Development of Revised Emission Estimates for Important VOC Area Sources in Texas

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ABSTRACT

Under subcontract to Environ, E.H. Pechan & Associates, Inc. (Pechan) supported the Texas Natural Resources Conservation Commission (TNRCC) in the development of revised 1999 emission estimates for volatile organic compounds (VOC) for several prominent area sources in Texas. These source categories were: architectural and industrial maintenance (AIM) coatings, consumer and commercial solvents, auto refinishing, industrial surface coatings, and traffic markings. Both annual and ozone season day emission estimates were developed at the county level. Improvements were made to the emission estimates through the use of updated emissions data (e.g., VOC content of coatings), activity data (e.g., use of employment-based allocation of emissions, where warranted), and subcategorization of certain source categories. The new information on VOC content was taken from both government and industrial survey reports. These new data better characterize the make-up of products being consumed in Texas in 1999. Pechan and TNRCC subcategorized emissions for all source categories to allow for better spatial allocation, improvement in VOC speciation, and more accurate assessment of the impact of future regulatory efforts.

INTRODUCTION

Under subcontract to Environ, Pechan supported the Texas Natural Resources Conservation Commission (TNRCC) in the development of revised 1999 volatile organic compounds (VOC) emission estimates for several important area source categories in Texas. These source categories were: architectural and industrial maintenance (AIM) coatings, consumer and commercial solvents, auto refinishing, industrial surface coatings, and traffic markings. Both annual and ozone season day emission estimates were developed at the county level. A brief discussion of the methods and data sources used in developing these estimates is provided by source category below. Additional details are provided in the project report (Environ, 2001).

METHODS AND DATA SOURCES USED IN REVISING 1999 VOC ESTIMATES

Architectural and Industrial Maintenance (AIM) Coatings

Architectural surface coatings are used primarily by homeowners and painting contractors to coat the interior and exterior of houses and buildings and on the surfaces of other structures such as pavements, curbs, and signs. In TNRCC's 1996 base year inventory for 16 nonattainment areas, architectural coating emissions are reported under Source Category Code (SCC) 2401001000. To take advantage of new and emerging information on emissions from this category, a more highly-resolved

source classification scheme, as shown in Table 1, was used in developing the 1999 inventory. By separating the AIM category into multiple subcategories, including the creation of thinning and clean-up solvent categories, emissions are more accurately allocated to the specific source (e.g., architectural versus industrial maintenance), and a distinction is made between the coating itself and its related solvents (e.g., for more accurate VOC speciation, control strategy assessment).

A variant of the alternative method provided in the Emission Inventory Improvement Program (EIIP) document (EPA, 1995) was used to develop the revised 1999 estimates. The alternative EIIP method involves the use of per capita-based emission factors derived from national AIM product shipments data. Information compiled by the California Air Resources Board (CARB) was utilized to develop emission factors for Texas (CARB, 1999). As one of five states that had an AIM coating rule in effect by 1995, the coatings used in Texas during the late 1990's are likely to be more comparable to those used in California than to those used in the nation as a whole. Emission factors (pounds VOC/capita or employee) for each category were derived using AIM product sales and VOC content data from CARB, national AIM product shipments, and national population (architectural coatings) or the national manufacturing employees (industrial maintenance coatings) for 1999 (BOC, 2001). For categories where the common California limit was significantly lower than what was in effect in Texas in 1999, the emission factor was adjusted upward by a ratio of the Texas to California VOC content limits (industrial maintenance coatings). Emission factors for thinning and clean-up solvents for both the architectural and industrial maintenance categories were created by using the CARB value of 1 pint per gallon of solvent-based coating consumed and assuming a VOC content of 6.28 lbs per gallon (ENVIRON, 2001).

To apply the emission factors to Texas counties, the county population data were taken from the Texas Comptrollers Office, and manufacturing employment for each county was estimated from the Bureau of the Census (BOC) County Business Patterns data. Quarterly shipments data from the BOC were used to develop seasonal adjustment factors (BOC, 2000).

Consumer and Commercial Products

Consumer and commercial products include household products, toiletries, aerosol products, rubbing compounds, windshield washing fluids, polishes and waxes, non-industrial adhesives, space deodorants, moth control products, laundry detergents and treatments, and a variety of other products. Volatile organic compounds in these products may act either as the carriers for the active product ingredients or as the active ingredients themselves. The overall consumer and commercial products category is broken out into the subcategories shown in Table 1.

TNRCC prepared per capita emission factors based on a 1997 CARB survey (TNRCC, 1999). The per capita emission factors were used with 1999 county population data from the Texas Comptrollers Office. The EIIP document states that there should not be significant variation in seasonal or weekly use (EPA, 1996). The only potentially significant adjustment factor would be for pesticide application (SCC 2460800000). Due to the lack of available data, no seasonal variation was assumed for pesticides or any other subcategory.

The activity rate for all subcategories, except pesticides, is 365 days per year. The activity rate selected for pesticides is 260.7 days/yr. The EIIP (EPA, 2001) indicates that commercial and municipal pesticide application occurs 5 or 6 days per week, while residential application occurs 7 days per week.

Auto Refinishing

Automobile refinishing is the repainting of automobiles, light trucks, and other vehicles. It does not include surface coating during manufacturing. Emissions are from the use of surface preparation and clean-up solvents, primers, and various types of topcoats. Emissions for this category have historically been reported under SCC 2401005000. For the 1999 inventory, a more resolved source classification scheme, shown in Table 1, was employed to allow for future refinement of VOC speciation, as well as additional information for control strategy analysis.

The 1999 inventory was developed using information developed by TNRCC (Smith and Dunn, 1999). This information was also used in the EIIP document for auto refinishing to derive national VOC emission estimates (EPA, 2000). This method uses annual revenue categories from auto refinishing or body shops to estimate material use and resulting VOC emissions. Dun & Bradstreet databases were used to identify all facilities located in Texas in 1999 (D&B, 2000). Industry subcategories that were not associated with vehicle refinishing were excluded. The 8-digit Standard Industrial Classification (SIC) codes that were included in the inventory are as follows: 7532-0000; 7532-0200; 7532-0202; 7532-0203; 7532-0300; 7532-0301; 7532-0400; 7532-0401; 7532-0402; 7532-0404; 7532-9901; 7532-9902.

The size categories used by Smith and Dunn only cover shops emitting up to 1.8 tons per year. Therefore, two more size categories were added to account for potentially larger shops. These assignments were based on the Dun & Bradstreet revenue size classifications of $1.0MM to $2.4MM and $2.5MM to $4.9MM, respectively (D&B, 2000). Emission levels were derived by extrapolation of the weekly emission rates given by Smith and Dunn (1999). The revenue size classes of Smith and Dunn were also adjusted slightly to be consistent with those reported by Dun & Bradstreet.

Several QA measures were taken after an initial review of the Dunn & Bradstreet data. Records that appeared to be classified incorrectly (e.g., car washes, auto glass shops, etc.) or were record duplicates were excluded from the emission estimates. In addition, rules were established to assign size categories to facilities with unknown revenue; facilities designated as headquarters; body shops aligned with dealerships; and businesses involved in selling trailers, mobile homes, etc (ENVIRON, 2001).

A telephone survey of 33 facilities designated as headquarters facilities was conducted to verify information in the Dun & Bradstreet database (D&B, 2000). Primarily, this survey was performed to verify that: 1) painting actually occurred at the facility; and 2) that the facility size information was for the facility and not for the overall company; and 3) revenue estimates were accurate. Contacts were successfully made with 26 of these facilities. For the facilities that were not contacted (either due to refusal, change in phone number, etc.), the records were left in the inventory estimates and assigned to the appropriate size class based on the Dun & Bradstreet data.

Emissions for surface preparation and clean-up solvents appear under “Other Products.” These emissions were estimated based on paint usage and the breakdown of emissions provided in the draft EIIP (i.e., 2 percent of the total emissions for surface cleaning, and 8 percent for clean-up). Also, based on the draft EIIP, it was assumed that 90 percent of the total emissions were from coatings (EPA, 2000).

Seasonal adjustment of emissions may be important for this category, since activity may be higher during summer (drier) months. Painting contacts have indicated that winter months are much slower than summer months, potentially due to higher humidity conditions, which are not conducive to high-quality painting (Smith, 2001). The economics of the holidays and tax season contribute to less activity as compared to shops’ busier warmer months. The EIIP draft states that seasonal activity may be associated with seasons with higher traffic accidents. If higher traffic accidents occur during periods of poor weather (i.e., winter), then this assumption would be in contrast with the information relayed by painting contacts. For the 1999 inventory, we derived an ozone SAF of 1.072 from quarterly shipments of special purpose coatings from the U.S. Department of Commerce (DOC, 2000).

The activity rate (AR) of 250 days/yr is based on an operating schedule of 5 days per week during 50 weeks of the year (Smith, 2001). The 5 days per week estimate is consistent with the draft EIIP, existing TNRCC methods, and other state inventories (e.g., CARB). Some shops may operate six days per week (e.g., half a day on Saturday).

Industrial Surface Coatings

Area source emissions associated with industrial surface coating operations include emissions from product finishes for original equipment manufacturers and other special purpose coatings not included in the point source inventory. The overall industrial surface coatings category is broken out into fourteen subcategories, listed in Table 2.

National SCC-specific emission factors were developed using information on the amount of coatings used by each industry from national shipments of coatings from the U.S. Department of Commerce and VOC content data from the National Paint and Coatings Association (ENVIRON, 2001). When combined with national Bureau of Census employment data for each industry sector [based on North American Industry Classification System (NAICS) codes], the emission factors took the form of pounds of VOC per employee. Table 1 provides the NAICS codes used during inventory development.

County-level employment was multiplied by the emission factors to obtain total SCC emissions. County-level employment data for Texas in 1999 were obtained from the BOC (ENVIRON, 2001). Uncontrolled point source emissions were obtained from TNRCC so that these emissions could be backed-out of the total (ENVIRON, 2001). In counties where the total uncontrolled point source emissions were equal to or exceeded the total estimated emissions for that county, the county area source emissions were set to zero.

For miscellaneous industrial surface coating categories, all point source industrial coating emissions that could not be associated with one of the industrial surface coatings area source categories were grouped together at the county-level. Since there was not enough information to determine whether they were associated with manufacturing or industrial maintenance, TNRCC calculated a fraction based on the emission factors of each to allocate the point source emissions between the two categories.

The Paint and Allied Products Report upon which the activity data are based indicates slight differences in activity by calendar quarter (DOC, 2000). This information was used to calculate an ozone SAF of 1.015. The EIIP indicates that activity generally occurs 5 days/week for 52.143 weeks/year, which yields 260.7 operating days per year.

Traffic Markings

This category is a source of VOC emissions resulting from the evaporation of organic solvents during and shortly after the application of traffic paints used to mark pavement. Examples of these markings include the dividing lines to denote traffic lanes, and lines to mark parking spaces and crosswalks. Emissions from this category are reported under SCC 2401008000.

The amount of paint applied in 1999 by the Texas Department of Transportation (TXDOT) was estimated by calculating the annual average of the amount of traffic paint purchased in 1996-2000, because more paint is purchased than applied in some years, with the excess inventory used to cover a portion of the following year's demand (ENVIRON, 2001). Several different formulations with different emission factors were purchased between 1996 and 2000. Therefore, a weighted consumption normalized to the 1999 average total consumption was calculated for each formulation. Total state emissions were calculated by multiplying the consumption for each formulation by the appropriate VOC content (provided by TXDOT) and summing across all formulations (Environ, 2001). The state-level data were allocated to counties based on 1999 state highway lane miles provided by the Texas Department of Transportation (TXDOT, 2001).

The amount of traffic paints used on city and county roads in 1999 was estimated based on information that 65 percent of all marking paint purchased is used by state highway departments and 25 percent is used by cities and counties (SRI, 1990). County and city road lane miles data were used to allocate state-level paint use to the county level. To compute 1999 county emissions for this subcategory, the estimated county volume of paints was multiplied by the Federal limit for traffic markings (1.3 pounds of VOC per gallon).

The amount of traffic paints used on private roads and parking lots in 1999 was estimated based on information that 10 percent of all marking paint purchased is used by State highway departments is used for this purpose (SRI, 1990). Traffic paint use for private roads and parking lots was allocated to counties based on population data (TCPA, 2001). To calculate the 1999 county emissions for this subcategory, the estimated county volume of paints was multiplied by the Federal limit for zone markings, markings used for private roads and parking lots (3.8 pounds of VOC per gallon). A contact

at the TXDOT indicated that road painting is uniform throughout the year, so an ozone SAF of 1 was used (ENVIRON, 2001).

RESULTS

A summary of the original versus revised 1999 emission estimates for the state of Texas is provided in Table 3. Overall, there was a decrease in annual VOC emissions of over 26%. Significant decreases are seen in AIM coatings, auto refinishing, and several industrial surface coating categories. Much of the decreases in emissions from AIM coatings is due to the use of newer VOC content data on coating products. Previous auto refinishing numbers were estimated using an emission factor of 2.3 lb VOC/year/capita. We believe that the revised estimates (based on a material balance method, number of facilities, and revenues of these facilities) provide a much more accurate accounting of emissions from this category. The major differences in industrial coatings emission estimates primarily stem from the use of a per capita-based method to an allocation method based on county-level employment.

Differences in the original versus revised emission estimates for Texas ozone non-attainment areas are shown in Table 4. The table shows reductions in emission estimates from 20 percent to over 33 percent in these non-attainment areas. Finally, Figures 1 and 2 are pie charts showing the contribution of each VOC area source category to the total area source VOC emissions both before and after the revisions, respectively.

In addition to the significant changes in annual VOC emissions for most of the categories reviewed, the changes in methods produced opportunities for improved modeling inventories. These opportunities include improved spatial allocation of emissions through more refined source categorization (e.g. industrial maintenance coatings allocated to commercial/industrial land use). Also, better VOC speciation is now possible through the use of new speciation data (e.g. CARB profiles, where applicable).

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Table 1. Comparison of TNRCC original SCC to TNRCC revised SCCs.

TNRCC Original SCC	TNRCC Original SCC Description	TNRCC Revised SCCs	TNRCC Revised SCC Description
Architectural Coatings			
2401001000	Architectural Coatings	2401001000	Overall Architectural and Industrial Maintenance (AIM) Category
		2401001001	Flat Paints
		2401001005	Nonflat Paints – Low and Medium Gloss
		2401001006	Nonflat Paints – High Gloss
		2401001010	Primers, Sealers, and Undercoaters
		2401001011	Quick Dry – Primers, Sealers, and Undercoaters
		2401001015	Stains – Semitransparent
		2401001020	Quick Dry – Enamels
		2401001025	Lacquers – Clear
		2401001050	All Other Architectural Categories
		2401001060	Thinning and Clean – Up of Solvent – Based Architectural Coatings
Industrial Maintenance Coatings were previously part of the Industrial Surface Coatings Category		2401100000	Industrial Maintenance Coatings
		2401100001	Thinning and Clean-Up of Solvent-Based Industrial Maintenance Coatings
Traffic Markings			
Previously part of the AIM category		2401008000	Traffic Markings
Auto Refinishing			
2401005000	Automotive Refinishing	2401005500	Surface Preparation Solvents
		2401005600	Primers
		2401005700	Top Coats
		2401005800	Clean-Up Solvents
Consumer and Commercial Products			
2460000000	Consumer and Commercial Products	2460000000	Overall Consumer and Commercial Products
		2460100000	Personal Care Products
		2460200000	Household Products
		2460400000	Automotive Aftermarket Products
		2460500000	Coatings and Related Products
		2460600000	Adhesives and Sealants
		2460800000	FIFRA-Regulated Products
		2460900000	Miscellaneous Products
Industrial Surface Coating			
2401015000	Factory Finished Wood	2401015000	Factory Finished Wood
2401020000	Wood Furniture	2401020000	Wood Furniture
2401025000	Metal Furniture and Fixtures	2401025000	Metal Furniture and Fixtures
2401030000	Paper, Foil and Film	2401030000	Paper, Foil and Film
2401040000	Metal Containers	2401040000	Metal Containers
2401045000	Sheet, Strip, and Coil	2401045000	Sheet, Strip, and Coil
2401055000	Machinery and Equipment	2401055000	Machinery and Equipment
2401060000	Large Appliances	2401060000	Large Appliances
2401065000	Electronic and Other Electrical	2401065000	Electronic and Other Electrical
2401070000	Motor Vehicles	2401070000	Motor Vehicles
2401075000	Aircraft	2401075000	Aircraft
2401080000	Marine	2401080000	Marine
2401085000	Railroad	2401085000	Railroad
2401090000	Miscellaneous Manufacturing	2401090000	Miscellaneous Manufacturing
2401100000	Industrial Maintenance Coatings		

Table 2. Industrial surface coating SCCs and associated NAICS codes.

Source Category (SCC)	NAICS Codes
Factory finished wood (2401015000)	32192; 33711; 321113; 321211; 321212; 321213; 321214; 321219; 321911; 321912; 321918; 321991; 321992; 321999; 337215
Wood furniture (2401020000)	337122; 337129; 337211; 337212; 337215
Metal furniture and fixtures (2401025000)	337121; 337124; 337214; 337127; 339111
Paper, foil and film (2401030000)	3222; 326111; 326112; 326113
Metal containers (2401040000)	332431; 332439
Sheet, strip and coil (2401045000)	332812
Machinery and equipment (2401055000)	333; 332997; 332991; 33271
Large appliances (2401060000)	333414; 335211; 335212; 335221; 335222; 335224; 335228
Electronic and other electrical (2401065000)	331319; 331422; 331491; 335921; 335929; 335311
Motor vehicles (2401070000)	336111; 336112; 33612; 336211; 336992
Aircraft (2401075000)	336411; 336413
Marine (2401080000)	336611; 336612
Railroad (2401085000)	33651
Miscellaneous manufacturing (2401090000)	all 31-33, except those listed above

Table 3. Comparison of revised 1999 VOC emission estimates for Texas (VOC TPY).

Area Sources	TNRCC Original	TNRCC Revised	Difference	% Change
Architectural Coatings	49,528	30,224	-19,304	-39.0
Auto Refinishing	9,163	3,054	-6,110	-66.7
Consumer and Commercial Products	67,768	66,482	-1,286	-1.9
IS -Aircraft	1,979	2,656	676	34.2
IS -Electronic and other Electrical	216	231	15	6.9
IS -Factory Finished Wood	540	381	-158	-29.3
IS -Large Appliances	1,460	545	-915	-62.7
IS -Machinery and Equipment	2,688	1,763	-925	-34.4
IS -Marine	1,200	201	-999	-83.3
IS -Metal Containers	5,900	2,766	-3,134	-53.1
IS -Metal Furniture and Fixtures	4,233	1,775	-2,458	-58.1
IS -Miscellaneous Manufacturing	2,056	2,273	217	10.6
IS -Motor Vehicles	6,923	870	-6,053	-87.4
IS -Paper, Foil and Film	2,529	1,704	-826	-32.7
IS -Railroad	1,699	2,066	367	21.6
IS -Sheet, Strip and Coil	5,462	2,283	-3,179	-58.2
Industrial Maintenance Coatings	2,033	1,583	-450	-22.1
State Total	***165,376***	***120,855***	***-44,521***	***-26.9***

Table 4. Comparison of Revised 1999 Emission Estimates for Ozone Non-Attainment Regions in Texas (VOC TPY)

Non-Attainment Region	TNRCC Original	TNRCC Revised	Difference	% Change
Beaumont/Port Arthur	2,915	2,317	-598	-20.5
Dallas/Fort Worth	35,660	27,461	-8,199	-23.0
El Paso	6,156	4,090	-2,066	-33.6
Houston/Galveston	33,501	24,163	-9,338	-27.9

Figure 1. Previous 1999 area source VOC emission estimates for the Houston/Galveston non-attainment region.

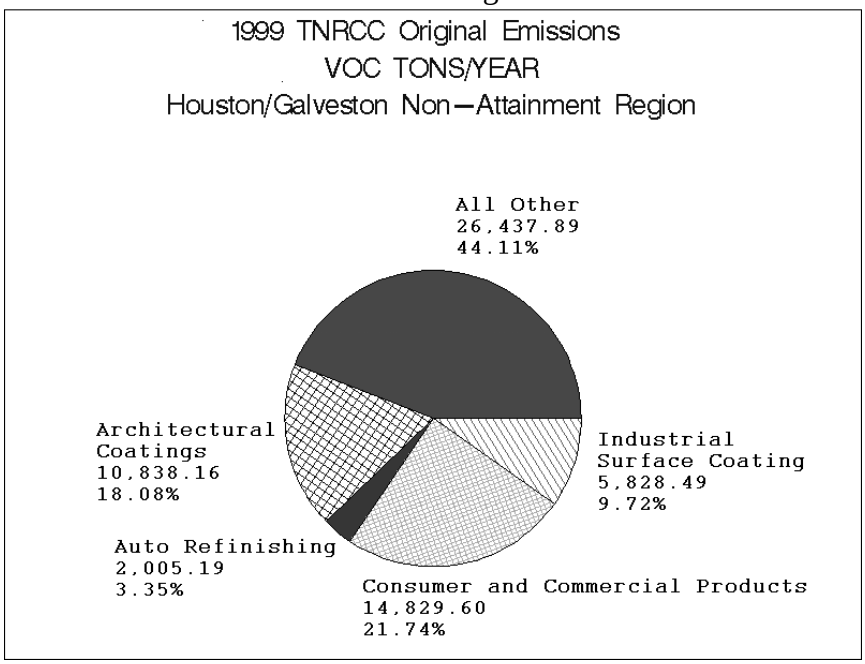
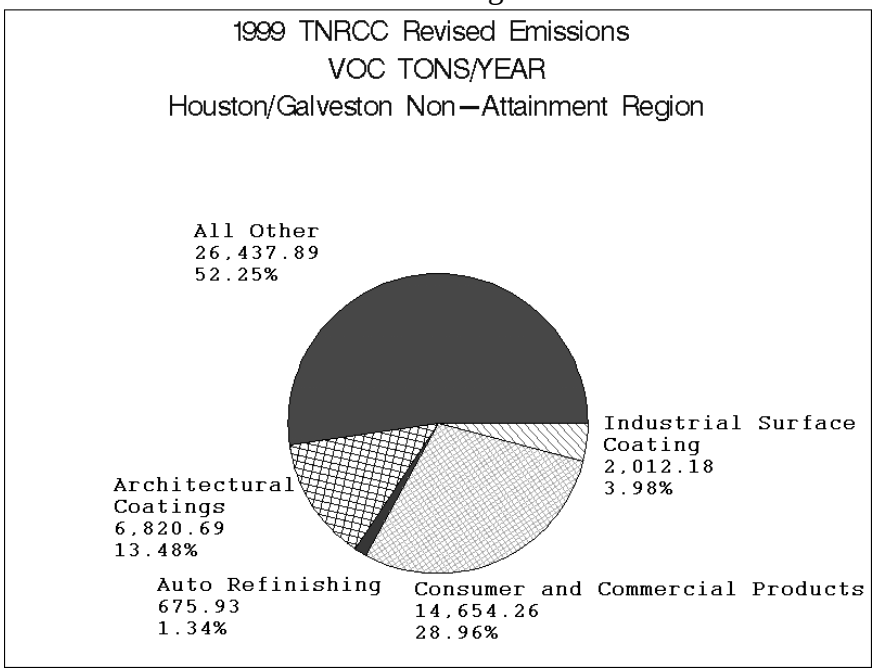


Figure 2. Revised 1999 area source VOC emission estimates for the Houston/Galveston non-attainment region.



Key Words

VOC
area sources
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