Documentation for the Commercial Marine Vessel Component of the National Emissions Inventory*[8] as follows:

- For port emissions, GIS data or maps provided directly from the port were used. Next, maps or port descriptions from local port authorities, port districts, etc. were used in combination with existing GIS data to identify port boundaries. Finally, satellite imagery from tools such as Google Earth and street layers from StreetMap USA were used to delineate port areas. Emphasis was placed on mapping the 117 ports with Category 3 vessel activity using available shape files of the port area. Each polygon was identified by the port name and state and county FIPS in addition to a unique ShapeID. Smaller ports with Category 1 and 2 activities were mapped as small circles.
- For underway emissions, a GIS polygon layer was created to more accurately represent the location of CMV-related activity and emissions. Inland waterway polygons were obtained from the Bureau of Transportation Statistics' National Transportation Atlas Database hydro polygon layer (U.S. DOT, 2007). These polygons were further divided by county boundary and waterway ID. Coastal waters were drawn using Mineral Management Service state-federal boundary files and were also divided to indicate county boundaries. Federal waters were included as large area blocks outlined by the Exclusive Economic Zone (EEZ) boundary provided by EPA, which extends to approximately 200 nautical miles from the coastline. The final product is a polygon layer that includes all inland and coastal state waters and federal waters along with FIP, polygon area, and a unique ShapeID.

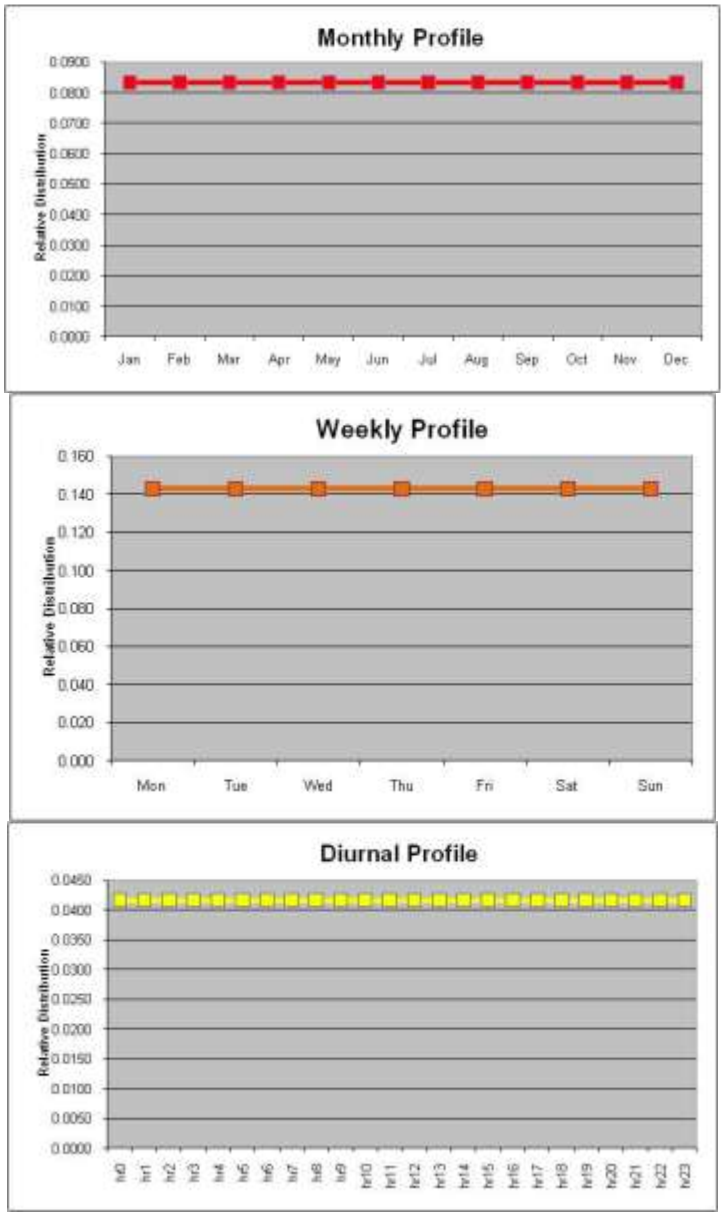
EPA provided the shapefiles for input into the Spatial Surrogate Tool, which is stand-alone tool for generating spatial surrogates that are inputs to emission models such as SMOKE. This tool allows users to generate, merge or gapfill surrogate ratios for a user-specified grid, regardless of the type of operating system used and without needing third-party software.

Figure 7 shows the SMOKE temporal allocation for CMV Diesel Port emissions. The SMOKE profiles for CMV Diesel Underway is the same. Both are flat on a monthly, day of week, hour of day basis. We conducted a search of the Bureau of Transportation Statistics for information to develop improved temporal profiles for C1/C2 CMV, but could not locate any useful data.

[7] ftp://ftp.epa.gov/EmisInventory/2008_nei/mobile/rail_cmv_shapefiles
[8] http://www.epa.gov/ttn/chief/net/cmv_report4.pdf

Figure 7 Temporal Profiles for CMV Diesel (Class 1 and 2)

Example SCC:	22-80-002-100 Mobile Sources; Marine Vessels, Commercial; Diesel; Port emissions
Similar SCCs:	22-80-002-200 Mobile Sources; Marine Vessels, Commercial; Diesel; Underway emissions
Geographic Variability?	National Default



Spatial and Temporal Profiles for Railroads

The SMOKE spatial allocation files for assigning county level rail emissions to grid cells are as follows:

- 22-85-002-006 Class I Ops uses profile 270 (Class I Railroad Miles)
- 22-85-002-007 Class II/III Ops uses profile 280 (Class II/III Railroad Miles)
- 22-85-002-008 AMTRAK uses profile 260 (Total Railroad Miles)
- 22-85-002-009 Commuter Rail uses profile 260 (Total Railroad Miles)
- 22-85-002-010 Rail Yards uses profile 260 (Total Railroad Miles)

New York State plotted the spatial distribution of gridding surrogates 260, 270 and 280 (see: map_railroad_gridding.PDF). The first three maps shows the total amount of this "feature" (total railroad miles for 260, class 1 railroad miles for 270, class II/III railroad miles for 280) for each grid cell in our domain. Grid cells containing more than one county show the sum of this feature across all intersecting counties. This is for illustration only, for the actual gridding of county-level emissions SMOKE will use the gridding ratios (i.e. the amount of a "feature" in a given grid cell in a county to the sum of this "feature" across all grid cells in the county). This is illustrated on pages 4-6 for Aroostook County, ME, a separate map would have to be generated for each county to QA the gridding ratios. Note that for this county, surrogates 260, 270 and 280 all have the same weights. This may mean that the underlying shapefile did not distinguish between the different railroad classes in ME. This also seems to be the case for NH and VT.

ERTAC did not investigate spatial profiles when preparing the rail inventory for line haul or passenger rail. However, ERTAC did estimate rail yard locomotives (SCC 22-85-002-010) emissions at specific yard locations. The specific ERTAC yard locations could be used rather than the entire track route mileage in a county to spatially allocate county level rail year emissions. However, there are several problems with this approach. First, only three States used the ERTAC rail yard emission estimates in the MANE-VU+VA 2007 inventory (NY, PA, VA). Four States (CT, DE, ME, RI) provided state-supplied rail yard emission estimates but do not have any specific rail yard locations in the ERTAC database. Three States (DC, MA, MD) provided state-supplied rail yard emission estimates and do have specific rail yard locations in the ERTAC database. Finally, three States (NH, NJ, VT) did not supply rail yard emissions for the MANE-VU+VA 2007 inventory and do not have specific rail yards in the ERTAC database. This information is summarized in Exhibit 4. Detailed summaries are contained in a spreadsheet (Railyards MANEVU ERTAC.xlsx)

Because of the types of data available varies by State, different spatial allocation schemes would be necessary for different States as shown in the following table. We do not think it is worth the time and effort to implement the three different approaches for spatially allocating rail yard emissions. Rail yard NOx emissions amount to 6,414 tons, only about 8% of all railroad equipment NOx emissions in the region, and only about 0.5% of all NOx emissions from point, area, and nonroad sources. Because of the small amount of emissions from rail yards, improving the spatial allocation would likely not have any significant impact on regional air quality model performance.

Exhibit 4 - Data Availability for 2285002010 Yard Locomotives

State	Data Source for MANE-VU+VA Inventory	Railyard Specific Emissions in ERTAC?	Option for Spatial Allocation
CT	State Supplied	No	Allocate county level emissions using SMOKE profile 260 (total railroad miles)
DE	State Supplied	No	Allocate county level emissions using SMOKE profile 260 (total railroad miles)
DC	State Supplied	Yes	Apportion State-supplied county-level emissions to specific ERTAC railyards; Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file
ME	State Supplied	No	Allocate county level emissions using SMOKE profile 260 (total railroad miles)
MD	State Supplied	Yes	Apportion State-supplied county-level emissions to specific ERTAC railyards; Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file
MA	State Supplied	Yes	Apportion State-supplied county-level emissions to specific ERTAC railyards; Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file
NH	n/a	No	None required
NJ	n/a	No	None required
NY	EPA ERTAC	Yes	Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file
PA	EPA ERTAC	Yes	Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file
RI	State Supplied	No	Allocate county level emissions using SMOKE profile 260 (total railroad miles)
VT	n/a	No	None required
VA	EPA ERTAC	Yes	Prepare Point ORL file using specific lat/lon and emissions for each ERTAC rail yard Zero out emissions in Area ORL file

EPA has posted rail line shape files on their ftp site[9] Since there is no documentation associated with these files, it is not clear how these shape files differ from the SMOKE ready gridded surrogate ratio files discussed above. EPA provided the shapefiles for input into the Spatial Surrogate Tool[10], which is stand-alone tool for generating spatial surrogates that are inputs to emission models such as SMOKE. This tool allows users to generate, merge or gapfill surrogate ratios for a user-specified grid, regardless of the type of operating system used and without needing third-party software.

9 (ftp://ftp.epa.gov/EmisInventory/2008_nei/mobile/rail_cmv_shapefiles).
10 http://www.ie.unc.edu/cempd/projects/mims/spatial

Figure 8 shows the SMOKE temporal allocation profiles for Rail. The profiles are all flat – monthly, day of week, hour of day. These profiles may be appropriate for Class I and Class II/III line haul locomotives, but it is reasonable to assume that AMTRAK and Commuter trains would have a different Weekday/Weekend and Hour-of-Day profile to reflect when most AMTRAK/commuter trains are operating in the NE corridor. ERTAC did not investigate temporal profiles when preparing the rail inventory. We conducted a search of the Bureau of Transportation Statistics for information to develop improved temporal profiles for rail, but could not locate any useful data. We recommend as a future research effort that MARAMA investigate the temporal profiles for AMTRAK/commuter trains, which are likely to vary for each commuter line.

Spatial and Temporal Profiles for Lightering Operations

Two States – Delaware and New York - reported emissions from lightering operations. No other State has significant lightering operations and no other State reported emissions.

- Delaware included VOC emissions from lightering operations in the point source inventory using SCC 40600248. The Delaware lightering operation emitted 1,564 tons of VOC in 2007. The operation is geographically located at a specific latitude and longitude off of the coast of Sussex County. The SMOKE temporal profile for SCC 40600248 is shown in Figure 9. In the NIF EP table, Delaware reported a flat quarterly profile for this source, with activity occurring 24 hours per day, 7 days per week, 52 weeks per year.
- New York included VOC emissions from lightering operations in the CMV inventory using SCC 22-80-002-000. The New York lightering operations emitted 938 tons of VOC in 2007 and occurred in Nassau, Queens, Richmond, and Suffolk counties. These county level emissions will be allocated to grid cells using SMOKE spatial profile 800 – Marine Ports. The SMOKE temporal profile for SCC 22-80-002-000 is flat for all time periods – monthly, day of week, and hour of day.

The spatial and temporal allocation profiles above appear to be reasonable, and we do not recommend any changes.

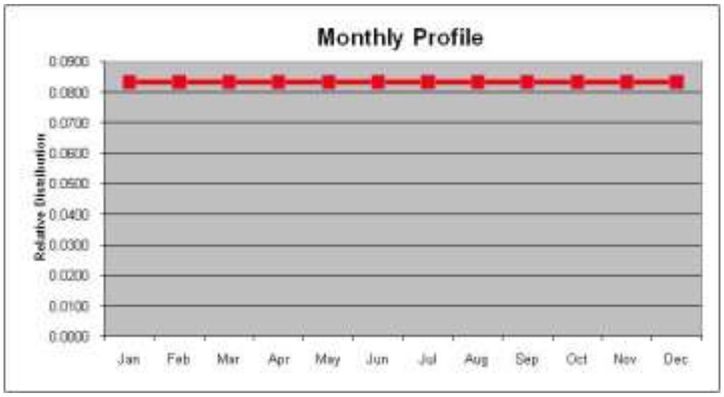
GRAPHICAL REPRESENTATIONS OF SMOKE TEMPORAL PROFILES

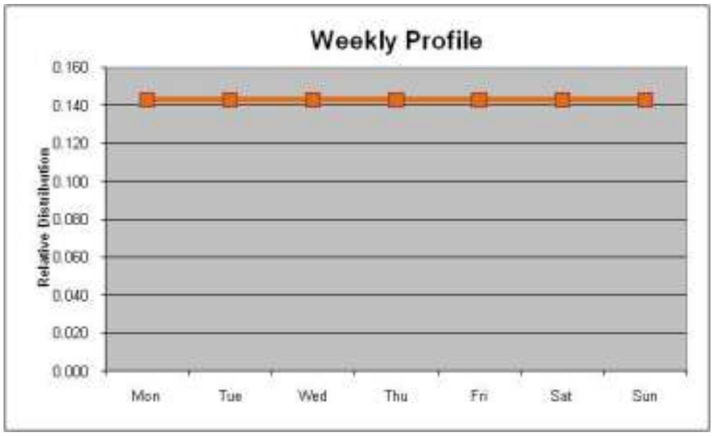
We prepared an Excel workbook (amptref.xls) which allows MARAMA States to select and review the temporal profiles by SCC and for specific FIPS-SCC combinations from the SMOKE temporal profile cross-reference table. In this workbook, once the FIPS-SCC combination is selected, the associated temporal profile (and relative distribution values) for month of year, day of week and hour of day are presented in tabular and graphical format. This will facilitate State review of the temporal allocation of emission for every SCC and FIPS-SCC combination.

As shown in Figures 10-12, we examined the temporal profiles for three key VOC categories – architectural coatings, consumer products, and portable fuel containers. The profiles appear to be reasonable. Since different States used different SCCs for consumer products, the monthly profiles for consumer products vary by State. MARAMA states should review these monthly profiles and either change the SCC used or adjust the SMOKE monthly temporal profiles for consistency.

Figure 8 Temporal Profiles for Railroad Equipment

Example SCC:	22-85-002-006 Mobile Sources; Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
Similar SCCs:	All SCCs in 22-85-xxx-xxx series (i.e., no variation by type of railroad)
Emission Summary:	22-85-xxx-xxx accounts for 81,546 tons of NOx per year, about 6% of all NOx from the point, area, and nonroad sectors.
Geographic Variability?	National Default





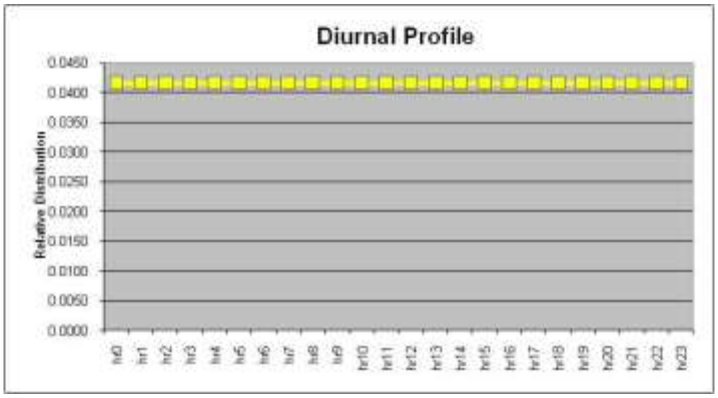
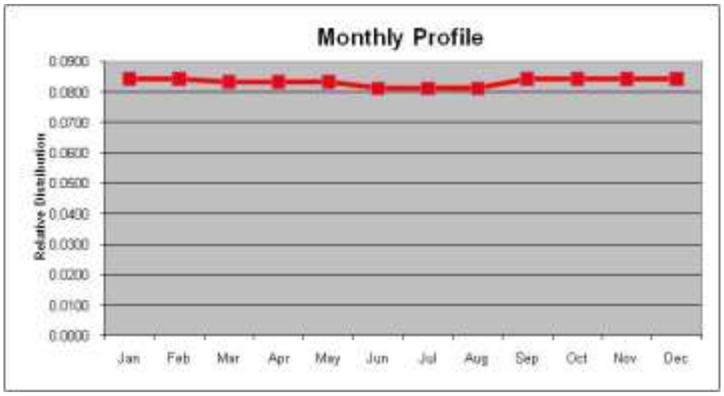
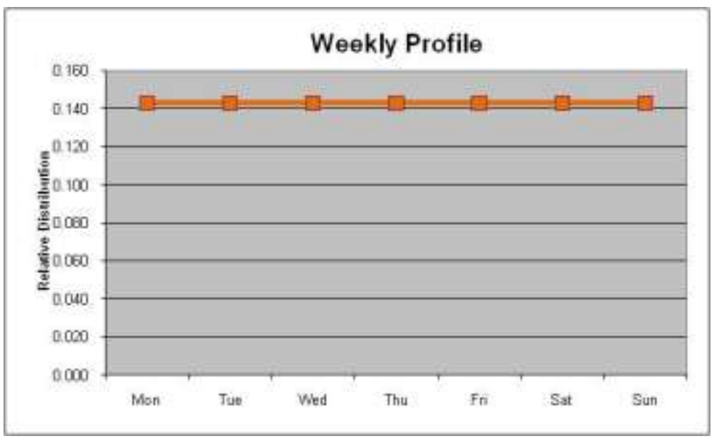


Figure 9 Temporal Profiles for Delaware Lightering Operation

Example SCC:	4-06-002-48 Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Crude Oil: Loading Barges
Similar SCCs:	None, the Delaware operation is the only source in the inventory that uses this SCC
Emission Summary:	This source accounts for 1,564 tons of VOC in 2007
Geographic Variability?	National Default





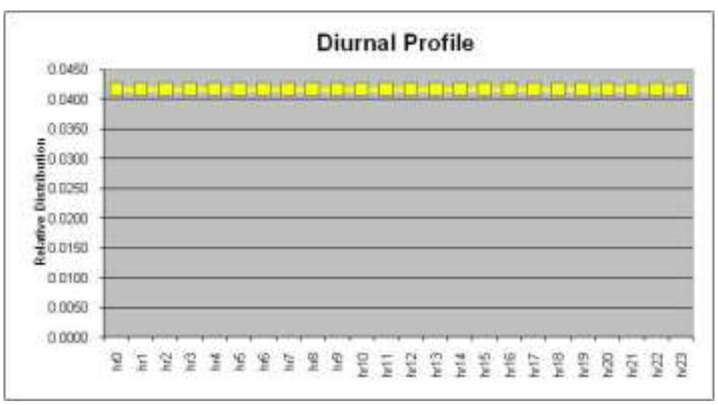


Figure 10 Temporal Profiles for Architectural Coatings

Example SCC:	24-01-001-000 Solvent Utilization; Surface Coating; Architectural Coatings; Total: All Solvent Types
Similar SCCs:	24-01-002-000 (solvent based AIM) and 24-01-003-000 (water-based AIM)
Emission Summary:	These three SCCs account for 85,000 tons of VOC per year, about 5% of all VOC from the point, area, and nonroad sectors.
Geographic Variability?	National Default

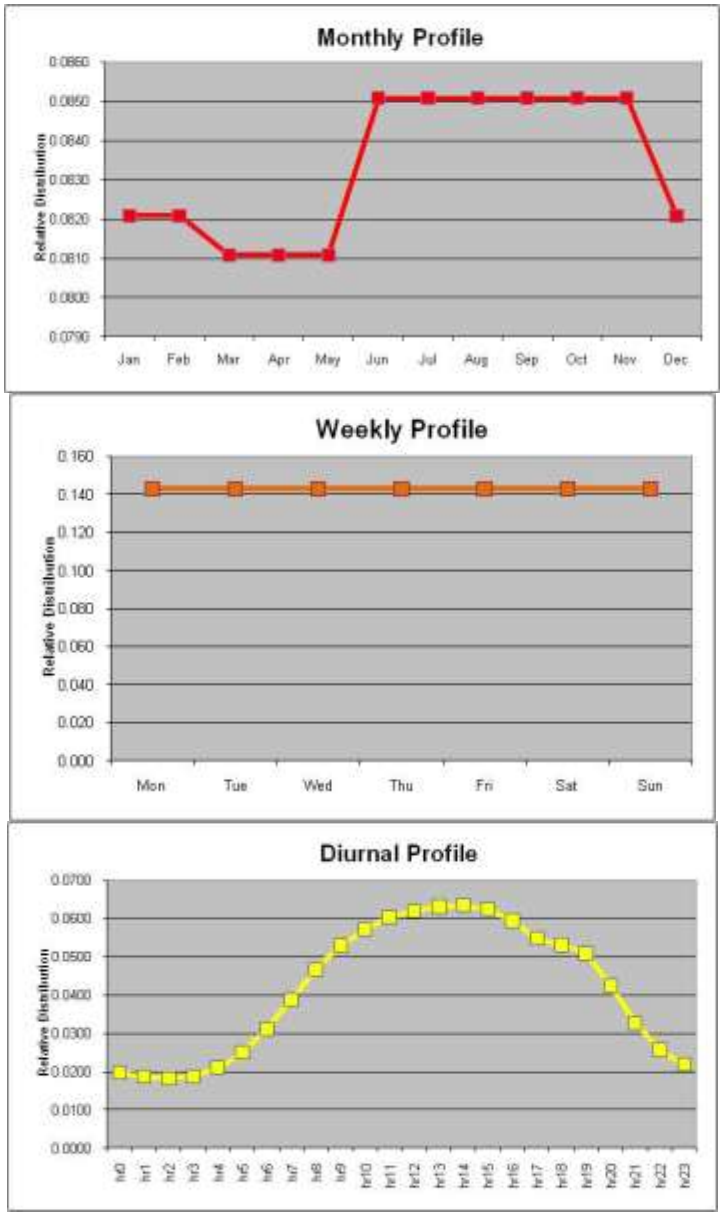
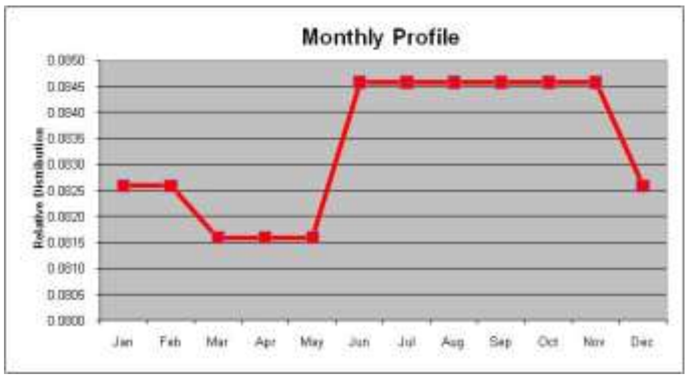


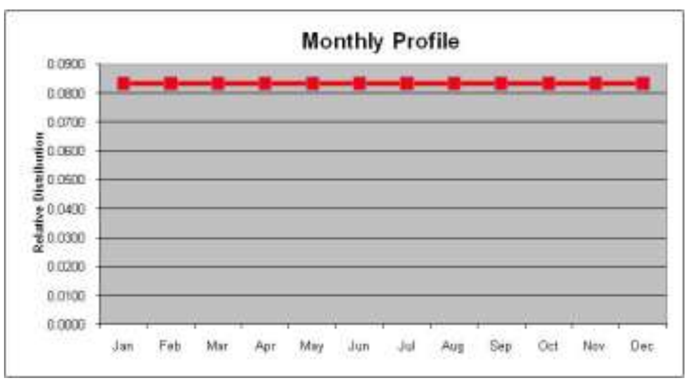
Figure 11 Temporal Profiles for Consumer Products

Example SCCs:	24-60-000-000 Consumer Products, all categories 24-60-xxx-000 Consumer Products; each category has a separate SCC 24-65-000-000 Consumer Products, all categories
Similar SCCs:	Some States group all consumer products into a single SCC; other States itemize the 7 different types of products; the SMOKE monthly profiles vary depending on the SCC used
Emission Summary:	The three SCC groupings above account for 299,578 tons of VOC per year, about 19% of all VOC from the point, area, and nonroad sectors.
Geographic Variability?	National Default

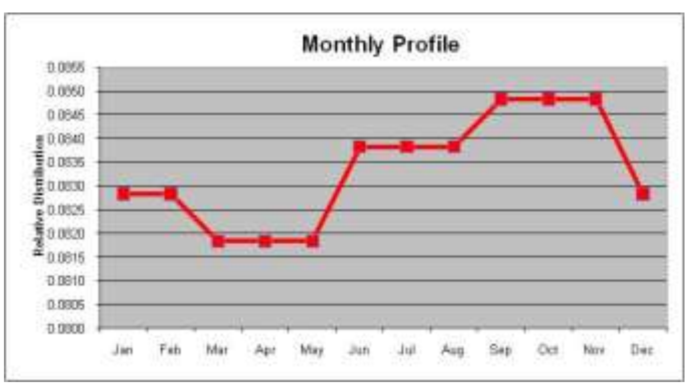
Monthly Profile for 24-60-000-000 (used by MA, NH, NJ)



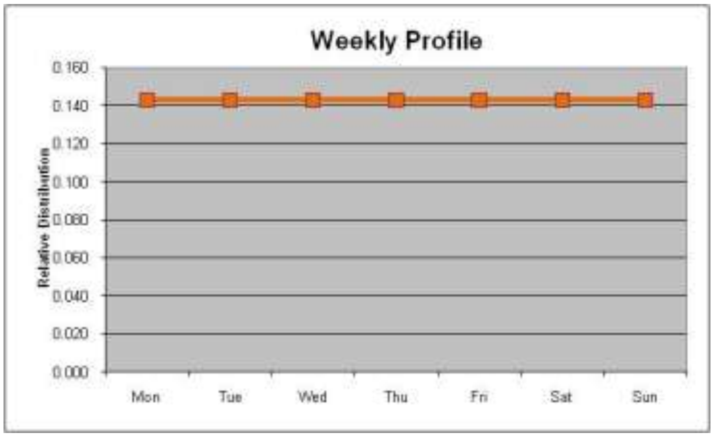
Monthly Profile for 24-60-100-000, 24-60-200-000, etc.
(used by CT, DE, DC, ME, MD, PA, RI, VT, VA)



Monthly Profile for 24-65-000-000 (used by NY)



Day of Week Profile is the same for all Consumer Product SCCs



Hour of Day Profile is the same for all Consumer Product SCCs

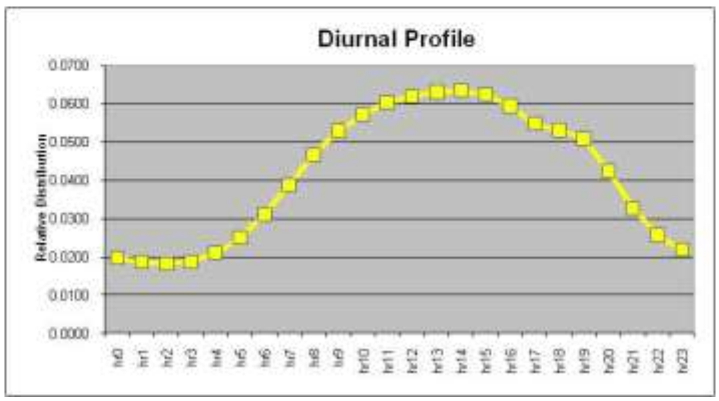
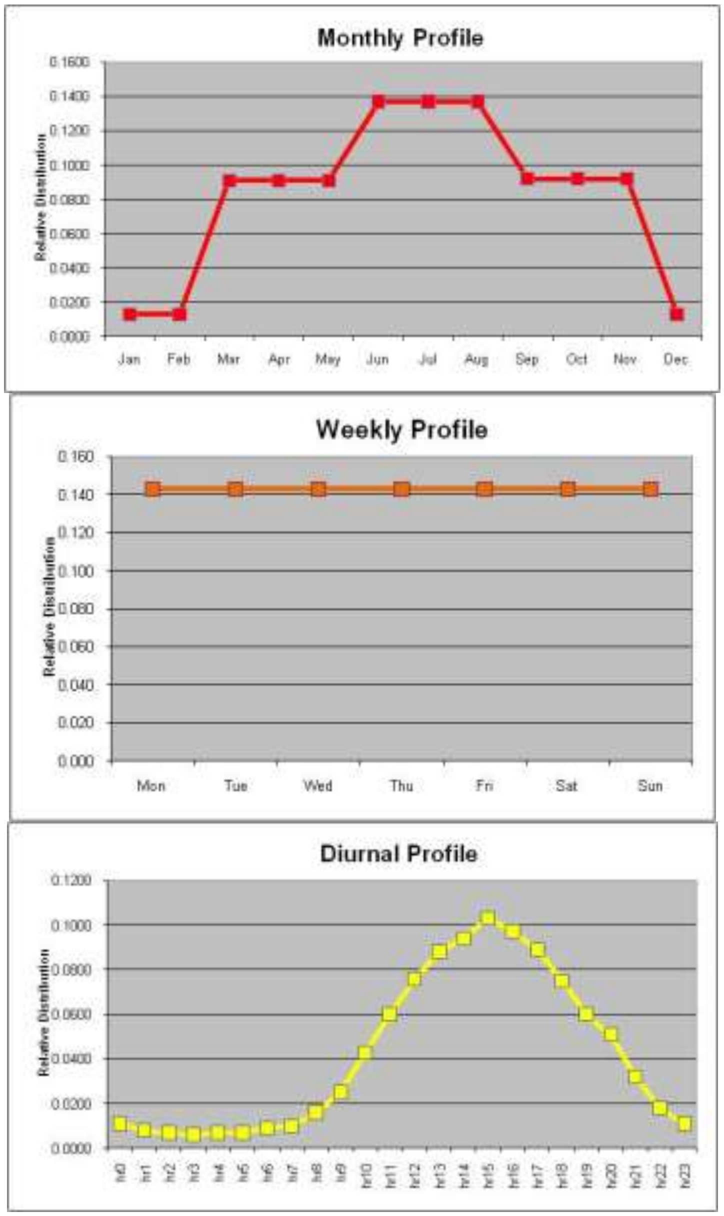


Figure 12 Temporal Profiles for Portable Fuel Containers

Example SCC:	25-01-011-012 Residential Portable Gas Cans/Evaporation
Similar SCCs:	25-01-011-xxx (Residential) and 25-01-012-xxx (commercial))
Emission Summary:	These three SCCs account for 37,674 tons of VOC per year, about 2% of all VOC from the point, area, and nonroad sectors.
Geographic Variability?	National Default



RECOMMENDATIONS

1. The GSREF file should be updated to include the missing SCC/pollutant code/speciation profile combinations identified in Exhibit 1.
2. The AMGREF file should be updated to include the missing SCC/spatial profile combinations identified in Exhibit 2.
3. The AMPTREF file should be updated to include the missing SCC/temporal profile combinations identified in Exhibit 3.
4. MARAMA should monitor the work of ERTAC and/or EPA in determining whether any improvements to temporal allocation of agricultural ammonia emissions have been made.
5. MARAMA should further investigate whether to replace the current temporal profiles for residential fuel consumption (based on 2002 heating degree days) with profiles based on the heating degree day distributions for calendar year 2007. This would allow the emissions modeling to match the 2007 calendar year meteorological data set being used for air quality modeling.
6. The temporal profiles for commercial airport operations should be updated using the BTS Airline On-Time Performance Database, which contains 2007-specific information on monthly, day-of-week, and hour-of-day air travel.
7. MARAMA should further investigate options for spatially allocating MANE-VU+VA CMV C3 emissions, perhaps by adjusting the October 2010 EPA C3 point source ORL file and replacing the EPA calculated emissions with the State-supplied emissions on a county-by-county and SCC-by-SCC basis.
8. MARAMA should further investigate the temporal profiles for AMTRAK/commuter trains, which are likely to vary for each line.
9. Since different States used different SCCs for consumer products, the monthly profiles for consumer products vary by State. MARAMA states should review these monthly profiles and either change the SCC used or adjust the SMOKE monthly temporal profiles for consistency.

ATTACHMENTS

Exhibit 1 Speciation Unmatched SCCs.xlsx

Exhibit 2 Spatial Unmatched SCCs.xlsx

Exhibit 3 Temporal Unmatched SCCs.xlsx

Airport_Spatial_Temporal_Allocation.xlsx

CMV_C3_Emission_Summary.xlsx

Railyards MANEVU ERTAC.xlsx

Map_railroad_gridding.PDF

amptref.xls