INDUSTRIAL CLEANING SOLVENTS AND ADHESIVES INVENTORY RESEARCH

FINAL REPORT

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EXECUTIVE SUMMARY

The United States Environmental Protection Agency issued Control Techniques Guidelines (CTGs) for industrial cleaning solvents in 2006 and miscellaneous industrial adhesives in 2008. The purpose of this study is to gather information on facilities in the Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB) eight-hour ozone nonattainment areas that meet the applicability criteria outlined in these CTGs. The information will be used to support the reasonably available control technology (RACT) analysis for these specific emission source categories and may potentially be used to support the development of TCEQ environmental regulations. The objective of the research is to estimate: (1) the number of facilities affected by these CTGs; (2) the volatile organic compound (VOC) emissions from industrial adhesive application processes and industrial cleaning unit operations; and (3) the emissions reductions and the potential financial impact of implementing the CTG recommended control strategies.

A comprehensive end-user survey was developed and conducted to gather the necessary data to estimate the number of facilities impacted by the CTG recommendations and to assess the impacts of implementing the control strategies recommended in the CTGs. Emissions estimates for facilities responding to the survey were calculated using the survey responses and used to determine whether a responding facility emits more than 15 pounds per day (ppd) of VOCs from adhesive application processes or cleaning unit operations (the applicability criteria specified in the CTGs). The fraction of responding facilities emitting more than 15 ppd was then applied to the user universe to estimate the total number of affected facilities in DFW and HGB.

Table ES-1 shows the number of facilities affected by the Miscellaneous Industrial Adhesives CTG and Table ES-2 shows the number of facilities affected by the Industrial Cleaning Solvents CTG. In 2008, the estimated number of facilities in DFW and HGB affected by the Miscellaneous Industrial Adhesives CTG recommendations is 102 with 81 (or 79 percent) being small businesses. The estimated number of facilities affected by the Industrial Cleaning Solvents CTG recommendations is 247 with 108 (or 44 percent) being small businesses. The majority of the affected facilities are in the miscellaneous manufacturing group (Group 8).

Table ES-1. Number of Facilities in DFW and HGB Affected by the Miscellaneous Industrial Adhesives CTG

Group	Business Size	2008		
		Applicable Facilities	Applicable Facilities with Controls	Affected Facilities
(2) Food Manufacturing	Large	4		4
(4) Wood and Wood Products	Large	7		7
(4) Wood and Wood Products	Small	6		6
(8) Other Manufacturing	Large	15	5	10
(8) Other Manufacturing	Small	75		75
Total Small		**81**	**0**	**81**
Total Large		**26**	**5**	**21**
Total All		**107**	**5**	**102**

Table ES-2. Number of Facilities in DFW and HGB Affected by the Industrial Cleaning Solvents CTG

Group	Business Size	2008		
		Applicable Facilities	Applicable Facilities with Controls	Affected Facilities
(1) Non-manufacturing	Large	20		20
(2) Food Manufacturing	Large	4		4
(5) Fabricated Metals	Large	18	6	12
(5) Fabricated Metals	Small	27		27
(6) Industrial Machinery	Large	18		18
(7) Transportation Equipment	Large	9	3	6
(7) Transportation Equipment	Small	6		6
(8) Other Manufacturing	Large	89	10	79
(8) Other Manufacturing	Small	75		75
Total Small		**108**	**0**	**108**
Total Large		**158**	**19**	**139**
Total All		**266**	**19**	**247**

An emission model was developed from nearly 600 survey responses. The model consists of activity factors, impact factors, and user fractions (emission model variables) and an emissions allocation dataset. The emissions allocation dataset selected for this project is employment data obtained from Dun and Bradstreet. The estimated county-level VOC emissions from adhesive application processes and cleaning unit operations are presented in Table ES-3. This table also shows the estimated VOC reductions expected from implementing the recommended control strategies.

Total VOC emissions in DFW and HGB from the usage of industrial adhesives and industrial cleaning solvents are estimated to be 13,382 tons in 2008. Implementation of the recommendations in the Miscellaneous Industrial Adhesives CTG and Industrial Cleaning Solvents CTG is estimated to reduce VOC emissions from adhesive application processes and cleaning unit operations in DFW and HGB by 829 tons (6.2 percent). The majority of these emissions reductions are associated with contact adhesive application, general adhesive application, the cleaning of small manufactured parts, spray gun cleaning and parts cleaning in non-manufacturing and miscellaneous manufacturing facilities in Dallas, Harris and Tarrant counties. A concentration of emissions in these counties is expected since they are the most populous counties and have a higher concentration of businesses compared to other counties in DFW and HGB. The minor impact on VOC emissions from implementing the recommendations is a result of the VOC emissions from facilities affected by the CTGs being small compared to the aggregate VOC emissions from unaffected facilities.

Table ES-3. Summary of Estimated VOC Emissions Reductions from Implementing CTG Recommendations

Area	County	2008 VOC Emissions (tons)								
		Industrial Adhesives			Industrial Cleaning Solvents			Totals		
		BAU[1]	CTG[2]	Reduction[3]	BAU	CTG	Reduction	BAU	CTG	Reduction
DFW	Collin	134	127	7	478	447	31	**612**	**574**	**38**
	Dallas	676	640	36	2,439	2,283	156	**3,115**	**2,923**	**192**
	Denton	95	90	5	338	316	22	**433**	**406**	**27**
	Ellis	45	43	2	174	163	11	**219**	**205**	**13**
	Johnson	32	30	2	123	115	8	**154**	**145**	**10**
	Kaufman	18	17	1	87	81	5	**105**	**98**	**7**
	Parker	19	18	1	70	66	5	**89**	**84**	**6**
	Rockwall	13	12	1	52	49	3	**65**	**61**	**4**
	Tarrant	408	386	22	1,495	1,399	95	**1,903**	**1,785**	**118**
	All Counties	1,439	1,362	77	5,255	4,918	337	**6,695**	**6,281**	**414**
HGB	Brazoria	51	49	3	189	177	12	**240**	**225**	**15**
	Chambers	8	8	0	34	32	2	**42**	**40**	**3**
	Fort Bend	92	87	5	348	326	22	**441**	**413**	**27**
	Galveston	33	31	2	118	110	8	**151**	**142**	**9**
	Harris	1,118	1,058	59	4,231	3,958	272	**5,349**	**5,017**	**332**
	Liberty	9	8	0	34	31	2	**43**	**40**	**3**
	Montgomery	70	66	4	268	250	17	**337**	**316**	**21**
	Waller	15	14	1	69	65	4	**84**	**79**	**5**
	All Counties	1,397	1,322	74	5,291	4,950	341	**6,687**	**6,272**	**415**
All Areas	**All Counties**	**2,836**	**2,685**	**151**	**10,546**	**9,868**	**678**	**13,382**	**12,553**	**829**

[1]BAU =Business-as-Usual emissions. These are emissions assuming that the recommendations in the CTGs are not implemented.

[2]CTG = Control Techniques Guidelines emissions. These are emissions occurring after the recommendations in the CTGs are implemented.

[3]Reductions = emissions reductions associated with implementing the recommendations in the CTG (BAU emissions minus CTG emissions).

Efforts to supplement the economic analysis presented in the CTGs with additional studies proved unsuccessful. While extensive literature searches revealed additional studies evaluating the cost of some of the recommended control strategies outlined in the CTGs, none of the studies were directly relevant to the industrial sectors evaluated in this project. Therefore, California's Ventura County APCD Rule 74.20 Staff Report and California's Bay Area Air Quality Management District Regulation 8, Rule 16 were used to derive cost-effectiveness values for switching from high- to low-VOC containing adhesives and cleaning solvents, the primary control strategy recommended in the CTGs.

Table ES-4 depicts the estimated costs to small and large businesses in DFW and HGB by industry grouping. The total annual estimated cost from implementing the Miscellaneous Industrial Adhesives CTG to small businesses is $121,000 and the cost to large businesses is $94,000. On a cost per facility basis, complying with the Miscellaneous Industrial Adhesives CTG recommendations is estimated to cost an affected small business $1,490 per year, on average, versus $4,480 for a large business. This is expected since large businesses are likely to use, on average, a larger volume of high-VOC adhesives than small businesses.

Implementing the Industrial Cleaning Solvents CTG recommendations is estimated to result in a total cost savings to small businesses in DFW and HGB of $298,000 and a total cost savings to large businesses of $255,000. On a cost savings per facility basis, complying with the Industrial Cleaning Solvents CTG recommendations will save an affected small business $2,760 per year, on average, versus $1,840 for a large business. The difference in cost savings can be attributed to the fact that affected large businesses have a larger share of emissions associated with parts cleaners, the only cleaning unit operation expected to have a net annual cost.

If the recommendations in both CTGs are implemented, the estimated cost savings associated with implementing the Industrial Cleaning Solvents CTG recommendations will outweigh the estimated costs from implementing the recommendations in the Miscellaneous Industrial Adhesives CTG. In aggregate, the estimated cost savings are $338,000. However, the cost-effectiveness information is derived from relatively few studies and may not be applicable to all facilities. Consequently, there is a high-degree of uncertainty in the cost analysis presented in this report. Additional studies on the inter- and intra-industry variability in product switching costs would enable refinement of the cost analysis, resulting in a more accurate cost estimate.

Table ES-4. Estimated Costs to Facilities in DFW and HGB from Implementing the Recommendations in the Miscellaneous Industrial Adhesives and Industrial Cleaning Solvents CTGs

Group	Business Size	2008 Costs (2008$)		
		Miscellaneous Industrial Adhesives CTG	Industrial Cleaning Solvents CTG	Total
(1) Non-manufacturing	Small	58,235	-183,021	-124,787
(2) Food Manufacturing	Small	3,278	-1,997	1,281
(3) Fabric and Fiber Manufacturing	Small	557	-6,890	-6,333
(4) Wood and Wood Products	Small	5,586	-11,094	-5,508
(5) Fabricated Metals	Small	9,888	118,324	128,212
(6) Industrial Machinery	Small	7,928	-27,112	-19,184
(7) Transportation Equipment	Small	1,753	-9,538	-7,785
(8) Other Manufacturing	Small	33,708	-176,409	-142,702
(1) Non-manufacturing	Large	31,639	5,074	36,713
(2) Food Manufacturing	Large	6,176	-790	5,385
(3) Fabric and Fiber Manufacturing	Large	77	-1,206	-1,128
(4) Wood and Wood Products	Large	4,476	-11,200	-6,724
(5) Fabricated Metals	Large	5,576	-31,442	-25,866
(6) Industrial Machinery	Large	6,074	-29,091	-23,017
(7) Transportation Equipment	Large	3,046	-4,108	-1,062
(8) Other Manufacturing	Large	36,928	-182,325	-145,397
Total Small		**120,931**	**-297,738**	**-176,806**
Total Large		**93,992**	**-255,088**	**-161,096**
Total All		**214,923**	**-552,826**	**-337,902**

A limited uncertainty analysis for VOC emissions estimates was performed for several of the adhesive application processes and cleaning unit operations. From this analysis, it becomes clear that additional data are needed for some of the application processes and cleaning unit operations to reduce uncertainty in the emission estimates. The only way to reduce the uncertainty in the emission estimates is to better characterize the usage patterns, including volumes and chemical compositions of the materials, for those adhesive application processes and cleaning unit operations displaying high degrees of uncertainty. This could be accomplished through further disaggregation of activity and impact factors (e.g., model variables) and further disaggregation of adhesive application processes and cleaning unit operations. These more highly resolved activity/impact factors (i.e., factors that are industry- or geographic region-specific) will likely have much lower variability, and hence, less uncertainty.

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CHAPTER I. INTRODUCTION

A. PURPOSE OF THIS PROJECT

The purpose of this study is to gather information on Texas facilities that meet the applicability criteria specified in the United States Environmental Protection Agency's (EPA) 2006 Industrial Cleaning Solvents Control Techniques Guidelines (CTG) and 2008 Miscellaneous Industrial Adhesives CTG. The information will be used to support the reasonably available control technology (RACT) analysis for these specific emission source categories and may potentially be used to support the development of TCEQ environmental regulations. The research primarily focused on facilities in the Dallas-Fort Worth eight-hour ozone nonattainment area (DFW) and the Houston-Galveston-Brazoria eight-hour ozone nonattainment area (HGB); however, some general information was also collected in the San Antonio area (SA). The objective of the research is to identify the facilities affected by these CTGs, determine the volatile organic compound (VOC) emissions from adhesives and cleaning solvents used in these operations, and assess the potential financial impacts of implementing EPA's CTG recommended control strategies.

B. BACKGROUND

Under the 1997 eight-hour ozone standard, the DFW and HGB areas are required to meet the mandates of the Federal Clean Air Act (FCAA) under §§172(c)(1), 182(b)(2) and 182(f), requiring states containing areas classified as moderate nonattainment or higher to submit a state implementation plan (SIP) revision demonstrating that their current rules fulfill the RACT requirements for all CTG emission source categories. The EPA defines RACT as the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility (44 FR 53761, September 17, 1979). CTG documents provide information to assist states and local air pollution control authorities in determining RACT for specific emission sources and provide the EPA's RACT recommendations for controlling emissions from these sources.

The EPA issued CTG recommendations for industrial cleaning solvents in 2006 and miscellaneous industrial adhesives in 2008. Although some industrial solvent-using operations are currently regulated in Title 30 Texas Administrative Code Chapter 115, the rules do not specifically target these CTG emission source categories and the TCEQ does not currently have the necessary information to approximate the impacts of these CTG recommendations.

The industrial cleaning solvents CTG recommendations affect industrial cleaning operations at facilities in ozone nonattainment areas that have the uncontrolled potential to emit at least 15 pounds per day (ppd) of VOC. Using the applicability criteria for industrial cleaning solvents, the EPA estimated 92 facilities in Texas would be affected by the CTG recommendations (EPA, 2006). Similarly, the Miscellaneous Industrial Adhesives CTG recommendations affect facilities using industrial adhesive processes that have the uncontrolled potential to emit at least 15 ppd of VOC. The source classification codes (SCC) in the CTG provides a list of the facilities

anticipated to be affected by the recommendations; however, the EPA did not include an estimated number of these facilities for Texas.

The TCEQ's initial assessment indicates that the EPA substantially underestimated the scope and potential impact of the CTG recommendations. Based on the EPA's suggested exemption threshold of only 15 ppd of VOC, the TCEQ estimates that implementing the CTG recommendations may have widespread and potentially adverse impacts to small businesses. Texas Government Code, §2006.001 defines small businesses as having fewer than 100 employees or having annual gross receipts of less than $6 million. Additionally, the ambiguity associated with the industrial source categories provided in these CTG recommendations suggests a much broader applicability than anticipated by the EPA. This research project provides additional information for the TCEQ to determine the scope and potential impact of the CTG recommendations, including whether the proposed controls are technologically and economically feasible.

C. OVERVIEW OF CONTROL TECHNIQUES GUIDELINES

Clean Air Act (CAA) section 183(e) directs EPA to list for regulation those categories of products that account for at least 80 percent of the VOC emissions, on a reactivity-adjusted basis, from consumer and commercial products in areas that violate the National Ambient Air Quality Standard (NAAQS) for ozone (i.e., ozone nonattainment areas). EPA issued the list on March 23, 1995, and has revised the list periodically. See 60 FR 15264 (March 23, 1995); see also 71 FR 28320 (May 16, 2006), 70 FR 69759 (Nov. 17, 2005); 64 FR 13422 (March 18, 1999). Miscellaneous industrial adhesives and industrial cleaning solvents are both included on the current section 183(e) list.

CTGs are intended to provide State and local air permitting control authorities with information to assist in determining RACT for VOCs from categories on the section 183(e) list. For the miscellaneous industrial adhesives and industrial cleaning solvents categories, the CTGs present an evaluation of the sources of VOC emissions from these categories, the available control approaches for reducing emissions, and the estimated costs of such control approaches.

1. Miscellaneous Industrial Adhesives

Adhesives are used for joining surfaces in assembly and construction of a large variety of products. Adhesives allow for faster assembly speeds, less labor input, and more ability for joining dissimilar materials than other fastening methods. Although there are a wide variety of adhesives formulated from a multitude of synthetic and natural raw materials, all adhesives can be generally classified as solution/waterborne, solvent-borne, solventless or solid (e.g., hot melt adhesives), pressure sensitive, or reactive (e.g., epoxy adhesives and ultraviolet-curable adhesives). Adhesives can also be generally classified according to whether they are structural or nonstructural. Structural adhesives are commonly used in industrial assembly processes and are designed to maintain product structural integrity. The VOC emissions from miscellaneous industrial adhesives result from evaporation of the solvents contained in many of the primers, adhesives and cleaning materials during adhesive application and drying processes, as well as during surface preparation and cleaning processes associated with adhesives application.

The miscellaneous industrial adhesives product category includes adhesives (as well as adhesive primers used in conjunction with certain types of adhesives) used at industrial manufacturing and repair facilities for a wide variety of products and equipment that operate adhesives application processes. Motor vehicle adhesives, glass bonding primers, and weatherstrip adhesives that are used at a facility that is not an automobile or light-duty truck assembly coatings facility are also addressed in the miscellaneous industrial adhesives CTG.

The miscellaneous industrial adhesives product category does not include adhesives that are addressed by CTGs already issued for categories listed under CAA Section 183(e) or by earlier CTGs. These include the CTGs issued under Section 183(e) for aerospace coatings; metal furniture coatings; large appliance coatings; flat wood paneling coatings; paper, film, and foil coatings; offset lithographic printing and letterpress printing; and flexible package printing. Coil coating, fabric coating, and rubber tire manufacturing were not listed under CAA Section 183(e); however, they were the subject of earlier CTGs which address adhesives used in those processes.

For facilities where the total VOC emissions from all miscellaneous industrial adhesive application processes, including related cleaning activities, equal or exceed 15 ppd before consideration of controls, specific VOC emission limits based on application processes (i.e., the types of adhesives and substrates) are recommended (see Table I-1). Alternatively, an add-on control with an overall control efficiency of 85 percent may be employed. This alternative provides facilities operational flexibility when the use of high-VOC adhesives is necessary or desirable for product efficacy. In addition, reducing VOC emissions via work practice procedures is recommended. Work practice procedures include: (1) storing all VOC-containing adhesives, adhesive primers, and process-related waste materials in closed containers; (2) ensuring that mixing and storage containers used for VOC-containing adhesives, adhesive primers, and process-related waste materials are kept closed at all times except when depositing or removing these materials; (3) minimizing spills of VOC-containing adhesives, adhesive primers, and process-related waste materials; and (4) transporting VOC-containing adhesives, adhesive primers, and process-related waste materials from one location to another in closed containers or pipes.

For cleaning materials associated with adhesive application, insufficient information is available to determine a RACT limit. Therefore, the recommended control for cleaning materials is to implement work practice procedures such as: (1) storing all VOC-containing cleaning materials and used shop towels in closed containers; (2) ensuring that storage containers used for VOC-containing cleaning materials are kept closed at all times except when depositing or removing these materials; (3) minimizing spills of VOC-containing cleaning materials; (4) transporting VOC-containing cleaning materials from one location to another in closed containers or pipes; and (5) minimizing VOC emissions from cleaning of application, storage, mixing, and conveying equipment by ensuring that equipment cleaning is performed without atomizing the cleaning solvent and that all spent solvent is captured in closed containers.

The CTG recommends that the VOC emission limits and 85 percent control efficiency not be applied to the following types of adhesives and adhesive primer application processes:

- Adhesives or adhesive primers being tested or evaluated in any research and development, quality assurance, or analytical laboratory;
- Adhesives or adhesive primers used in the assembly, repair, or manufacture of aerospace or undersea-based weapon systems;
- Adhesives or adhesive primers used in medical equipment manufacturing operations;
- Cyanoacrylate adhesive application processes;
- Aerosol adhesive and aerosol adhesive primer application processes. Aerosol adhesives are regulated under EPA's VOC Emission Standards for Consumer Products at 40 CFR 59 subpart C and aerosol adhesive primers are regulated under EPA's VOC Emission Standards for Aerosol Coatings at 40 CFR 59 subpart E;
- Processes using polyester bonding putties to assemble fiberglass parts at fiberglass boat manufacturing facilities and at other reinforced plastic composite manufacturing facilities; and
- Processes using adhesives and adhesive primers that are supplied to the manufacturer in containers with a net volume of 16 ounces or less, or a net weight of one pound or less.

However, VOC emissions from the above listed adhesive types and adhesive primer application processes should be included when determining whether a facility's VOC emissions are above the applicability threshold of 15 ppd.

2. Industrial Cleaning Solvents

Industrial cleaning solvents include a variety of products that are used to remove contaminants such as adhesives, inks, paint, dirt, soil, oil, and grease. Contaminants are removed from parts, products, tools, machinery, equipment, vessels, floors, walls, and other work production related work areas for a variety of reasons including safety, operability, and to avoid product contamination. The cleaning solvents used in these unit operations are, in many cases, generally available bulk solvents that are used for a multitude of applications not limited to cleaning. For example, petroleum distillates may be used as a cleaning solvent, as a paint thinner, or as an ingredient used in the manufacture of a coating, such as paint. The cleaning activities include actions such as wiping, flushing, or spraying. Because a portion of all solvents evaporate during use, such solvent-based cleaning has the potential to result in large amounts of VOC emissions.

Based on a 1994 EPA study of industrial cleaning solvents that characterized cleaning operations carried out within six focus industries to evaluate sources of evaporative emissions from VOC solvents used as cleaning materials, there are generally nine types of cleaning unit operations (UOs; EPA, 2006). These UOs are listed below:

- Spray Gun Cleaning;
- Spray Booth Cleaning;
- Large Manufactured Components Cleaning;
- Parts Cleaning;
- Equipment Cleaning;
- Line Cleaning;
- Floor Cleaning;

- Tank Cleaning; and
- Small Manufactured Components Cleaning.

For facilities where the total VOC emissions from all cleaning unit operations equal or exceed 15 ppd before consideration of controls, a generally applicable VOC content limit of 50 grams VOC per liter of cleaning material is recommended unless emissions are controlled by an emission control system with an overall control efficiency of 85 percent. However, not all facilities using industrial cleaning solvents are subject to the applicability criteria. Product categories recommended for exclusion include those that EPA has listed for regulation under section 183(e) as well as categories of cleaning operations that are specifically excluded from applicability in California's Bay Area Regulation 8 Rule 4 (BAAQMD, 2010). The following categories are recommended for exclusion from applicability:

<u>CAA §183(e)</u>

- Aerospace coatings;
- Wood furniture coatings;
- Shipbuilding and repair coatings;
- Flexible packaging printing materials;
- Lithographic printing materials;
- Letterpress printing materials;
- Flat wood paneling coatings;
- Large appliance coatings;
- Metal furniture coatings;
- Paper film and foil coating;
- Plastic parts coatings;
- Miscellaneous metals parts coatings;
- Fiberglass boat manufacturing materials;
- Miscellaneous industrial adhesives; and
- Auto and light-duty truck assembly coatings.

<u>Bay Area 8-4-116</u>

- Electrical and electronic components;
- Precision optics;
- Numismatic dies;
- Stripping of cured inks, coatings, and adhesives;
- Cleaning of resin, coating, ink, and adhesive mixing, molding, and application equipment;
- Research and development laboratories;
- Medical device or pharmaceutical manufacturing; and
- Performance or quality assurance testing of coatings, inks, or adhesives.

<u>Bay Area 8-4-117</u>

- Architectural coating;
- Metal container, closure, and coil coating;

- Paper, fabric, and film coating;
- Light and medium duty motor vehicle assembly plants;
- Surface coating of metal furniture and large appliances;
- Surface coating of miscellaneous metal parts and products;
- Graphic arts printing and coating operations;
- Coating of flat wood paneling and wood flat stock;
- Magnet wire coating operations;
- Aerospace assembly and component coating operations;
- Semiconductor wafer fabrication operations;
- Surface coating of plastic parts and products;
- Wood products coating;
- Coating, ink, and adhesive manufacturing;
- Flexible and rigid disc manufacturing;
- Marine vessel coating;
- Motor vehicle and mobile equipment coating operations; and
- Polyester resin operations.

In addition to these exclusions, janitorial supplies used for cleaning offices, bathrooms or other similar areas are not covered under the Industrial Cleaning Solvents CTG.

3. Available Controls for VOC Emissions

The predominant control technique used to reduce VOC emissions arising from the use of industrial adhesives and industrial cleaning solvents is the implementation of pollution prevention measures. Such measures include product substitution/reformulation, work practice procedures, and equipment substitution. Product substitution is the replacement of higher-solvent containing formulations with formulations containing little or no solvents. For adhesives, this includes switching to waterborne adhesives, higher solids adhesives, and reactive adhesives. For cleaning solvents, this includes switching to water-based cleaners or VOC exempt cleaners such as acetone or methylene chloride.

Work practice procedures are physical actions intended to affect emission reductions. For example, the reduction of waste generation will lead to a reduction in VOC emissions because less VOC-containing adhesives or cleaning solvents will be needed for production. Adhesive waste may be reduced by effectively controlling material preparation, maximizing the amount of adhesive transferred to the substrate through the use of application methods with higher transfer efficiencies and improved spray technique, and using proper equipment maintenance procedures. Additional work practice procedures are described above in section C.1.

Equipment substitution is only recommended for controlling VOC emissions from adhesive application processes. Conventional air atomized spray application systems utilize high atomizing air pressure with typical transfer efficiencies of 25 to 40 percent. More modern technologies, such as electrostatic and high-volume/low-pressure (HVLP) spray equipment, can achieve much higher transfer efficiencies (65 to 90 percent). The increase in transfer efficiency translates to a decrease in usage of materials containing VOC.

The use of add-on control systems is another control technique; however, add-on control systems tend to be cost-prohibitive and are typically only employed when the use of high-VOC adhesives or cleaning solvents is necessary or desirable for product efficacy. The two categories of add-on controls relevant to controlling VOC emissions from industrial adhesives or cleaning solvents are oxidation (thermal or catalytic) and recovery (adsorption).

Oxidation destroys VOC emissions in an exhaust stream by exposing the stream to an oxidizing atmosphere at high temperatures. Oxidizers may be of thermal or catalytic design and combust VOC-containing exhaust streams. Catalytic oxidizers are similar to thermal oxidizers but employ a catalyst to aid in the oxidation reaction. As a result, catalytic oxidizers operate at lower combustion temperatures relative to that required in thermal oxidizers.

Carbon adsorption is the most popular type of recovery add-on control. Carbon adsorption systems can achieve control device efficiencies greater than 95 percent. In contrast to combustion, carbon adsorption does not destroy the VOC it removes from the air stream. Carbon adsorbers used can be thermally regenerated, usually by passing steam through the carbon beds. The VOC is removed from the carbon (desorbed) and transferred to the steam. The VOC-containing steam is then condensed, and the VOC solvent is separated from the water. The recovered solvent can then be decanted for sale or reuse. Carbon adsorbers are most suitable for solvents that are immiscible with water, such as toluene and xylene, but are not recommended for water-soluble VOC, such as methyl ethyl ketone and methyl isobutyl ketone. In the case where a water-soluble VOC is present, the water vapor will be adsorbed and desorbed along with the VOC vapor, and the VOC may require subsequent purification if it is to be reused.

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CHAPTER II. APPROACH TO DEVELOPING VOC EMISSION ESTIMATES FROM INDUSTRIAL ADHESIVES AND INDUSTRIAL CLEANING SOLVENTS

A. EMISSION ESTIMATION APPROACH

To develop emission estimates for most area VOC sources, two general approaches are considered: a top-down approach and a bottom-up approach. A top-down approach involves gathering information on production, distribution, and adhesive or cleaning solvent end-use patterns, and then building logical relationships between these stages. National emission estimates are made using the solvent production data as a starting point and algorithms are developed from distribution, end-use, and disposal data. The national emission estimates are then distributed to counties, air districts, and the state with the use of an allocation data set, such as census data. Top-down approaches have been used in previous emission estimation efforts for EPA (Pechan, 2010a).

A bottom-up approach involves gathering information directly from solvent users and scaling up the emission estimates using census or other data to a geographic region of interest (e.g., counties, air districts, state). Bottom-up approaches have also been used in previous emission estimation efforts for EPA (Pechan, 2010b).

For this project, TCEQ wanted industrial adhesive and cleaning solvent VOC emissions to be characterized according to adhesive application processes and cleaning unit operations. Information on these processes and operations can only be obtained through a bottom-up approach using end-user surveys. The biggest challenge associated with a bottom-up approach to inventory development is coverage of the entire source category. However, this problem also exists with the top-down approach, since production data are not available for all adhesives and cleaning solvents in use. Since the primary data source in a bottom-up approach is a user survey, the sampling frame needs to be representative of the entire user universe. For ubiquitous source categories, such as industrial adhesives and industrial cleaning solvents, this is a difficult task constrained by limited resources. Despite these limitations, an end-user survey is a necessary component of the project since it is the only means by which to gather process-specific data. Therefore, a bottom-up approach that included a comprehensive end-user survey was selected as the primary data gathering method.

B. END-USER SURVEYS

1. Survey Planning

The first step was to evaluate whether a single user universe could be developed that represents significant users of both industrial adhesives and industrial cleaning solvents. Pechan developed the initial North American Industry Classification System (NAICS) code list for miscellaneous industrial adhesives by querying the 2002 National Emissions Inventory for the six SCCs outlined in the Miscellaneous Industrial Adhesives CTG (i.e., 40200701, 40200706, 40200707, 40200710, 40200711, and 40200712). This list was then narrowed down by removing all NAICS

codes where adhesive emissions are already addressed by CTGs issued for categories listed under CAA Section 183(e) and provided in section I.C.1 of this report.

The initial NAICS list for industrial cleaning solvents was provided in the Industrial Cleaning Solvents CTG. Again, Pechan narrowed this list down by removing all NAICS codes where cleaning solvent emissions are already addressed by CTGs issued for categories listed under CAA Section 183(e). In addition, the list was further narrowed by excluding categories with specific exemptions under California's Bay Area AQMD 8-4-116 and 8-4-117 rules, and provided in section I.C.2 of this report, as recommended in the Industrial Cleaning Solvents CTG. A comparison of the NAICS code list developed for miscellaneous industrial adhesive application with the NAICS codes listed in the Industrial Cleaning Solvents CTG revealed significant overlap. Since there is overlap between facilities that use industrial adhesives and facilities that use industrial cleaning solvents, Pechan concluded that a single user universe could be developed. Therefore, the miscellaneous industrial adhesives NAICS list and the industrial cleaning solvents list were combined and all duplicate NAICS codes removed. This combined list of NAICS codes represents the industry-level user universe that may potentially meet the applicability criteria outlined in the CTGs.

A depiction of this assumed user universe is shown in Table II-1. The user universe is divided into eight industry groups based on NAICS code. Seven of the eight groups (Groups 2-8) make up the manufacturing sector of the universe. The remaining group (Group 1) includes service industries, such as vehicle repair. A listing by group of all NAICS codes, including descriptions, is presented in Appendix A.

Table II-1. Assumed Universe of Industrial Adhesive and Cleaning Solvent End-Users

Group	Primary NAICS	Description
1	22, 23, 42, 44, 48, 49, 81	Non-manufacturing
2	311, 312	Food Manufacturing
3	313, 314, 315, 316	Fabric and Fiber Manufacturing
4	321, 322	Wood and Wood Products
5	332	Fabricated Metals
6	333	Industrial Machinery
7	336	Transportation Equipment
8	323, 324, 325, 326, 327, 331, 334, 335, 337, 339	Other Manufacturing

Since the VOC content limits recommended in the Miscellaneous Industrial Adhesives and Industrial Cleaning Solvents CTGs are based on adhesive application processes or cleaning unit operations, two tables were created. Table II-2 lists the adhesive application processes and the assigned process codes. Table II-3 lists the cleaning unit operations and the assigned operation codes.

Table II-2. Application Processes for Industrial Adhesives

Application Process	Code
General Adhesive Application	
Flexible Vinyl	GA1
Metal	GA2
Porous Material (except wood)	GA3
Reinforced Plastic Composite	GA4
Rubber	GA5
Wood	GA6
Other Substrates	GA7
Specialty Adhesive Application	
Ceramic Tile Installation	SA1
Contact Adhesive	SA2
Cove Base Installation	SA3
Floor Covering Installation (indoor)	SA4
Floor Covering Installation (outdoor)	SA5
Floor Covering Installation (perimeter bonded sheet vinyl)	SA6
Metal to Urethane/Rubber Molding or Casting	SA7
Motor Vehicle Adhesive	SA8
Motor Vehicle Weatherstrip Adhesive	SA9
Multipurpose Construction	SA10
Plastic Solvent Welding (acrylonitrile-butadiene-styrene)	SA11
Plastic Solvent Welding (except acrylonitrile-butadiene-styrene)	SA12
Sheet Rubber Lining Installation	SA13
Single-Ply Roof Membrane Installation/Repair (except EPDM)	SA14
Structural Glazing	SA15
Thin Metal Laminating	SA16
Tire Repair	SA17
Waterproof Resorcinol Glue	SA18
Other Specialty Adhesive Application Process	SA19
Adhesive Primer Application	
Motor Vehicle Glass Bonding Primer	AP1
Plastic Solvent Welding Adhesive Primer	AP2
Single-Ply Roof Membrane Adhesive Primer	AP3
Other Adhesive Primer	AP4

Table II-3. Cleaning Unit Operations

Cleaning Unit Operation	Code
Maintenance	
Equipment Cleaning	EQC
Floor Cleaning	FLC
Line Cleaning	LIC
Parts Cleaning	PAC
Spray Booth Cleaning	SBC
Spray Gun Cleaning	SGC
Tank Cleaning	TAC
Manufacturing	
Large Manufactured Components Cleaning	LMC
Small Manufactured Components Cleaning	SMC

The research team selected a mail-out survey package to gather data since the usage patterns were expected to be diverse for both industrial adhesives and cleaning solvents as well as adhesive application processes and cleaning unit operations. The survey package that the research team developed included: cover letters from TCEQ and Pechan, two pages of instructions, a one page example, two tables (the adhesive application process code table and the cleaning unit operation code table), and two survey forms (one for industrial adhesive uses and one for industrial cleaning solvent uses). An example survey package is presented in Appendix B.

Respondents to the mail-out survey were requested to fill out one form in response to questions about industrial adhesive use and one form in response to questions about industrial cleaning solvent usage. Each record in the forms corresponded to an adhesive application process or industrial cleaning unit operation performed at the facility in 2008. The 2008 base year was selected since it represented the latest calendar year for which a facility was likely to have a full set of usage data.

Control equipment was divided into three categories: thermal, catalytic and absorption. Where applicable, respondents were prompted to write in the type of control being used to reduce VOC emissions. Overall, the survey was designed to be as simple and concise as possible while still providing the minimum amount of data required to estimate VOC emissions and the number of facilities potentially affected by the CTGs.

The initial list of facilities in the DFW, HGB, and SA areas was obtained from Dun and Bradstreet (D&B) based on the NAICS code list described above and excluding any facility location classified as a headquarters. An attempt was made to confirm/supplement this initial list with information from trade associations such as the Automotive Service Association, Federation of Societies for Coatings Technology, National Association for Surface Finishing and service providers like Safety-Kleen, Inc. However, the trade associations were reluctant to provide Pechan with specific information, such as facility name or contact information, for the companies they represent.

Pechan was able to obtain a list of facilities based on NAICS code from the Texas State Comptroller. However, comparison between the Comptroller database and the D&B database proved challenging as there was no unique key between the two databases that would allow comparison based on a data query. Random checks were conducted to test whether facilities in the Comptroller database were listed in the D&B database. While some matches were able to be made, it was difficult to discern whether the non-matches were resulting from human error in trying to manually compare the datasets. Furthermore, the Comptroller database provided to Pechan did not contain employment information, a critical parameter used in creating the sampling frame and in estimating VOC emissions as discussed below.

Pechan queried the 2007 Texas Point Source Emissions Inventory provided by TCEQ using the NAICS and SCCs provided in the CTGs. This yielded similar results to the query performed by the EPA on the 2002 NEI for facilities anticipated to meet the applicability criteria under the Industrial Cleaning Solvents CTG (95 facilities in the 2007 Texas Point Source Emissions Inventory versus 92 facilities in the 2002 NEI). Pechan checked the list of facilities from D&B to

insure that the facilities from the Texas Point Source Emissions Inventory were included. In cases where a facility was not included, the facility was added to the D&B facility list.

A third database, the U.S. Census Bureau's County Business Patterns (CBP), was queried to determine the total number of facilities that may meet the applicability criteria outlined in the CTGs. The CBP database is based on tax records which makes it similar to the Comptroller database. However, unlike the Comptroller database, the CBP has employment data. Using the same query criteria, the CBP database contained significantly fewer facilities than the D&B database (17,675 facilities versus 22,087). However, it was reasoned that a database built around tax records is likely to include a single entry for an entire company as opposed to an entry for all facilities that a company owns. Based on these comparisons and overall qualitative assessments, it was the conclusion of the research team that the D&B database supplemented with facilities from the Texas Point Source Emissions Inventory offers the most representative user universe.

Since solvent usage patterns may be influenced by geographic area (i.e., federal ozone attainment status) and facility size (e.g., differences between a small "mom and pop" plating shop versus a large modern facility), the sampling frame from D&B was stratified by industry group, region, and whether the facility is classified as a small business or large business under Texas law. Facilities with fewer than 100 employees or less than $6 million in annual revenue are defined as small businesses under Texas Government Code §2006.001. Facilities with fewer than five employees are unlikely to emit at least 15 ppd and were therefore excluded from the user universe. Table II-4 provides the sampling frame that was used for the mail-out survey. From the D&B database, the sampling frame consists of about 22,000 Texas facilities.

Table II-4. Sample Frame

Group	Number of Facilities by Region/Business Size						Total
	DFW		HGB		SA		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing	5,123	193	4,965	175	1,621	42	**12,119**
(2) Food Manufacturing	247	37	155	23	64	17	**543**
(3) Fabric and Fiber Manufacturing	238	2	150	3	44	3	**440**
(4) Wood and Wood Products	240	30	159	7	58	2	**496**
(5) Fabricated Metals	678	41	933	57	111	6	**1,826**
(6) Industrial Machinery	416	32	634	37	91	6	**1,216**
(7) Transportation Equipment	135	14	137	6	19	7	**318**
(8) Other Manufacturing	2,384	185	1,950	152	428	30	**5,129**
Total	**9,461**	**534**	**9,083**	**460**	**2,436**	**113**	**22,087**

Due to budget constraints, sampling the entire user universe is not an option. Therefore, a subset of the user universe must be sampled to arrive at a reasonable approximation of total VOC emissions and the potential total financial impact of the CTG recommended control strategies. The sample size was determined by first calculating the minimum sample size required. Since there are no pre-existing data on the variability of solvent or adhesive use, a calculation for proportional sampling was used. Because some proportions, such as the proportion of users employing a specific application process, are to be estimated from the survey data, this is not an unreasonable sample size calculation method. Also, this method generally computes sample sizes larger than a method incorporating a known variance, unless the variance is very large. The formula assumes a variance of 0.25 and uses a 90 percent confidence level with a given precision. To calculate a sample size (η), Equation II-1 was used:

Equation II-1

$$\eta = \frac{(\sigma z^2)}{e^2}$$

where the variance (σ) is equal to p(l-p) and p=0.5 (i.e., a 50 percent probability of a yes or no answer). The confidence level (z) is the value 1.645 and e is the predetermined level of precision for the estimated proportion. Since the user universe is known for each group (N), the sample size was further refined using Equation II-2:

Equation II-2

$$\eta_{adj} = \frac{\eta}{1+(\eta-1)/N}$$

Table II-5 shows the derivation of the minimum sample size. The minimum sample was designed to achieve a 15 percent within cell precision and an 8 to 11 percent precision at the group level. The total minimum sample size required for the DFW and HGB areas is 684 (achieving an overall 3 percent level of precision). San Antonio was not included in the group or total precision calculations since the results from the SA surveys will not be included in the final analysis.

The required sample size of nearly 3,800 reported in Table II-6 was derived by assuming a 20 percent response rate to the survey.

After determining the number of facilities to survey, facilities were selected at random from the user universe. The facilities for each sampling group were then checked for any inconsistencies or inaccuracies, such as multiple facilities occurring at the same location, facilities listed more than once, and missing facility data. In all cases, inconsistencies were able to be resolved via telephone conversations with personnel at the facilities or by assuming that the facility was no longer in business if the telephone number was out of service.

Table II-5. Minimum Sample Size

Group	Number of Facilities by Region/Business Size						Total for DFW and HGB	Precision for DFW and HGB
	DFW		HGB		SA			
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	Small Businesses	Large Businesses		
(1) Non-manufacturing	30	26	30	26	30	18	**112**	**0.08**
(2) Food Manufacturing	27	17	25	13	21	11	**82**	**0.09**
(3) Fabric and Fiber Manufacturing	27	2	25	3	18	3	**57**	**0.11**
(4) Wood and Wood Products	27	15	25	6	20	2	**73**	**0.10**
(5) Fabricated Metals	29	18	29	20	24	5	**95**	**0.08**
(6) Industrial Machinery	28	16	29	17	23	5	**89**	**0.09**
(7) Transportation Equipment	25	10	25	5	12	6	**64**	**0.10**
(8) Other Manufacturing	30	26	30	25	28	15	**111**	**0.08**
Total	**222**	**129**	**218**	**115**			**684**	**0.03**
Precision	**0.06**	**0.07**	**0.06**	**0.08**				

Table II-6. Number of Surveys Based on Response Rate

Group	Number of Facilities by Region/Business Size						Total
	DFW		HGB		SA		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing	149	131	149	129	148	42	**748**
(2) Food Manufacturing	135	37	127	23	64	17	**403**
(3) Fabric and Fiber Manufacturing	134	2	126	3	44	3	**312**
(4) Wood and Wood Products	134	30	127	7	58	2	**358**
(5) Fabricated Metals	144	41	146	57	111	6	**505**
(6) Industrial Machinery	141	32	144	37	91	6	**451**
(7) Transportation Equipment	124	14	124	6	19	7	**294**
(8) Other Manufacturing	149	130	148	126	141	30	**724**
Total	**1,110**	**417**	**1,091**	**388**	**676**	**113**	**3,795**

2. Survey Execution

Prior to mailing the surveys, an automated telephone call with a pre-recorded message was placed to each facility explaining that they would be receiving a survey from Pechan. Of the calls placed, 89 percent successfully reached a person or answering machine. Survey packages were mailed within three days of placing the automated call. Approximately four weeks after the mailing, a follow-up automated telephone call was placed to all facilities for which a completed survey had not been received. The follow-up call reminded facilities to complete and return their surveys. A total of 2,923 reminder calls were attempted (77 percent of the surveyed facilities) and reminders successfully left for 91 percent of these.

The research team operated both email and telephone hot-lines during the course of the survey (March through June of 2010) to answer questions and assist respondents in completing their survey forms. Questions received via these hotlines mainly pertained to incorrect default information (NAICS code, employment, or revenue) and to the need to perform the survey. In the cases of incorrect default information, respondents were instructed to strike through the default information and write in the correct information. For respondents questioning the need to perform the survey, background information was provided and it was explained that their responses to the survey were necessary to achieve the study goals.

After about half of the targeted responses had been received, the research team analyzed the responses to make sure that certain industry groups, geographic areas, or business sizes would not be underrepresented in the final results. The analysis showed that the response rate of large businesses was lagging behind the response rate of small businesses. Without adjustment to the survey collection effort, the data for large businesses would have been relatively dilute compared to small businesses. Consequently, a call-back procedure to place more emphasis on large businesses was implemented to try to obtain a higher percentage of responses. The call-back procedure involved placing calls to all large businesses in Groups 2 through 7 in the DFW and HGB areas. The call-back procedure did not include businesses in SA, since SA is not included in the final analysis of this report. The results of the adaptation to the survey procedure were mixed. The percentage of total responses from large businesses for Groups 2, 5, 6, and 7 increased more than that from groups 2 and 4. In reviewing the final valid responses, Groups 2, 3 and 7 are least represented with each group representing roughly 8.5 percent of the total responses (see Table II-7). Group 8 is the most represented.

A total of 785 survey responses were received. Of these, 728 were considered acceptable responses after all quality assurance checks had been performed. Hence, the overall acceptable response rate was 19.2 percent (728/3,795). Of the 728 acceptable responses, 382 indicated no industrial adhesive or industrial cleaning solvent use, while 184 indicated industrial adhesive usage for at least one adhesive application process and 292 indicated industrial cleaning solvent usage for at least one cleaning unit operation.

Table II-7. Survey Responses by Industry Group

Group Number	Responses[1]	Response Rate (percentage)	Percentage of Total Responses
(1) Non-manufacturing	115	16.1	15.8
(2) Food Manufacturing	65	17.3	8.9
(3) Fabric and Fiber Manufacturing	62	21.4	8.5
(4) Wood and Wood Products	86	25.6	11.8
(5) Fabricated Metals	115	23.6	15.8
(6) Industrial Machinery	74	17.3	10.2
(7) Transportation Equipment	59	21.7	8.1
(8) Other Manufacturing	152	21.9	20.9
All Groups	**728**	**20.2**	

[1]Final number of valid responses following quality assurance checks.

3. Quality Assurance/Quality Control

At the beginning of the project, Pechan prepared a quality assurance project plan (QAPP). Appendix C of this report explains how Pechan implemented the technical requirements of the QAPP.

Quality assurance efforts for the mail-out survey included checking for missing or technically invalid data once completed surveys were received. In cases where corrections or additional data were needed, the facility was re-contacted by telephone. Typical data validations and corrections are listed below:

- Verification of facility NAICS code;
- Gathering of missing usage data, process and operation codes, or MSDSs;
- Correction of invalid adhesive application process codes or cleaning unit operation codes;
- Validation of the absence of an exhaust control if the reported usage resulted in excessively high VOC emissions; and
- Clarification on whether cleaning solvent usage was associated with adhesive application processes.

All data reported on returned surveys was entered into a Microsoft (MS) Access database and visual rechecks of 25 percent of the data were conducted to check for and correct data entry errors. The database was also systematically checked by each field for technically invalid entries. This search revealed, for example, that several cleaning operation codes were reported in the

adhesive usage section of the database and vice versa. These records were subsequently transferred to the correct section of the database.

Throughout the data gathering phase, an attempt was made to exclude all adhesive or cleaning materials that the CTGs do not recommend controlling. For example, some facilities reported inorganic cleaning solutions such as sodium hydroxide. Any aerosol or cyanoacrylate adhesives reported were flagged since these materials are not recommended for regulation as discussed in section I.C.1 of this report.

CHAPTER III. DEVELOPMENT OF THE EMISSION MODEL

Developing 2008 VOC emission estimates from the usage of industrial adhesives and industrial cleaning solvents required: (1) quality assurance of survey responses; (2) statistical analyses; (3) selection of an emissions allocation method; and (4) allocation of emissions to counties. These efforts are discussed in this chapter and the 2008 VOC emission estimates for both industrial adhesive usage and industrial cleaning solvent usage by facilities in DFW and HGB are presented.

A. DISTRIBUTION OF RESPONDING FACILITIES

As discussed earlier in section II.B, a mail-out survey was used to gather data on industrial adhesive and industrial cleaning solvent usage. Valid survey forms were received from 728 facilities. Table III-1 shows the distribution of these responding facilities across the survey strata – group, region, and business size (small businesses are defined as 5-99 employees or <$6 million in revenue and large businesses are defined as >99 employees and ≥$6 million in revenue).

Table III-1. Number of Surveys Returned that Contain Valid Responses

Group	Number of Facilities by Region/Business Size						Total for DFW and HGB	Total for All Areas
	DFW		HGB		SA			
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	Small Businesses	Large Businesses		
(1) Non-manufacturing	25	15	24	21	25	5	**85**	**115**
(2) Food Manufacturing	22	8	16	7	10	2	**53**	**65**
(3) Fabric and Fiber Manufacturing	28	0	20	2	12	0	**50**	**62**
(4) Wood and Wood Products	37	9	26	1	12	1	**73**	**86**
(5) Fabricated Metals	35	11	25	19	25	0	**90**	**115**
(6) Industrial Machinery	22	7	21	12	11	1	**62**	**74**
(7) Transportation Equipment	29	6	13	2	6	3	**50**	**59**
(8) Other Manufacturing	30	37	28	30	22	5	**125**	**152**
Total	**228**	**93**	**173**	**94**	**123**	**17**	**588**	**728**

As expected, based on the sample frame, the bulk of responding facilities were small businesses, with Groups 1, 5, and 8 have the highest number of responses. There are relatively few large facilities in SA, reflecting the fact that SA is a less populated area with a smaller industrial base. The responses from SA are included in the above table for informational purposes only. The development of the emission model and determination of VOC emissions are based only on the responses from the DFW and HGB areas.

Detailed quality assurance procedures were used to arrive at the final 728 facility responses and to verify the accuracy of the submitted data. In total, 785 facilities responded to the survey; however, 57 were considered invalid for one of the following reasons:

- Facility refused to provide or could not provide necessary data;
- Facility's actual NAICS code was outside the codes included in the user universe;
- Facility was not in business in 2008; and
- Response arrived too late for inclusion in the data analysis.

As discussed in section II.B.1 above, the survey had facilities select among 30 adhesive application processes and nine cleaning unit operations to characterize their industrial adhesive and industrial cleaning solvent usage. Adhesive process code SA19 (Other Specialty Adhesive Application Process) was included to provide consistency in the range of choices for respondents. However, any adhesive application process not defined in codes SA1 through SA18 is considered a general adhesive application process under the CTG. Therefore, all SA19 codes were reassigned to GA7 (General Adhesive Application – Other Substrates) and the SA19 group was eliminated. Of the remaining 29 adhesive application processes, facilities in DFW and HGB reported usage in 26. There was no adhesive usage reported for thin metal laminating, for waterproof resorcinol glue, or single-ply roof membrane adhesive primer. Metal and other substrates dominated the general adhesive application process responses, while contact adhesive dominated the specialty adhesive application process responses. Table III-2 provides the number of records reported by adhesive application process.

Table III-2. Number of Adhesive Application Process Records Reported by Facilities in DFW and HGB

Process Code	Process Description	Number of Records
	General Adhesive Application	
GA1	Flexible Vinyl	11
GA2	Metal	32
GA3	Porous Material (except wood)	16
GA4	Reinforced Plastic Composite	6
GA5	Rubber	7
GA6	Wood	17
GA7	Other Substrates	35
	Specialty Adhesive Application	
SA1	Ceramic Tile Installation	1
SA2	Contact Adhesive	35
SA3	Cove Base Installation	1
SA4	Floor Covering Installation (indoor)	4
SA5	Floor Covering Installation (outdoor)	1
SA6	Floor Covering Installation (perimeter bonded sheet vinyl)	1
SA7	Metal to Urethane/Rubber Molding or Casting	2
SA8	Motor Vehicle Adhesive	12
SA9	Motor Vehicle Weatherstrip Adhesive	7
SA10	Multipurpose Construction	8
SA11	Plastic Solvent Welding (acrylonitrile-butadiene-styrene)	4

Process Code	Process Description	Number of Records
SA12	Plastic Solvent Welding (except acrylonitrile-butadiene-styrene)	4
SA13	Sheet Rubber Lining Installation	3
SA14	Single-Ply Roof Membrane Installation/Repair (except EPDM)	2
SA15	Structural Glazing	1
SA16	Thin Metal Laminating	0
SA17	Tire Repair	5
SA18	Waterproof Resorcinol Glue	0
Adhesive Primer Application		
AP1	Motor Vehicle Glass Bonding Primer	5
AP2	Plastic Solvent Welding Adhesive Primer	7
AP3	Single-Ply Roof Membrane Adhesive Primer	0
AP4	Other Adhesive Primer	13

For industrial cleaning solvents, facilities in DFW and HGB reported usage in all nine cleaning unit operations. Maintenance was dominated by parts cleaning and equipment cleaning, while manufacturing was dominated by small manufactured components cleaning. Table III-3 provides the number of records reported by cleaning unit operation.

Table III-3. Number of Cleaning Unit Operation Records Reported by Facilities in DFW and HGB

Operation Code	Operation Description	Number of Records
Maintenance		
EQC	Equipment Cleaning	62
FLC	Floor Cleaning	17
LIC	Line Cleaning	5
PAC	Parts Cleaning	149
SBC	Spray Booth Cleaning	2
SGC	Spray Gun Cleaning	33
TAC	Tank Cleaning	2
Manufacturing		
LMC	Large Manufactured Components Cleaning	17
SMC	Small Manufactured Components Cleaning	48

When reviewing survey responses, the following items were flagged:

- Incorrect records, such as inorganic cleaners;
- Missing VOC contents; and
- Adhesives and adhesives primer application processes recommended for exclusion from regulation, but inclusion in determination of applicability as discussed in section I.C.1 of this report.

Any incorrect records were excluded from the data analysis. For records with missing VOC contents, the VOC content was obtained from MSDSs returned with the surveys or from MSDSs

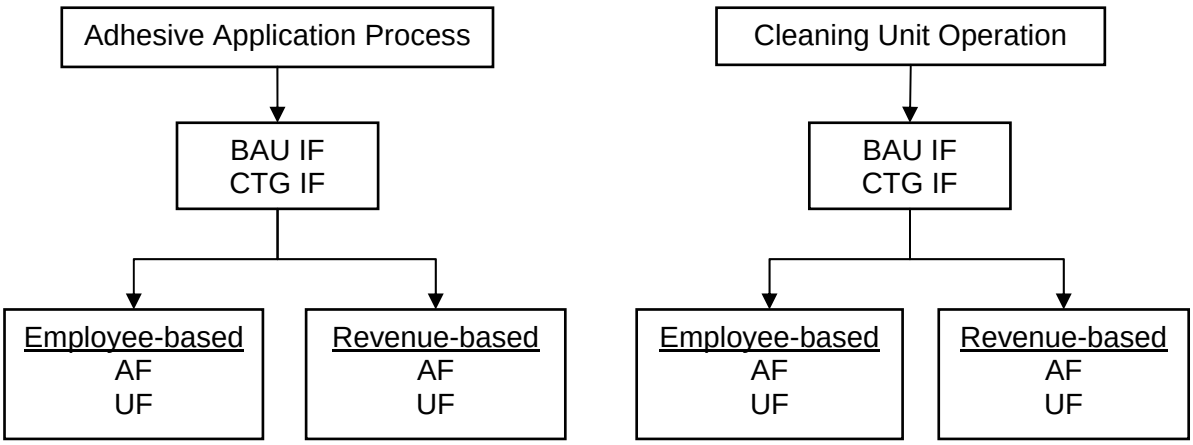
acquired by the research team through internet searches using the material name and manufacturer. Furthermore, for any facility where adding the estimated VOC emissions from industrial cleaning solvents to the estimated VOC emissions from industrial adhesives resulted in the facility's total emissions exceeding 15 ppd, the facility was contacted to determine whether reported cleaning solvent use was associated with adhesive application processes (e.g., using cleaning solvents to prepare a surface before adhesive application or using cleaning solvents to remove adhesive residues). If a facility indicated that industrial cleaning solvent use was associated with adhesive application processes, then the cleaning solvent records associated with adhesive application processes were flagged for inclusion in determining applicability under the industrial adhesive CTG.

B. EMISSION MODEL DEVELOPMENT

The first step in preparing the data for emission model development was to convert all adhesive and cleaning solvent volumes to gallons, and VOC contents to pounds per gallon. The next step was the calculation of the key variables for each adhesive application code and cleaning unit operation. These variables include activity factors (AF), business as usual impact factors (BAU IF), control techniques guidelines impact factors that reflect the emissions reductions associated with implementing the recommendations in the CTGs (CTG IF), and user fractions (UF).

In the survey, default information from D&B on a facility's annual revenue and number of employees was included and facilities were asked to correct the default information, if necessary. Therefore, an AF can be calculated using either annual revenue or employees. As will be discussed later, the two versions of the AF were compared to determine the best emissions allocation method. In total, six different key variables were calculated for each adhesive application process and each cleaning unit operation. Figure III-1 provides a schematic of the key variables.

Figure III-1. Schematic of Key Variables in the Emission Model



For the sake of simplicity in illustrating the calculation of key variables, the discussion and equations presented will focus on the employee-based allocation method and BAU IF for adhesives. The calculations for the other variables follow the same logic.

The AF is the gallons of adhesives, including water and exempt solvents, used per employee per year (or per $million revenue per year). It is calculated with the use of Equation III-1:

Equation III-1

$$AF = \frac{\textit{annual gal adhesive used}}{\textit{number of employees}}$$

The numerator of the AF equation represents the net gallons of solvent used, including water and exempt solvents, in the adhesive application process. It was assumed that there were no disposed or recycled fractions, meaning that 100 percent of the VOCs were assumed to be emitted during the application process. Annual gallons of solvent used in 2008 were taken directly from the survey responses.

The second key variable to be calculated for each record, BAU IF, is the pounds of VOC emissions per gallon of adhesive used, including water and exempt solvents. The BAU IF is calculated with the use of Equation III-2:

Equation III-2

$$\textit{BAU IF} = \textit{VOC content} \times [1-(\textit{collection efficiency} \times \textit{control efficiency})]$$

where: VOC content = lb VOC/gal adhesive

VOC contents were obtained from survey response forms or attached MSDSs. In some cases, VOC contents could not be determined based on attached MSDSs. For these cases, VOC contents from MSDSs for similar products were used.

A few facilities employed exhaust controls for their adhesive application processes. Of all facilities, five included thermal incinerators and two included carbon adsorption. For all records with an exhaust control, an overall control effectiveness (i.e., collection efficiency × control efficiency) of 85 percent (0.85) was assumed in Equation III-2, equal to the overall control effectiveness recommended in the CTG. (For cleaning unit operations, six facilities included thermal incinerators and two included carbon adsorption. The same overall control effectiveness was also assumed for controls on cleaning unit operations.)

Emissions estimates calculated using actual facility-level data reported in survey responses, as discussed in section III.E below, were used to determine whether a facility meets the applicability criteria of emitting 15 ppd of VOC. In the CTGs, the EPA notes that the VOC content limits recommended for adhesives and solvents used at facilities exceeding 15 ppd of VOC emissions are comparable to applying a control device with an overall effectiveness of 85 percent. Since insufficient data were available to determine the VOC content minus water and exempt solvents (the basis for the recommended VOC content limits) for materials currently

being used, the research team developed CTG IFs by applying an overall control effectiveness of 85 percent to all uncontrolled processes at facilities determined to meet the applicability criteria.

Because AF is based only on the employees at facilities which use that particular adhesive application process, but emissions allocations will be made based on user and non-user employees, UF is needed to appropriately scale the data. With no prior user universe data by adhesive application process available, the best UFs are obtained from the survey data itself. UF can be in terms of employees or revenue, but must always match the data type used to develop AF. AF could have been developed using all survey responses (including non-users) which would have precluded the need for UF. However, in this case, the AF data would have been significantly skewed (negative) making statistical manipulations more difficult.

With AF, BAU IF, and CTG IF for each record calculated, the development of the emission model for the adhesive usage category was begun. For each record, Equation III-3 was used to calculate annual VOC emissions per employee:

Equation III-3

$$AF \times IF \times UF = lb\ VOC/employee$$

where:

AF	=	gal adhesive used/employee-year
IF	=	BAU IF or CTG IF (lb VOC/gal adhesive used)
UF	=	adhesive application process user employees/survey employees

The emission model consists of tables, one for each of the adhesive application processes. Developing an emission model table for an adhesive application process required calculation of the most appropriate mean AF and IF values, and using the appropriate UF scaling. The procedure is best explained through two examples, an adhesive application process requiring simple analyses and a more complex cleaning unit operation involving tests of significant differences between mean AFs among the survey strata. Each case is based on employees, rather than revenue.

Example 1: Simple Case – Adhesive usage for bonding flexible vinyl (code GA1) included 11 records. Distribution of these records across groups, regions, and facility size classes is presented in Table III-4. With no survey responses in Group 2, it was assumed that there is no usage of adhesives for bonding flexible vinyl in those industries and no emissions were developed for them. However, it was assumed that usage occurs in HGB despite the lack of responses for many groups. This was done because the distribution of business types between DFW and HGB are likely similar. The shaded area in Table III-4 represents the cells across which AF, IF, and UF were developed and emissions were allocated.

Table III-4. Survey Responses for Adhesive Application Process Code GA1 – Bonding Flexible Vinyl

Group	Number of Facilities by Region/Business Size				Total
	DFW		HGB		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing	1	0	0	0	**1**
(2) Food Manufacturing	0	0	0	0	**0**
(3) Fabric and Fiber Manufacturing	2	0	1	0	**3**
(4) Wood and Wood Products	0	1	0	0	**1**
(5) Fabricated Metals	0	1	0	0	**1**
(6) Industrial Machinery	1	1	0	0	**2**
(7) Transportation Equipment	1	0	0	0	**1**
(8) Other Manufacturing	1	0	0	1	**2**
Total	**6**	**3**	**1**	**1**	**11**

It is important to remember that the survey was stratified by group, region, and business size. Therefore, AF and IF values within each cell must be weighted to account for differences between the group of respondents and the sample frame. In this example, prior to averaging AF or IF across the shaded group of cells, the cell's sample weight, w_i, was applied to each response in cell i. The derivation of w_i is shown in Equation III-4:

Equation III-4

$$w_i = \frac{\dfrac{(\text{number of facilities within cell } i \text{ of sample frame})}{(\text{number of facilities within Groups 1,3-8 of sample frame})}}{\dfrac{(\text{number of facility records within cell } i \text{ of flexible vinyl responses})}{(\text{number of facility records within Groups 1,3-8 of flexible vinyl responses})}}$$

Cell weighting factors act as frequencies, forcing all responses to be in the same proportions as in the sample frame. A weighted mean AF was calculated by Equation III-5 for all of the combined cells:

Equation III-5

$$\text{Mean } AF = \frac{\Sigma(w \times AF)}{\eta}$$

where:

$$\eta = \Sigma w$$

Mean IFs were calculated in the same manner. Table III-5 below shows the sample frame facility data presented in Table II-4 above adjusted for exclusions and corrected NAICS. These facility data are used for weighting factor calculations. As discussed in section II.B.1, the facility data

were obtained from D&B. In this example of using adhesive to bond flexible vinyl, the weighting factor for the two records in cell Group 3/DFW/small businesses is shown here: w = (223/18,937)/(2/11) = 0.065.

Table III-5. Corrected Sample Frame Used for Weighting Factor Calculations

Group	Number of Facilities by Region/Business Size				Total
	DFW		HGB		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing	5,119	183	4,961	169	**10,432**
(2) Food Manufacturing	236	33	147	24	**440**
(3) Fabric and Fiber Manufacturing	223	2	145	3	**373**
(4) Wood and Wood Products	236	28	146	6	**416**
(5) Fabricated Metals	673	35	931	56	**1,695**
(6) Industrial Machinery	408	30	627	37	**1,102**
(7) Transportation Equipment	122	12	126	7	**267**
(8) Other Manufacturing	2,381	181	1,939	151	**4,652**
Total	**9,398**	**504**	**9,022**	**453**	**19,377**

If this adhesive application process contained enough records, a test for significant differences between mean AFs among strata would be performed to see if different mean AF values should be used in the emission model for different groups/business sizes. A nominal minimum of 20 records per strata (e.g., group) was selected to justify this more complex statistical analysis. As seen earlier in Table III-4, the flexible vinyl adhesive application process contained no more than three records in any one group, the first level of stratification. Therefore, for this adhesive application process, single overall AF and IF means were calculated across all strata in Groups 1 and 3-8 using Equation III-5. The results were as follows:

Mean AF = 1.22 gal adhesive used/employee-year
Mean IF = 5.07 lb VOC/gal solvent

UF was derived by dividing the total employees in facilities with records in this adhesive application process by the total employees in all Groups 1 and 3-8 facilities which responded to the survey. This yielded a value of 0.02, meaning an estimated 2 percent of Groups 1 and 3-8 employees work at facilities which use adhesives to bond flexible vinyl. The completed emission model table for this adhesive application process is shown in Table III-6. In this case, the same mean AF, mean IF, and UF were applied across all strata to which emissions will be allocated. The mean AF times mean IF times UF product can simply be multiplied by a county's total Groups 1 and 3-8 employment to yield the estimated mass of VOC emissions from this adhesive application process.

Table III-6. Example 1: Emission Model Table

Group		Region/Business Size			
		DFW		HGB	
		Small Businesses	Large Businesses	Small Businesses	Large Businesses
(1) Non-manufacturing	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(2) Food Manufacturing					
(3) Fabric and Fiber Manufacturing	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(4) Wood and Wood Products	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(5) Fabricated Metals	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(6) Industrial Machinery	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(7) Transportation Equipment	**AF**	1.22			
	IF	5.07			
	UF	0.02			
(8) Other Manufacturing	**AF**	1.22			
	IF	5.07			
	UF	0.02			

Notes: AF = activity factor in gallons solvent used/employee-year
IF = impact factor in lb VOC/gallon of adhesive
UF = user fraction (user total employees/total Groups 1 and 3-8 survey employees)

Example 2: Complex Case - The equipment cleaning unit operation (code EQC) contained 62 records distributed across cells as shown in Table III-7. The entire grid is shaded, indicating that usage was assumed and emissions were allocated across all strata. Group 8 contained more than 20 records, justifying a statistical comparison of mean AFs between Group 8 and the other groups.

Table III-7. Equipment Cleaning Unit Operation

Group	Number of Facilities by Region/Business Size				Total
	DFW		HGB		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing	0	2	2	3	**7**
(2) Food Manufacturing	3	2	0	2	**7**
(3) Fabric and Fiber Manufacturing	1	0	0	0	**1**
(4) Wood and Wood Products	5	1	0	0	**6**
(5) Fabricated Metals	3	0	0	5	**8**
(6) Industrial Machinery	0	2	1	1	**4**
(7) Transportation Equipment	3	0	0	0	**3**
(8) Other Manufacturing	2	15	2	7	**26**
Total	**17**	**22**	**5**	**18**	**62**

Mean AFs were calculated according to Equation III-5. The weighting factor was always based on the cells/strata over which the mean was being calculated. For example, in the mean AF for Group 8, the weighting factors were obtained from Equation III-6:

Equation III-6

$$w_i = \frac{\dfrac{\textit{(number of facilities within cell i of Group 8 of sample frame)}}{\textit{(number of facilities within Group 8 of sample frame)}}}{\dfrac{\textit{(number of facility records within cell i of Group 8 of EQC)}}{\textit{(number of facility records within Group 8 of EQC)}}}$$

Once calculated, the mean AFs were examined for significant differences using their variability data. The standard deviations, s, were obtained using Equation III-7 (Burington and May, 1970):

Equation III-7

$$s = \sqrt{\frac{\sum (\mathrm{w} \times (\mathrm{AF} - \text{mean AF})^2)}{\sum \mathrm{w}}}$$

Approximate 95 percent confidence intervals for the mean AFs were then determined using Equation III-8 (Hoel, 1960):

Equation III-8

$$95\%\ \text{Confidence Interval} = \text{Mean AF} \pm 2 \times \frac{s}{\sqrt{\sum w}}$$

A comparison of the mean AFs in Table III-8 revealed a high degree of overlap for the Group 1-7 and Group 8 confidence intervals. Because their mean AFs were not significantly different from each other, Groups 1-7 and Group 8 data were now grouped.

Table III-8. Comparison of Mean AFs

Group(s)	Number of Records	Mean AF (gal/employee-yr)	95% Confidence Interval of Mean AF
1-7	36	3.5	0.0 to 15.7
8	26	8.0	0.0 to 44.4

Note: 95% confidence intervals calculated using Equation III-8.

If significantly different mean AFs were established at the group level, a test for mean AF differences between business sizes within a group would be performed if enough data were available. For all adhesive application processes and cleaning unit operations with enough data, this same general procedure was used to determine the most appropriate emission model variables. Of the 29 adhesive application processes, none had enough responses in any one group to justify the more complex statistical analysis. Of the nine cleaning unit operations, two had enough responses in any one group to justify the more complex statistical analysis. However, neither of these was resolved to the group or business size level because of significant AF differences. Therefore, for all adhesive application processes and cleaning unit operations, emission models were developed like the simple case (Example 1) discussed earlier.

The emission model tables are presented in Table III-9, Table III-10, Table III-11, and Table III-12. These tables include the mean AF, mean BAU IF, mean CTG IF, and UF variables used to estimate emissions from industrial adhesives or industrial cleaning solvents. For each adhesive application process and cleaning unit operation, the mean AF is the average adhesive or cleaning solvent used per employee or per million dollars of revenue derived from the survey responses that is used to estimate usage for all facilities in the sample frame (i.e. user universe). The mean BAU IF is the average VOC emissions per gallon of adhesive or cleaning solvent used and only takes into account control measures that are currently in place. The CTG IF is the average VOC emissions per gallon of adhesive or cleaning solvent used, taking into account the additional control measures implemented in accordance with the recommendations in the CTGs. The UF is simply the fraction of facilities responding to the survey that indicated usage for a given application process or cleaning unit operation. The UF corrects for facilities in the sample frame that do not use adhesives or cleaning solvents for a given application process or cleaning unit operation.

If the mean AF is less than 0.005 gallons per employee, then the mean AF is rounded down and reported as zero in the tables. This explains why in some cases, such as adhesive application process SA5, the mean AF is zero, but the mean IF is greater than zero. In other cases, such as cleaning unit operation SBC, the mean AF is greater than zero, but the mean IF is zero. This indicates that the materials being used are low-/no-VOC.

Also, these tables include the standard deviations (s) and coefficients of variance (CV) for the mean AFs, mean BAU IFs, and mean CTG IFs. The standard deviation is an indication of the variability in the data provided in the survey responses. A high standard deviation is an indication that the data are spread out over a wide range of values. The CV is the normalized measure of the variability in the data provided in the survey responses. The CV value is used to compare the relative spread of data between application processes or cleaning unit operations. For example, an adhesive application process with a CV of four has a higher variability than an adhesive application process with a CV of two. As discussed in section IV.G of this report, a higher degree of variability leads to a higher degree of uncertainty in the estimated emissions from a given application process or cleaning unit operation.

Table III-9. Industrial Adhesive Usage: Summary of Employee-Based Emission Model Variables and Statistics

Application Process Code	Allocation To:			Emission Model Variables[1]										
					AF (gal/emp)			BAU IF (lb VOC/gal)[2]			CTG IF (lb VOC/gal)[3]			
	Group	Region	Business Size	n	Mean	s	CV	Mean	s	CV	Mean	s	CV	UF
AP1	1,7	All	All	5	0.03	0.54	21.44	4.48	0.81	0.18	4.48	0.81	0.18	0.12
AP2	1,2,4,8	All	All	7	2.04	16.82	8.26	4.31	1.21	0.28	4.21	1.34	0.32	0.05
AP4	1,2,5-8	All	All	13	0.35	1.50	4.24	5.19	1.66	0.32	5.17	1.69	0.33	0.04
GA1	1,3-8	All	All	11	1.22	3.64	2.99	5.07	1.56	0.31	5.06	1.58	0.31	0.02
GA2	1,5-8	All	All	32	1.00	3.93	3.95	1.82	1.23	0.68	1.82	1.23	0.68	0.12
GA3	2-4,7,8	All	All	16	5.61	28.41	5.06	0.19	0.89	4.57	0.19	0.89	4.66	0.04
GA4	1,6,8	All	All	6	2,542.50[4]	8,190.20	3.22	1.72	1.94	1.13	1.72	1.94	1.13	0.02
GA5	1,5,7,8	All	All	7	0.39	1.77	4.55	4.05	1.20	0.30	4.05	1.20	0.30	0.01
GA6	1,2,4,7,8	All	All	17	4.08	20.58	5.05	0.05	0.09	2.00	0.05	0.09	2.01	0.03
GA7	1-4,6-8	All	All	35	25.51	152.10	5.96	2.24	1.70	0.76	2.19	1.66	0.76	0.11
SA1	4	All	All	1	1.47	-------	-------	4.67	-------	-------	0.70	-------	-------	0.07
SA2	1,2,4-8	All	All	35	6.39	9.32	1.46	4.40	1.22	0.28	3.75	1.75	0.47	0.10
SA3	4	All	All	1	0.54	-------	-------	0.00	-------	-------	0.00	-------	-------	0.03
SA4	4,8	All	All	4	0.99	1.03	1.04	0.05	0.05	1.16	0.04	0.05	1.18	0.02
SA5	2	All	All	1	0.00	-------	-------	2.77	-------	-------	2.77	-------	-------	0.02
SA6	2	All	All	1	0.00	-------	-------	6.66	-------	-------	6.66	-------	-------	0.02
SA7	1,8	All	All	2	0.92	0.27	0.30	6.29	1.79	0.28	6.29	1.79	0.28	0.01
SA8	1,7,8	All	All	12	0.05	0.34	6.68	0.50	0.66	1.33	0.50	0.66	1.33	0.09
SA9	1,7	All	All	7	0.02	0.16	10.62	4.44	0.62	0.14	4.44	0.62	0.14	0.14
SA10	1,4,6-8	All	All	8	8.23	2.85	0.35	4.11	0.86	0.21	4.10	0.89	0.22	0.03
SA11	1,8	All	All	4	0.01	0.01	0.89	2.42	1.24	0.51	2.42	1.24	0.51	0.02
SA12	4,6,8	All	All	4	1.51	1.03	0.68	4.44	0.33	0.07	4.26	0.63	0.15	0.03
SA13	1,6,8	All	All	3	3.09	2.63	0.85	1.49	0.73	0.49	1.49	0.73	0.49	0.01
SA14	4,8	All	All	2	1.03	2.57	2.49	4.79	0.37	0.08	4.35	1.49	0.34	0.01
SA15	8	All	All	1	0.00	-------	-------	0.76	-------	-------	0.76	-------	-------	0.01
SA17	1,4	All	All	5	0.01	0.01	0.96	5.59	0.51	0.09	5.56	0.62	0.11	0.04

[1]n = number of records averaged; s = standard deviation; CV = coefficient of variation = s/mean; UF = user fraction

[2]BAU IF = Business-as-usual impact factor

[3]CTG IF = impact factor if recommendations in the Control Techniques Guidelines are implemented

[4]Due to severely skewed data, the median AF of 0.0762 was used in emission model. The median is the midpoint of the facility-level AFs arranged in order of value.

Table III-10. Industrial Cleaning Solvent Usage: Summary of Employee-Based Emission Model Variables and Statistics

Operation Code	Allocation To:			Emission Model Variables										
					AF (gal/emp)			BAU IF (lb VOC/gal)[2]			CTG IF (lb VOC/gal)[3]			
	Group	Region	Business Size	n	Mean	s	CV	Mean	s	CV	Mean	s	CV	UF
EQC	1-8	All	All	62	5.21	60.78	11.66	4.00	3.55	0.89	3.89	3.56	0.92	0.19
FLC	1-5,7,8	All	All	17	1.86	4.69	2.52	0.91	0.70	0.77	0.90	0.70	0.79	0.10
LIC	1,5,7,8	All	All	5	1.83	7.06	3.85	6.13	2.94	0.48	5.45	5.66	1.04	0.02
LMC	2,4-8	All	All	17	22.86	67.83	2.97	4.75	4.97	1.05	4.61	5.45	1.18	0.07
PAC	1-8	All	All	149	3.57	7.16	2.00	4.53	1.30	0.29	4.44	1.32	0.30	0.41
SBC	6,7	All	All	2	1.31	0.28	0.22	0.00	-------	-------	0.00	-------	-------	0.26
SGC	1,3-8	All	All	33	5.39	9.65	1.79	6.32	3.23	0.51	6.13	3.88	0.63	0.16
SMC	1,3-8	All	All	48	17.74	26.63	1.50	6.02	1.46	0.24	5.38	2.76	0.51	0.18
TAC	2,8	All	All	2	3.41	0.49	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.02

[1]n = number of records averaged; s = standard deviation; CV = coefficient of variation = s/mean; UF = user fraction

[2]BAU IF = Business-as-usual impact factor

[3]CTG IF = impact factor if recommendations in the Control Techniques Guidelines are implemented. In 2011, it is estimated that there are six additional facilities that meet the CTG applicability criteria. All uncontrolled emissions from these facilities are associated with parts cleaning (code PAC). Thus, before applying growth factors to estimate 2011 CTG emissions, the 2008 model was rerun with a revised mean CTG IF for PAC (mean CTG IF = 4.43 lb VOC/gal; s = 1.33 lb VOC/gal, CV = 0.30).

Table III-11. Industrial Adhesive Usage: Summary of Revenue-Based Emission Model Variables and Statistics

Application Process Code	Allocation To:			Emission Model Variables										
					AF (gal/$million)			BAU IF (lb VOC/gal)[2]			CTG IF (lb VOC/gal)[3]			
	Group	Region	Business Size	n	Mean	s	CV	Mean	s	CV	Mean	s	CV	UF
AP1	1,7	All	All	5	0.26	6.87	25.94	4.48	0.81	0.18	4.48	0.81	0.18	0.03
AP2	1,2,4,8	All	All	7	4.92	39.34	8.00	4.31	1.21	0.28	4.21	1.34	0.32	0.04
AP4	1,2,5-8	All	All	13	3.20	14.52	4.54	5.19	1.66	0.32	5.17	1.69	0.33	0.05
GA1	1,3-8	All	All	11	10.28	39.19	3.81	5.07	1.56	0.31	5.06	1.58	0.31	0.01
GA2	1,5-8	All	All	32	7.15	31.38	4.39	1.82	1.23	0.68	1.82	1.23	0.68	0.16
GA3	2-4,7,8	All	All	16	39.87	194.00	4.87	0.19	0.89	4.57	0.19	0.89	4.66	0.04
GA4	1,6,8	All	All	6	10,617.84[4]	34,160.23	3.22	1.72	1.94	1.13	1.72	1.94	1.13	0.01
GA5	1,5,7,8	All	All	7	4.97	23.11	4.65	4.05	1.20	0.30	4.05	1.20	0.30	0.01
GA6	1,2,4,7,8	All	All	17	43.90	155.01	3.53	0.05	0.09	2.00	0.05	0.09	2.01	0.02
GA7	1-4,6-8	All	All	35	105.48	522.43	4.95	2.24	1.70	0.76	2.19	1.66	0.76	0.22
SA1	4	All	All	1	3.99	-------	-------	4.67	-------	-------	0.70	-------	-------	0.14
SA2	1,2,4-8	All	All	35	108.88	96.80	0.89	4.40	1.22	0.28	3.75	1.75	0.47	0.14
SA3	4	All	All	1	3.32	-------	-------	0.00	-------	-------	0.00	-------	-------	0.03
SA4	4,8	All	All	4	91.08	106.66	1.17	0.05	0.05	1.16	0.04	0.05	1.18	0.01
SA5	2	All	All	1	0.00	-------	-------	2.77	-------	-------	2.77	-------	-------	0.02
SA6	2	All	All	1	0.00	-------	-------	6.66	-------	-------	6.66	-------	-------	0.04
SA7	1,8	All	All	2	9.15	2.77	0.30	6.29	1.79	0.28	6.29	1.79	0.28	0.00
SA8	1,7,8	All	All	12	0.34	7.38	21.85	0.50	0.66	1.33	0.50	0.66	1.33	0.05
SA9	1,7	All	All	7	0.22	3.97	18.32	4.44	0.62	0.14	4.44	0.62	0.14	0.07
SA10	1,4,6-8	All	All	8	82.00	28.95	0.35	4.11	0.86	0.21	4.10	0.89	0.22	0.02
SA11	1,8	All	All	4	0.04	0.08	2.16	2.42	1.24	0.51	2.42	1.24	0.51	0.01
SA12	4,6,8	All	All	4	8.75	6.19	0.71	4.44	0.33	0.07	4.26	0.63	0.15	0.02
SA13	1,6,8	All	All	3	13.21	11.35	0.86	1.49	0.73	0.49	1.49	0.73	0.49	0.01
SA14	4,8	All	All	2	6.31	15.83	2.51	4.79	0.37	0.08	4.35	1.49	0.34	0.01
SA15	8	All	All	1	0.01	-------	-------	0.76	-------	-------	0.76	-------	-------	0.01
SA17	1,4	All	All	5	0.11	0.10	0.94	5.59	0.51	0.09	5.56	0.62	0.11	0.05

[1]n = number of records averaged; s = standard deviation; CV = coefficient of variation = s/mean; UF = user fraction

[2]BAU IF = Business-as-usual impact factor

[3]CTG IF = impact factor if recommendations in the Control Techniques Guidelines are implemented

[4]Due to severely skewed data, the median AF of 0.3703 was used in emission model. The median is the midpoint of the facility-level AFs arranged in order of value.

Table III-12. Industrial Cleaning Solvent Usage: Summary of Revenue-Based Emission Model Variables and Statistics

Operation Code	Allocation To:			Emission Model Variables[1]										
					AF (gal/$million)			BAU IF (lb VOC/gal)[2]			CTG IF (lb VOC/gal)[3]			
	Group	Region	Business Size	n	Mean	s	CV	Mean	s	CV	Mean	s	CV	UF
EQC	1-8	All	All	62	24.55	198.16	8.07	4.00	3.55	0.89	3.89	3.56	0.92	0.29
FLC	1-5,7,8	All	All	17	44.96	60.34	1.34	0.91	0.70	0.77	0.90	0.70	0.79	0.16
LIC	1,5,7,8	All	All	5	8.56	27.13	3.17	6.13	2.94	0.48	5.45	5.66	1.04	0.01
LMC	2,4-8	All	All	17	164.47	220.26	1.34	4.75	4.97	1.05	4.61	5.45	1.18	0.04
PAC	1-8	All	All	149	68.18	124.50	1.83	4.53	1.30	0.29	4.44	1.32	0.30	0.50
SBC	6,7	All	All	2	7.20	4.04	0.56	0.00	-------	-------	0.00	-------	-------	0.67
SGC	1,3-8	All	All	33	80.53	66.99	0.83	6.32	3.23	0.51	6.13	3.88	0.63	0.18
SMC	1,3-8	All	All	48	335.02	659.95	1.97	6.02	1.46	0.24	5.38	2.76	0.51	0.21
TAC	2,8	All	All	2	11.88	8.54	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.11

[1]n = number of records averaged; s = standard deviation; CV = coefficient of variation = s/mean; UF = user fraction

[2]BAU IF = Business-as-usual impact factor

[3]CTG IF = impact factor if recommendations in the Control Techniques Guidelines are implemented

C. SELECTION OF ALLOCATION DATA SET

After completing the emission model tables for adhesive application processes and cleaning unit operations, analyses were conducted to determine whether employment or revenue was the best data for emissions allocation. Recall that the mean AF times mean IF times UF product could be calculated based on either total employees or revenue. If VOC emissions from a facility correlate well with the employment, perhaps allocation based on employees would be the more accurate way to estimate the 2008 VOC emissions. It was necessary to compare emissions allocations by both data types to quantitatively judge the best allocation data set.

The Texas 2007 Point Source Emissions Inventory was provided by TCEQ. Queries of the inventory using SCCs and NAICS associated with adhesive and cleaning solvent usage (discussed in section II.B.1) were performed to match, where possible, the facilities in the Texas Point Source Emissions Inventory to facilities in the D&B database. The matching of facilities between the Texas Point Source Emissions Inventory and the D&B acquired user universe proved unsuccessful for adhesives. However, for industrial cleaning solvents, 40 facility matches were able to be made between the two datasets.

Emission estimates for these 40 facilities were derived from the emission model. First, mean AF, mean BAU IF, and UF emission model variables were determined for all facilities based on group (NAICS codes are used to assign a given facility to a group). Variables were calculated on both employee and revenue bases. VOC emission estimates were calculated with the following general equations:

Equation III-9

Employee-based: VOC emissions (tons/yr) = mean AF × mean BAU IF×UF×(1/2000) x # of Employees

where:

mean AF	=	gal of cleaning solvent used/employee-year
mean BAU IF	=	lb VOC/gal of cleaning solvent
UF	=	cleaning unit operation user employees/survey employees

1/2,000 converts lbs to tons

Equation III-10

Revenue-based: VOC emissions (tons/yr) = mean AF × mean IF×UF×(1/2000) x Revenue

where:

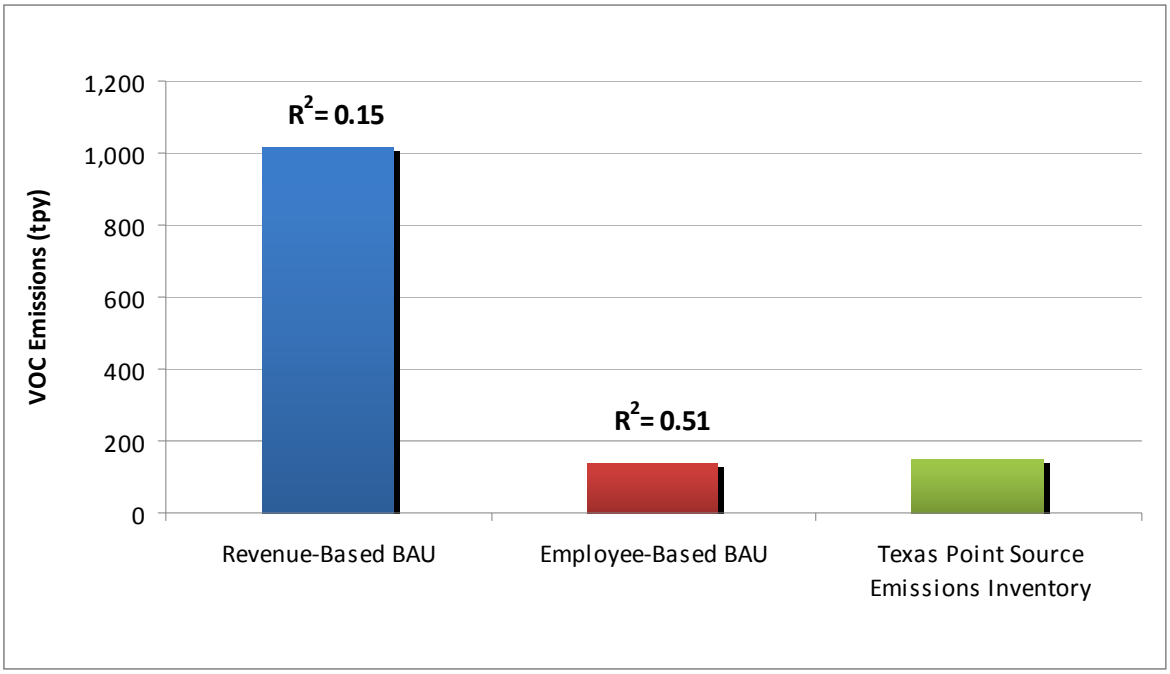
mean AF	=	gal of cleaning solvent used/$million-year
mean BAU IF	=	lb VOC/gal of cleaning solvent
UF	=	cleaning unit operation revenue/survey revenue

1/2,000 converts lbs to tons

Simple linear regression of VOC emissions from the Texas Point Source Emissions Inventory against the model's VOC estimates for the same facilities revealed a higher correlation coefficient, R^2, when employees were used ($R^2 = 0.51$ versus using revenue-based allocation ($R^2 = 0.15$)). See Figure III-2. The low correlation coefficient is expected since the resolution of the model precludes accurate estimation of emissions for a given facility. However, as can be seen in

Figure III-2, the total emissions from the employee-based model for the 40 facilities is similar to the total reported from these facilities in the Texas Point Source Emissions Inventory.

Figure III-2. Revenue- and Employee-Based VOC Emissions from 40 Facilities in Texas Point Source Emissions Inventory Using Industrial Cleaning Solvents



Based on its better correlations with actual data, the employment allocation method was chosen over the revenue method for preparing the 2008 emissions estimates from industrial adhesive and industrial cleaning solvent usage. Therefore, mean AF and UF emission model variables for all adhesive application processes and cleaning unit operations were calculated using employment data acquired from D&B or from the returned surveys. All VOC emissions estimates were generated using Equation III-9 above.

D. DETERMINING THE NUMBER OF FACILITIES RESPONDING TO THE SURVEY THAT MEET THE CTG APPLICABILITY CRITERIA

As mentioned above, facility-level emissions estimates for facilities responding to the survey were calculated using the survey responses and used to determine whether a responding facility meets the applicability criteria of emitting 15 ppd of VOC. Emissions calculations were performed for each valid record at a given facility by multiplying the volume of adhesive or cleaning solvent used by the VOC content of the adhesive or cleaning solvent. The sum of emissions from all industrial adhesive records, as well as cleaning solvent records associated with adhesive application processes, at a facility yielded the total VOC emissions used to determine the facility's applicability to the recommendations in the Miscellaneous Industrial Adhesives CTG. The sum of emissions from all industrial cleaning solvent records, minus those records associated with adhesive application processes, at a facility yields the total VOC emissions used to determine the facility's applicability to the recommendations in the Industrial Cleaning Solvents CTG. The number of facilities responding to the survey that meet the applicability criteria are presented in Table III-13 and Table III-14.

Table III-13. Number of Responding Facilities in DFW and HGB Meeting the Industrial Adhesive CTG Applicability Criteria

Group	Number of Facilities by Region/Business Size				Total
	DFW		HGB		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing					**0**
(2) Food Manufacturing		1			**1**
(3) Fabric and Fiber Manufacturing					**0**
(4) Wood and Wood Products		2	1		**3**
(5) Fabricated Metals					**0**
(6) Industrial Machinery					**0**
(7) Transportation Equipment					**0**
(8) Other Manufacturing	1	2		1 (1)	**4 (1)**
Total	**1**	**5**	**1**	**1 (1)**	**8 (1)**

Notes: The number in parentheses indicates the number of facilities that meet the applicability criteria, but are already using control devices.

Table III-14. Number of Responding Facilities in DFW and HGB Meeting the Industrial Cleaning Solvent CTG Applicability Criteria

Group	Number of Facilities by Region/Business Size				Total
	DFW		HGB		
	Small Businesses	Large Businesses	Small Businesses	Large Businesses	
(1) Non-manufacturing				2	**2**
(2) Food Manufacturing		1			**1**
(3) Fabric and Fiber Manufacturing					**0**
(4) Wood and Wood Products					**0**
(5) Fabricated Metals	1			6 (2)	**7 (2)**
(6) Industrial Machinery		1		4	**5**
(7) Transportation Equipment	1	3 (1)			**4 (1)**
(8) Other Manufacturing	1	10 (2)		8	**19 (2)**
Total	**3**	**15 (3)**	**0**	**20 (2)**	**38 (5)**

Notes: The number in parentheses indicates the number of facilities that meet the applicability criteria, but are already using control devices.

Eight facilities responding to the survey were determined to meet the applicability criteria specified in the Miscellaneous Industrial Adhesive CTG. Of these eight, one indicated that thermal VOC emissions controls were already being used.

Thirty-eight facilities responding to the survey were determined to meet the applicability criteria specified in the Industrial Cleaning Solvents CTG. Of these 38, five indicated that thermal VOC emissions controls were already being used.

The assessment of the total number of facilities in the sample frame meeting the applicability criteria and the financial impacts of implementing the CTG recommendations are discussed in Chapter V of this report.

E. DEVELOPMENT OF GROWTH FACTORS TO ASSESS THE IMPACT OF IMPLEMENTING THE CTG RECOMMENDATIONS IN 2011

There was some concern that the 2008 VOC emissions from the use of industrial adhesives and industrial cleaning solvents could be significantly different than the emissions in 2011, the likely year of implementing the CTG recommendations. To address this concern, growth factors were developed to adjust 2008 activity to 2011. The growth factors were developed using the regional and national output by industry group projected in the Annual Energy Outlook 2010 report

published by the Energy Information Administration (EIA, 2010).

A crosswalk was created to match NAICS codes to regional sector data. If regional data for a given sector were unavailable, national data were used. The crosswalk is presented in Appendix D. The 2008 sector outputs, as well as 2011 sector outputs, were summed by industrial group based on the NAICS code groupings developed for the survey study. Industry group growth factors were derived by dividing the summed 2011 sector outputs by the summed 2008 sector outputs. These growth factors are presented in Table III-15. The activity level between 2008 and 2011 is projected to remain similar for industries in Groups 1 and 7, decrease sharply for Group 2, decrease modestly for Groups 3, 4, 6, and 8, and increase sharply for Group 5. These growth factors were applied to emissions calculations to determine how the projected differences in output between 2008 and 2011 would affect overall VOC emissions as well as the number of facilities estimated to meet the applicability criteria.

Table III-15. Economic Growth Factors for West-South-Central Region[1]

Group	2008 (Billions of Fixed 2000 Dollars)	2011 (Billions of Fixed 2000 Dollars)	2008 to 2011 Growth Factor
(1) Non-manufacturing	9,052.49	8,930.47	0.99
(2) Food Manufacturing	4.20	3.21	0.76
(3) Fabric and Fiber Manufacturing	12.54	11.22	0.89
(4) Wood and Wood Products	21.49	19.46	0.91
(5) Fabricated Metals	47.84	59.00	1.23
(6) Industrial Machinery	31.88	29.80	0.93
(7) Transportation Equipment	9.80	10.02	1.02
(8) Other Manufacturing	369.15	351.23	0.95

[1]Regional output by industry group compiled from Annual Energy Outlook 2010. Texas is in the West-South-Central region.

As discussed in Chapter V, there are an estimated six additional facilities affected by the Industrial Cleaning Solvents CTG between 2008 and 2011 and no additional facilities affected by the Miscellaneous Industrial Adhesives CTG. Therefore, the difference in VOC emissions between 2008 and 2011 from implementing the industrial cleaning solvents CTG recommendations is a function of the projected change in output as well as the projected change in number of affected facilities.

All uncontrolled emissions from the six additional facilities affected by the Industrial Cleaning Solvents CTG in 2011 are associated with parts cleaning (code PAC). Thus, before estimating 2011 CTG emissions associated with industrial cleaning solvent usage, the emission model was rerun with a revised mean CTG IF for PAC (mean CTG IF = 4.43 lb VOC/gal; s = 1.33 lb VOC/gal, CV = 0.30) that takes into account the additional controls. The output of this model run was then multiplied by the growth factors in Table III-15 to estimate industrial cleaning solvent VOC emissions in 2011 after implementation of the recommendations in the industrial cleaning solvent CTG.

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CHAPTER IV. ESTIMATED ADHESIVE AND CLEANING SOLVENT USAGE, VOC EMISSIONS, AND EMISSIONS REDUCTIONS

This chapter presents the estimated 2008 and 2011 industrial adhesive and industrial cleaning solvent usage, the estimated VOC emissions associated with this usage, and the estimated reductions in VOC emissions resulting from the implementation of the CTG recommendations.

The volumes of industrial adhesives and industrial cleaning solvents used in 2008 were estimated using the mean AFs and UFs generated for the emission model (see Table III-9 and Table III-10) and Equation IV-1.

Equation IV-1

$$Usage\ (gal) = mean\ AF\ (gal/emp) \times UF \times Number\ of\ employees$$

Number of employees refers to the sum of employees from all sample frame cells determined to use adhesives or cleaning solvents for the given application process or cleaning unit operation. To calculate 2011 usage, 2008 usages were simply grown using the growth factors discussed in section IV.F.

A. ESTIMATED INDUSTRIAL ADHESIVE USE AND VOC EMISSIONS IN 2008 AND 2011 BY ADHESIVE APPLICATION PROCESS

Table IV-1, Figure IV-1, and Figure IV-3 depict the 2008 adhesive usage and VOC emissions for facilities in DFW and HGB, broken down by adhesive application process. Total adhesive usage for facilities in these areas in 2008 is estimated to be 2,155,744 gallons with 56 percent of this usage attributed to small businesses. According to Table IV-1, general application of adhesives to substrates other than flexible vinyl, metal, porous material, reinforced plastic composite, or rubber (code GA7) is estimated to be responsible for 66 percent of total adhesive usage in 2008 and 56 percent of total BAU VOC emissions. The large representation by this process code is not unexpected since survey respondents are more likely to select this code if there is uncertainty about what adhesive application process(es) is used at their facility.

The contact adhesive application process (code SA2) accounts for 16 percent of industrial adhesive usage, but 26 percent of BAU VOC emissions. The proportionally higher level of emissions for code SA2 is due to the fact that adhesive materials reported for the contact adhesive application process, on average, have a higher VOC content than materials reported for other application processes.

In total, implementing the recommendations in the industrial adhesives CTG is estimated to result in a 5.3 percent reduction in 2008 BAU VOC emissions from adhesive application processes in the DFW and HGB areas. The majority of these VOC emissions reductions would be associated with the contact adhesive application process (73 percent) and the general adhesive application process for other substrates (code GA7; 23 percent).

As discussed in section III.E of this report, most sectors of the economy are expected to have a lower output in 2011 compared to 2008. Consequently, the BAU VOC emissions from adhesive application processes are projected to be 3 percent lower in 2011 than in 2008. As Table IV-2 and Figure IV-2 depict, the overall BAU VOC emissions in 2011 from adhesive application processes, as well as emission reductions associated with implementing the Miscellaneous Industrial Adhesives CTG recommendations, exhibit a distribution similar to 2008. Since there are no estimated differences between 2008 and 2011 in the number of facilities affected by the industrial adhesives CTG, as discussed in section III.E of this report, the difference in VOC emissions reductions between 2008 and 2011 is due solely to the projected change in industrial output.

B. ESTIMATED INDUSTRIAL CLEANING SOLVENT USE AND VOC EMISSIONS IN 2008 AND 2011 BY CLEANING UNIT OPERATION

Table IV-3, Figure IV-4, and Figure IV-6 depict the 2008 industrial cleaning solvent usage and VOC emissions for facilities in DFW and HGB, broken down by cleaning unit operation. Total cleaning solvent usage for facilities in these areas in 2008 is estimated to be 4,074,420 gallons with 57 percent of this usage attributed to small businesses. According to Table IV-3, cleaning solvent usage associated with small manufactured components (code SMC) is estimated to be responsible for 41 percent of total cleaning solvent usage in 2008 and 47 percent of total BAU VOC emissions. The cleaning unit operations for parts cleaning (code PAC) and spray gun cleaning (code SGC) account for 20 percent and 11 percent of the cleaning solvent usage, respectively, and 17 percent and 13 percent of BAU VOC emissions, respectively. The proportionally higher level of emissions from small manufactured components is due to the fact that cleaning solvent materials reported for SMC, on average, have a higher VOC content than materials reported for other cleaning unit operations.

In total, implementing the recommendations in the Industrial Cleaning Solvents CTG is estimated to result in a 6.4 percent reduction in 2008 BAU VOC emissions from cleaning unit operations in the DFW and HGB areas. The majority of these VOC emissions reductions are estimated to be associated with the cleaning of small manufactured components (78 percent), spray gun cleaning (6.1 percent), and parts cleaning (5.5 percent).

As mentioned above, most sectors of the economy are expected to have a lower output in 2011 compared to 2008. Consequently, the BAU VOC emissions from cleaning unit operations are projected to be slightly lower (1 percent) in 2011 than in 2008. As Table IV-4 and Figure IV-5 depict, the overall VOC emissions in 2011 from cleaning unit operations exhibit a distribution similar to 2008. Recall from section III.E that 2011 CTG VOC emissions are dependent upon the projected change in industrial output as well as the projected change in number of affected facilities. Also recall that all of the uncontrolled emissions from the six additional affected facilities in 2011 are associated with parts cleaning. Thus, the difference in VOC emissions reductions between 2008 and 2011 for parts cleaning is dependent upon the additional controlled facilities as well as the projected change in industrial output. For all other cleaning unit operations, the difference in VOC emissions reductions between 2008 and 2011 is due solely to the projected change in industrial output.

Table IV-1. Industrial Adhesive Usage and VOC Emissions in DFW and HGB by Adhesive Application Process in 2008

Adhesive Application Process	2008 Adhesive Usage (gal)			2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
				BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
AP1	453	262	716	1	1	2	1	1	2	0	0.0
AP2	22,751	17,816	40,567	49	38	87	48	37	85	2	1.4
AP4	3,949	3,043	6,992	10	8	18	10	8	18	0	0.0
GA1	5,596	4,081	9,677	14	10	24	14	10	24	0	0.0
GA2	34,463	25,456	59,920	31	23	55	31	23	55	0	0.0
GA3	26,156	29,052	55,209	3	3	5	2	3	5	0	0.1
GA4	286	213	498	0	0	0	0	0	0	0	0.0
GA5	1,454	1,071	2,525	3	2	5	3	2	5	0	0.0
GA6	35,316	28,259	63,576	1	1	1	1	1	1	0	0.0
GA7	791,950	621,177	1,413,127	887	695	1,582	867	680	1,548	34	22.7
SA1	799	640	1,438	2	1	3	0	0	1	3	1.9
SA2	192,587	148,575	341,163	423	327	750	361	279	640	110	72.6
SA3	147	118	264	0	0	0	0	0	0	0	0.0
SA4	1,741	1,861	3,602	0	0	0	0	0	0	0	0.0
SA5	0	0	0	0	0	0	0	0	0	0	0.0
SA6	0	1	1	0	0	0	0	0	0	0	0.0
SA7	1,069	794	1,864	3	2	6	3	2	6	0	0.0
SA8	1,084	826	1,910	0	0	0	0	0	0	0	0.0
SA9	321	186	506	1	0	1	1	0	1	0	0.0
SA10	70,943	54,155	125,097	146	111	257	146	111	257	1	0.4
SA11	43	32	75	0	0	0	0	0	0	0	0.0
SA12	4,197	4,257	8,454	9	9	19	9	9	18	1	0.5
SA13	9,141	6,806	15,947	7	5	12	7	5	12	0	0.0
SA14	1,215	1,299	2,514	3	3	6	3	3	5	1	0.4
SA15	2	3	5	0	0	0	0	0	0	0	0.0
SA17	63	35	98	0	0	0	0	0	0	0	0.0
Total	**1,205,725**	**950,018**	**2,155,744**	**1,594**	**1,242**	**2,836**	**1,509**	**1,176**	**2,685**	**151**	**100 (5.3)**

Note: The value in parentheses in the Total/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial adhesive CTG.

Figure IV-1. Industrial Adhesive VOC Emissions in DFW and HGB by Adhesive Application Process in 2008

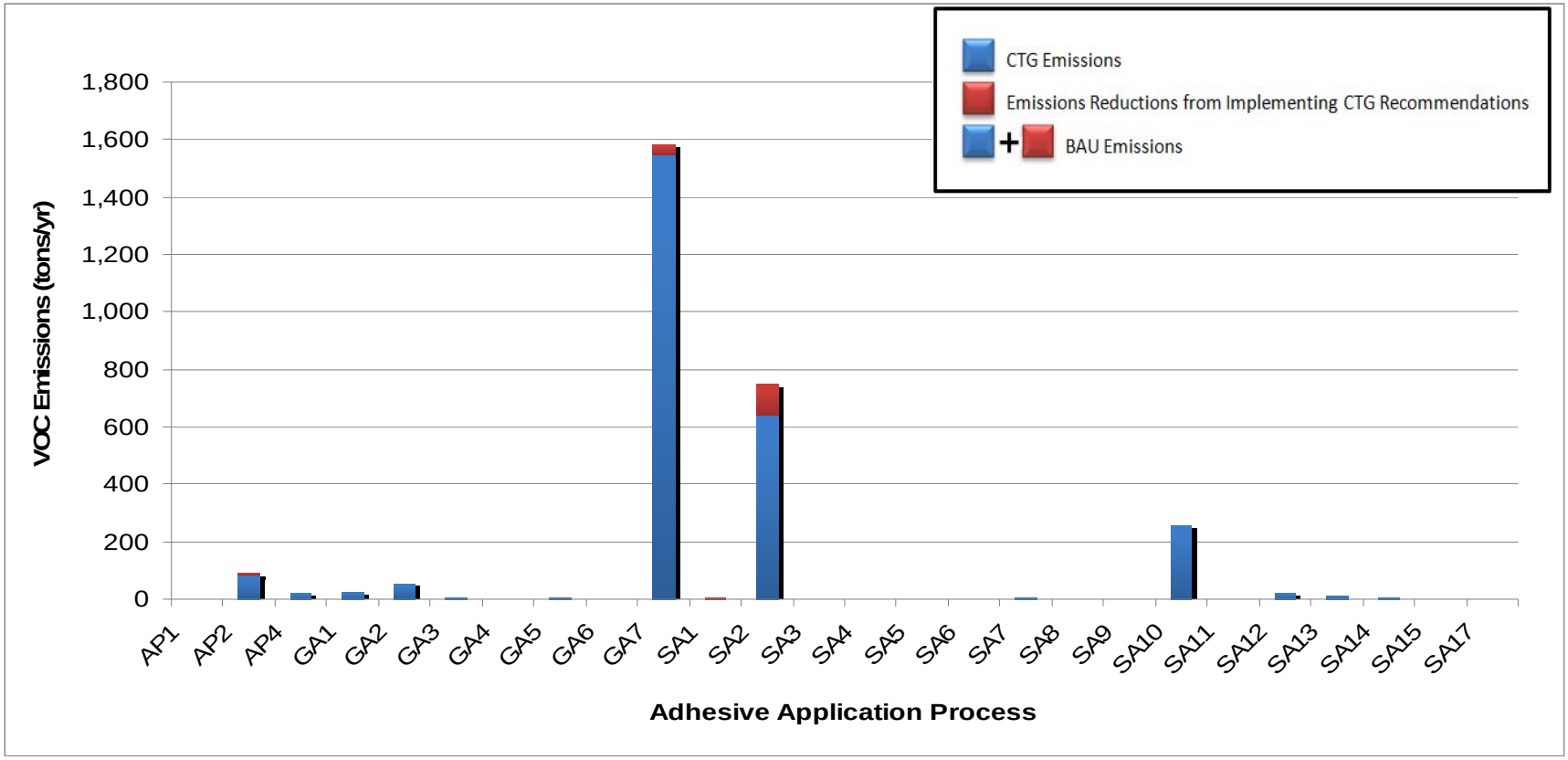


Table IV-2. Industrial Adhesive Usage and VOC Emissions in DFW and HGB by Adhesive Application Process in 2011

Adhesive Application Process	2011 Adhesive Usage (gal)			2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
				BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
AP1	448	260	708	1	1	2	1	1	2	0	0.0
AP2	21,947	16,912	38,860	47	36	84	46	36	82	2	1.3
AP4	3,933	2,970	6,904	10	8	18	10	8	18	0	0.0
GA1	5,585	4,034	9,620	14	10	24	14	10	24	0	0.1
GA2	34,557	25,238	59,795	31	23	54	31	23	54	0	0.0
GA3	24,420	26,986	51,406	2	3	5	2	3	5	0	0.1
GA4	277	205	483	0	0	0	0	0	0	0	0.0
GA5	1,465	1,066	2,532	3	2	5	3	2	5	0	0.0
GA6	34,106	26,906	61,012	1	1	1	1	1	1	0	0.0
GA7	761,904	590,550	1,352,454	853	661	1,514	835	647	1,481	33	22.3
SA1	724	580	1,303	2	1	3	0	0	0	3	1.8
SA2	191,364	144,712	336,076	421	318	739	359	272	631	108	73.3
SA3	133	106	239	0	0	0	0	0	0	0	0.0
SA4	1,648	1,764	3,412	0	0	0	0	0	0	0	0.0
SA5	0	0	0	0	0	0	0	0	0	0	0.0
SA6	0	1	1	0	0	0	0	0	0	0	0.0
SA7	1,042	769	1,810	3	2	6	3	2	6	0	0.0
SA8	1,057	801	1,858	0	0	0	0	0	0	0	0.0
SA9	317	184	500	1	0	1	1	0	1	0	0.0
SA10	68,794	52,280	121,074	141	108	249	141	107	248	1	0.4
SA11	42	31	73	0	0	0	0	0	0	0	0.0
SA12	3,965	4,028	7,993	9	9	18	8	9	17	1	0.5
SA13	8,874	6,569	15,443	7	5	11	7	5	11	0	0.0
SA14	1,151	1,231	2,382	3	3	6	3	3	5	1	0.4
SA15	2	3	5	0	0	0	0	0	0	0	0.0
SA17	62	34	96	0	0	0	0	0	0	0	0.0
Total	**1,167,817**	**908,222**	**2,076,039**	**1,550**	**1,192**	**2,742**	**1,466**	**1,128**	**2,594**	**148**	**100 (5.4)**

Note: The value in parentheses in the Total/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial adhesives CTG.

Figure IV-2. Industrial Adhesive VOC Emissions in DFW and HGB by Adhesive Application Process in 2011

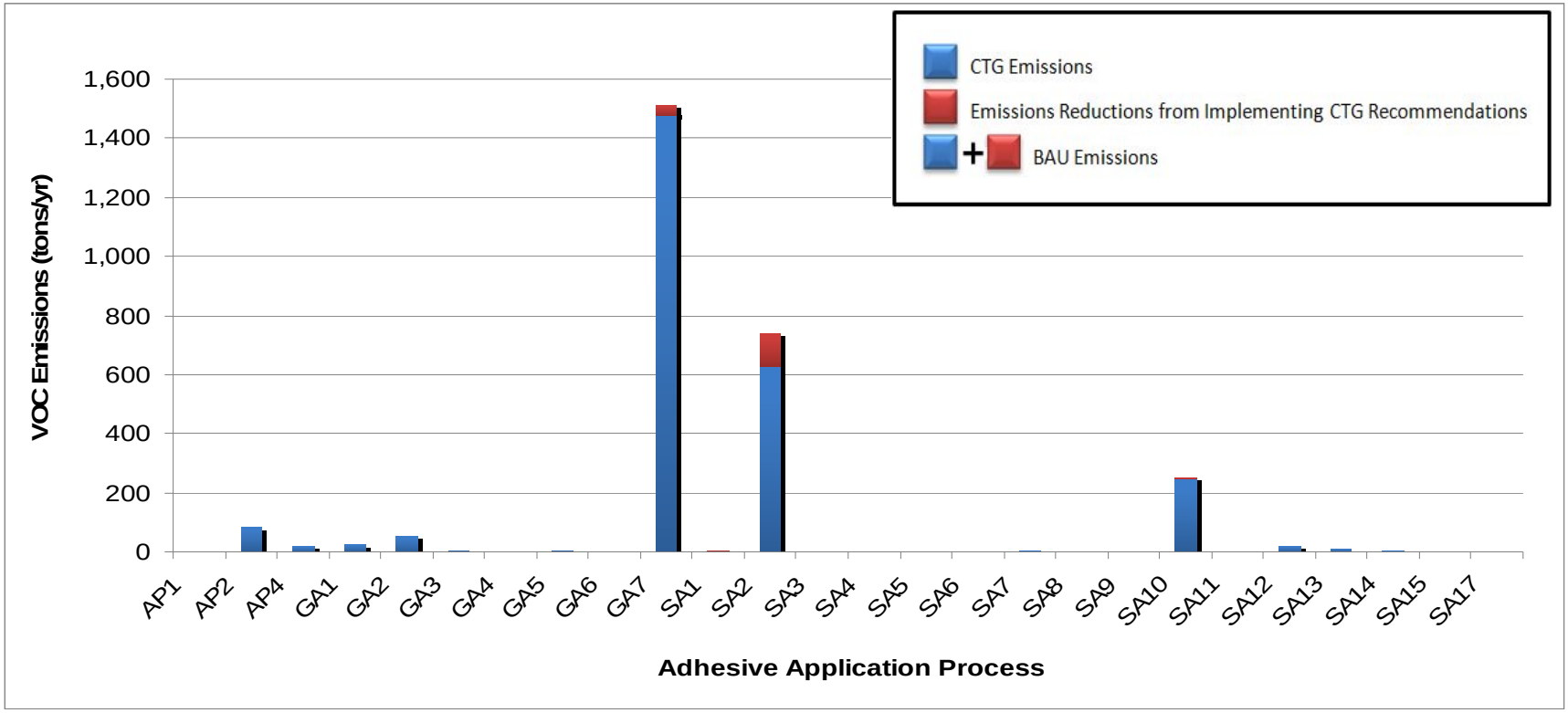


Figure IV-3. Industrial Adhesive Usage in DFW and HGB by Adhesive Application Process in 2008 and 2011

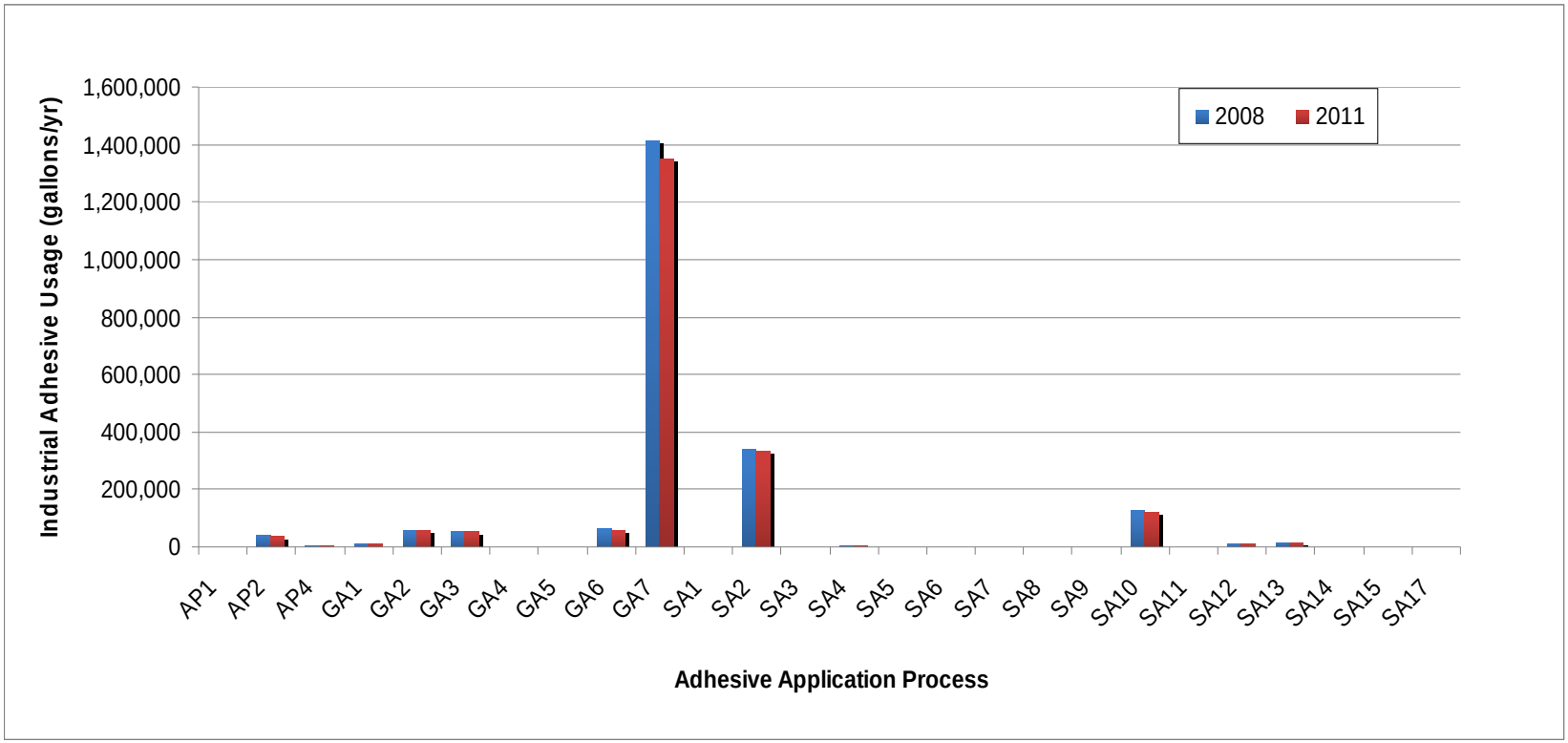


Table IV-3. Industrial Cleaning Solvent Usage and VOC Emissions in DFW and HGB by Cleaning Unit Operation in 2008

Cleaning Operation	2008 Solvent Usage (gal)			2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
				BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
EQC	306,231	232,768	538,999	612	465	1,077	595	452	1,047	30	4.4
FLC	53,601	40,720	94,321	24	18	43	24	18	42	0	0.1
LIC	9,192	6,771	15,962	28	21	49	25	18	43	5	0.8
LMC	246,552	242,395	488,947	586	576	1,162	568	558	1,126	36	5.3
PAC	456,259	346,805	803,063	1,034	786	1,819	1,013	770	1,782	37	5.5
SBC	8,199	7,737	15,936	0	0	0	0	0	0	0	0.0
SGC	259,099	188,958	448,057	819	597	1,416	795	580	1,374	42	6.1
SMC	957,333	698,172	1,655,505	2,880	2,101	4,981	2,575	1,878	4,453	528	77.9
TAC	6,289	7,340	13,629	0	0	0	0	0	0	0	0.0
Total	**2,302,755**	**1,771,665**	**4,074,420**	**5,983**	**4,563**	**10,546**	**5,594**	**4,274**	**9,868**	**678**	**100 (6.4)**

Note: The value in parentheses in the Total/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-4. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Cleaning Unit Operation in 2008

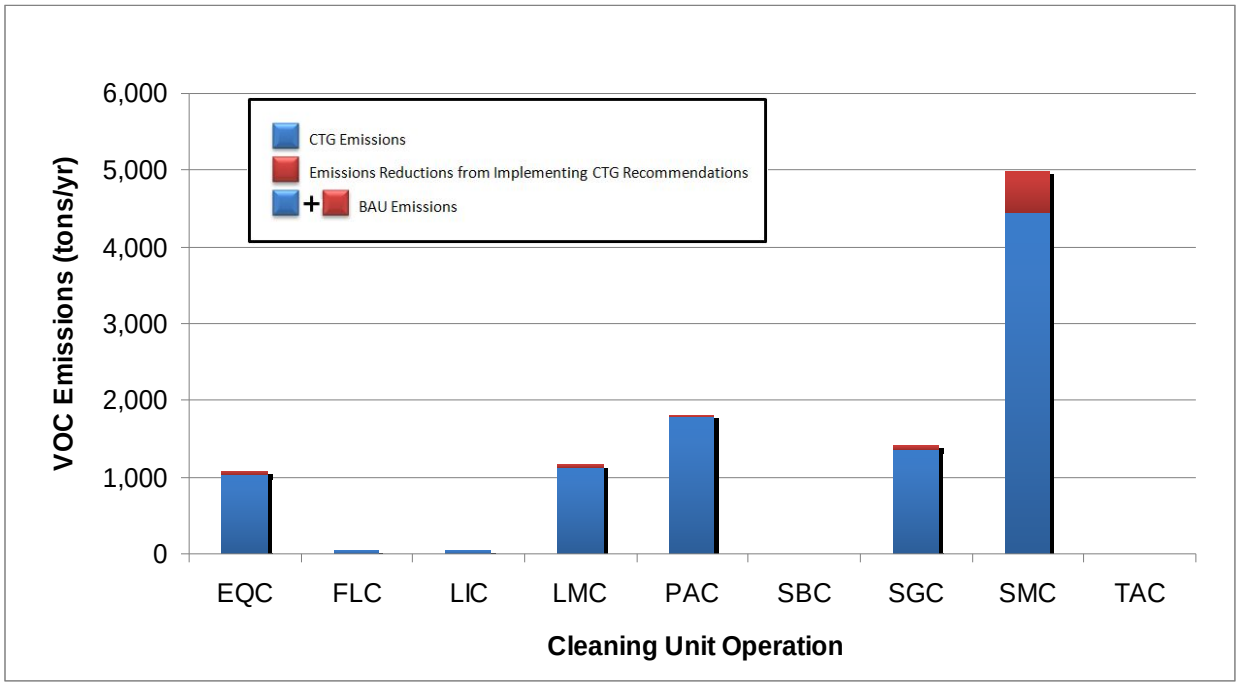


Table IV-4. Industrial Cleaning Solvent Usage and VOC Emissions in DFW and HGB by Cleaning Unit Operation in 2011

Cleaning Operation	2011 Solvent Usage (gal)			2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
				BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
EQC	303,743	226,656	530,400	607	453	1,060	590	440	1,030	29	4.3
FLC	53,376	39,761	93,137	24	18	42	24	18	42	0	0.1
LIC	9,263	6,742	16,006	28	21	49	25	18	44	5	0.8
LMC	246,507	234,478	480,985	586	557	1,143	568	540	1,108	35	5.2
PAC	452,552	337,698	790,250	1,025	765	1,790	1,003	748	1,751	39	5.8
SBC	7,796	7,460	15,257	0	0	0	0	0	0	0	0.0
SGC	258,606	186,790	445,397	817	590	1,407	793	573	1,366	41	6.1
SMC	955,512	690,163	1,645,675	2,875	2,077	4,951	2,570	1,857	4,427	525	77.7
TAC	5,874	6,780	12,655	0	0	0	0	0	0	0	0.0
Total	**2,293,231**	**1,736,530**	**4,029,761**	**5,962**	**4,480**	**10,442**	**5,573**	**4,194**	**9,767**	**675**	**100 (6.5)**

Note: The value in parentheses in the Total/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-5. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Cleaning Unit Operation in 2011

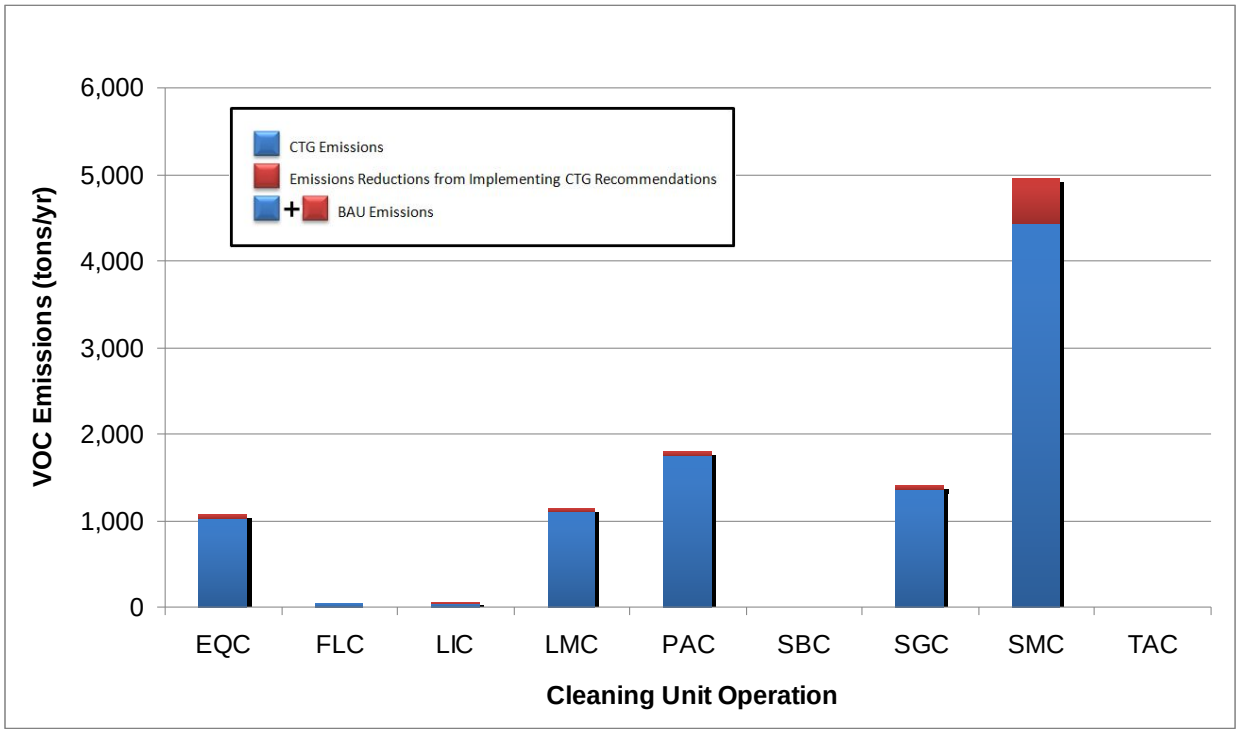
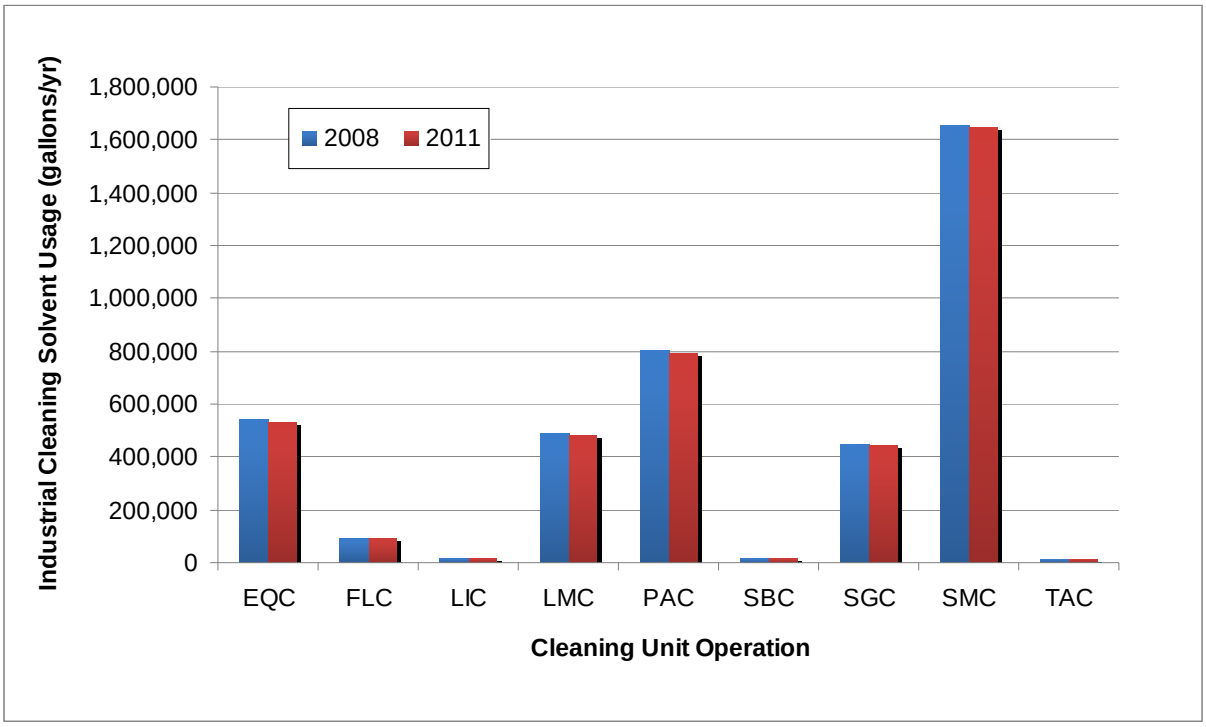


Figure IV-6. Industrial Cleaning Solvent Usage in DFW and HGB by Cleaning Unit Operation in 2008 and 2011



C. ESTIMATED VOC EMISSIONS FROM INDUSTRIAL ADHESIVE USE IN 2008 AND 2011 BY INDUSTRY GROUP

Table IV-5 and Figure IV-7 show the 2008 industrial adhesive VOC emissions from facilities in DFW and HGB, broken down by industry group. Group 1 (non-manufacturing facilities) and Group 8 (other manufacturing facilities not included in Groups 2-7) account for 45 percent and 35 percent of the BAU VOC emissions, respectively, and 42 percent and 33 percent of VOC emissions reductions, respectively. The large representation by these groups is a result of the number of facilities in these groups being significantly larger than that of other groups, as depicted in Table III-5. Within Groups 1 and 8, it is estimated that small businesses account for 65 percent and 48 percent of the BAU VOC emissions, respectively.

As shown in Table IV-6 and Figure IV-8, the VOC emissions and emissions reductions associated with cleaning solvents in 2011 are similar to the distributions observed in 2008. The only appreciable differences occur in Group 2 (food manufacturing) and Group 5 (fabricated metals). As shown in Table III-15, between 2008 and 2011 the output for industries in Group 2 is projected to decrease by 24 percent and the output for industries in Group 5 is projected to increase 23 percent. Since there are no estimated differences between 2008 and 2011 in the number of facilities affected by the Miscellaneous Industrial Adhesives CTG, as discussed in Chapter 5 of this report, the difference in VOC emissions reductions between 2008 and 2011 is due solely to the projected change in output.

Table IV-5. Industrial Adhesive VOC Emissions in DFW and HGB by Group in 2008

Group	2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
	BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
(1) Non-manufacturing	824	448	1,271	783	425	1,208	63	41.8
(2) Food Manufacturing	40	76	116	38	71	109	7	4.4
(3) Fabric and Fiber Manufacturing	18	3	21	18	2	20	0	0.3
(4) Wood and Wood Products	47	38	85	43	35	78	7	4.7
(5) Fabricated Metals	54	31	85	47	27	74	11	7.2
(6) Industrial Machinery	110	84	193	104	80	184	10	6.5
(7) Transportation Equipment	24	42	66	23	40	63	3	2.2
(8) Other Manufacturing	476	522	998	452	496	948	50	32.9
All Groups	**1,594**	**1,242**	**2,836**	**1,509**	**1,176**	**2,685**	**151**	**100 (5.3)**

Note: The value in parentheses in the All Groups/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial adhesive CTG.

Figure IV-7. Industrial Adhesive VOC Emissions in DFW and HGB by Group in 2008

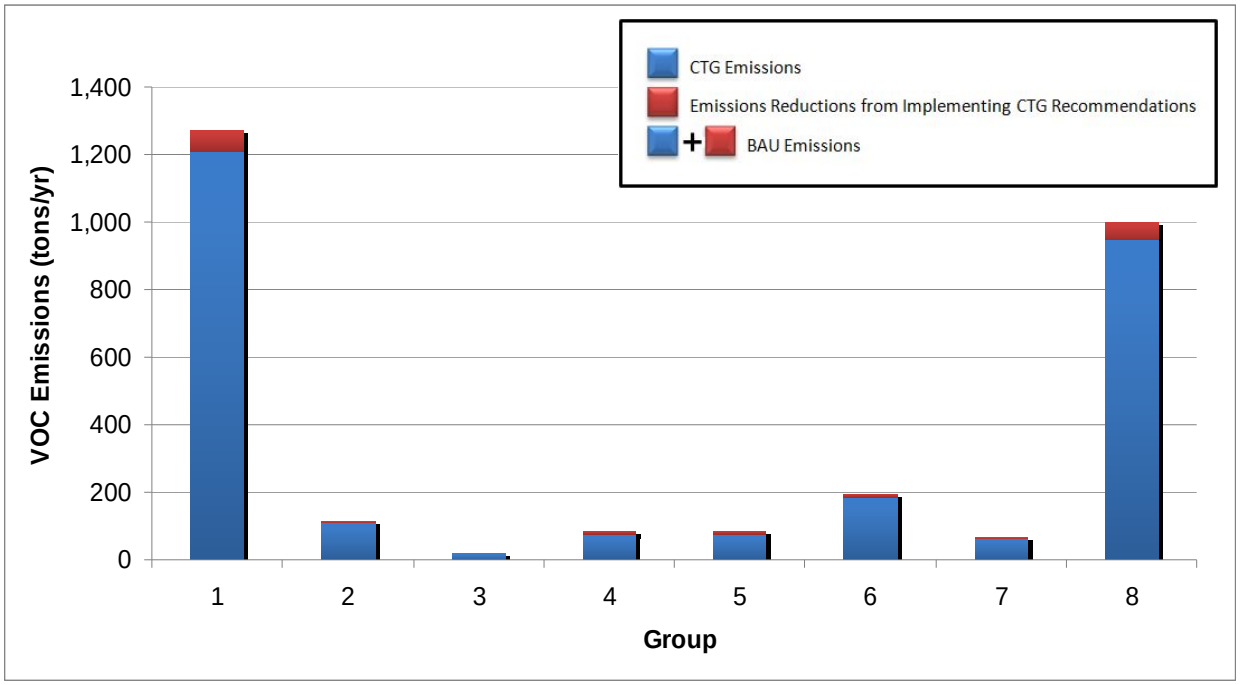
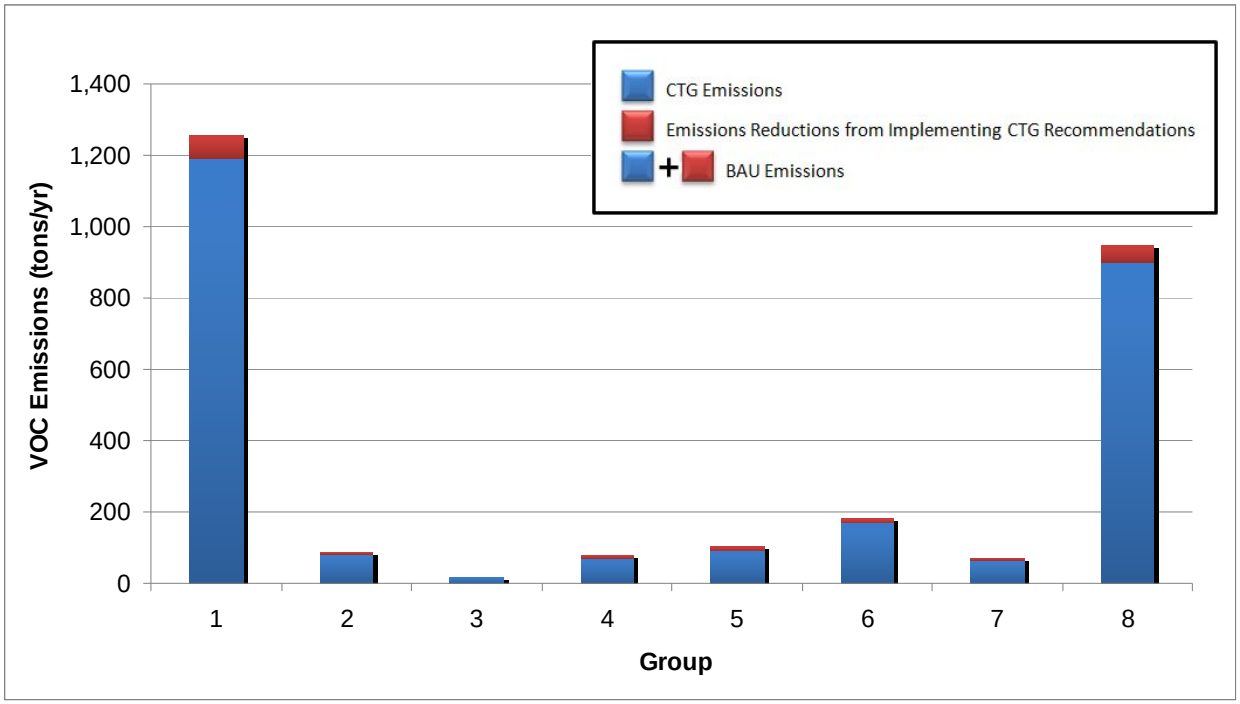


Table IV-6. Industrial Adhesive VOC Emissions in DFW and HGB by Group in 2011

Group	2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
	BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
(1) Non-manufacturing	813	442	1,255	773	420	1,192	62	42.3
(2) Food Manufacturing	31	58	89	29	55	84	5	3.4
(3) Fabric and Fiber Manufacturing	16	2	19	16	2	18	0	0.3
(4) Wood and Wood Products	43	34	77	39	32	71	6	4.3
(5) Fabricated Metals	67	38	105	58	33	91	13	9.1
(6) Industrial Machinery	102	78	181	97	74	172	9	6.2
(7) Transportation Equipment	25	43	68	23	41	64	3	2.3
(8) Other Manufacturing	453	496	949	430	471	902	47	32.0
All Groups	**1,550**	**1,192**	**2,742**	**1,466**	**1,128**	**2,594**	**148**	**100 (5.4)**

Note: The value in parentheses in the All Groups/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial adhesive CTG.

Figure IV-8. Industrial Adhesive VOC Emissions in DFW and HGB by Group in 2011



D. ESTIMATED VOC EMISSIONS FROM INDUSTRIAL CLEANING SOLVENT USE IN 2008 AND 2011 BY INDUSTRY GROUP

Table IV-7 and Figure IV-9 show the 2008 industrial cleaning solvent VOC emissions from facilities in DFW and HGB, broken down by industry group. Group 1 (non-manufacturing facilities) and Group 8 (other manufacturing facilities not included in Groups 2-7) account for 38 percent and 35 percent of the BAU VOC emissions, respectively, and 41 percent and 34 percent of 2008 VOC emissions reductions, respectively. As mentioned before, the large representation by these groups is a result of the number of facilities in these groups being significantly larger than that of other groups, as depicted in Table III-5. Within Groups 1 and 8, it is estimated that small businesses account for 65 percent and 48 percent of the BAU VOC emissions, respectively.

As shown in Table IV-8 and Figure IV-10, the VOC emissions associated with cleaning solvents in 2011 are similar to the distributions observed in 2008. The only appreciable differences occur in Group 2 (food manufacturing) and Group 5 (fabricated metals), as discussed above. However, as discussed in Chapter V, there are an estimated six additional facilities in Group 5 affected by the Industrial Cleaning Solvents CTG between 2008 and 2011. Reviewing the expected emissions reductions in Group 5 indicates that the relative influence of the additional controls on the quantity of emissions reductions is relatively minor compared to the influence from the projected growth in industrial output. Recall that Group 5 VOC emissions from industrial cleaning solvent usage in 2011 are projected to increase by 23 percent as a result of increased industrial output. Consequently, the quantity of VOC emissions reduced in 2011 will be 23 percent larger due to the projected growth. From Table IV-8, the projected VOC emissions reduction in Group 5 in 2011 is 88 tons. This value is 24 percent higher than the estimated quantity of VOC emissions reduced in 2008 (71 tons from Table IV-7). Therefore, the projected change in industrial output is estimated to account for 96 percent of the increase in VOC emissions reductions for Group 5 between 2008 and 2011 (23 percent divided by 24 percent). Again, for all other groups, the estimated changes in VOC emissions and emissions reductions between 2008 and 2011 are driven solely by the projected changes in industrial output.

Table IV-7. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Group in 2008

Group	2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
	BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
(1) Non-manufacturing	2,601	1,413	4,015	2,422	1,316	3,738	277	40.9
(2) Food Manufacturing	75	142	217	73	138	211	6	0.8
(3) Fabric and Fiber Manufacturing	98	14	112	92	13	104	8	1.1
(4) Wood and Wood Products	175	140	315	164	132	296	20	2.9
(5) Fabricated Metals	732	413	1,145	687	387	1,074	71	10.5
(6) Industrial Machinery	427	327	753	400	306	706	47	6.9
(7) Transportation Equipment	96	167	263	90	157	247	16	2.4
(8) Other Manufacturing	1,778	1,947	3,725	1,667	1,826	3,492	232	34.3
All Groups	**5,983**	**4,563**	**10,546**	**5,594**	**4,274**	**9,868**	**678**	**100 (6.4)**

Note: The value in parentheses in the All Groups/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-9. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Group in 2008

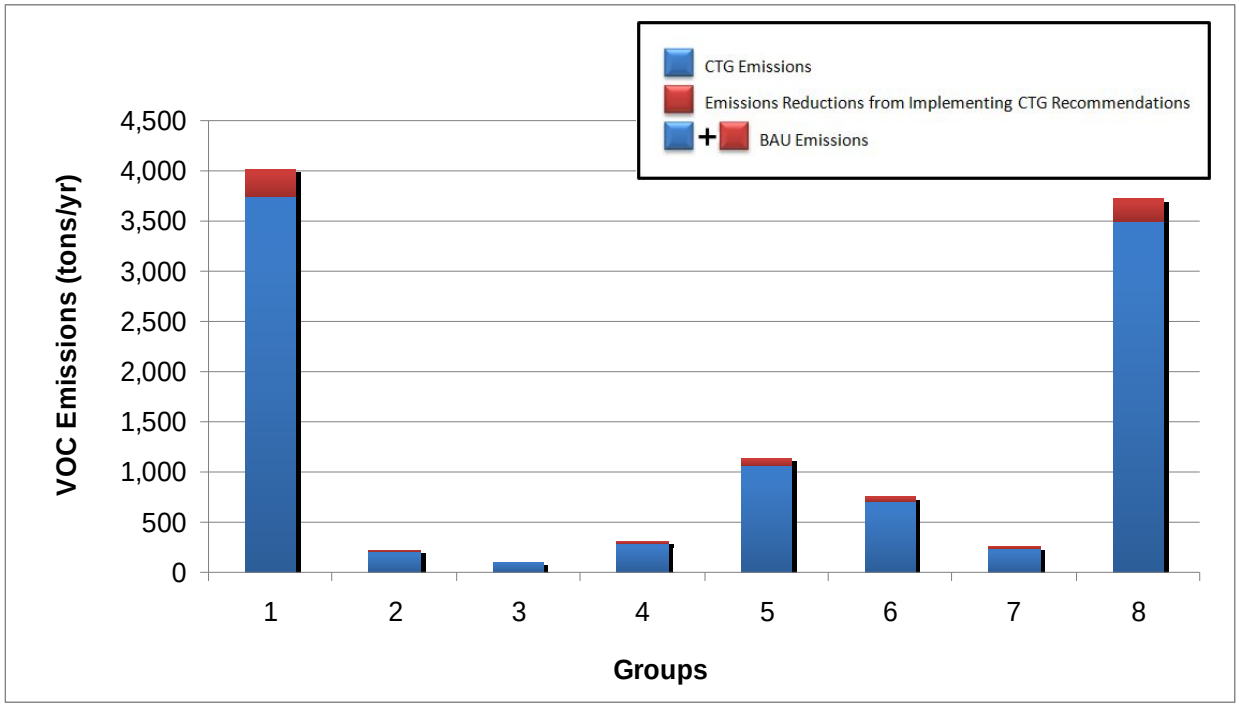
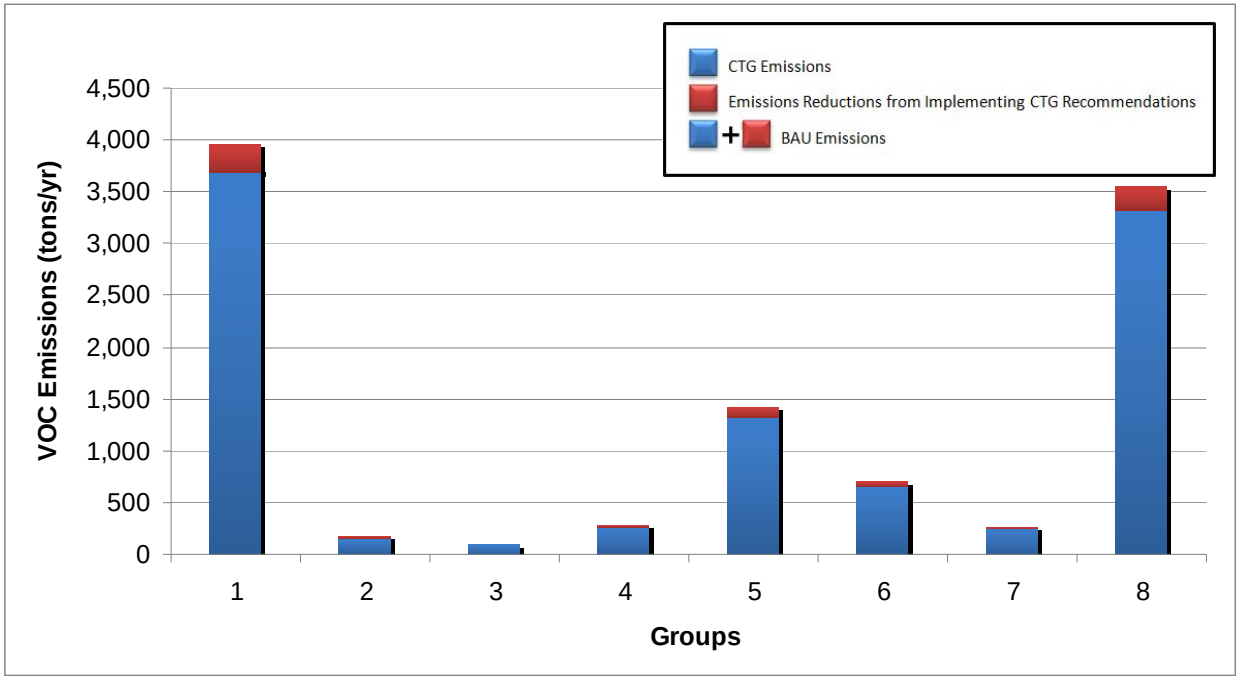


Table IV-8. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Group in 2011

Group	2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
	BAU			CTG				
	Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
(1) Non-manufacturing	2,568	1,395	3,963	2,390	1,298	3,688	275	40.7
(2) Food Manufacturing	58	109	166	56	106	162	4	0.7
(3) Fabric and Fiber Manufacturing	88	12	100	82	11	93	7	1.0
(4) Wood and Wood Products	159	127	286	149	119	268	18	2.6
(5) Fabricated Metals	903	509	1,412	846	477	1,324	88	13.1
(6) Industrial Machinery	399	306	704	374	286	660	44	6.5
(7) Transportation Equipment	98	171	269	92	160	252	17	2.5
(8) Other Manufacturing	1,690	1,852	3,542	1,585	1,736	3,321	222	32.9
All Groups	**5,962**	**4,480**	**10,442**	**5,573**	**4,194**	**9,767**	**675**	**100 (6.5)**

Note: The value in parentheses in the All Groups/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-10. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by Group in 2011



E. ESTIMATED VOC EMISSIONS FROM INDUSTRIAL ADHESIVE USE IN 2008 AND 2011 BY COUNTY

Table IV-9 and Figure IV-11 show the estimated 2008 industrial adhesive VOC emissions from facilities in DFW and HGB, broken down by area and county. Estimated BAU VOC emissions in 2008 are roughly the same between the DFW and HGB areas, with DFW accounting for 51 percent of the emissions (1,439 tons) and HGB accounting for 49 percent (1,397 tons). The similarity in industrial adhesive emissions between DFW and HGB is expected since the number of businesses per industrial group/business size between the two areas is similar, as depicted in Table III-5.

Of the total estimated BAU VOC emissions from industrial adhesives in DFW, 47 percent occur in Dallas County and 28 percent occur in Tarrant County. The concentration of emissions in these counties is expected since they are the most populous counties and have a higher concentration of businesses compared to other counties in the DFW area (TSLAC, 2010). In HGB, 80 percent of the total estimated BAU VOC emissions from industrial adhesives are concentrated in Harris County. Again, this is expected due to the same reasons mentioned for DFW. For both DFW and HGB, Table IV-9 indicates that small businesses generate the majority of the VOC emissions associated with industrial adhesive usage (58 percent in DFW and 54 percent in HGB).

As shown in Table IV-10 and Figure IV-12, the VOC emissions and emissions reductions associated with adhesives in 2011 are similar to the distributions observed in 2008. The explanation for the similar distribution is the same as that provided in sections IV.A and IV.C of this report.

Table IV-9. Industrial Adhesive VOC Emissions in DFW and HGB by County in 2008

Area	County	2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
		BAU			CTG				
		Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
Dallas-Fort Worth	Collin	64	70	134	61	66	127	7	4.6
	Dallas	407	269	676	385	255	640	36	23.7
	Denton	57	38	95	54	36	90	5	3.2
	Ellis	19	26	45	18	25	43	2	1.6
	Johnson	21	11	32	20	10	30	2	1.1
	Kaufman	11	7	18	10	7	17	1	0.7
	Parker	15	4	19	15	4	18	1	0.7
	Rockwall	12	1	13	11	1	12	1	0.5
	Tarrant	234	175	408	221	165	386	22	14.7
	All Counties	840	600	1,439	795	567	1,362	77	50.9
Houston -Galveston-Brazoria	Brazoria	31	20	51	29	19	49	3	1.8
	Chambers	4	5	8	4	4	8	0	0.3
	Fort Bend	47	45	92	45	43	87	5	3.2
	Galveston	25	8	33	24	8	31	2	1.1
	Harris	585	533	1,118	554	505	1,058	59	39.3
	Liberty	8	1	9	8	1	8	0	0.3
	Montgomery	47	23	70	44	22	66	4	2.5
	Waller	7	8	15	7	8	14	1	0.6
	All Counties	754	642	1,397	714	609	1,322	74	49.1
All Areas	**All Counties**	**1,594**	**1,242**	**2,836**	**1,509**	**1,176**	**2,685**	**151**	**100 (5.3)**

Note: The value in parentheses in the All Areas/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial adhesive CTG.

Figure IV-11. Industrial Adhesive VOC Emissions in DFW and HGB by County in 2008

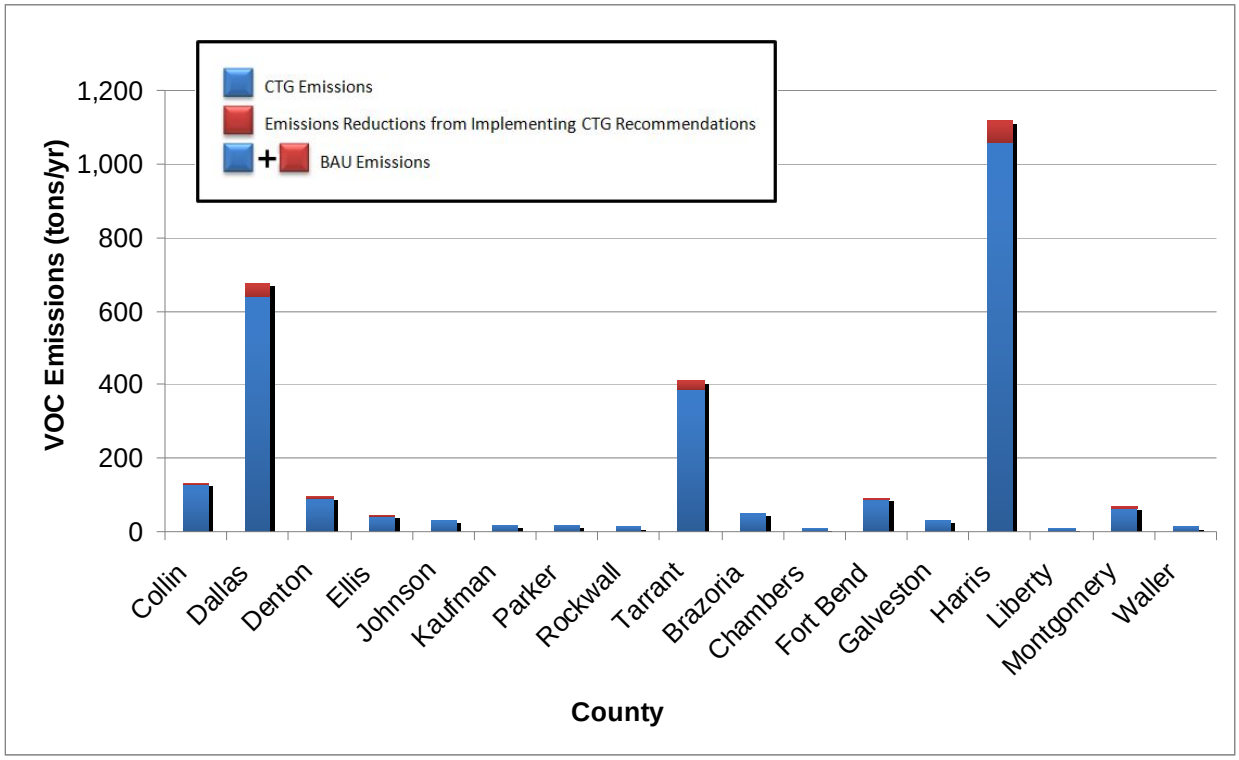
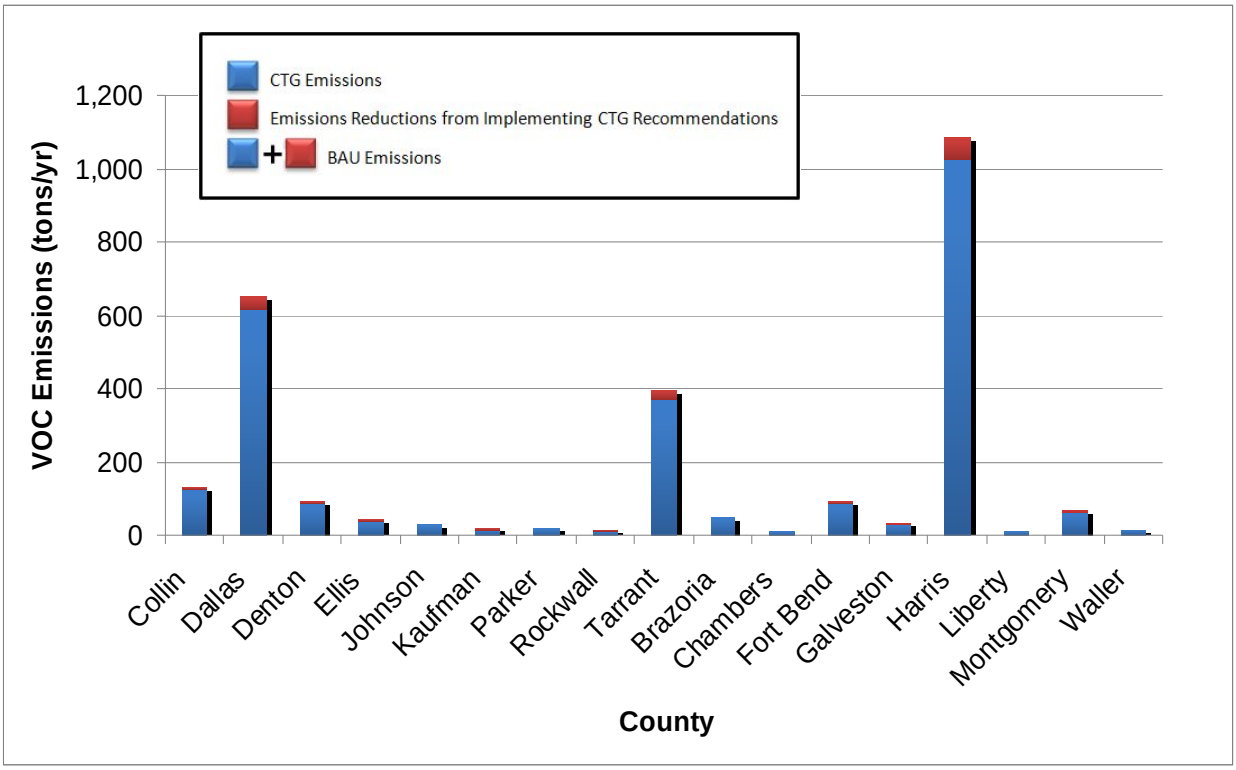


Table IV-10. Industrial Adhesive VOC Emissions in DFW and HGB by County in 2011

Area	County	2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
		BAU			CTG				
		Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
Dallas-Fort Worth	Collin	62	67	130	59	64	123	7	4.6
	Dallas	393	256	649	372	242	614	35	23.5
	Denton	55	37	92	52	35	87	5	3.2
	Ellis	18	25	43	17	23	41	2	1.6
	Johnson	21	10	31	20	10	29	2	1.2
	Kaufman	11	7	18	10	7	17	1	0.8
	Parker	15	4	19	14	3	18	1	0.7
	Rockwall	11	1	12	11	1	12	1	0.5
	Tarrant	227	166	393	215	157	371	22	14.6
	All Counties	814	573	1,387	770	542	1,312	75	50.5
Houston -Galveston-Brazoria	Brazoria	30	20	50	29	19	47	3	1.8
	Chambers	4	4	8	3	4	8	0	0.3
	Fort Bend	46	43	89	44	41	84	5	3.2
	Galveston	25	8	32	23	7	31	2	1.1
	Harris	571	513	1,084	540	486	1,026	58	39.5
	Liberty	8	1	9	8	1	8	0	0.3
	Montgomery	46	22	67	43	20	64	4	2.5
	Waller	7	8	15	6	8	14	1	0.6
	All Counties	736	618	1,355	696	586	1,282	73	49.5
All Areas	**All Counties**	**1,550**	**1,192**	**2,742**	**1,466**	**1,128**	**2,594**	**148**	**100 (5.4)**

Note: The value in parentheses in the All Areas/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial adhesive CTG.

Figure IV-12. Industrial Adhesive VOC Emissions in DFW and HGB by County in 2011



F. ESTIMATED VOC EMISSIONS FROM INDUSTRIAL CLEANING SOLVENT USE IN 2008 AND 2011 BY COUNTY

Table IV-11 and Figure IV-13 show the estimated 2008 industrial cleaning solvent VOC emissions from facilities in DFW and HGB, broken down by area and county. Estimated BAU VOC emissions in 2008 are roughly the same between the DFW and HGB areas, with DFW accounting for 50 percent of the emissions (5,255 tons) and HGB accounting for 50 percent (5,291 tons). The similarity in industrial cleaning solvent emissions between DFW and HGB is expected since the number of businesses per industrial group/business size between the two areas is similar, as depicted in Table III-5.

Of the total estimated BAU VOC emissions from industrial cleaning solvents in DFW, 46 percent occur in Dallas County and 28 percent occur in Tarrant County. The concentration of emissions in these counties is expected since they are the most populous counties and have a higher concentration of businesses compared to other counties in the DFW area (TSLAC, 2010). In HGB, 80 percent of the total estimated BAU VOC emissions from industrial cleaning solvents are concentrated in Harris County. Again, this is expected due to the same reasons mentioned for DFW. For both DFW and HGB, Table IV-11 indicates that small businesses generate the majority of the VOC emissions associated with industrial cleaning solvent usage (59 percent in DFW and 55 percent in HGB).

As shown in Table IV-12 and Figure IV-14, the VOC emissions and emissions reductions associated with cleaning solvents in 2011 are similar to the distributions observed in 2008. The explanation for the similar distribution is the same as that provided in sections IV.B and IV.D of this report.

Table IV-11. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by County in 2008

Area	County	2008 VOC Emissions (tons)						2008 VOC Emission Reduction (tons)	Percent of Total 2008 VOC Emission Reduction
		BAU			CTG				
		Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
Dallas-Fort Worth	Collin	231	247	478	216	231	447	31	4.6
	Dallas	1,488	951	2,439	1,392	891	2,283	156	23.1
	Denton	198	141	338	185	132	316	22	3.2
	Ellis	71	102	174	67	96	163	11	1.6
	Johnson	77	45	123	72	42	115	8	1.2
	Kaufman	47	40	87	44	38	81	5	0.8
	Parker	57	13	70	53	12	66	5	0.7
	Rockwall	44	8	52	41	8	49	3	0.5
	Tarrant	868	626	1,495	812	587	1,399	95	14.1
	All Counties	3,082	2,174	5,255	2,882	2,037	4,918	337	49.7
Houston -Galveston-Brazoria	Brazoria	114	75	189	107	70	177	12	1.8
	Chambers	14	20	34	13	18	32	2	0.3
	Fort Bend	182	167	348	170	156	326	22	3.3
	Galveston	90	28	118	84	26	110	8	1.1
	Harris	2,262	1,968	4,231	2,115	1,843	3,958	272	40.2
	Liberty	30	4	34	28	4	31	2	0.3
	Montgomery	180	88	268	168	82	250	17	2.5
	Waller	29	40	69	27	38	65	4	0.7
	All Counties	2,901	2,390	5,291	2,712	2,237	4,950	341	50.3
All Areas	All Counties	**5,983**	**4,563**	**10,546**	**5,594**	**4,274**	**9,868**	**678**	**100 (6.4)**

Note: The value in parentheses in the All Areas/Percent of Total 2008 VOC Emission Reduction cell is the percent of total emissions reduction in 2008 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-13. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by County in 2008

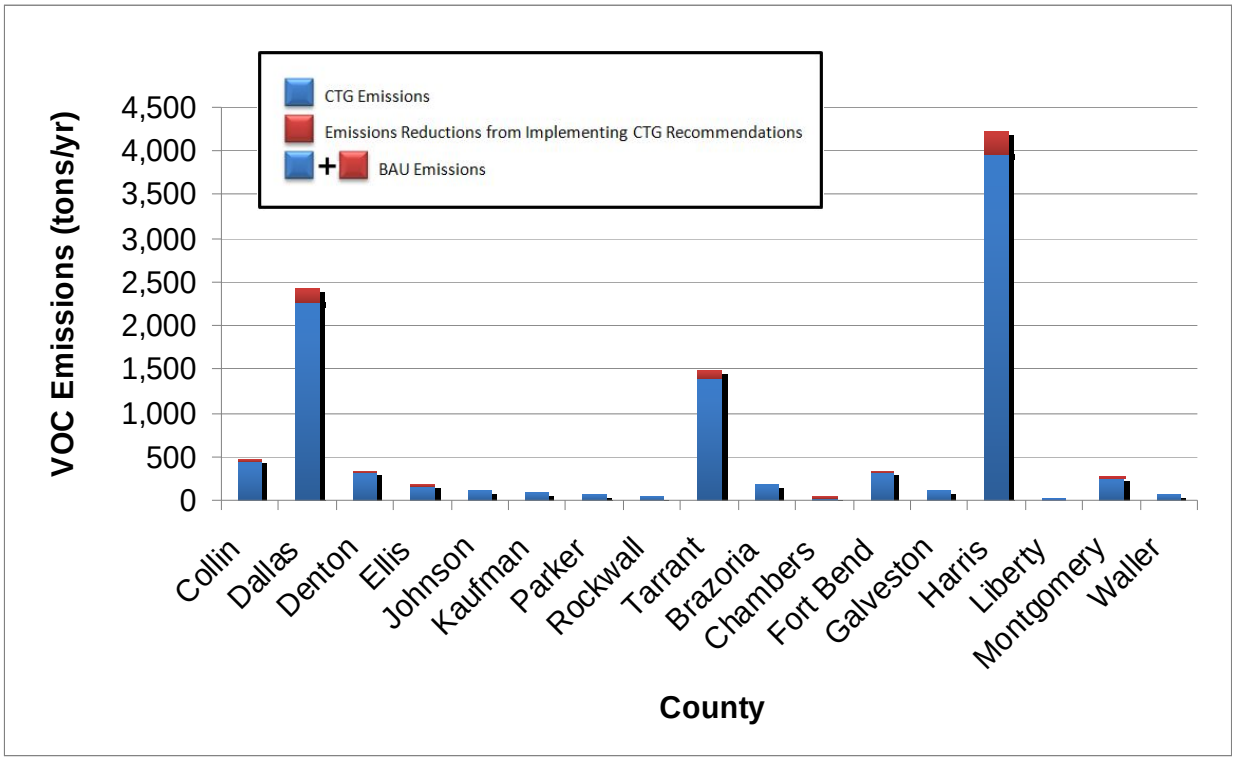
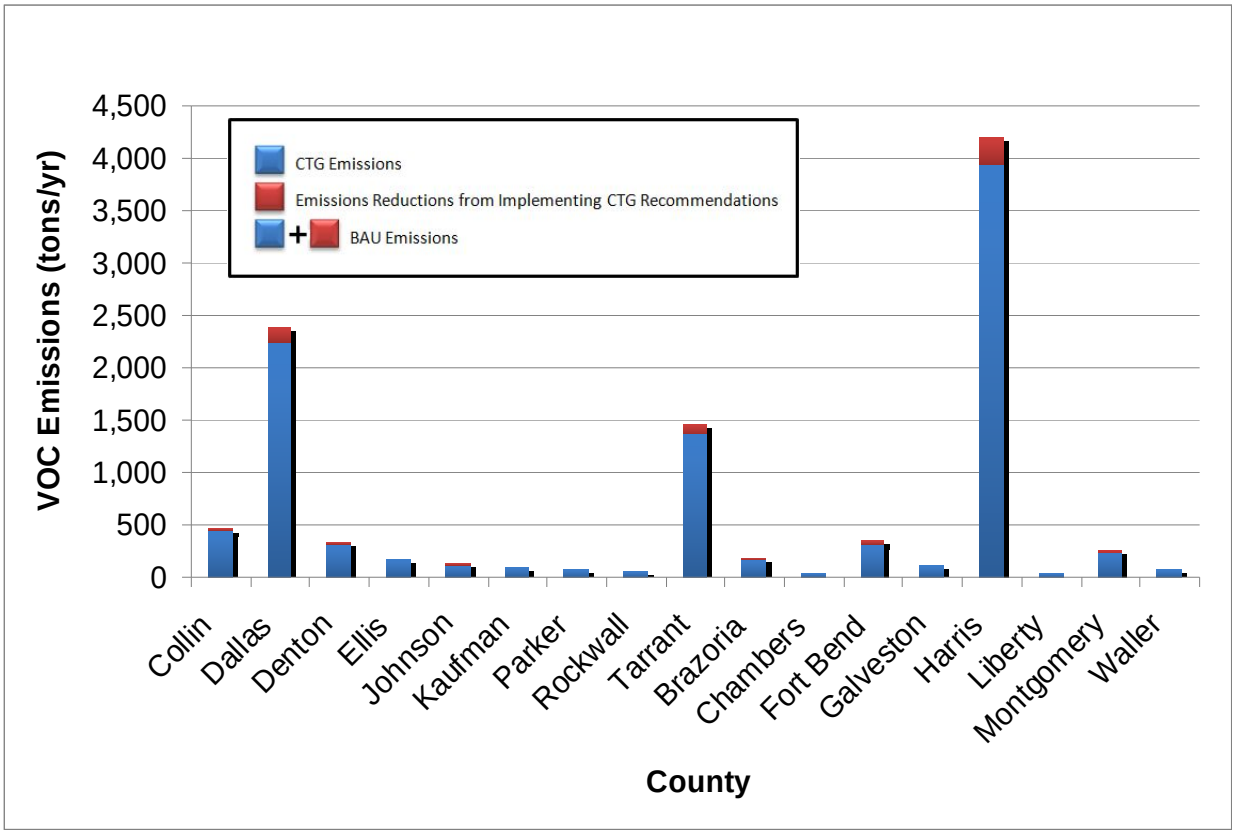


Table IV-12. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by County in 2011

Area	County	2011 VOC Emissions (tons)						2011 VOC Emission Reduction (tons)	Percent of Total 2011 VOC Emission Reduction
		BAU			CTG				
		Small Businesses	Large Businesses	All Businesses	Small Businesses	Large Businesses	All Businesses		
Dallas-Fort Worth	Collin	227	240	467	212	225	437	31	4.5
	Dallas	1,467	928	2,395	1,371	869	2,240	155	22.9
	Denton	194	138	333	182	130	311	22	3.2
	Ellis	71	99	170	66	93	159	11	1.6
	Johnson	76	45	122	71	43	114	8	1.2
	Kaufman	48	44	91	45	41	86	6	0.9
	Parker	57	13	70	54	12	65	5	0.7
	Rockwall	44	10	54	41	9	50	3	0.5
	Tarrant	863	609	1,472	807	570	1,377	95	14.0
	All Counties	3,047	2,126	5,173	2,848	1,991	4,839	334	6.5
Houston -Galveston-Brazoria	Brazoria	114	73	187	107	68	175	12	1.8
	Chambers	14	20	34	13	18	32	2	0.3
	Fort Bend	180	165	346	169	155	324	22	3.3
	Galveston	90	27	117	84	25	110	8	1.1
	Harris	2,275	1,935	4,211	2,127	1,811	3,938	272	40.4
	Liberty	30	5	34	28	4	32	2	0.3
	Montgomery	181	86	267	170	80	250	17	2.5
	Waller	29	44	72	27	41	68	5	0.7
	All Counties	2,915	2,354	5,269	2,725	2,203	4,928	341	50.5
All Areas	All Counties	**5,962**	**4,480**	**10,442**	**5,573**	**4,194**	**9,767**	**675**	**100 (6.5)**

Note: The value in parentheses in the All Areas/Percent of Total 2011 VOC Emission Reduction cell is the percent of total emissions reduction in 2011 associated with implementing the recommendations in the industrial cleaning solvents CTG.

Figure IV-14. Industrial Cleaning Solvent VOC Emissions in DFW and HGB by County in 2011



G. UNCERTAINTY ANALYSIS

A comprehensive assessment of the uncertainty in the emissions estimates was beyond the scope of this study. However, an assessment of the range of uncertainty associated with a few of the adhesive application process and cleaning unit operation emission estimates, which were derived from a range of variability in mean AFs and mean IFs, can provide a good qualitative sense of the overall uncertainty. For example, a higher level of certainty is obtained for an adhesive application process or cleaning unit operation with a low variability in mean AF or mean IF. The coefficient of variation (standard deviation divided by the mean) is a good statistic to use in identifying those adhesive application processes and cleaning unit operations with relatively high or low uncertainty. Sources of uncertainty for VOC emissions for each of the adhesive application processes and cleaning unit operations include the following:

- Variability in adhesive or cleaning solvent usage (AF);
- Variability in impact factor (IF);
- Error in the estimation of the user population (UF); and
- Error in the overall population estimates used to allocate emissions.

The variability in the emission estimation parameters, mean AF and mean IF, can be assessed with the descriptive statistics for each adhesive application process or cleaning unit operation, such as the weighted mean and standard deviation (see Table III-9 and Table III-10). In this analysis, the variability in the mean AF and mean IF is assumed to be plus or minus one standard deviation. The error associated with the user fraction, UF, is assumed to be represented by the sampling error of the survey. This survey achieved a sampling error of ±8 to 12 percent for each industry group (a value of 10 percent was used in this uncertainty analysis). Since the adhesive application processes and cleaning unit operations are generally weighted across industry groups, the sampling error by industry group should provide a reasonable estimation of the error in the user fraction estimate.

Employee population estimates were obtained from D&B. No information was available as to the error associated with their population data. Therefore, an error of ±10 percent was assumed for the D&B employment data.

The coefficients of variation of mean AF and mean IF for each of the adhesive application processes and cleaning unit operations were examined to determine which processes or operations would be representative of a low-degree and high-degree of variability. The application processes and cleaning unit operations with the lowest degree of variability should be represented by the mean AF and mean IF values with the lowest coefficient of variance. Those with the highest degree of variability should be represented by the AF and IF values with the highest coefficient of variance. The range of emissions uncertainty for each of the selected adhesive application processes and cleaning unit operations was calculated by multiplying the lowest value of each variable together to get the low end of the range and the highest value of each variable together to get the high end of the range (mean AF × mean IF × UF × employees). The results of the uncertainty analysis are presented in Table IV-13.

Table IV-13. Results of the Uncertainty Analysis

Code	Description	Emission Estimates (tons VOC/yr)		
		Mean	-1 Standard Deviation	+1 Standard Deviation
Adhesive Application Process				
GA3	Gluing Porous Material (except wood)	5	0	205
SA10	Multipurpose Construction Adhesive	257	98	461
Cleaning Unit Operation				
EQC	Equipment Cleaning	1,077	0	31,526
SMC	Small Manufactured Components Cleaning	4,981	0	18,826

For adhesive application processes, gluing porous material provides a sense of the highest degree of variability, whereas multipurpose construction adhesive provides a sense of the lowest degree of variability. For cleaning solvents, equipment cleaning provides a sense of the highest degree of variability, whereas small manufactured components cleaning provides a sense of the lowest degree of variability. The level of uncertainty in emissions is likely driven by the fact that low- and high-VOC containing materials are being averaged for any given adhesive application process or cleaning unit operation. As discussed in Chapter VI of this report, future studies should consider grouping low- and high-VOC containing (i.e., water-based versus solvent-based) materials separately. Additionally, future studies should target industry groups with high variability to gather larger samples. A larger sample size would improve model results by enabling more rigorous statistical analysis.

H. SUMMARY OF ESTIMATED VOC EMISSIONS REDUCTIONS

The data analysis presented in this chapter indicates that implementation of the recommendations in the Miscellaneous Industrial Adhesives CTG and Industrial Cleaning Solvents CTG is estimated to reduce VOC emissions from adhesive application processes and cleaning unit operations in DFW and HGB by 6.2 percent. The majority of these emissions reductions are associated with contact adhesive application, general adhesive application, the cleaning of small manufactured parts, spray gun cleaning and parts cleaning in non-manufacturing and miscellaneous manufacturing facilities in Dallas, Harris and Tarrant counties. A concentration of emissions in these counties is expected since they are the most populous counties and have a higher concentration of businesses compared to other counties in the DFW and HGB areas (TSLAC, 2010). The minor impact on VOC emissions from implementing the recommendations is a result of the VOC emissions from facilities affected by the CTGs being small compared to the aggregate VOC emissions from unaffected facilities.

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CHAPTER V. ASSESSMENT OF THE FINANCIAL IMPACT ON SMALL AND LARGE BUSINESSES IN TEXAS

A. DETERMINATION OF THE NUMBER OF AFFECTED FACILITIES

Section III.D outlines the procedure for determining whether a responding facility meets the applicability criteria of emitting 15 ppd of VOC. In determining the number of applicable facilities in the sample frame, it was assumed that there is no difference in the fraction of applicable facilities between DFW and HGB. This assumption is supported by the similar distribution of facilities by group in the sample frame. Therefore, the number of applicable facilities responding to the survey was used to generate the fraction of applicable facilities by business size and group. For any group/business size containing an applicable facility, the fraction of applicable facilities was multiplied by the total number of facilities in the sample frame to estimate the number of applicable facilities in the sample frame. An example calculation using Equation V-1 for adhesive users from Group 2/large businesses is provided below.

Equation V-1

$$\textit{Applicable Facilities}_{\textit{group/business size}} = \frac{\textit{\# applicable responding facilities}}{\textit{\# responding facilities}} \times \textit{\# facilities in sample frame}$$

From Table V-1, the number of applicable responding facilities in Group 2/large businesses is one. From Table III-1, the total number of responding facilities is 15. From Table III-5, the number of facilities in the sample frame is 57.

$$\text{Applicable Facilities}_{\text{Group 2/large}} = (1/15) \times 57 = 4$$

Table V-1. Number of Responding Facilities Meeting the Miscellaneous Industrial Adhesives CTG Applicability Criteria in 2008

Group	Number of Facilities		Total
	Small Businesses	Large Businesses	
(1) Non-manufacturing			**0**
(2) Food Manufacturing		1	**1**
(3) Fabric and Fiber Manufacturing			**0**
(4) Wood and Wood Products	1	2	**3**
(5) Fabricated Metals			**0**
(6) Industrial Machinery			**0**
(7) Transportation Equipment			**0**
(8) Other Manufacturing	1	3 (1)	**4 (1)**
Total	**2**	**6**	**8 (1)**

Notes: The number in parentheses indicates the number of facilities that meet the applicability criteria, but are already using control devices.

Similar logic was used to calculate the number of facilities that meet the applicability criteria in the industrial cleaning solvent CTG and the number of facilities that meet the applicability criteria that are already using control devices. Table V-2 provides an estimate of the number of responding facilities affected by the industrial cleaning solvent CTG. The number of facilities affected by the CTG is simply the number of applicable facilities minus the number of applicable facilities that are already using control devices.

Table V-2. Number of Responding Facilities Meeting the Industrial Cleaning Solvents CTG Applicability Criteria in 2008

Group	Number of Facilities		Total
	Small Businesses	Large Businesses	
(1) Non-manufacturing		2	**2**
(2) Food Manufacturing		1	**1**
(3) Fabric and Fiber Manufacturing			**0**
(4) Wood and Wood Products			**0**
(5) Fabricated Metals	1	6 (2)	**7 (2)**
(6) Industrial Machinery		5	**5**
(7) Transportation Equipment	1	3 (1)	**4 (1)**
(8) Other Manufacturing	1	18 (2)	**19 (2)**
Total	**3**	**35 (5)**	**38 (5)**

Notes: The number in parentheses indicates the number of facilities that meet the applicability criteria, but are already using control devices.

A similar approach was also used to estimate the number of affected facilities in 2011. The facility-level emissions estimates calculated in section III.D were grown to 2011 using the growth factors provided in section III.E. The facility level emissions were then used to determine whether a responding facility meets the applicability criteria of emitting 15 ppd of VOC. The calculation of affected facilities described above was then used to determine the number of facilities impacted by the CTGs in 2011.

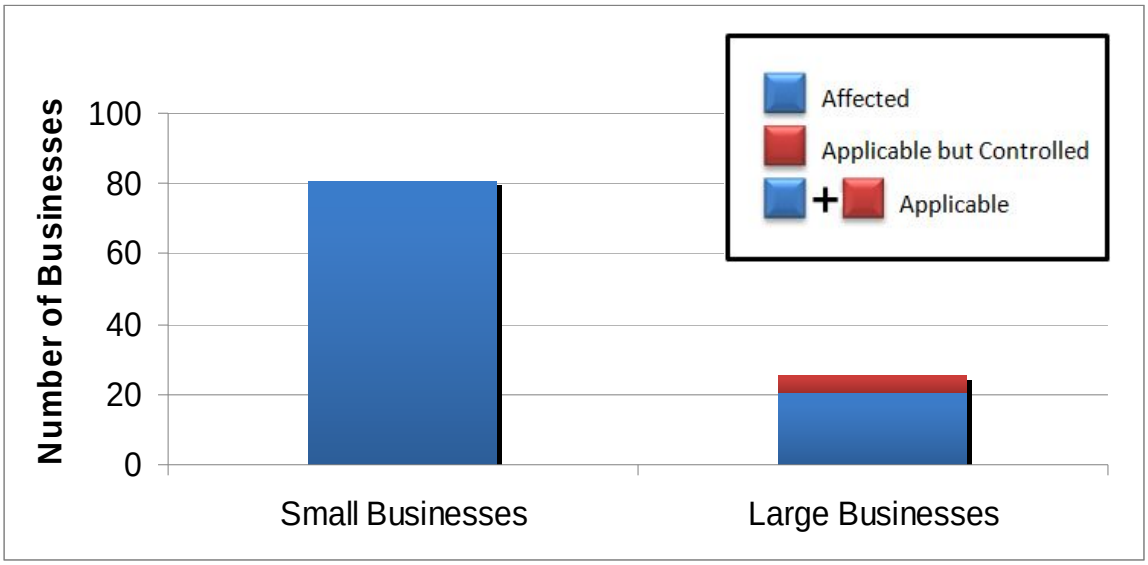
The total number of facilities estimated to be affected by the Miscellaneous Industrial Adhesives CTG is presented in Table V-3 and Figure V-1. In total, it is estimated that there are 107 facilities emitting more than 15 ppd of VOC from the use of industrial adhesives in 2008. Of these, 81 (or 76 percent) are small businesses and 26 (or 24 percent) are large businesses. It is estimated that none of the small businesses and five of the large businesses are already using control devices. Therefore, the total number of affected facilities is 102 with 81 (or 79 percent) being small businesses. The majority of affected facilities (83 percent) are in Group 8, the miscellaneous manufacturing group. The number of facilities affected by the Miscellaneous Industrial Adhesives CTG in 2011 is the same as those affected in 2008.

Table V-3. Estimated Number of DFW and HGB Facilities Affected by the Miscellaneous Industrial Adhesives CTG[1]

Group	Business Size	Applicable Facilities	Applicable Facilities with Controls	Affected Facilities
(2) Food Manufacturing	Large	4		4
(4) Wood and Wood Products	Large	7		7
(4) Wood and Wood Products	Small	6		6
(8) Other Manufacturing	Large	15	5	10
(8) Other Manufacturing	Small	75		75
Total Small		**81**	**0**	**81**
Total Large		**26**	**5**	**21**
Total All		**107**	**5**	**102**

[1]There are no differences in the number of facilities affected by the adhesives CTG in 2008 versus 2011.

Figure V-1. Estimated Number of DFW and HGB Facilities Affected by the Miscellaneous Industrial Adhesives CTG



Note: There are no differences in the number of facilities affected by the Miscellaneous Industrial Adhesives CTG in 2008 versus 2011.

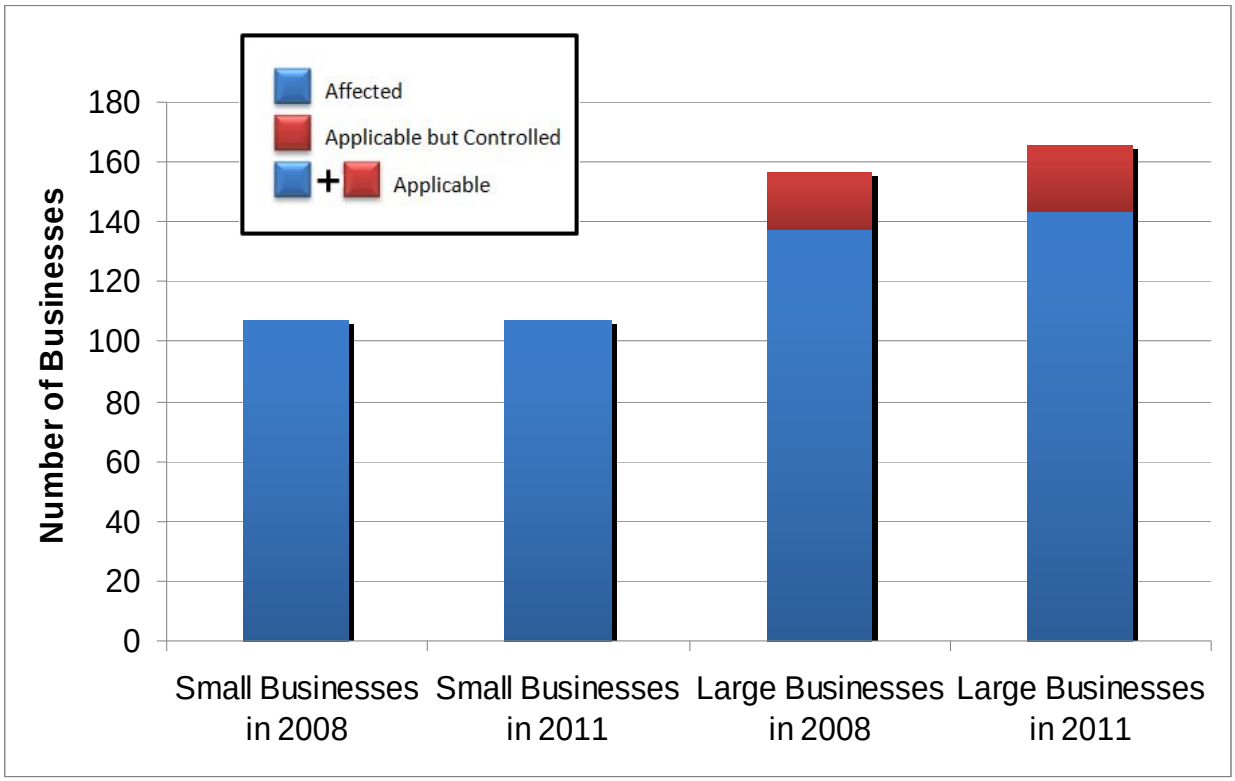
The total number of facilities estimated to be affected by the Industrial Cleaning Solvents CTG is presented in Table V-4 and Figure V-2. In total, it is estimated that there are 266 facilities emitting more than 15 ppd of VOC from the use of industrial cleaning solvents in 2008. Of these, 108 (or 41 percent) are small businesses and 158 (or 59 percent) are large businesses. It is estimated that none of the small businesses and 19 of the large businesses are already using control devices. Therefore, the total number of affected facilities is 247 with 108 (or 44 percent) being small businesses. The majority of affected facilities (62 percent) are in Group 8, the miscellaneous manufacturing group. The number of facilities affected by the Industrial Cleaning Solvents CTG in 2011 is the same as for all groups, except large businesses in Group 5 (fabricated metal manufacturing industries). For this group, there are six additional facilities anticipated to be affected by the CTG in 2011.

All of the installed control devices occur at large businesses. This is not unexpected since the expense of add-on control devices makes them cost-prohibitive to small businesses.

Table V-4. Estimated Number of DFW and HGB Facilities Affected by the Industrial Cleaning Solvents CTG

Group	Business Size	2008			2011		
		Applicable Facilities	Applicable Facilities with Controls	Affected Facilities	Applicable Facilities	Applicable Facilities with Controls	Affected Facilities
(1) Non-manufacturing	Large	20		20	20		20
(2) Food Manufacturing	Large	4		4	4		4
(5) Fabricated Metals	Large	18	6	12	27	9	18
(5) Fabricated Metals	Small	27		27	27		27
(6) Industrial Machinery	Large	18		18	18		18
(7) Transportation Equipment	Large	9	3	6	9	3	6
(7) Transportation Equipment	Small	6		6	6		6
(8) Other Manufacturing	Large	89	10	79	89	10	79
(8) Other Manufacturing	Small	75		75	75		75
Total Small		**108**	**0**	**108**	**108**	**0**	**108**
Total Large		**158**	**19**	**139**	**167**	**22**	**145**
Total All		**266**	**19**	**247**	**275**	**22**	**253**

Figure V-2. Estimated Number of DFW and HGB Facilities Affected by the Industrial Cleaning Solvents CTG



B. DETERMINING THE COST-EFFECTIVENESS ASSOCIATED WITH IMPLEMENTING THE CTG RECOMMENDATIONS

For facilities meeting the applicability requirements outlined in the CTGs, EPA recommends that facilities implement work place practices and switch from high-to-low VOC materials. Due to costs, the use of add-on controls, such as catalytic or thermal incinerators, are not recommended, but offered as an alternative to provide facilities operational flexibility when the use of high-VOC adhesives is necessary, or desirable, for product efficacy. The costs for thermal incinerators can reach into the hundreds of thousands of dollars depending on the flue gas volumetric flow rate and energy recovery, a cost that would be prohibitive for many small businesses (EPA, 2000).

The research team performed literature searches in an attempt to obtain additional economic studies on product switching beyond those cited in the CTGs. While several additional studies were found, none of the studies proved relevant for use in estimating the economic impacts of implementing the CTG recommendations. Brief summaries of the studies found are presented below along with how the research team developed the cost-effectiveness values used in this study.

1. Industrial Adhesives

An EPA study prepared by the Institute for Research and Technical Assistance (IRTA) evaluated the cost and performance of adhesive switching in the foam fabrication, upholstered furniture manufacturing, and mattress manufacturing industries (IRTA, 2000). However, a review of the study revealed that most adhesive switching was from methylene chloride-based to n-propyl bromide-based adhesives to reduce worker exposure to methylene chloride. Since methylene chloride is exempt from VOC regulation, the results of the study are not suitable to evaluate the cost of switching from high- to low-VOC adhesives.

Since no additional studies were identified, the research team reviewed the economic analysis included in the Miscellaneous Industrial Adhesives CTG. This analysis was based on the 1993 Ventura County APCD Rule 74.20 Staff Report which included a cost analysis of adhesive switching in a commercial furniture manufacturing facility. The process evaluated at the facility was lamination of particle board panels with melamine and phenolic plastic. The annualized cost per facility of switching from a high- to low-VOC adhesive in this application process was estimated at $2,300 (1993$ with a cost of capital of 10 percent and payback time of 10 years). This annualized cost includes capital costs, operation/maintenance costs, solvent savings, and adhesive costs. To estimate the total annualized cost associated with implementing the CTG recommendations, EPA scaled the 1993 annualized cost to 2007 and multiplied the scaled annualized cost value per facility ($3,356) by the number of facilities estimated to emit above the recommended VOC emissions applicability threshold of 15 ppd. The EPA derived a cost-effectiveness value of $265 per ton of VOC emissions reduction by dividing the total annualized cost by the estimated VOC reductions resulting from implementation of the Miscellaneous Industrial Adhesives CTG recommendations.

After reviewing the 1993 Ventura County APCD Rule 74.20 Staff Report, the research team concluded that a better method for estimating total annualized cost is to multiply a cost-effectiveness value derived from the furniture manufacturing facility study by total emission reductions at that facility. Using such an approach will capture the inter-facility variability in emissions reductions, which are correlated with the volume of high-VOC adhesives being switched to low-VOC adhesives. A cost-effectiveness of $0.43 per pound of VOC reduced was reported in the Staff Report. The capital cost portion of this value was adjusted assuming a cost of capital of 5 percent and a payback time of 5 years. This adjusted value was then scaled to 2008 dollars using the consumer price index and converted to a per ton basis by multiplying by 2,000 pounds/ton (BLS, 2010). The resulting cost-effectiveness value of $1,421 per ton of VOC emissions reduced was used to assess the financial impact of the CTG recommendations and is significantly higher than the cost-effectiveness that EPA calculated.

While no information was found on the costs associated with work practice procedures, the research team agrees with EPA's assertion that such procedures should contribute to cost reductions by reducing the amount of cleaning materials used.

2. Industrial Cleaning Solvents

Another study by IRTA evaluated the costs associated with switching from high- to low-VOC cleaning materials for two wood refinishing companies, three contractors, and five autobody shops (IRTA, 2004). In almost all cases, the low-VOC materials evaluated were acetone (an exempt VOC solvent) or an acetone/methyl acetate blend. While switching from high-VOC to VOC-exempt cleaning solvents is likely at some Texas facilities affected by the CTG recommendations, the research team concluded that the analysis provided in the IRTA study is not superior to the economic analysis included in the CTG. For example, in the IRTA study, the volume of cleaning solvents used at one wood furniture company is 52 gallons per year and the usage at the other wood furniture company is 2 gallons per year. Both of these volumes are well below the approximate usage volume of 730 gallons per year necessary to meet the CTG applicability criteria. Usage volumes reported for the autobody shops were also well below the usage to trigger applicability.

Since no additional studies proved relevant, the research team reviewed the economic analysis included in the Industrial Cleaning Solvents CTG. For parts cleaning, a cost-effectiveness value of $1,664 per ton of VOC reduced (2002$ with a cost of capital of 10 percent and payback time of 10 years; $2,589 per ton in 2008$ with a cost of capital of 5 percent and a payback time of 5 years) was taken from a study used to support amendments to California's Bay Area Air Quality Management District Regulation 8, Rule 16. This value is based on the cost-effectiveness of meeting a 50 grams of VOC per liter of cleaning material requirement (the same limit recommended in the CTG). For all other cleaning unit operations, EPA derived a cost-effectiveness value of -$1,325 (a cost savings of $1,590 in 2008$) based on the cost difference in cleaning material cost and cost difference in waste disposal cost. The savings is a result of the lower cleaning materials cost offsetting the increase in waste disposal cost.

The cost-effectiveness values applied in this study were derived by weighting the cost-effectiveness values above according to the percentage of emissions reduced by cleaning unit operation. For example, 33 percent of the emissions reductions associated with large businesses in Group 2 are associated with parts cleaning. The remaining 67 percent of emissions reductions are associated with other cleaning unit operations. The calculation of the weighted cost-effectiveness is presented in the following example calculation:

$$(\$2{,}589 \times 0.33) + (-\$1{,}590 \times 0.67) = -\$214 \text{ per ton of VOC emission reductions}$$

The weighted cost-effectiveness values are presented in Table V-6.

Again, while no information was found on the costs associated with work practice procedures, the research team agrees with EPA's assertion that such procedures should contribute to cost reductions by reducing the amount of cleaning materials used.

C. ESTIMATED FINANCIAL IMPACT ON SMALL AND LARGE BUSINESSES IN TEXAS

The costs to small and large businesses affected by the CTGs were calculated by group/business size by multiplying the cost-effectiveness by the estimated VOC emissions reductions resulting from implementing the recommendations in the CTGs. The results of the costs analysis for adhesives and cleaning solvents are presented in Table V-5 and Table V-6, respectively.

For affected facilities using industrial adhesives in 2008, the cost distribution between small and large businesses indicates that, in total, small businesses will shoulder slightly more of the cost burden (56 percent of the cost vs. 44 percent). However, on a cost per facility basis, complying with the CTG recommendations will cost an affected small business $1,490 per year, on average, versus $4,480 for a large business. This is expected since large businesses are likely to use, on average, a larger volume of high-VOC adhesives than small businesses. The overall cost burden in 2011 is estimated to be slightly less than 2008, with the cost distribution between small and large businesses similar to that of 2008.

For affected facilities using industrial cleaning solvents in 2008, the cost distribution between small and large businesses indicates that, in total, small businesses will realize a higher cost savings (54 percent of total savings vs. 46 percent). On a cost per facility basis, complying with the CTG recommendations will save an affected small business $2,760 per year, on average, versus $1,840 for a large business. The difference in cost savings can be attributed to the fact that affected large businesses have a larger share of emissions associated with parts cleaners. As discussed in section V.C, the cost-effectiveness for switching to low-VOC cleaning materials for parts cleaning is estimated at $2,589 per ton of VOC reduced. This compares to a cost savings of $1,590 for switching from high- to low-VOC cleaning materials in other cleaning unit operations. The overall cost savings in 2011 are estimated to be 8 percent less than 2008, with the distribution of cost savings between small and large businesses similar to that of 2008.

Table V-5. Costs of Implementing the Recommendations in the Industrial Adhesives CTG

Group	Business Size	2008 VOC Emission Reduction by Implementing CTG (tons)	2011 VOC Emission Reduction by Implementing CTG (tons)	Cost-Effectiveness (2008$ per ton)	2008 Cost (2008$)	2011 Cost (2008$)
(1) Non-manufacturing	Small	41	40	1,421	58,235	57,477
(2) Food Manufacturing	Small	2	2	1,421	3,278	2,508
(3) Fabric and Fiber Manufacturing	Small	0	0	1,421	557	498
(4) Wood and Wood Products	Small	4	4	1,421	5,586	5,061
(5) Fabricated Metals	Small	7	9	1,421	9,888	12,192
(6) Industrial Machinery	Small	6	5	1,421	7,928	7,412
(7) Transportation Equipment	Small	1	1	1,421	1,753	1,791
(8) Other Manufacturing	Small	24	23	1,421	33,708	32,056
(1) Non-manufacturing	Large	22	22	1,421	31,639	31,228
(2) Food Manufacturing	Large	4	3	1,421	6,176	4,724
(3) Fabric and Fiber Manufacturing	Large	0	0	1,421	77	69
(4) Wood and Wood Products	Large	3	3	1,421	4,476	4,055
(5) Fabricated Metals	Large	4	5	1,421	5,576	6,875
(6) Industrial Machinery	Large	4	4	1,421	6,074	5,679
(7) Transportation Equipment	Large	2	2	1,421	3,046	3,113
(8) Other Manufacturing	Large	26	25	1,421	36,928	35,119
Total Small		**85**	**84**		**120,931**	**118,996**
Total Large		**66**	**64**		**93,992**	**90,863**
Total All		**151**	**148**		**214,923**	**209,858**

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Table V-6. Costs of Implementing the Recommendations in the Industrial Cleaning Solvents CTG

Group	Business Size	2008 VOC Emission Reduction by Implementing CTG (tons)	2011 VOC Emission Reduction by Implementing CTG (tons)	Cost-Effectiveness (2008$ per ton)	2008 Cost (2008$)	2011 Cost (2008$)
(1) Non-manufacturing	Small	180	178	-1,019	-183,021	-181,323
(2) Food Manufacturing	Small	2	2	-1,019	-1,997	-1,558
(3) Fabric and Fiber Manufacturing	Small	7	6	-1,019	-6,890	-6,190
(4) Wood and Wood Products	Small	11	10	-1,019	-11,094	-10,086
(5) Fabricated Metals	Small	46	57	2,589	118,324	146,397
(6) Industrial Machinery	Small	27	25	-1,019	-27,112	-25,438
(7) Transportation Equipment	Small	6	6	-1,590	-9,538	-9,782
(8) Other Manufacturing	Small	111	106	-1,590	-176,409	-168,344
(1) Non-manufacturing	Large	98	97	52	5,074	5,027
(2) Food Manufacturing	Large	4	3	-214	-790	-616
(3) Fabric and Fiber Manufacturing	Large	1	1	-1,284	-1,206	-1,083
(4) Wood and Wood Products	Large	9	8	-1,284	-11,200	-10,182
(5) Fabricated Metals	Large	26	32	-1,220	-31,442	-38,902
(6) Industrial Machinery	Large	20	19	-1,427	-29,091	-27,295
(7) Transportation Equipment	Large	10	11	-394	-4,108	-4,213
(8) Other Manufacturing	Large	122	116	-1,500	-182,325	-173,989
Total Small		**388**	**389**		**-297,738**	**-256,323**
Total Large		**289**	**286**		**-255,088**	**-251,253**
Total All		**678**	**675**		**-552,826**	**-507,576**

D. SUMMARY OF THE ESTIMATED NUMBER OF AFFECTED FACILITIES AND ESTIMATED FINANCIAL IMPACT

In 2008, the estimated number of facilities in DFW and HGB affected by the Miscellaneous Industrial Adhesives CTG recommendations is 102 with 81 (or 79 percent) being small businesses. The majority of these affected facilities (83 percent) are in the miscellaneous manufacturing group. The total annual estimated cost from implementing the Miscellaneous Industrial Adhesives CTG to small businesses in DFW and HGB is $121,000 and the cost to large businesses is $94,000. On a cost per facility basis, complying with the Miscellaneous Industrial Adhesives CTG recommendations is estimated to cost an affected small business $1,490 per year, on average, versus $4,480 for a large business. This is expected since large businesses are likely to use, on average, a larger volume of high-VOC adhesives than small businesses.

The total number of facilities affected by the Industrial Cleaning Solvents CTG recommendations is 247 with 108 (or 44 percent) being small businesses. The majority of these affected facilities (62 percent) are in Group 8, the miscellaneous manufacturing group. The total annual estimated cost savings from implementing the Industrial Cleaning Solvents CTG recommendations to small businesses in DFW and HGB is $298,000 and the cost savings to large businesses is $255,000. On a cost savings per facility basis, complying with the Industrial Cleaning Solvents CTG recommendations will save an affected small business $2,760 per year, on average, versus $1,840 for a large business. The difference in cost savings can be attributed to the fact that affected large businesses have a larger share of emissions associated with parts cleaners.

If the recommendations in both CTGs are implemented, the estimated cost savings associated with implementing the Industrial Cleaning Solvents CTG recommendations will outweigh the estimated costs from implementing the recommendations in the Miscellaneous Industrial Adhesives CTG. In total, the estimated cost savings are $338,000. However, as discussed in section V.B, the cost-effectiveness information is derived from relatively few studies and may not be applicable to all facilities. Consequently, there is a high-degree of uncertainty in the cost analysis presented in this report. Additional studies on the inter- and intra-industry variability in product switching costs would enable refinement of the cost analysis presented in this study, resulting in a more accurate cost estimate.

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CHAPTER VI. RECOMMENDATIONS FOR FUTURE STUDIES

The limited uncertainty analysis performed as part of this study shows that considerable uncertainties exist for emission estimates from many of the industrial adhesive application processes and industrial cleaning unit operations. The only way to reduce the uncertainty in the emission estimates is to better characterize the usage patterns, including volumes and chemical compositions of the materials, for those adhesive application processes and cleaning unit operations displaying high degrees of uncertainty. This could be accomplished through further disaggregation of the emission model variables and further disaggregation of adhesive application processes and cleaning unit operations. For example, the data for each adhesive application process or cleaning unit operation could be further divided according to whether the application process or unit operation is using water-based or solvent-based materials. This would reduce the variability in the mean IF since low- and high-VOC materials would be averaged separately. In the future, additional surveys could be used to fill these data needs. Additional data would also allow for further disaggregation by industry group, which would likely lead to model variables with lower variability, and hence, less uncertainty.

Future studies should also address the percentage of industrial cleaning solvents that are recycled, as opposed to assuming that all of the VOCs in the cleaning materials are emitted during use. Accounting for the recycled portion will better reflect the true emissions from the cleaning unit operations. For example, this study likely overestimates VOC emissions from parts cleaning since a portion of industrial cleaning solvents used in parts washers is usually recycled.

The cost-effectiveness values applied in this study were derived from relatively few studies and, as discussed in Chapter V, may not be applicable to all facilities. Consequently, there is a high-degree of uncertainty in the cost analysis. Additional studies on the inter- and intra-industry variability in product switching costs, as well as costs associated with work practice procedures, would enable refinement of the cost analysis, resulting in a more accurate cost estimate.

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CHAPTER VII. REFERENCES

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APPENDIX A. NAICS CODES INCLUDED IN EACH INDUSTRY GROUP

Table A-1. Non-manufacturing

NAICS	NAICS Description
211111	Crude Petroleum and Natural Gas Extraction
236115	New Single-Family Housing Construction (except Operative Builders)
236118	Residential Remodelers
236220	Commercial and Institutional Building Construction
237120	Oil and Gas Pipeline and Related Structures Construction
237130	Power and Communication Line and Related Structures Construction
237310	Highway, Street, and Bridge Construction
238170	Siding Contractors
238290	Other Building Equipment Contractors
238320	Painting and Wall Covering Contractors
238350	Finish Carpentry Contractors
238910	Site Preparation Contractors
423110	Automobile and Other Motor Vehicle Merchant Wholesalers
423120	Motor Vehicle Supplies and New Parts Merchant Wholesalers
423130	Tire and Tube Merchant Wholesalers
423140	Motor Vehicle Parts (Used) Merchant Wholesalers
423860	Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers
441110	New Car Dealers
441120	Used Car Dealers
441310	Automotive Parts and Accessories Stores
481112	Scheduled Freight Air Transportation
481211	Nonscheduled Chartered Passenger Air Transportation
481219	Other Nonscheduled Air Transportation
485111	Mixed Mode Transit Systems
485113	Bus and Other Motor Vehicle Transit Systems
485410	School and Employee Bus Transportation
485510	Charter Bus Industry
485999	All Other Transit and Ground Passenger Transportation
487110	Scenic and Sightseeing Transportation, Land
488190	Other Support Activities for Air Transportation
488210	Support Activities for Rail Transportation
488490	Other Support Activities for Road Transportation
488999	All Other Support Activities for Transportation
492110	Couriers
532411	Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing
811111	General Automotive Repair
811118	Other Automotive Mechanical and Electrical Repair and Maintenance
811121	Automotive Body, Paint, and Interior Repair and Maintenance
811122	Automotive Glass Replacement Shops
811198	All Other Automotive Repair and Maintenance
811211	Consumer Electronics Repair and Maintenance
811212	Computer and Office Machine Repair and Maintenance
811213	Communication Equipment Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
811412	Appliance Repair and Maintenance
811420	Reupholstery and Furniture Repair
811490	Other Personal and Household Goods Repair and Maintenance

Table A-2. Food Manufacturing

NAICS	NAICS Description
311111	Dog and Cat Food Manufacturing
311119	Other Animal Food Manufacturing
311211	Flour Milling
311212	Rice Milling
311221	Wet Corn Milling
311222	Soybean Processing
311223	Other Oilseed Processing
311225	Fats and Oils Refining and Blending
311230	Breakfast Cereal Manufacturing
311312	Cane Sugar Refining
311320	Chocolate and Confectionery Manufacturing from Cacao Beans
311330	Confectionery Manufacturing from Purchased Chocolate
311340	Nonchocolate Confectionery Manufacturing
311412	Frozen Specialty Food Manufacturing
311421	Fruit and Vegetable Canning
311422	Specialty Canning
311423	Dried and Dehydrated Food Manufacturing
311511	Fluid Milk Manufacturing
311512	Creamery Butter Manufacturing
311513	Cheese Manufacturing
311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
311520	Ice Cream and Frozen Dessert Manufacturing
311812	Commercial Bakeries
311813	Frozen Cakes, Pies, and Other Pastries Manufacturing
311821	Cookie and Cracker Manufacturing
311822	Flour Mixes and Dough Manufacturing from Purchased Flour
311823	Dry Pasta Manufacturing
311830	Tortilla Manufacturing
311911	Roasted Nuts and Peanut Butter Manufacturing
311919	Other Snack Food Manufacturing
311920	Coffee and Tea Manufacturing
311930	Flavoring Syrup and Concentrate Manufacturing
311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing
311942	Spice and Extract Manufacturing
311991	Perishable Prepared Food Manufacturing
311999	All Other Miscellaneous Food Manufacturing
312111	Soft Drink Manufacturing
312112	Bottled Water Manufacturing
312113	Ice Manufacturing
312120	Breweries
312130	Wineries
312221	Cigarette Manufacturing
312229	Other Tobacco Product Manufacturing

Table A-3. Fabric and Fiber Manufacturing

NAICS	NAICS Description
313113	Thread Mills
313210	Broadwoven Fabric Mills
313221	Narrow Fabric Mills
313222	Schiffli Machine Embroidery
313230	Nonwoven Fabric Mills
313241	Weft Knit Fabric Mills
313249	Other Knit Fabric and Lace Mills
313311	Broadwoven Fabric Finishing Mills
313312	Textile and Fabric Finishing (except Broadwoven Fabric) Mills
314110	Carpet and Rug Mills
314121	Curtain and Drapery Mills
314129	Other Household Textile Product Mills
314911	Textile Bag Mills
314912	Canvas and Related Product Mills
314991	Rope, Cordage, and Twine Mills
314999	All Other Miscellaneous Textile Product Mills
315111	Sheer Hosiery Mills
315191	Outerwear Knitting Mills
315211	Men's and Boys' Cut and Sew Apparel Contractors
315212	Women's, Girls', and Infants' Cut and Sew Apparel Contractors
315222	Men's and Boys' Cut and Sew Suit, Coat, and Overcoat Manufacturing
315223	Men's and Boys' Cut and Sew Shirt (except Work Shirt) Manufacturing
315224	Men's and Boys' Cut and Sew Trouser, Slack, and Jean Manufacturing
315225	Men's and Boys' Cut and Sew Work Clothing Manufacturing
315231	Women's and Girls' Cut and Sew Lingerie, Loungewear, and Nightwear Manufacturing
315232	Women's and Girls' Cut and Sew Blouse and Shirt Manufacturing
315233	Women's and Girls' Cut and Sew Dress Manufacturing
315234	Women's and Girls' Cut and Sew Suit, Coat, Tailored Jacket, and Skirt Manufacturing
315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing
315292	Fur and Leather Apparel Manufacturing
315299	All Other Cut and Sew Apparel Manufacturing
315991	Hat, Cap, and Millinery Manufacturing
315992	Glove and Mitten Manufacturing
315999	Other Apparel Accessories and Other Apparel Manufacturing
316110	Leather and Hide Tanning and Finishing
316211	Rubber and Plastics Footwear Manufacturing
316213	Men's Footwear (except Athletic) Manufacturing
316214	Women's Footwear (except Athletic) Manufacturing
316219	Other Footwear Manufacturing
316991	Luggage Manufacturing
316992	Women's Handbag and Purse Manufacturing
316993	Personal Leather Good (except Women's Handbag and Purse) Manufacturing
316999	All Other Leather Good Manufacturing

Table A-4. Wood and Wood Products

NAICS	NAICS Description
321113	Sawmills
321114	Wood Preservation
321213	Engineered Wood Member (except Truss) Manufacturing
321214	Truss Manufacturing
321911	Wood Window and Door Manufacturing
321912	Cut Stock, Resawing Lumber, and Planing
321918	Other Millwork (including Flooring)
321920	Wood Container and Pallet Manufacturing
321991	Manufactured Home (Mobile Home) Manufacturing
321992	Prefabricated Wood Building Manufacturing
321999	All Other Miscellaneous Wood Product Manufacturing
322121	Paper (except Newsprint) Mills
322122	Newsprint Mills
322130	Paperboard Mills
322211	Corrugated and Solid Fiber Box Manufacturing
322212	Folding Paperboard Box Manufacturing
322213	Setup Paperboard Box Manufacturing
322214	Fiber Can, Tube, Drum, and Similar Products Manufacturing
322215	Nonfolding Sanitary Food Container Manufacturing
322224	Uncoated Paper and Multiwall Bag Manufacturing
322231	Die-Cut Paper and Paperboard Office Supplies Manufacturing
322232	Envelope Manufacturing
322233	Stationery, Tablet, and Related Product Manufacturing
322291	Sanitary Paper Product Manufacturing
322299	All Other Converted Paper Product Manufacturing

Table A-5. Fabricated Metals

NAICS	NAICS Description
332111	Iron and Steel Forging
332112	Nonferrous Forging
332114	Custom Roll Forming
332115	Crown and Closure Manufacturing
332116	Metal Stamping
332117	Powder Metallurgy Part Manufacturing
332211	Cutlery and Flatware (except Precious) Manufacturing
332212	Hand and Edge Tool Manufacturing
332213	Saw Blade and Handsaw Manufacturing
332214	Kitchen Utensil, Pot, and Pan Manufacturing
332311	Prefabricated Metal Building and Component Manufacturing
332312	Fabricated Structural Metal Manufacturing
332313	Plate Work Manufacturing
332321	Metal Window and Door Manufacturing
332322	Sheet Metal Work Manufacturing
332323	Ornamental and Architectural Metal Work Manufacturing
332410	Power Boiler and Heat Exchanger Manufacturing
332420	Metal Tank (Heavy Gauge) Manufacturing
332431	Metal Can Manufacturing
332439	Other Metal Container Manufacturing
332510	Hardware Manufacturing
332611	Spring (Heavy Gauge) Manufacturing
332612	Spring (Light Gauge) Manufacturing
332618	Other Fabricated Wire Product Manufacturing
332710	Machine Shops
332721	Precision Turned Product Manufacturing
332722	Bolt, Nut, Screw, Rivet, and Washer Manufacturing
332811	Metal Heat Treating
332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
332911	Industrial Valve Manufacturing
332912	Fluid Power Valve and Hose Fitting Manufacturing
332913	Plumbing Fixture Fitting and Trim Manufacturing
332919	Other Metal Valve and Pipe Fitting Manufacturing
332991	Ball and Roller Bearing Manufacturing
332992	Small Arms Ammunition Manufacturing
332993	Ammunition (except Small Arms) Manufacturing
332994	Small Arms Manufacturing
332995	Other Ordnance and Accessories Manufacturing
332996	Fabricated Pipe and Pipe Fitting Manufacturing
332997	Industrial Pattern Manufacturing
332998	Enameled Iron and Metal Sanitary Ware Manufacturing
332999	All Other Miscellaneous Fabricated Metal Product Manufacturing

Table A-6. Industrial Machinery

NAICS	NAICS Description
333111	Farm Machinery and Equipment Manufacturing
333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing
333120	Construction Machinery Manufacturing
333131	Mining Machinery and Equipment Manufacturing
333132	Oil and Gas Field Machinery and Equipment Manufacturing
333210	Sawmill and Woodworking Machinery Manufacturing
333220	Plastics and Rubber Industry Machinery Manufacturing
333291	Paper Industry Machinery Manufacturing
333292	Textile Machinery Manufacturing
333293	Printing Machinery and Equipment Manufacturing
333294	Food Product Machinery Manufacturing
333295	Semiconductor Machinery Manufacturing
333298	All Other Industrial Machinery Manufacturing
333311	Automatic Vending Machine Manufacturing
333312	Commercial Laundry, Drycleaning, and Pressing Machine Manufacturing
333313	Office Machinery Manufacturing
333314	Optical Instrument and Lens Manufacturing
333315	Photographic and Photocopying Equipment Manufacturing
333319	Other Commercial and Service Industry Machinery Manufacturing
333411	Air Purification Equipment Manufacturing
333412	Industrial and Commercial Fan and Blower Manufacturing
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
333511	Industrial Mold Manufacturing
333512	Machine Tool (Metal Cutting Types) Manufacturing
333513	Machine Tool (Metal Forming Types) Manufacturing
333514	Special Die and Tool, Die Set, Jig, and Fixture Manufacturing
333515	Cutting Tool and Machine Tool Accessory Manufacturing
333516	Rolling Mill Machinery and Equipment Manufacturing
333518	Other Metalworking Machinery Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing
333618	Other Engine Equipment Manufacturing
333911	Pump and Pumping Equipment Manufacturing
333912	Air and Gas Compressor Manufacturing
333913	Measuring and Dispensing Pump Manufacturing
333921	Elevator and Moving Stairway Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing
333924	Industrial Truck, Tractor, Trailer, and Stacker Machinery Manufacturing
333991	Power-Driven Handtool Manufacturing
333992	Welding and Soldering Equipment Manufacturing
333993	Packaging Machinery Manufacturing
333994	Industrial Process Furnace and Oven Manufacturing
333995	Fluid Power Cylinder and Actuator Manufacturing
333996	Fluid Power Pump and Motor Manufacturing
333997	Scale and Balance (except Laboratory) Manufacturing
333999	All Other Miscellaneous General Purpose Machinery Manufacturing

Table A-7. Transportation Equipment

NAICS	NAICS Description
336111	Automobile Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336120	Heavy Duty Truck Manufacturing
336211	Motor Vehicle Body Manufacturing
336212	Truck Trailer Manufacturing
336213	Motor Home Manufacturing
336214	Travel Trailer and Camper Manufacturing
336311	Carburetor, Piston, Piston Ring, and Valve Manufacturing
336312	Gasoline Engine and Engine Parts Manufacturing
336321	Vehicular Lighting Equipment Manufacturing
336322	Other Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
336340	Motor Vehicle Brake System Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336370	Motor Vehicle Metal Stamping
336391	Motor Vehicle Air-Conditioning Manufacturing
336399	All Other Motor Vehicle Parts Manufacturing
336510	Railroad Rolling Stock Manufacturing
336611	Ship Building and Repairing
336612	Boat Building
336991	Motorcycle, Bicycle, and Parts Manufacturing
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing
336999	All Other Transportation Equipment Manufacturing

Table A-8. Other Manufacturing and Printing

NAICS	NAICS Description
323113	Commercial Screen Printing
323114	Quick Printing
323115	Digital Printing
323116	Manifold Business Forms Printing
323117	Books Printing
323118	Blankbook, Looseleaf Binders, and Devices Manufacturing
323119	Other Commercial Printing
323121	Tradebinding and Related Work
323122	Prepress Services
324110	Petroleum Refineries
324121	Asphalt Paving Mixture and Block Manufacturing
324122	Asphalt Shingle and Coating Materials Manufacturing
324191	Petroleum Lubricating Oil and Grease Manufacturing
324199	All Other Petroleum and Coal Products Manufacturing
325110	Petrochemical Manufacturing
325120	Industrial Gas Manufacturing
325132	Synthetic Organic Dye and Pigment Manufacturing
325181	Alkalies and Chlorine Manufacturing
325182	Carbon Black Manufacturing
325188	All Other Basic Inorganic Chemical Manufacturing
325191	Gum and Wood Chemical Manufacturing
325192	Cyclic Crude and Intermediate Manufacturing
325193	Ethyl Alcohol Manufacturing
325199	All Other Basic Organic Chemical Manufacturing
325211	Plastics Material and Resin Manufacturing
325212	Synthetic Rubber Manufacturing
325222	Noncellulosic Organic Fiber Manufacturing
325311	Nitrogenous Fertilizer Manufacturing
325312	Phosphatic Fertilizer Manufacturing
325314	Fertilizer (Mixing Only) Manufacturing
325320	Pesticide and Other Agricultural Chemical Manufacturing
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325510	Paint and Coating Manufacturing
325520	Adhesive Manufacturing
325611	Soap and Other Detergent Manufacturing
325612	Polish and Other Sanitation Good Manufacturing
325613	Surface Active Agent Manufacturing
325620	Toilet Preparation Manufacturing
325910	Printing Ink Manufacturing
325920	Explosives Manufacturing
325991	Custom Compounding of Purchased Resins
325992	Photographic Film, Paper, Plate, and Chemical Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326111	Plastics Bag Manufacturing
326112	Plastics Packaging Film and Sheet (including Laminated) Manufacturing
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing
326121	Unlaminated Plastics Profile Shape Manufacturing
326122	Plastics Pipe and Pipe Fitting Manufacturing
326130	Laminated Plastics Plate, Sheet (except Packaging), and Shape Manufacturing

NAICS	NAICS Description
326140	Polystyrene Foam Product Manufacturing
326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing
326160	Plastics Bottle Manufacturing
326191	Plastics Plumbing Fixture Manufacturing
326192	Resilient Floor Covering Manufacturing
326199	All Other Plastics Product Manufacturing
326211	Tire Manufacturing (except Retreading)
326212	Tire Retreading
326220	Rubber and Plastics Hoses and Belting Manufacturing
326291	Rubber Product Manufacturing for Mechanical Use
326299	All Other Rubber Product Manufacturing
327112	Vitreous China, Fine Earthenware, and Other Pottery Product Manufacturing
327113	Porcelain Electrical Supply Manufacturing
327121	Brick and Structural Clay Tile Manufacturing
327122	Ceramic Wall and Floor Tile Manufacturing
327123	Other Structural Clay Product Manufacturing
327124	Clay Refractory Manufacturing
327211	Flat Glass Manufacturing
327212	Other Pressed and Blown Glass and Glassware Manufacturing
327213	Glass Container Manufacturing
327215	Glass Product Manufacturing Made of Purchased Glass
327310	Cement Manufacturing
327320	Ready-Mix Concrete Manufacturing
327331	Concrete Block and Brick Manufacturing
327332	Concrete Pipe Manufacturing
327390	Other Concrete Product Manufacturing
327410	Lime Manufacturing
327420	Gypsum Product Manufacturing
327910	Abrasive Product Manufacturing
327991	Cut Stone and Stone Product Manufacturing
327992	Ground or Treated Mineral and Earth Manufacturing
327993	Mineral Wool Manufacturing
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing
331111	Iron and Steel Mills
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel
331221	Rolled Steel Shape Manufacturing
331222	Steel Wire Drawing
331312	Primary Aluminum Production
331314	Secondary Smelting and Alloying of Aluminum
331315	Aluminum Sheet, Plate, and Foil Manufacturing
331316	Aluminum Extruded Product Manufacturing
331319	Other Aluminum Rolling and Drawing
331419	Primary Smelting and Refining of Nonferrous Metal (except Copper and Aluminum)
331421	Copper Rolling, Drawing, and Extruding
331422	Copper Wire (except Mechanical) Drawing
331491	Nonferrous Metal (except Copper and Aluminum) Rolling, Drawing, and Extruding
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)
331511	Iron Foundries
331512	Steel Investment Foundries
331513	Steel Foundries (except Investment)
331521	Aluminum Die-Casting Foundries
331522	Nonferrous (except Aluminum) Die-Casting Foundries
331524	Aluminum Foundries (except Die-Casting)

NAICS	NAICS Description
331525	Copper Foundries (except Die-Casting)
331528	Other Nonferrous Foundries (except Die-Casting)
334111	Electronic Computer Manufacturing
334112	Computer Storage Device Manufacturing
334113	Computer Terminal Manufacturing
334119	Other Computer Peripheral Equipment Manufacturing
334210	Telephone Apparatus Manufacturing
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing
334290	Other Communications Equipment Manufacturing
334310	Audio and Video Equipment Manufacturing
334411	Electron Tube Manufacturing
334412	Bare Printed Circuit Board Manufacturing
334413	Semiconductor and Related Device Manufacturing
334415	Electronic Resistor Manufacturing
334416	Electronic Coil, Transformer, and Other Inductor Manufacturing
334417	Electronic Connector Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
334419	Other Electronic Component Manufacturing
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334514	Totalizing Fluid Meter and Counting Device Manufacturing
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
334518	Watch, Clock, and Part Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
334611	Software Reproducing
334612	Prerecorded Compact Disc (except Software), Tape, and Record Reproducing
334613	Magnetic and Optical Recording Media Manufacturing
335110	Electric Lamp Bulb and Part Manufacturing
335121	Residential Electric Lighting Fixture Manufacturing
335122	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing
335129	Other Lighting Equipment Manufacturing
335211	Electric Housewares and Household Fan Manufacturing
335212	Household Vacuum Cleaner Manufacturing
335311	Power, Distribution, and Specialty Transformer Manufacturing
335312	Motor and Generator Manufacturing
335313	Switchgear and Switchboard Apparatus Manufacturing
335314	Relay and Industrial Control Manufacturing
335911	Storage Battery Manufacturing
335912	Primary Battery Manufacturing
335921	Fiber Optic Cable Manufacturing
335929	Other Communication and Energy Wire Manufacturing
335931	Current-Carrying Wiring Device Manufacturing
335932	Noncurrent-Carrying Wiring Device Manufacturing
335991	Carbon and Graphite Product Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing
337110	Wood Kitchen Cabinet and Countertop Manufacturing
337121	Upholstered Household Furniture Manufacturing
337122	Nonupholstered Wood Household Furniture Manufacturing

NAICS	NAICS Description
337125	Household Furniture (except Wood and Metal) Manufacturing
337127	Institutional Furniture Manufacturing
337129	Wood Television, Radio, and Sewing Machine Cabinet Manufacturing
337211	Wood Office Furniture Manufacturing
337212	Custom Architectural Woodwork and Millwork Manufacturing
337214	Office Furniture (except Wood) Manufacturing
337215	Showcase, Partition, Shelving, and Locker Manufacturing
337910	Mattress Manufacturing
337920	Blind and Shade Manufacturing
339111	Laboratory Apparatus and Furniture Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Appliance and Supplies Manufacturing
339114	Dental Equipment and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
339911	Jewelry (except Costume) Manufacturing
339912	Silverware and Hollowware Manufacturing
339914	Costume Jewelry and Novelty Manufacturing
339920	Sporting and Athletic Goods Manufacturing
339931	Doll and Stuffed Toy Manufacturing
339932	Game, Toy, and Children's Vehicle Manufacturing
339941	Pen and Mechanical Pencil Manufacturing
339942	Lead Pencil and Art Good Manufacturing
339943	Marking Device Manufacturing
339944	Carbon Paper and Inked Ribbon Manufacturing
339950	Sign Manufacturing
339991	Gasket, Packing, and Sealing Device Manufacturing
339992	Musical Instrument Manufacturing
339993	Fastener, Button, Needle, and Pin Manufacturing
339994	Broom, Brush, and Mop Manufacturing
339995	Burial Casket Manufacturing
339999	All Other Miscellaneous Manufacturing

APPENDIX B. 2008 INDUSTRIAL ADHESIVES AND CLEANING SOLVENTS SURVEY PACKAGE

E.H. Pechan & Associates, Inc.
3622 Lyckan Parkway, Suite 2005 - Durham, NC 27707
Phone 919.493.3144 - Fax 919.493.3182

April 1, 2010

Dear Respondent:

As indicated in the attached letter signed by David Brymer of the Texas Commission on Environmental Quality (TCEQ), E.H. Pechan & Associates, Inc. (Pechan) is under contract to assess air pollutant emissions from industrial adhesive and industrial cleaning solvent operations. In order to assess emissions from adhesive and cleaning solvent operations, several thousand facilities, including yours, have been selected at random to participate in this adhesive and solvent users' survey. The survey results from your facility will be combined with information received from other facilities to develop improved estimates of air emissions for the Dallas-Fort Worth, Houston, and San Antonio areas. Only summaries of adhesive and cleaning solvent data will be published. Although some of the requested data are similar to information submitted by some companies to local districts during annual emissions reporting, please be assured that the information requested here is not available to Pechan from the local district in the necessary format and level of detail.

There is a two-part survey questionnaire enclosed covering adhesive and cleaning solvent usage in 2008. The first part is for reporting adhesive use during the manufacturing, installation or repair of products, including adhesive primers used in conjunction with certain types of adhesives. The second part is for reporting cleaning solvent use during manufacturing and maintenance activities. Manufacturing use includes the cleaning of parts during manufacturing and any final cleaning prior to packaging. Maintenance activities include the cleaning of machinery, tools, vehicle parts, or other equipment that are not incorporated into a product. This questionnaire was designed to obtain the minimum amount of information required for the project and should only include information pertaining to the specific facility surveyed (i.e., do not use total company data if your company has more than one facility). Please enter all of the requested information for each line on the survey questionnaire. **If your facility does not use industrial adhesives or industrial cleaning solvents, it is important to indicate this in Part I and Part II of the questionnaire and return the questionnaire.**

In each part of the questionnaire, you have the option of designating certain information as trade secret. Information marked as a trade secret will be kept confidential (see attached Nondisclosure Agreement).

Please return both parts of the completed questionnaire and any necessary Material Safety Data Sheets by May 17, 2010 in the enclosed postage-paid envelope. A telephone line (1-919-493-3144, ext. 190) and email account (survey.tceq@pechan.com) have been set up to assist you with any technical issues regarding completion of the questionnaire. Thank you for your assistance.

Sincerely,

Jonathan G. Dorn
Project Manager
TCEQ Adhesives and Cleaning Solvents Project

Enclosures

E.H. Pechan & Associates, Inc.
3622 Lyckan Parkway, Suite 2005 - Durham, NC 27707
Phone 919.493.3144 - Fax 919.493.3182

Nondisclosure Agreement

Whereas, E.H. Pechan and Associates, Inc. (Pechan) is under contract (the Contract) with the Texas Commission on Environmental Quality (TCEQ) to gather information on Texas facilities that meet the applicability criteria in the United States Environmental Protection Agency's 2006 Industrial Cleaning Solvents Control Techniques Guidelines (CTG) and 2008 Miscellaneous Industrial Adhesives CTG;

Whereas, in order to fully perform the Contract, it will be necessary for Pechan to have access to data in the possession of the TCEQ and surveyed businesses which pertains to facility data, including adhesive and solvent usage and associated air pollutant emissions, and which has been designated confidential by the businesses which have furnished the data (the Confidential Data);

Now, therefore, in consideration of the granting to Pechan of the Contract, Pechan agrees and represents as follows:

1. Pechan shall preserve in strict confidence all Confidential Data supplied to Pechan by the TCEQ and businesses during the performance of the Contract, and shall not use any Confidential Data in such a manner as to disclose it to any person or entity except as specifically authorized in writing by a duly authorized representative of the TCEQ.

2. The Confidential Data shall only be supplied to Pechan employees authorized to work under this TCEQ contract.

3. Pechan shall return to the TCEQ all Confidential Data it has received from the TCEQ and businesses when the Confidential Data are no longer required by Pechan for performance of the work required by the Contract, or upon completion of the Contract, whichever first occurs.

E.H. Pechan and Associates, Inc.

By: _____
Kathleen Aguilar

Title: Contracts Administrator

Date: April 1, 2010

E.H. Pechan & Associates, Inc./Texas Commission on Environmental Quality
Industrial Adhesive and Cleaning Solvent Use for 2008

INSTRUCTIONS

Please follow the instructions below (each number corresponds to a section on the questionnaire) for filling out Part I (blue sheet) and Part II (green sheet) of the questionnaire. Report facility information and 2008 adhesive use, including associated primers, during the manufacturing, installation or repair of products in Part I. Report 2008 cleaning solvent use during the manufacturing of products and maintenance of equipment in Part II. An example (yellow sheet) is included on pages 5 and 6. After completing the forms, please return only the forms, and any necessary Material Safety Data Sheets (MSDS) in the envelope provided. **If your facility does not use industrial adhesives or industrial cleaning solvents, it is important to indicate this in Part I and Part II of the questionnaire and to return the questionnaire.**

PART I (blue sheet)

1. **Facility Information -** Please fill out this section with information relevant to the 2008 operations at your facility (i.e., do not include information for other facilities within your company). When available, default information on the North American Industry Classification System (NAICS) code and on employment and revenue for your facility has been included. Please make any necessary corrections and fill in any missing information. If default employment and revenue data were not included, please indicate whether your facility has fewer than 100 employees and whether your facility earned less than $1 million, $1 million to $6 million, or more than $6 million in 2008. More information on NAICS codes can be found on the Web at http://www.census.gov/eos/www/naics/.

2. **Application Process -** From Table 1 (see page 2), enter the adhesive application process code(s) that most closely describes the activities at your facility. For example, if your facility used adhesives to repair tires in 2008, you would enter code SA17.

3. **Adhesive or Primer Type** – For each application process identified in step 2, enter the name, manufacturer and VOC content of the adhesive or primer used in the application process. <u>The VOC content should be reported in grams per liter (g/L). Do not use "VOC content less water and exempt solvents." If the VOC content is not known, please attach and return Sections 1, 2, 3 and 9 of the MSDS. Only primers associated with adhesive application should be reported.</u>

4. **2008 Adhesive and Primer Usage -** For each adhesive or primer reported in step 3, enter the volume of adhesive or primer used in Calendar Year 2008. Please report volume in gallons (gal).

5. **Exhaust Control** – An exhaust control device is defined as any device that thermally or catalytically destroys VOC emissions or any device that captures VOC emissions via adsorption. If the adhesive or primer application process identified in step 2 is served by an exhaust control device, please write the type of control on the survey form (i.e., please write "thermal," "catalytic" or "adsorption"). If the adhesive or primer application process is not served by a control device, please write "No" on the survey form. <u>NOTE: Fans and blowers are not part of an exhaust control system and should not be reported. Also, controls included in or on equipment, such as dry filters or waterwash booths, should not be reported.</u>

6. **Trade Secret (TS) -** Check this box if the information entered on this line should be considered trade secret (TS). NOTE: If this box is checked, you must attach justification why the information is considered trade secret.

PART II (green sheet)

7. **Cleaning Unit Operation** – From Table 2 (see page 4), enter the cleaning unit operation code that most closely describes the solvent cleaning or degreasing activities at your facility.

8. **Solvent -** For each cleaning unit operation identified in step 7, enter the name, manufacturer and VOC content of the cleaning solvent used in the application process. <u>The VOC content should be reported in grams per liter (g/L). Do not use "VOC content less water and exempt solvents." If the VOC content is not known, please attach and return Sections 1, 2, 3 and 9 of the MSDS.</u>

9. **2008 Solvent Usage** - For each cleaning solvent reported in step 8, enter the volume of cleaning solvent used in Calendar Year 2008. Please report volume in gallons (gal).

10. **Exhaust Control** - An exhaust control device is defined as any device that thermally or catalytically destroys VOC emissions or any device that captures VOC emissions via adsorption. If the cleaning unit operation identified in step 7 is served by an exhaust control device, please write the type of control on the survey form (i.e., please write "thermal," "catalytic" or "adsorption"). If the cleaning unit operation is not served by a control device, please write "No" on the survey form. NOTE: Fans and blowers are not part of an exhaust control system and should not be reported. Also, controls included in or on equipment, such as freeboard chillers, recycling condensers, and lids, should not be reported.

11. **Trade Secret (TS)** - Check this box if the information entered on this line should be considered trade secret (TS). NOTE: If this box is checked, you must attach justification why the information is considered trade secret.

If you have any questions, or need assistance completing this survey, please call 1-919-493-3144, ext. 190 or email survey.tceq@pechan.com.

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Table 1. Application Processes for Industrial Adhesives

Application Process	Code
General Adhesive Application	
Flexible Vinyl	GA1
Metal	GA2
Porous Material (except wood)	GA3
Reinforced Plastic Composite	GA4
Rubber	GA5
Wood	GA6
Other Substrates	GA7
Specialty Adhesive Application	
Ceramic Tile Installation	SA1
Contact Adhesive	SA2
Cove Base Installation	SA3
Floor Covering Installation (indoor)	SA4
Floor Covering Installation (outdoor)	SA5
Floor Covering Installation (perimeter bonded sheet vinyl)	SA6
Metal to Urethane/Rubber Molding or Casting	SA7
Motor Vehicle Adhesive	SA8
Motor Vehicle Weatherstrip Adhesive	SA9
Multipurpose Construction	SA10
Plastic Solvent Welding (acrylonitrile-butadiene-styrene)	SA11
Plastic Solvent Welding (except acrylonitrile-butadiene-styrene)	SA12
Sheet Rubber Lining Installation	SA13
Single-Ply Roof Membrane Installation/Repair (except EPDM)	SA14
Structural Glazing	SA15
Thin Metal Laminating	SA16
Tire Repair	SA17
Waterproof Resorcinol Glue	SA18
Other Specialty Adhesive Application Process	SA19
Adhesive Primer Application	
Motor Vehicle Glass Bonding Primer	AP1
Plastic Solvent Welding Adhesive Primer	AP2
Single-Ply Roof Membrane Adhesive Primer	AP3
Other Adhesive Primer	AP4

Acrylonitrile-butadiene-styrene or **ABS welding** means any process to weld acrylonitrile-butadiene-styrene pipe.

Contact bond adhesive means an adhesive that: (i) is designed for application to both surfaces to be bonded together, and (ii) is allowed to dry before the two surfaces are placed in contact with each other, and (iii) forms an immediate bond that is impossible, or difficult, to reposition after both adhesive-coated surfaces are placed in contact with each other, and (iv) does not need sustained pressure or clamping of surfaces after the adhesive-coated surfaces have been brought together using sufficient momentary pressure to establish full contact between both surfaces. *Contact adhesive* does not include rubber cements that are primarily intended for use on paper substrates. *Contact adhesive* also does not include vulcanizing fluids that are designed and labeled for tire repair only.

Cove base installation adhesive means any adhesive intended by the manufacturer to be used for the installation of cove base or wall base on a wall or vertical surface at floor level. Cove base means a flooring trim unit, generally made of vinyl or rubber, having a concave radius on one edge and a convex radius on the opposite edge that is used in forming a junction between the bottom wall course and the floor or to form an inside corner.

EPDM roof membrane means a prefabricated single sheet of elastomeric material composed of ethylene propylenediene monomer and that is field applied to a building roof using one layer or membrane material.

Metal to urethane/rubber molding or casting adhesive means any adhesive intended by the manufacturer to bond metal to high density or elastomeric urethane or molded rubber materials, in heater molding or casting processes, to fabricate products such as rollers for computer printers or other paper handling equipment.

Motor vehicle adhesive means an adhesive, including glass bonding adhesive, used at a facility that is not an automobile or light-duty truck assembly coating facility, applied for the purpose of bonding two vehicle surfaces together without regard to the substrates involved.

Motor vehicle glass bonding primer means a primer, used at a facility that is not an automobile or light-duty truck assembly coating facility, applied to windshield or other glass, or to body openings, to prepare the glass or body opening for the application of glass bonding adhesives or the installation of adhesive bonded glass. Motor vehicle glass bonding primer includes glass bonding/cleaning primers that perform both functions (cleaning and priming of the windshield or other glass, or body openings) prior to the application of adhesive or the installation of adhesive bonded glass.

Motor vehicle weatherstrip adhesive means an adhesive, used at a facility that is not an automobile or light-duty truck assembly coating facility, applied to weatherstripping materials for the purpose of bonding the weatherstrip material to the surface of the vehicle.

Perimeter bonded sheet flooring means the installation of sheet flooring with vinyl backing onto a nonporous substrate using an adhesive designed to be applied only to a strip of up to four inches wide around the perimeter of the sheet flooring.

Plastic solvent welding adhesive means any adhesive intended by the manufacturer for use to dissolve the surface of plastic to form a bond between mating surfaces.

Sheet rubber lining means the process of applying sheet rubber liners by hand to metal or plastic substrates to protect the underlying substrate from corrosion or abrasion. These operations also include laminating sheet rubber to fabric by hand.

Single-ply roof membrane means a prefabricated single sheet of rubber, normally ethylene-propylenediene terpolymer that is field applied to a building roof using one layer of membrane material. Single-ply roof membrane does not include membranes prefabricated from ethylene-propylenediene monomer (EPDM).

Thin metal laminating adhesive means any adhesive intended by the manufacturer for use in bonding multiple layers of metal to metal or metal to plastic in the production of electronic or magnetic components in which the thickness of the bond line(s) is less than 0.25 millimeters.

Tire repair means a process that includes expanding a hole, tear, fissure or blemish in a tire casing by grinding or gouging, applying adhesive and filling the hole or crevice with rubber.

Waterproof resorcinol glue means a two-part resorcinol-resin-based adhesive designed for applications where the bond line must be resistant to conditions of continuous immersion in fresh or salt water.

Table 2. Cleaning Operations

Cleaning Unit Operation	Code
Maintenance	
Equipment Cleaning	EQC
Floor Cleaning	FLC
Line Cleaning	LIC
Parts Cleaning	PAC
Spray Booth Cleaning	SBC
Spray Gun Cleaning	SGC
Tank Cleaning	TAC
Manufacturing	
Large Manufactured Components Cleaning	LMC
Small Manufactured Components Cleaning	SMC

Large manufactured components cleaning is the cleaning of large parts as a step in the manufacture process. Large manufactured components include auto bodies, sheet metal prior to stamping, etc. The distinction between small and large manufactured components is roughly based on whether the component can be moved by an individual.

Maintenance cleaning operations refers to the cleaning of machinery, tools, vehicle parts, or other equipment that are not incorporated into a product. Janitorial activities, such as cleaning offices, bathrooms or other similar areas, should **not** be included in the maintenance activities.

Manufacturing cleaning operations refers to any activity where a solvent is used to clean products during manufacturing, including cleaning prior to final packaging.

Small manufactured components cleaning is the cleaning of small parts as a step in the manufacture process. Small manufactured components include glass windows, engine components, subassemblies, sheet metal panels, molded parts, electrical contacts, steel and copper components, tin/silver-plated terminals, plastic parts, upholstered parts, circuit breaker cases, switch covers, threads, bolts, etc. The distinction between small and large manufactured components is roughly based on whether the component can be moved by an individual.

EXAMPLE: METAL FABRICATION FACILITY

Facility A is independently owned and operated and produces large finished metal parts for the aerospace industry. The facility's primary North American Industry Classification System code is 336410. The facility employs 47 people and the facility's annual revenue is $5,245,000. The facility would review the information in Part I, Section 1 of the questionnaire, make any necessary corrections and fill in any missing information.

Facility A identifies the following 2008 adhesive usage:

- General metal adhesive application (GA2) used to bond two metal parts with MetaBond adhesive manufactured by Acme Chemical. This adhesive is applied without priming. The exhaust is controlled using a thermal oxidation control device.

The facility would enter the adhesive application process code (from Table 1) and the adhesive name, manufacturer and usage information in Part I of the questionnaire. The completed entry for Facility A's adhesive usage is shown below in Part I of the Example Survey.

EXAMPLE SURVEY

1. 2008 Facility Information

Primary NAICS code 336410

Type of product or service Aerospace Product and Parts Manufacturing

Is your facility individually owned and operated? Yes

Total number of employees at your facility 47

Approximate revenue generated at your facility in calendar year 2008 (U.S. dollars) $5,245,000

If the approximate revenue listed on the line above is incorrect or missing, please indicate the correct revenue range for 2008 by checking one of the boxes to the right.

- ☐ **Less than $1,000,000**
- ☐ **$1,000,000 to $6,000,000**
- ☐ **More than $6,000,000**

Does your facility use industrial adhesives? (if no, please proceed to Part II of the survey) Yes

EXAMPLE PART I: ADHESIVE DATA FOR 2008 EXAMPLE

2. Adhesive Application Process	3. Adhesive or Primer Type			4. 2008 Adhesive and Primer Usage	5. Exhaust Control	6. TS
Code (from Table 1)	**Name**	**Manufacturer**	**VOC Content (g/L)**	**Volume (gallons)**		
GA2	MetaBond	Acme Chemical	70 g/L	850	Thermal	

EXAMPLE CONTINUED ON BACK OF PAGE

Facility A identifies the following 2008 solvent cleaning and degreasing unit operations:

- Cleaning of large metal parts (LMC) with methyl ethyl ketone manufactured by Acme Chemical prior to bonding the metal parts with MetaBond adhesive;
- Cleaning of the spray gun (SGC) used to apply MetaBond adhesive to the metal parts. The spray gun is cleaned using methyl ethyl ketone manufactured by Acme Chemical.

There are no exhaust controls for these cleaning operations. Facility A would enter the cleaning operation codes (from Table 2) and the cleaning solvent names, manufacturers and usage information in Part II of the questionnaire. The completed entry for Facility A's cleaning solvent usage is shown below in Part II of the Example Survey.

EXAMPLE PART II: CLEANING SOLVENT DATA FOR 2008 EXAMPLE						
7. Cleaning Operation	**8. Solvent**			**9. 2008 Solvent Usage**	**10. Exhaust Control**	**11. TS**
Code (from Table 2)	**Name**	**Manufacturer**	**VOC Content (g/L)**	**Volume (gallons)**		
LMC	Methyl Ethyl Ketone	Acme Chemical	805 g/L	425	no	
SGC	Methyl Ethyl Ketone	Acme Chemical	805 g/L	200	no	

E.H. Pechan & Associates, Inc./Texas Commission on Environmental Quality
Industrial Adhesive and Cleaning Solvent Use for 2008

PART I. ADHESIVE USES (adhesive use during manufacturing, installation and repair processes). See attached Instructions (page 1). See the example given on page 5 (yellow sheet).

If you have questions, or need assistance completing this survey, please call 1-919-493-3144, ext. 190 or email survey.tceq@pechan.com.

1. 2008 Facility Information	Form No.

Primary NAICS code _____

Type of product or service _____

Is your facility individually owned and operated? _____

Total number of employees at your facility _____

Approximate revenue generated at your facility in calendar year 2008 (U.S. dollars) _____

If the approximate revenue listed on the line above is incorrect or missing, please indicate the correct revenue range for 2008 by checking one of the boxes to the right.

- ☐ Less than $1,000,000
- ☐ $1,000,000 to $6,000,000
- ☐ More than $6,000,000

Does your facility use industrial adhesives? (if no, please proceed to Part II of the survey) _____

PART I: ADHESIVE DATA FOR 2008

2. Adhesive Application Process	3. Adhesive or Primer Type			4. 2008 Adhesive and Primer Usage	5. Exhaust Control	6. TS
Code (from Table 1)	Name	Manufacturer	VOC Content (g/L)	Volume (gallons)		

(Additional space provided on back)

PART I: ADHESIVE DATA FOR 2008						
2. Adhesive Application Process	3. Adhesive Type			4. 2008 Adhesive Usage	5. Exhaust Control	6. TS
Code (from Table 1)	Name	Manufacturer	VOC Content (g/L)	Volume (gallons)		

E.H. Pechan & Associates, Inc./Texas Commission on Environmental Quality
Industrial Adhesive and Cleaning Solvent Use for 2008

PART II. CLEANING SOLVENT USES (solvent use during manufacturing of products and maintenance of equipment). See attached instructions (page 1). See the example given on page 5 (yellow sheet).

If you have questions, or need assistance completing this survey, please call 1-919-493-3144, ext. 190 or email survey.tceq@pechan.com.

Does your facility use industrial cleaning solvents? (if no, please indicate on this line and return Part I and Part II of the questionnaire) _____

PART II: CLEANING SOLVENT DATA FOR 2008

7. Cleaning Operation	8. Cleaning Solvent			9. 2008 Cleaning Solvent Usage	10. Exhaust Control	11. TS
Code (from Table 2)	Name	Manufacturer	VOC Content (g/L)	Volume (gallons)		

(Additional space provided on back)

PART II: CLEANING SOLVENT DATA FOR 2008						
7. Cleaning Operation	8. Cleaning Solvent			9. 2008 Cleaning Solvent Usage	10. Exhaust Control	11. TS
Code (from Table 2)	Name	Manufacturer	VOC Content (g/L)	Volume (gallons)		

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APPENDIX C. QUALITY ASSURANCE PROCEDURES

At the beginning of this project, E.H. Pechan & Associates, Inc. (Pechan) prepared a quality assurance project plan (QAPP) for the project. The QAPP describes the procedures that Pechan followed to ensure that data collection and data analysis were performed in accordance with well-defined procedures; were reliable and complete; and were consistent with the Texas Commission on Environmental Quality's (TCEQ) overall objectives of determining whether the proposed controls recommended in the Control Technique Guidelines (CTG) documents are technologically and economically feasible.

The QAPP addresses the elements required by and follows the format specified in the EPA Requirements for Quality Assurance Project Plans (QA/R-5) for QA Category II (EPA, 2001). In addition, the QAPP addresses technical system audits, audits of data quality, and reports of QA findings in accordance with the requirements outlined in TCEQ Work Order No. 582-7-84007-FY10-03.

TCEQ reviewed subsequently approved the QAPP. This section of the report explains how Pechan implemented the technical requirements of the QAPP.

A. TASK PLANNING

Task planning included allocating the resources needed to implement the QA procedures outlined in the QAPP, ensuring that project personnel were appropriately trained to complete the scope of work, and scheduling QA activities at appropriate points during survey development, data collection, and data analysis. In the first step, Pechan developed and documented the methods for survey design and data collection. In the second step, Pechan prepared the data handling procedures and QA audit questionnaires. In the third step, Pechan implemented the QA procedures to ensure data integrity throughout the emissions development process.

1. Personnel Training

All project personnel received a copy of the QAPP. After project personnel read the QAPP, Pechan's Project Manager held a project team meeting with the personnel to review the QAPP and to answer questions. In addition, all members of the project team received training on the data collection and handling formats and procedures, documentation methods, and reporting procedures used during the project. This training ensured that all personnel collected, documented, and recorded data in a consistent manner.

Pechan's Project Manager was responsible for providing this training. In addition, all project personnel reviewed the QAPP and became familiar with the QA procedures applied during the project. Pechan's QA Coordinator provided additional quality-related training.

2. Schedule and Project Planning

Pechan developed and implemented the methods and data file formats for implementing the technical requirements of the QAPP at the beginning of the project. This approach focused on early detection and prevention of potential quality problems, rather than inspecting completed work and correcting problems that already occurred. The Project Manager and QA Coordinator assisted the project team to maintain the quality of the data collected and the deliverables produced. Key elements of the decisions included preparing documentation of the methods (i.e., survey development, data tracking, and data analysis) and preparing the Access database used to store survey responses. Pechan reviewed and revised these elements as needed.

B. DATA HANDLING

Data handling includes all the aspects of following the data through the collection and analysis process. These aspects include: coding and recording the data; data tracking; correcting data and handling corrected data.

Pechan's Project Manager and QA Coordinator developed standard formats for compiling and storing activity and impact factor data for each facility in an MS Access database. These formats included units for activity data and impact factors, comments fields to track any problems identified with the data, contact fields to track any communication between Pechan and a facility, and check boxes to flag when data were modified.

Pechan compared the emissions calculated in the Access database to the emissions included in the final data summary to ensure that the emissions were calculated correctly.

1. Data Coding and Recording

Pechan assigned a unique tracking number to each facility being surveyed. This tracking number provided a consistent key to ensure that data were entered into the correct database form and to ensure proper matching between data tables during data analysis and emissions calculations.

2. Data Tracking and Correcting Data

Data tracking takes place through the use of forms developed in MS Access to ensure consistent formats for recording survey data and performing calculations. The MS Access database also tracks corrections made to the data. The Pechan QA Coordinator periodically checked the database to ensure that problems were being noted and that the QA issues identified were being addressed and documented.

3. Missing Data

Pechan identified missing data elements throughout the project and worked to collect missing elements. These efforts are documented in the comments fields in the MS Access database.

4. Review of Estimates

Pechan reviewed the raw data as well as emission estimates for quality and identification of outliers. Pechan documented and corrected any errors noted.

In addition, Pechan prepared emission summaries. These summaries display annual emissions by county, industry group, and adhesive or cleaning code. Pechan compared the overall emissions to previous emissions estimates in the 2005 Texas Area Source Emissions Inventory and 2007 Texas Point Source Emissions Inventory. If Pechan identified significant differences in the emissions estimates, Pechan reviewed the data.

Pechan also reviewed the facility-specific VOC emission estimates submitted in the surveys for identification of outliers. Pechan cross-checked any outliers with the original survey to ensure that an error did not occur during data entry into the survey database.

C. DATA ANALYSIS

Data analysis includes data collection, development of activity and impact factors, emission estimation methods, emission calculations, and data validation procedures. Data QA and control is an iterative process with automated and manual steps that Pechan performs to check the reasonableness and completeness of collected data and calculations.

1. Survey Data Collection

In accordance with requirements in the TCEQ work order, a data quality check was performed by a designee of the QA Coordinator on 25 percent of the data received from surveyed facilities to ensure that the data entered in the database matched what was submitted via questionnaire. The data entry error rate was less than 2 percent and all errors found were corrected. The data entry error rate was discussed with the TCEQ Project Manager and determined to be acceptable.

2. VOC Emissions Calculations

The first QA review involved comparing the units of the activity data to the impact factor units to verify unit compatibility. For activity and impact factor units that did not match, Pechan converted the impact factors to the appropriate units. Pechan preformed spot checks on calculations to verify the results. Replication of calculations was a basic quantitative QA/QC procedure. Members of Pechan's project team were responsible for self-checking all original calculations. Team members self-checked the calculation method via manual calculation. Team members replicated one complete set of calculations from every Access query and table. In addition to verifying the mathematical correctness of the calculation, team members verified the data values used in the calculation. Additional checks were performed to ensure that the results of the calculations made sense. For example, the CTG impact factor should always be equal to or less than the BAU impact factor. In addition, the BAU IF should always be less than or equal to the density of the materials being used. Pechan's QA Coordinator independently reviewed calculations completed by project team staff.

3. Data Reporting

In addition to the data summaries and documentation that are provided in this report, Pechan also prepared and submitted to TCEQ the survey data in MS Access and the results of the data analysis in MS Excel.

D. QUALITY ASSURANCE AUDITS

The Pechan QA Coordinator conducted two internal audits of project activities. The audits included an assessment of data collection, documentation, handling, calculation, and reporting procedures as well as an evaluation of whether the QA procedures outlined in this QAPP were followed. The primary goals of the audits were to prevent quality problems from occurring and to correct any problems identified.

The QA Coordinator worked with the Project Manager and technical team to develop a questionnaire for each audit. The audits focused on overall quality issues as well as specific issues that were identified by the Project Manager and technical reviewer as potential problems. The audits included interviews with members of the project team; review of project notebooks and data collection forms; and review of documentation. The two audit questionnaires are provided below.

1. Questionnaire for Quality Assurance Audit Number 1

Documentation, Handling, and Reporting:

- Do staff members working on the project have the documents and resources necessary to do their work?
- Are the documents for the project stored in one location that is accessible by the staff members working on the project?
- Do staff members have a clear understanding of what tasks are expected of them on the project?
- Have staff members been briefed on what to do if they identify any problems in the course of completing their tasks?
- Is a tracking log of contact information being maintained for all individuals contacted by Pechan during the course of the project?

Data collection:

- Was the survey primarily developed using information from the Miscellaneous Industrial Adhesives and Industrial Cleaning Solvents Control Techniques Guidelines?
- Has the survey questionnaire been read by someone not involved in its creation to ensure readability?

- Have the trade associations, vendors, and government organizations listed in the Amended Work Plan been contacted in an effort to confirm the completeness of the facility survey list?

Calculations:

- Have the statistical sampling calculations been double-checked to ensure that the correct number of facilities is being sampled?

2. Questionnaire for Quality Assurance Audit Number 2

Data Collection:

- Were the zip codes of the targeted facilities screened to ensure they are located in the geographic area of interest?
- Since default data were included in the questionnaire, was a procedure established to ensure that the correct questionnaire was sent to the correct facility?
- Were 5 percent of the survey packages checked to ensure that each survey package contained all survey materials?
- Were 25 percent of the data entry records checked for differences or discrepancies between the key entered data and the written survey responses?
- Have follow-up phone calls been placed to clarify illegible entries or to obtain missing data?
- Has a technical staff member reviewed the survey data collected to ensure that survey responses are valid?

Documentation, Handling, and Reporting:

- Has a filing system been maintained for all returned surveys?
- Is a written log being kept for any corrections made to the survey database resulting from data quality checks?
- Has missing data been identified and reported to the Project Manager? Has Pechan documented the results of decisions made by TCEQ regarding missing data that cannot be collected?

Data Review, Verification, and Validation:

- Have Pechan team members self-checked all original calculations, including replicating one complete set of calculations for each spreadsheet?
- In addition to verifying the mathematical correctness of calculations, have team members verified the data values used in the calculations?

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APPENDIX D. ANNUAL ENERGY OUTLOOK 2010 SECTOR TO NAICS CODE CROSSWALK

Table D-1. Annual Energy Outlook 2010 Sector to NAICS Code Crosswalk

Annual Energy Outlook 2010 Sector	NAICS Code(s)	Group							
		1	2	3	4	5	6	7	8
Region: West-South-Central									
REVIND1 Food Products	311		X						
REVIND2 Beverage and Tobacco Products	312		X						
REVIND3 Textile Mills & Textile Products	313, 314			X					
REVIND4 Apparel	315			X					
REVIND5 Wood Products	321				X				
REVIND6 Furniture and Related Products	337								X
REVIND7 Paper Products	322				X				
REVIND8 Printing	323								X
REVIND9 Basic Inorganic Chemicals	32512 to 32518								X
REVIND10 Basic Organic Chemicals	32511, 32519								X
REVIND11 Plastic and Synthetic Rubber Materials	3252								X
REVIND12 Agricultural Chemicals	3253								X
REVIND13 Other Chemical Products	3254 - 3259								X
REVIND14 Petroleum Refineries	32411								X
REVIND15 Other Petroleum and Coal Products	32412, 32419								X
REVIND16 Plastics and Rubber Products	326								X
REVIND17 Leather and Allied Products	316			X					
REVIND18 Glass & Glass Products	3272								X
REVIND19 Cement Manufacturing	32731								X
REVIND20 Other Nonmetallic Mineral Products	327 less 3272 & 32731								X
REVIND21 Iron & Steel Mills, Ferroalloy & Steel Products	3311, 3312								X
REVIND22 Alumina & Aluminum Products	3313								X
REVIND23 Other Primary Metals	3314, 3315								X
REVIND24 Fabricated Metal Products	332					X			
REVIND25 Machinery	333						X		
REVIND26 Other Electronic & Electric Products	334 less 3345, 335								X
REVIND27 Transportation Equipment	336							X	
REVIND28 Measuring & Control Instruments	3345								X
REVIND29 Miscellaneous Manufacturing	339								X
REVIND30 Crop Production	111								
REVIND31 Other Agriculture, Forestry, Fishing & Hunting	112 - 115								
REVIND32 Coal Mining	2121								
REVIND33 Oil & Gas Extraction & Support Activities	211, 213								
REVIND34 Other Mining & Quarrying	2122, 2123								
REVIND35 Construction	23	X							
Region: United States									
REVSER1 Transportation & Warehousing	48, 49	X							
REVSER2 Broadcasting & Telecommunications	513								
REVSER3 Electric Power Generation & Distribution	2211	X							
REVSER4 Natural Gas Distribution	2212	X							
REVSER5 Water, Sewage & Related System	2213	X							
REVSER6 Wholesale Trade	42	X							
REVSER7 Retail Trade	44, 45	X							
REVSER8 Finance & Insurance, Real Estate	52, 53								
REVSER9 Other Services	51, 54 - 81								
REVSER10 Public Administration	921, 922, 923								