AUTO BODY REFINISHING

Draft
EIIP Area Sources Committee

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1

INTRODUCTION

This chapter describes the procedures and recommended approaches for estimating emissions from automobile (auto body) refinishing operations. Section 2 of this chapter contains a general description of the auto body refinishing category and an overview of available control technologies. Section 3 of this chapter provides an overview of available emission estimation methods. Section 4 presents the preferred emission estimation methods for auto body refinishing, and Section 5 presents alternative emission estimation techniques. Quality assurance and quality control procedures are described in Section 6. Data coding procedures are discussed in Section 7, and Section 8 lists all references cited in this chapter.

This EIIP chapter is one of a series of chapters developed to provide cost-effective, reliable and consistent approaches to estimating emissions for area source inventories. Multiple methods are provided in the chapters to accommodate needs of state agencies with different levels of available resources and skills, and different levels of needs for accuracy and reliability of their estimates. More information about the EIIP program can be found in Volume 1 of the EIIP series, *Introduction and Use of EIIP Guidance for Emissions Inventory Development.*[1]

Throughout this chapter and other EIIP area source methods chapters, we stress that area source categories should be prioritized by the inventory planners so that resources can be spent on the source categories that are the largest emitters; most likely to be subject to regulations or are already subject to regulations; or require special effort because of some policy reason. Prioritization is particularly important for area source inventories, because in some cases, a source category that is difficult to characterize may contribute very little to overall emissions and attempting to prepare a high quality estimate for that source category may not be cost effective.

EIIP chapters are written for the state and local air pollution agencies, with their input and review. EIIP is a response to the U.S. Environmental Protection Agency's (EPA's) understanding that state and local agency personnel have more knowledge about their inventory area's activities, processes, emissions, and availability of information; and require flexible inventory methods to best use their sometimes limited resources. These EIIP area source chapters are written as a set of options presented to inventory professionals capable of using their own experience and judgement to apply the method that best fits their overall needs and constraints.

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[1] EIIP volumes area available at: http://www.epa.gov/ttn/chief/eiip/.

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2

SOURCE CATEGORY DESCRIPTION

2.1 CATEGORY DESCRIPTION

Auto body refinishing is the repairing of worn or damaged automobiles, light trucks, and other vehicles, and refers to any coating applications that occur subsequent to those at original equipment manufacturer (OEM) assembly plants. (Coating of new cars is not included in this category.) The majority of these operations occur at small body shops that repair and refinish automobiles. This category covers solvent emissions from the refinishing of automobiles, including paint solvents, thinning solvents, and solvents used for surface preparation and cleanup. According to data published in 1994, nationwide solvent usage in automobile refinishing was estimated to be 37.5 million gallons per year (Kline and Company, 1995). Data published in 1998 estimate that about 64,000 auto body shops were operating in the United States (Dun and Bradstreet, 1998). Facilities performing these operations are classified with the Standard Industrial Classification (SIC) code 7532 (establishments primarily engaged in the repair of automotive tops, bodies, and interiors, or automotive painting and refinishing). Two parts of SIC code 7532 are *top and body repair shops*, which are establishments primarily engaged in the repair of automobile tops and bodies with or without painting, and *refinishing and paint shops*, which include establishments primarily engaged in automobile painting and refinishing. Coatings applied at OEM assembly plants are classified with SIC code 3711, and are not included here.

Most auto refinishing jobs are performed as part of collision repair and involve only a small portion of a vehicle, such as a panel or a spot on a panel ("spot" repair). About 17 percent of refinishing jobs involve the entire vehicle. For a typical shop, approximately 90 percent of the work consists of spot and panel repairing, and the entire vehicle is completely refinished only about ten percent of the time. Shops specializing in repainting entire automobiles are referred to as "production" shops.

Auto body refinishing shops may be area or point sources, but the majority of shops are considered area sources of emissions. Point source emissions must be subtracted from total emissions to produce an estimate of auto body refinishing area source emissions.

2.2   PROCESS DESCRIPTION AND EMISSION SOURCES

Auto body refinishing operations consist of four steps: (1) vehicle preparation, (2) primer application, (3) topcoat application, and (4) spray equipment cleaning. The products and equipment used in these steps are usually bought from distributors, also known as jobbers. Prior to any painting, the surface is prepared, *i.e.*, washed thoroughly with water and detergent and allowed to dry. It is then cleaned with a solvent (generally a blend of toluene, xylene, and other petroleum distillates) to remove any wax, grease, and dirt to ensure proper adhesion of the primer and topcoats. Solvents typically used are 100 percent volatile, with the volatile organic compound (VOC) content ranging from 5.8 pounds VOC per gallon to 6.5 pounds VOC per gallon (EPA, 1994a). A tack cloth is often used as a final step to remove any remaining dirt or debris prior to the coating application.

Next, the surface is primed to provide corrosion resistance, fill surface imperfections, and provide a bond for the topcoat. Primers fall into four general categories: prepcoat, primer-surfacers, primer-sealers, and sealers. A prepcoat is a metal conditioner that etches the surface and prevents flash rusting, which can occur from base metal exposure to the atmosphere. Prepcoats have good corrosion resistance and adhesion properties, but have little or no filling capacity. Primer-surfacers provide the best filling or "build" properties for deep scratches or dents, but some of these provide limited corrosion protection. They are frequently used over prepcoats. The three types of primer-surfacers are nitrocellulose lacquer, acrylic lacquer, and alkyd enamel. Primer-sealers combine the corrosion resistance and adhesion properties of prepcoats with some of the scratch-filling capacity of primer-surfacers. Primer-sealers also add a sealing property needed when an old finish is being repainted. This type of primer is typically enamel-based. Sealers differ from primer-sealers in that they cannot be used as a primer and must be sprayed over a prepcoat, a primer-surfacer, or an old finish. Sealers are acrylic lacquer-based products.

The third step is topcoat application, which consists of a series of coats applied over the primer. Topcoat determines the final color and appearance of the refinished area. For optional results, topcoats (as well as other coating applications) are typically applied in a spray booth, which minimizes the possibility of dirt adhering to the wet coating. Metallic finishes and some other finishes require a two-stage topcoat system, consisting of a basecoat and a clearcoat. Since most repairs are spot and panel repairs, the refinisher is concerned with matching the OEM color as closely as possible. Paint mixing machines are typically provided by the shop's paint supplier. These machines are capable of mixing coatings to manufacturer's specifications to allow for precise matching. As paints fade, it becomes increasingly difficult for refinishers to match OEM paints to the faded paint. OEM paints manufactured after 1991 typically have more durability and less fading, which makes matching paints easier, but older paints are more likely to fade. In some cases, the paint may be so faded that it is impossible to match colors. Topcoats can be divided into four categories: acrylic lacquer, alkyd enamel, acrylic enamel,

and polyurethane. Based on 1994 data derived from the *Chemical Economics Handbook* (SRI International, 1997), acrylic lacquers accounted for 20 percent of topcoats, acrylic and alkyd enamels 20 percent, and urethanes 60 percent.

The last step in auto body refinishing is spray equipment cleaning. Spray equipment can be cleaned manually or with gun cleaning systems specially designed for this purpose. Shops that do not have spray gun cleaning systems usually rinse the outside of the gun and cup, add solvent to the cup, and then spray the solvent into the air or into a drum set aside for spent solvent (EPA, 1994a). The cleaning solvent is recirculated until it is too contaminated to use. Waste solvents are then disposed of by evaporation or incineration, or are reclaimed via distillation. The EIIP chapter on solvent cleaning contains a thorough description of equipment cleaning operations.

The breakdown of solvent usage and emissions among the four steps is approximately 2 percent for vehicle preparation, 20 percent for primer application, 70 percent for topcoats, and 8 percent for equipment cleaning (EPA, 1994a).

2.3 FACTORS INFLUENCING EMISSIONS

VOC emissions from automobile refinishing are influenced by several factors. Emissions from surface preparation and coating applications are a function of the VOC content of the product used. Emissions are also a function of the transfer efficiency of the spray equipment. Transfer efficiency is the percent of paint solids sprayed that actually adheres to the surface being painted.

Equipment with lower transfer efficiency would require more material to be sprayed, thus, increasing VOC emissions. Emissions from cleaning operations are dependent on the type of cleanup and housekeeping practices used.

2.4 CONTROL TECHNIQUES

There are three main approaches for reducing VOC emissions from auto body refinishing shops: (1) use of lower-VOC coatings, (2) increased transfer efficiency, and (3) use of enclosed equipment cleaning devices. Specific control strategies for auto body refinishing operations include the following: for vehicle preparation - using reduced-VOC cleaners and using a second detergent for cleaning; for primer application - improving transfer efficiency of spray guns (e.g., high-volume, low-pressure, or HVLP, spray guns), and using lower-VOC primers, such as waterborne primers and urethane primers; for topcoat application - improving transfer efficiency of spray guns (HVLP spray guns) and using reduced-VOC coatings; and for equipment cleaning - using a solvent recovery system. By using a cleanup solvent recovery system, facilities of any size can reduce VOC emissions by about 15 percent.

Reductions of 30 to 45 percent can be achieved when HVLP spray guns are used in place of conventional air-atomizing spray guns (EPA, 1988). In addition, shops can use add-on controls for their spray booths such as thermal incineration, catalytic incineration, and carbon adsorption. A control efficiency of 90 percent or more can be achieved with the use of add-on controls (EPA, 1991a). Although the use of these add-on controls is technically feasible, cost has been the primary limiting factor. One 1990 reference estimated the annual operating cost of an incinerator at $120,000 and of a carbon adsorber at $40,000 (EPA, 1990). These costs are prohibitive to body shops, one-quarter of which have annual sales less than $100,000 (Babcox Publications, 1993). In addition, since small facilities may not have spray booths, the add-on control techniques are not applicable to their situation.

Other housekeeping activities can also be used to reduce emissions from auto body refinishing operations. These activities include using tight fitting containers, reducing spills, mixing paint to need to avoid waste paint disposal, providing operator training, and maintaining rigid control of inventory.

On September 11, 1998, national EPA regulations were promulgated to control VOC emissions from the use of automobile refinishing coatings. The regulations set specific VOC content limits on seven categories of automobile refinish coatings. The VOC limits are to be met by the manufacturers of refinish coatings that are manufactured on or after January 11, 1999. Table 13.2-1 provides the approximate emission reductions that can be achieved based on the VOC limits set forth in the September 11, 1998, rulemaking.

A few states also have regulations in place that require VOC content limits on coatings as they are applied in body shops. In these states, body shops are usually required to keep extensive records on coating usage and VOC content. Maximum Achievable Control Technology (MACT) standards applicable to hazardous air pollutant (HAP) emissions for existing and new facilities engaged in automobile and light-duty truck refinishing operations are scheduled to be promulgated before November 15, 2000.

TABLE 13.2-1. ESTIMATED VOC EMISSION REDUCTIONS FOR AUTOMOTIVE REFINISHING COATINGS

Coating Category	Regulation VOC Content Limit (lb/gal)[a]	Approximate Percent Reduction in Emissions[b]
Pretreatment Wash Primer	6.5	0
Primer/Primer Surfacer	4.8	55
Primer Sealer	4.6	75
Single/2-Stage Topcoats	5.0	40-70[c]
Topcoats of 3 or more stages	5.2	30
Multicolored Topcoats	5.7	Not Available
Specialty Coatings	7.0	0
Overall		37

[a]   Federal Register, 1998.

[b]   EPA, 1995.

[c]   The percent reduction ranges from about 70 percent for lacquers to approximately 40 percent for all other topcoats.

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3

OVERVIEW OF AVAILABLE METHODS

3.1 EMISSION ESTIMATION METHODOLOGIES

There are several methodologies available for calculating emissions from auto body refinishing. The selection of a method to use depends on the degree of accuracy required in the estimate, the available data, and the available resources. Estimating emissions accurately depends on accurately estimating the amount and type of coating materials used. This section discusses the methods available for estimating emissions from auto body refinishing and identifies the preferred method for this category.

3.2 AVAILABLE METHODOLOGIES

3.2.1 VOLATILE ORGANIC COMPOUNDS

Methods available for estimating emissions from auto body refinishing operations include conducting surveys to collect activity (e.g., annual solvent and coatings usage), and apportioning a national estimate to the local level by using a per employee or per capita emission factor. These methods are summarized in Table 13.3-1.

Although theoretically it would be possible to conduct a survey to collect activity, product use, and product-specific VOC content data to develop product-specific, site-specific detailed emissions estimates, this approach is not practical due to resource and information availability at both the facility and the inventorying agency levels, and to the variety of surface preparation, primers, coatings, and cleaning products. For example, five companies (i.e., E.I. duPont de Nemours and Company, Inc., including Nason Automotive Finishes; PPG Industries; the Sherwin-Williams Company; BASF Chemicals; and Akzo Coatings) account for about 95 percent of automobile refinish coating sales. These five manufacturers also produce components such as catalysts, solvents (thinners or reducers), and additives for use with their coatings. The remaining five percent of coatings are supplied by approximately 12 smaller manufacturers. About two dozen other U.S. manufacturers produce lower-cost coating components that are marketed for use with the coatings produced by the major manufacturers (EPA, 1994a).

TABLE 13.3-1

**PREFERRED AND ALTERNATE METHODS FOR ESTIMATING
EMISSIONS FROM AUTO BODY REFINISHING**

Methods	Description
Preferred Method - Apportion National Data and Survey Very Large Shops	Part I - Using information from Dun and Bradstreet[a,b], apportion the national estimate for each shop size category to the state or county level by multiplying the national estimate by the ratio local-to-national SIC code employment. Part II - Survey shops with expected annual revenues greater than $624,000 for annual coatings and solvent usage data. Using the MSDS, calculate emissions for each facility and then sum the emissions for the local level. This local estimate may replace the estimate from Part I for very large shops.
Alternate Method 1 - Apportion National Data With Employment	Similar to the preferred method, except without the survey. If Dun and Bradstreet data are not available, then County Business Patterns[c] can be used to apportion the national estimate based on the ratio of local-to-national SIC code employment.
Alternate Method 2 - Apportion National Data With Population	Similar to alternate method 1, except that population data from the Bureau of Census is used instead of SIC code employment for the ratio.

[a] Dun and Bradstreet data are available electronically on their Internet World Wide Web page at
     http://www.dnb.com/. Note, there is a fee for accessing Dun and Bradstreet information.
[b] There are also alternate sources that provide auto body shop information. For example, American Business
     Information (ABI) provides shop-specific information similar to Dun and Bradstreet; the difference is that ABI
     only gives employment by size ranges for each shop instead of specific values (ABI/INFORM is a registered
     trademark of Bell & Howell Information and Learning, Ann Arbor, MI).
[c] Annual County Business Patterns data are available electronically on the U.S. Census Internet World Wide Web
     page at: http://www.census.gov/epcd/cbp/view/cbpview.html, and can be reached by phone at (301) 457-2580.

Individual manufacturers often market several lines of products, with each line containing a specific series of surface preparation, primer, coating, cleaning, thinning, reducing, etc., products. Material Safety Data Sheets (MSDS) are available from the manufacturers for each product in each line and

show the chemical species and percent (or range of percent) contribution of each species. These MSDS can be used with information on amount of each specific product used from local surveys to develop emission estimates. However, the level of effort required to complete a detailed survey to collect the product-specific VOC content and use data may be a significant burden on the auto body refinishing shop. Some coating suppliers may, however, have software programs that can assist shop personnel in tracking this information. In addition, your agency may not have sufficient resources to interpret, analyze, and compile these data.

Instead, surveys of the largest shops can be conducted to collect only general activity data (e.g., annual usage of coatings and solvents). These survey data can then be used with MSDS to develop emission estimates.

Another method for estimating emissions from auto body refinishing operations involves apportioning a national estimate to the county level. The national estimate may be apportioned by using a ratio of local-to-national SIC code employment, or population.

3.2.2 HAZARDOUS AIR POLLUTANTS

HAP emissions from this source are determined by the survey methods discussed above for VOC emissions. Since the type(s) of HAPs present differ from product to product, developing a detailed inventory may be very resource intensive. You may choose to forego some level of accuracy by determining the most commonly used products in the inventory from the survey and assuming that the HAP makeup of those products is representative of the product category in general. The emissions of each HAP are assumed to be proportional to the amount of HAP in each product.

3.3 DATA NEEDS

3.3.1 DATA ELEMENTS

The data elements needed to calculate emission estimates for auto body refinishing operations depend on the methodology used for data collection. The data elements needed for each emission estimation technique are presented in Table 13.3-2.

3.3.2 ADJUSTMENTS TO EMISSIONS ESTIMATES

Adjustments applied to annual emissions estimates include point source corrections, applications of controls, spatial allocation, and temporal resolution. The type of adjustment is dependent on the type of inventory required. The data needs for point source emission estimate adjustments

TABLE 13.3-2

DATA ELEMENTS NEEDED FOR EACH METHOD

Data Element	Method		
	Preferred	Alt 1	Alt 2
Annual solvent and coatings usage for very large shops	x		
Material Safety Data Sheets (MSDS)	x		
National and inventory area Dun and Bradstreet employment data sorted by revenue for SIC code 7532[a]	x		
Annual Sales[b]	x[b]		
National and inventory area County Business Pattern employment data for SIC code 7532[a]		x	
National and inventory area population from the U.S. Bureau of the Census			x

[a] SIC code 7532 (Top, body and upholstery repair shops and paint shops) includes establishments primarily engaged in the repair of automobile tops, bodies, and interiors, or automotive painting and refinishing.

[b] This data element is used only for Part II of the Preferred Method. Revenue is then used to determine which facilities will receive surveys.

are dependent in part on the methodology used. Data needs for the adjustments listed below are as follows:

• Point source corrections point source emissions or point source employment for inventory area for SIC code 7532

• Application of controls control efficiency; rule effectiveness; rule penetration

- Spatial allocation   employment; population; facility locale; rural/urban
                                              population

- Temporal resolution   seasonal throughput; operating days per week;
                                              operating hours per day

3.3.3 POINT SOURCE CORRECTIONS

The point source correction is performed by subtracting point source emissions for SIC code 7532 from the area source estimate.

Note however that employment in SIC code 7532 includes not only establishments primarily engaged in automotive painting and refinishing, but also establishments involved in the repair of automotive interiors (upholstery) and auto top (plastic and canvas) installation and repair.

3.3.4 APPLICATION OF CONTROLS

Section 3.8 of *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I* (EPA, 1991b) provides guidance for determining and applying rule effectiveness (RE) for a source category. In addition, the EPA document *Procedures for Estimating and Applying Rule Effectiveness in Post-1987 Base Year Emission Inventories for Ozone and Carbon Monoxide State Implementation Plans* (June, 1989) provides more detailed information on RE (EPA, 1989).

Sections 4.1.1 and 5.4 of the EPA procedures document (1991b) describe how to account for emissions reductions expected to result from applying a regulation. If a regulation exists for auto body refinishing in the inventory area and you use a "top down" approach to estimate emissions from this category, you should incorporate an estimate of rule penetration.

If an area source is controlled (e.g., VOC content of surface coating products controlled by regulation), the following general equations can be used to calculate emissions:

$$CAE_A = (RA)(Q)[1 - (CE)(RP)(RE)] \qquad (13.3\text{-}1)$$

or

$$CAE_A = (UAE_A)[1 - (CE)(RP)(RE)] \qquad (13.3\text{-}2)$$

where:

CAE_A	=	controlled area source emissions of pollutant A
RA	=	Ratio of local-to-national SIC code employment or population
Q	=	national estimate
CE	=	control efficiency/100
RP	=	rule penetration/100
RE	=	rule effectiveness/100
UAE_A	=	uncontrolled area source emissions of pollutant A

3.3.5 SPATIAL ALLOCATION

If a survey, Dun and Bradstreet, or some other source is used to develop emission estimates for the very large shops, then the spatial allocation of part of the emissions can be based on facility location, as with the point source inventory, or with local employment data. If allocation is based on facility location, you can use the address matching capability of a Geographical Information System to assign map coordinates to shop locations. From these coordinates, shops can then be assigned to grid cells for spatial allocations of emissions.

If you need to estimate emissions at the sub-county level, you should consider that the location of auto body shops does not necessarily mirror the location of population within a county. You will need to evaluate options for allocating county emissions, such as urban versus rural population (available from U.S. Bureau of the Census publications), actual location data identified from surveys, etc.

3.3.6 TEMPORAL RESOLUTION

Seasonal Apportioning. In *Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I: General Guidance for Stationary Sources*, EPA (1991b) reports that auto body refinishing emissions do not seem to demonstrate differences in activity from season to season. However, other references have indicated that since there is a direct relationship between auto body refinishing activity and number of automobile accidents, if there is a seasonal difference in accident occurrence, the same seasonal variation may be seen in auto body refinishing activity. If time permits, you could review annual accident statistics to determine if any seasonal variability exists for your inventory area. The National Safety Council annual publication, *Accident Facts* provides this information.

Daily Resolution. From the EPA procedures document (1991b), auto body refinishing shops typically operate five days per week. This figure may be used if local data on daily resolution are not available.

3.4 PROJECTING EMISSIONS

The type of surrogate used to project emissions is dependent on the methodology used to develop the initial emissions estimate. In "growing" the emissions estimate, you should use the same activity parameter as was used to develop the initial estimate. For example, if a per capita factor was used to develop the initial estimate, population growth should be used to develop the projected emissions estimate. Any source survey conducted to gather information on auto body refinishing activity should include questions on source growth and expected changes in factors that affect emissions (EPA, 1991b).

The equation for developing the projected emissions is:

$$\text{EMIS}_{PY} = \text{ORATE}_{BY,O} * \text{RAT}_{PY,pc} * \text{EMF}_{PY,pe} * [1 - (\frac{\text{CE}_{PY}}{100})(\frac{\text{RP}_{PY}}{100})(\frac{\text{RE}_{PY}}{100})] * \text{GF} \qquad (13.3\text{-}3)$$

where:

EMIS_{PY}	=	projection year emissions: ozone season typical weekday (mass of pollutant/day)
$\text{ORATE}_{BY,O}$	=	base year operating rate: ozone season daily activity level
$\text{EMF}_{PY,pe}$	=	emission factor (mass of pollutant per activity level)
$\text{RAT}_{PY,pc}$	=	ratio of local-to-national SIC code employment or population
CE_{PY}	=	projection year control efficiency (percent)
RE_{PY}	=	projection year rule effectiveness (percent)
RP_{PY}	=	projection year rule penetration (percent)
GF	=	growth factor (dimensionless)

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4

PREFERRED METHODS FOR ESTIMATING EMISSIONS

The preferred method for estimating emissions from auto body refinishing operations involves apportioning a national estimate to the local level for each shop size category, and surveying shops with annual revenues in excess of $624,000 (i.e., very large size shops) for annual coatings and solvents usage data. Emission estimates for the surveyed shops will replace those apportioned to very large shops from the national estimate. Figure 13.4-1, at the end of this section, is an example survey questionnaire for auto body refinishing facilities. The questionnaire should be modified to meet your specific needs, but should contain sections for the following types of information: (1) identification, including firm name, address, and contact, and type of facility, (2) number of employees, and (3) annual coating and solvent usage based on user information.

4.1 NATIONAL VOC EMISSION ESTIMATE

A national VOC emission estimate of 79,429.39 tons per year has been developed using 1997 activity and 1998 and 1999 emission rate information. Dun and Bradstreet sales and employment statistics for auto body refinishing businesses were used to scale emission rates for equipment cleaning solvent use from the Connecticut Department of Environmental Protection Bureau of Air Management (CT DEP, 1998); and to scale emission rates for coating applications from the Texas Natural Resources Conservation Commission (TNRCC) (Smith and Dunn, 1999).

4.2 PREFERRED METHOD

Using the preferred method, the first step is to apportion the national estimate to the local level for each shop size. This operation is shown by the following equation:

$$E_{AS} = NE_{AS} \times (E_I \div E_N) \qquad (13.4\text{-}1)$$

where:

E_{AS} =   Local VOC emissions for shop size S (tons/year)

NE_{AS} =   National VOC emissions for shop size S (tons/year)

E_I =   Number of employees for SIC code 7532 in area of interest

E_N =   Number of employees for SIC code 7532 in U.S.

National emissions by shop size are shown in Table 13.4-1.

The second step in estimating emissions is to determine if the survey responses for very large shops adequately represent the local activity. You can compare the survey responses to Dun and Bradstreet employee counts for SIC code 7532 to estimate the coverage of the survey. If you believe the survey results are a more accurate reflection of the activity for very large shops, then the survey-derived estimates should replace the estimates apportioned to very large shops from the national estimate.

Using the preferred method, the equation for estimating emissions for each specific auto body refinishing product at each very large shop:

$$E_A = P_x \times 4 \times 12 \times C_x \div 2,000 \text{ lbs/ton} \qquad (13.4\text{-}2)$$

where:

E_A =   VOC emissions (tons/year)

P_x =   Amount of product x used in quarts (from survey) per month

C_x =   VOC content of product x in pounds per gallon (from MSDS)

The emission totals from all products and shops would then be summed to develop total emissions for all very large shops.

Depending on the quality of the survey responses, you may need to modify the source of C_x, the VOC content of product x. If you do not have the resources or the survey responses do not provide sufficient data to evaluate each MSDS for each product to develop VOC content values, you may calculate emissions using average or default values for product categories (e.g., pretreatment, precoat, base coats, etc.). Table 13.4-2 provides data on VOC range (in pounds per gallon), and average VOC content (in pounds per gallon) by product category.

Be sure to account for point source emissions by subtracting point source emissions from the total emissions estimate developed through this preferred method.

TABLE 13.4-1

NATIONAL VOC EMISSIONS BY BODY SHOP SIZE

Body Shop Size	Average Annual Revenue/ Shop	National Annual VOC Emissions from Coating Applications (tpy)[a]	National Annual VOC Emissions From Equipment Cleaning (tpy)[b]	Total National Annual VOC Emissions (tpy)
Small	<$104,000	6,401.49	4,753.65	11,155.14
Medium	$104,000 - 364,000	22,426.94	18,671.85	41,098.79
Large	$364,000 - 624,000	4,166.96	5,791.65	9,958.61
Very Large	>$624,000	6,733.55	10,483.50	17,217.05
Total		39,728.94	39,700.65	79,429.59

[a] Estimate is for all shops this size in the U.S. based on data collected in 1999.

[b] Estimate is for all shops this size in the U.S. based on data collected in 1998.

TABLE 13.4-2

VOC PARAMETERS OF CONVENTIONAL (PRE-REGULATION) AUTO BODY REFINISHING PRODUCTS (EPA, 1988; EPA 1994a)

Category	VOC Range (lb/gal)	Average VOC Content (lb/gal)
Pretreatment	5.8 - 6.5	6.3
Primers		
Prepcoat	4.6 - 7.1	5.8
Primer/Primer-Surfacer	4.6 - 7.1	5.7
Primer-Sealer	5.0 - 6.7	6.3
Coatings		
Single Stage - Lacquer	5.8 - 6.7	6.3
Single Stage - Enamel	4.8 - 6.0	5.6
Basecoat	5.8 - 6.7	6.2
Acrylic Lacquer	N/A	6.3
Acrylic Enamel	N/A	5.3
Clearcoat	4.6 - 6.7	5.2
Acrylic Lacquer	N/A	6.4
Acrylic Enamel	N/A	5.6
Specialty Coatings	N/A	7.0
Surface Cleaners	6.2 - 7.3	6.75
Cleanup	6.2 - 7.3	6.75

N/A = Not available.

[a] Assumes 0.25 pints of surface preparation products are used per job (EPA, 1994a).

Auto Refinishing Questionnaire

A.   **Identification**

1.   Firm Name: _____
        Mailing Address: _____
        City: _____ State_____ Zip _____
        Street Location: _____
        Business Telephone Number: (____)_____ - _____
        Respondent's Name: _____
        Respondent's Title: _____

2.   Please indicate which type of operation is your primary function.
        A.   New and Used Car Dealership   C.   Auto Refinishing Shop
        B.   Used Car Dealership   D.   General Automotive Repair Shop
        E.   Other (specify)_____

3.   Do you provide autobody refinishing services at this location?
                01 . . . YES ☞ CONTINUE to B.1.   02 . . NO   STOP. Thank you for your
                                                                 time. Return the questionnaire in
                                                                 the envelope provided.

4.   How many total employees do you currently have working at this shop location?
                Number of employees: _____

Figure 13.4-1. Example Survey Questions

B. <u>**Solvent and Coatings Usage**</u>

1. We need to know about the amount of volatile organic compound (VOC)-containing material your shop is using. *This is the most important question in this survey*. **Ask your distributor or jobber to help you with any of this information.**

    We would like to obtain information about your paint and solvent usage during *one month*. Specifically, we are interested in the quantity of surface preps, primers, surfacers/fillers, sealers, topcoats (single and base/clear), thinners/reducers, hardeners, catalysts, newly purchased cleaning solvent, and other solvent-based products used and their VOC content.

    This information can be provided using Table 1. Please enter the time period for your information on the line at the top of the table. The table is organized into columns that are described below. An example is shown in the first few lines of the table; start your shop's information in the next available space.

    Column 1: Category. A definition of the general class of solvent-containing materials used in your shop such as topcoats, surface preps, primers, surfacers, fillers, sealers, thinners, reducers, hardeners, catalysts, and cleaners.

    Column 2: Name and/or Specific Identifier. Identification of the specific products used in your shop. At a minimum, we would like the manufacturer's name (e.g., DuPont, BASF, ICI Autocolor, PPG Industries), the material ID or product number, and a brief description of the product (color and/or paint type).

    Column 3: Quarts Used. The number of quarts of the material used during the month reported.

    Column 4: How the Quarts Used Were Estimated. How you calculated the number of quarts of material. Examples include: "summarizing customer invoices," "monthly material inventory," and "best guess."

    Column 5: VOC Content. This information can be found on the label for each material. Alternatively, we can determine this information if you provide the product manufacturer's name and ID/product number.

C. <u>**Control Equipment**</u>

Various equipment is available to control VOC emissions in work areas (i.e., carbon filters, incinerators). Does this body shop use any of this equipment? If so, please describe the equipment.
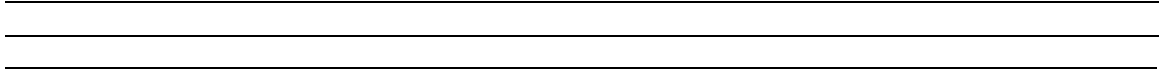
Figure 13.4-1. Example Survey Questions (Continued)

Example for Table 1. Information for the Time Period: August 1999

Column 1	Column 2	Column 3	Column 4	Column 5
Category	**Name and/or Specific Identifier**	**Quarts Used**	**How the Quarts Used Were Estimated**	**VOC Content (pounds/gallon)**
Base coat	PPG-DBC Acrylic Basecoat	4.5	Inventory records	6.7
Primer/surfacer	PPG-NCP270 Surfacer	1.5	Invoices	6.0
Cleaner	PPG-DX440 Wax and Grease Remover	0.5	Guess	6.9
Cleaner	PPG-Solvent Mixture	1.0	Invoices	6.7
Primer	PPG-DPU35 Durethane Primer	4.0	Inventory records	6.7
Hardener	PPG-DAU3 Acrylic Urethane Hardener	2.0	Guess	6.2
Additive	PPG-DBX689 Basecoat Additive	0.5	Guess	6.8
Blender	PPG-DBC500 Blender	1.0	Invoices	6.2
Reducer	PPG-DRR1150 Reactive Reducer	0.5	Invoices	6.5
Clear Topcoat	PPG-DCU2050 Graffiti Resistant Clear Coat	4.5	Invoices	2.9

Figure 13.4-1. Example Survey Questions (Continued)

TABLE 1. Information for the Time Period _____.

	LIST YOUR SHOP'S INFORMATION IN THE SPACES BELOW			
Column 1	**Column 2**	**Column 3**	**Column 4**	**Column 5**
Category	**Name and/or Specific Identifier**	**Quarts Used**	**How the Quarts Used Were Estimated**	**VOC Content (pounds/gallon)**
Surface Preps				
Primers/sealers				
Surface/fillers				
Topcoats				
Hardeners/catalysts				
Newly-purchased cleaning solvents				

NOTE: DON'T FORGET TO PUT THE MONTH AND YEAR FOR THIS INFORMATION

Figure 13.4-1. Example Survey Questions (Continued)

5

ALTERNATE METHODS FOR ESTIMATING EMISSIONS

5.1 ALTERNATE METHOD 1 - APPORTION NATIONAL EMPLOYMENT DATA

This method is identical to the preferred method except that survey data are not included in the development of the estimate. Equation 13.4-1 is applicable for this method, with the following modification: if only County Business Patterns data are available (i.e., Dun and Bradstreet data are not available), then instead of calculating emission estimates for each shop size, a single estimate for all shop sizes will result from Equation 13.4-1. County Business Patterns data do not contain revenue data, so emissions cannot be determined for each "revenue-based" shop size category. Dun and Bradstreet data is the preferred source for developing emissions using this method; however, limited resources on the part of the inventorying agency may prevent it from being used.

5.2 ALTERNATE METHOD 2 - APPORTION NATIONAL POPULATION DATA

This method is similar to the alternate method 1 except that instead of using employment data to allocate a national emissions estimate, population data from the Bureau of Census are used:

$$E_A = NE_A \times (P_I \div P_N)$$

(13.5-1)

where:

E_A	=	Local VOC emissions
NE_A	=	National VOC emissions
P_I	=	Population of the area of interest
P_N	=	U.S. population

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6

QUALITY ASSURANCE/ QUALITY CONTROL (QA/AC)

Data collection and handling for the auto body refinishing source category should be planned and documented in the Quality Assurance Plan. When using survey methods, the survey planning and data handling should also be documented. Refer to the discussion of survey planning and survey QA/QC in Chapter 1, Introduction to Area Source Emission Inventory Development, of this volume, and Volume VI, Quality Assurance Procedures, of the Emission Inventory Improvement Program (EIIP) series. Potential pitfalls to avoid when developing emission estimates by using a survey for this category are data gaps due to surveys not returned, unanswered or misunderstood survey questions, inappropriate assumptions used to compensate for missing information or scaling up the survey sample, errors in compiling the returned survey information, and calculation errors which can include unit conversion errors, and data handling errors.

6.1   EMISSION ESTIMATE QUALITY INDICATORS

In this chapter, one preferred and two alternate methods are presented. In the preferred method, activity level is the amount of product used by large shops, and is being collected by a survey. Alternate Methods 1 and 2 recommend scaling the national VOC emissions estimate to the local level using either employment or population.

6.2   DATA ATTRIBUTE RATING SYSTEM (DARS) SCORES

The DARS scores for each method are summarized in Tables 13.6-1 through 13.6-3. A range of scores is provided for the method that uses surveys because the implementation of this method can vary. The higher scores assume that reliable data were collected specifically for the inventory area, the inventory time period, and the full range of very large auto body refinishing operations and few, if any, assumptions or generalizations have been made in using the data gathered. All scores assume that satisfactory QA/QC measures are performed and no significant deviations from good inventory practice have been made. If these assumptions are not met, new DARS scores should be developed according to the guidance provided in the QA volume.

The survey of products used for the inventory area and time period by large shops, the preferred method, has the highest potential DARS scores (Table 13.6-1). This method also requires the most effort, because this category includes many facilities, which can be difficult to include in a survey even when limited to only very large shops. Ranges in the scores for this method are based on the completeness of the survey used for this category. Spatial and temporal scores are highest when local product usage data are collected because the national emissions do not take into account the effects of local rules or work practices. Temporal scores can be improved if new emissions data are developed from the most recent data available when the inventory is undertaken. The auto body refinishing industry is changing rapidly, and new paint formulations mean that emission estimates for the industry should go down. The industry has also enjoyed technological advances in high efficiency equipment like HVLP guns, whose improved efficiency has reduced paint use emissions.

Tables 13.6-2 and 13.6-3 provide DARS scores for the two alternate methods. The level of effort required for each method goes down as the DARS score for the method becomes smaller. For this category, activity surrogates such as employment and population are not necessarily very specific to activity in the category, which may be influenced more by population density, climate, and economic factors. Given the uncertainty associated with this industry overall, however, they can be used unless more refined estimates are needed.

6.3   SOURCES OF UNCERTAINTY

Another way to evaluate the emission estimates is to examine the associated uncertainty. For estimates derived from survey data, the uncertainty can be quantified (see Chapter 4 of Volume VI of the EIIP series). Statistics needed to quantify the uncertainty of emissions derived by emission factor methods are incomplete.

Sources of uncertainty in estimating emissions from this source category include the difficulty of collecting information that truly represents auto body refinishing operations, variability in the types and amounts of products used, and the rapidly changing level of emissions from the industry. Emissions will decrease as higher VOC products can no longer be manufactured because of the federal rule that applies to the VOC content of coating manufactured on or after January 11, 1999. When using a national average, state- or local-level rules, product formulations, or frequency of repairs may increase the uncertainty of the emission estimate.

TABLE 13.6-1

PREFERRED METHOD: AUTO BODY REFINISHING SURVEY OF VERY LARGE SHOPS

Attribute	Scores		
	Factor	**Activity**	**Emissions**
Measurement	0.5	0.6 - 0.8	0.30 - 0.40
Source Specificity	0.7 - 0.8	0.7	0.49 - 0.56
Spatial Congruity	0.6	0.6 - 07	0.36 - 0.42
Temporal Congruity	0.7	0.7 - 0.8	0.49 - 0.56
Composite Scores	0.63 - 0.65	0.65 - 0.75	0.41 - 0.49

TABLE 13.6-2

ALTERNATE METHOD 1: APPORTION NATIONAL EMPLOYMENT DATA

Attribute	Scores		
	Factor	**Activity**	**Emissions**
Measurement	0.5	0.7	0.35
Source Specificity	0.7	0.6	0.42
Spatial Congruity	0.6	0.6	0.36
Temporal Congruity	0.7	0.7	0.49
Composite Scores	0.63	0.65	0.41

TABLE 13.6-3

ALTERNATE METHOD 2: APPORTION NATIONAL POPULATION DATA

Attribute	Scores		
	Factor	**Activity**	**Emissions**
Measurement	0.5	0.6	0.30
Source Specificity	0.7	0.3	0.21
Spatial Congruity	0.6	0.5	0.30
Temporal Congruity	0.7	0.7	0.49
Composite Scores	0.63	0.53	0.33

7

DATA CODING PROCEDURES

This section describes the codes available to characterize auto body refinishing emission estimates. Consistent categorization and coding will result in greater uniformity among inventories.

7.1 PROCESS AND CONTROL CODES

The process codes for auto body refinishing operations are shown in Table 13.7-1. These codes are compatible with the AIRS AMS source category codes (EPA, 1994b). The control codes for use with AMS are shown in Table 13.7-2. Federal, State, and local regulations can be used as guides to estimate the type of control used and the level of efficiency that can be achieved. Be careful to apply only the regulations that specifically includes area sources. If the regulation is applicable only to point sources, it should not be assumed that similar controls exist at area sources without a survey. The "099" control code can be used for miscellaneous control devices that do not have a unique identification code. The "999" code can be used for a combination of control devices where only the overall control efficiency is known.

TABLE 13.7-1

AMS CODES FOR AUTO BODY REFINISHING OPERATIONS

Category Description	Process Description	AMS Code	Units
Auto Body Refinishing: SIC Code 7532		24-01-005	
	All Solvent Types	24-01-005-000	Tons Consumed
	Acetone	24-01-005-030	Tons Consumed
	Butyl Acetate	24-01-005-055	Tons Consumed
	Butyl Alcohols: All Types	24-01-005-060	Tons Consumed
	n-Butyl Alcohol	24-01-005-065	Tons Consumed
	Isobutyl Alcohol	24-01-005-070	Tons Consumed
	Diethylene Glycol Monobutyl Ether	24-01-005-125	Tons Consumed
	Diethylene Glycol Monoethyl Ether	24-01-005-130	Tons Consumed
	Diethylene Glycol Monomethyl Ether	24-01-005-135	Tons Consumed
	Ethyl Acetate	24-01-005-170	Tons Consumed
	Ethylene Glycol Monoethyl Ether (2-Ethoxyethanol)	24-01-005-200	Tons Consumed
	Ethylene Glycol Monomethyl Ether (2-Methoxyethanol)	24-01-005-210	Tons Consumed
	Ethylene Glycol Monobutyl Ether (2-Butoxyethanol)	24-01-005-215	Tons Consumed
	Glycol Ethers: All Types	24-01-005-235	Tons Consumed
	Isopropanol	24-01-005-250	Tons Consumed
	Methyl Ethyl Ketone	24-01-005-275	Tons Consumed
	Methyl Isobutyl Ketone	24-01-005-285	Tons Consumed
	Special Naphthas	24-01-005-370	Tons Consumed
	Solvents: NEC	24-01-005-999	Tons Consumed

TABLE 13.7-2

AIRS CONTROL DEVICE CODES

Control Device	Code
Catalytic Afterburner	019
Catalytic Afterburner with Heat Exchanger	020
Direct Flame Afterburner	021
Direct Flame Afterburner with Heat Exchanger	022
Carbon Adsorption	048
Miscellaneous Control Device	099
Combined Control Efficiency	999

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8

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