Development of Updated ARB Solvent Cleaning Emissions Inventories

FINAL REPORT

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California Air Resources Board
Research Division
P.O. Box 2815
Sacramento, CA 95812

University of California, Riverside
Bourns College of Engineering
Center for Environmental Research and Technology

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Disclaimer

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Abstract

Solvent cleaning is a major source category of volatile organic compound (VOC) emissions in California. The Air Resources Board's (ARB's) current solvent cleaning and emissions inventories are based on data that no longer reflect current technology and solvents. Under contract with the ARB, the University of California, Riverside conducted a study to update the statewide emissions inventory from this source category. The main objective of the study is to update ARB's solvent cleaning emissions inventory and chemical species profiles. The approach included information collection through surveys and development of emission factors for various equipment/solvent combinations. The emission factors were then combined with current employment data to estimate the statewide emissions inventory.

Methods used to reduce the survey data and develop the emissions inventory are discussed. There were 11 types of equipment, 38 solvents, and 102 different types of businesses identified in the survey. State-level emissions estimates for the current study are 109 tons per day (tpd) of total organic gases (TOG). This is compared with ARB's 2007 inventory estimate of 96 tpd TOG, and the 1993 inventory estimate of 215 tpd TOG.[1] Most notable in the comparisons is a dramatic reduction in the use of chlorinated solvents, which have been replaced to a large extent by alcohols, ketones, and petroleum distillates. The emissions model developed during this project will allow the ARB to develop emissions estimates and allocate them to counties and air districts throughout the state.

[1] Roe, S.M., Jones, L.W. and P.J. Costello, E.H. Pechan and Associates, Inc., *Solvent Cleaning/Degreasing Source Category Emissions Inventory*, California Air Resources Board Contract 93-341, 1996

Executive Summary

Background

Solvent cleaning is one of the top five non-mobile sources of volatile organic compound (VOC) emissions in California. The Air Resources Board's (ARB's) current solvent cleaning emissions inventories are based on data that are more than ten years old and no longer reflect current technology or the new types of solvents that have been developed more recently. Under contract with the ARB, the University of California, Riverside conducted a study to update the statewide emissions inventory from this source category. The main objective of the study is to update ARB's solvent cleaning emissions inventory and chemical species profiles to reflect current materials and technologies.

Methods

The overall approach for this program included information collection through surveys and development of emission factors for various equipment/solvent combinations. The emission factors were then combined with current employment data to estimate the statewide emissions inventory. The initial information gathering tasks involved direct contact and surveying of businesses utilizing solvents for cleaning operations. As part of the survey, information was gathered about the types of solvents and equipment used. Additional information on the various materials was obtained from the literature to better understand the variety of chemicals used in the most widely used solvents. The chemical composition of the solvents was also investigated to obtain species profiles. Emissions factors were developed for a variety of different solvent cleaning processes. These emission factors were utilized along with activity estimates, solvent usage rates, and employment data from different application categories to provide updated inventories. Methods used to reduce the survey data and develop the emissions inventory are discussed.

Results

There were 11 types of equipment, 38 solvent categories, and 102 different types of businesses identified in the survey. Equipment/solvent combinations were characterized by four categories: cold cleaners (e.g., batch-loaded or conveyorized cold cleaners, remote reservoir cleaners), vapor degreasers (e.g., batch or conveyorized vapor degreasers), handwiping activities, and other (or not specified). There are also 18 solvent categories that are represented in the inventory; some of which are pure solvents (e.g., methylene chloride), and others that are blends (e.g., petroleum distillates). State-level emissions estimates for the current study are 109 tons per day (tpd) of total organic gases (TOG). This is compared with ARB's 2007 inventory estimate of 96.5 TOG, and the 1993 inventory estimate of 215 tpd TOG.[1] Most notable in the comparisons is a dramatic reduction in the use of chlorinated solvents (e.g., trichloroethane, chlorofluorocarbons). The current study suggests that the chlorinated solvents have been replaced to a large extent by alcohols, ketones, and petroleum distillates.

Conclusions

Results from the current (2008) study suggest that TOG emissions from solvent cleaning operations are 13.1% higher than those projected for 2007, but have decreased by 49.3% since 1993. These reductions can be mainly attributed to the implementation of new technologies and the replacement of traditional solvents with less volatile materials. While there have been significant reductions in manufacturing cleaning operations due to closure and relocation of these businesses, there has been a dramatic increase in the number of small facilities that mainly utilize solvents for maintenance operations. The emissions model developed during this project will allow the ARB to develop emissions estimates and allocate them to counties and air districts throughout the state. Following the analysis and recommendation of the previous study[1], the model uses employment data (rather than population) to determine inventories. Methods for updating the current model for future estimates are discussed, along with recommendations for improving emissions estimates.

1 Introduction

Currently, the available data to provide improved solvent emissions inventories is limited. In California, the Department of Toxic Substances Control and the Institute for Research and Technical Assistance (IRTA) have performed some field studies to assist businesses in converting to low-VOC solvents, but these studies are not extensive enough to provide the data that is needed to update the statewide inventory. D.L. Jones, et al. presented a paper titled "Solvent Mass Balance Approach for Estimating VOC Emissions from Eleven NonPoint Solvent Source Categories" at the 14th Annual Emission Inventory Conference. This paper focuses on national regulations, however, and it advises states/local agencies to assess the effects of local regulations.

Many districts need to update their solvent cleaning rules to obtain additional VOC emission reductions and meet State Implementation Plan (SIP) commitments, but they don't have the up-to-date inventory information that is needed to accurately calculate those reductions. In addition, solvent cleaning is often conducted by small businesses that do not have air permits and are located near residential areas, particularly in environmental justice communities. The ARB needs improved data, including speciation profiles, to assess exposure in these communities. The ARB also needs more accurate information and speciation profiles to pursue innovative approaches for achieving additional emission reductions, such as reactivity-based measures.

The objective of this study is to update ARB's solvent cleaning and emission inventories and speciation profiles to reflect current solvent cleaning materials and technologies. The study includes business surveys, identification of types of solvents, and development of updated solvent cleaning emissions inventories.

In order to meet the objective, the University of California, Riverside (UCR) collected business survey information, identified types and quantities of solvents used, identified types of equipment used, developed emission factors, gathered employment information by industry code, and developed statewide emissions inventory and species profiles for solvent cleaning operations.

2 Methods

The overall approach for this program was to combine information from business surveys, to develop emission factors for various processes, and subsequently to develop emissions inventories. In conjunction with the ARB and six of the largest air districts in California, a list of businesses using solvents for cleaning was developed. The initial information gathering task involved surveying of these businesses. As part of this survey, information was gathered about the types of solvents and equipment being used. Additional information on various solvents was obtained from literature to better understand the variety of chemicals used in the most widely used solvents on processes. The chemical composition of the solvents was also investigated to obtain the species profiles of the solvent chemicals. Emissions factors were developed for a variety of different solvent cleaning processes. These emission factors were utilized along with activity estimates, solvent usage rates, and employment data to provide an updated emissions inventory.

The originally proposed method focused on gathering data from businesses directly via field audits. This was to be facilitated by air district inspectors to assist the UCR team in gaining access to facilities. After consultation with the ARB and air districts, it was determined that this approach would be resource intensive. As a result, the approach was modified to direct end-users to the online survey. This was supplemented by air district audits to complete the database.

2.1 Survey of Businesses that Conduct Solvent Cleaning Operations

In conjunction with the ARB and air districts in California, UCR conducted a comprehensive survey of businesses using solvent cleaning operations. A questionnaire was developed for the survey that focused on gathering important information related to solvent cleaning operations. The information collected included the types and quantities of materials used, the application and technologies for which the materials were used, as well as generic information regarding the type of business, number of employees, etc. Some information was also gathered on the types of materials that had been replaced over the past 10 years, to get a better understanding of how the chemical composition of the inventory has changed.

The on-line survey questionnaire was developed and made available to survey participants on the UCR website. The survey was designed to gather important information related to solvent cleaning operations. As part of this process, the most recent study[1] was reviewed and discussed among project staff. Particular attention was paid to the types of solvents and processes used in 1993 in relation to current practice. Many of the solvents prevalent in the previous study have been phased out and replaced with low-VOC and aqueous solvents in order to comply with regulatory actions. New processes have been developed and deployed that dramatically reduce VOC emissions. While it is true that California lost a significant number of manufacturing jobs since 1993, this has largely been offset by increases in productivity. Between 1990 and 2008 industrial production increased by 57%, but productivity increased by 93%.[2]

[2] Center for Continuing Study of the California Economy, *Numbers in the News – Why are Manufacturing Job Losses so Large?*, March, 2009

Based on a review of the 1993 Pechan study and discussions among project staff, an outline of the current survey was developed and discussed with staff from the ARB, Bay Area Air Quality Management District (BAAQMD), and South Coast Air Quality Management District (SCAQMD). A draft survey was then developed for end-users in two parts; one with general questions (company description, number of employees, etc.), and a second with questions specific to solvent cleaning operations. These questions related to brand names of solvents used, VOC content, equipment or process in which the solvent is used, and volumes purchased and disposed of. The draft survey was submitted to the ARB and district staff for review and comment. After making recommended changes, the survey was converted to a portable document format (PDF), and posted online at UCR's website. The survey forms were enabled on May 18, 2008. The two surveys are presented in Appendix A.

Lists of end-users were developed in conjunction with the ARB and staff from the various district contacts. Permit databases specific to solvent cleaning were procured from the BAAQMD, SCAQMD, Ventura County APCD, Sacramento Metropolitan AQMD, San Joaquin Valley APCD, and the San Diego County APCD. Non-permitted area sources were identified through other district databases and the Bureau of Automotive Repair (BAR).

UCR worked with each of the above districts to develop a mail-out letter on district letterhead, requesting end users to participate in the on-line survey. With each district letter, a letter from the ARB was included to provide background and non-disclosure information. The ARB letter and examples of letters from each district are included in Appendix B. Survey letters from the districts were sent out to respective end users, and responses were obtained either online or via hard copy. The following Table shows the responses from each of the participating air districts.

Table I - Initial Survey Responses by Air District

Air District	Letters Sent	Non-Respondents	Respondents
Ventura County Air Pollution Control District	338	312	26
Sacramento Metropolitan Air Quality Management District	1932	1916	16
San Joaquin Valley Air Pollution Control District	904	892	12
San Diego County Air Pollution Control District	1387	1308	79
Bay Area Air Quality Management District	596	547	49
South Coast Air Quality Management District	9317	9147	170

Initial response rates ranged from 0.8% in the Sacramento Metropolitan Air Quality Management District to 8.2% in the Bay Area Air Quality Management District. A number of the survey responses (13%) were found to be incomplete. Follow-up calls were made to these survey participants in an effort to gather missing information. This effort was discontinued after obtaining completed surveys from only 2 of 35 respondents contacted. The total number of 352 respondents provided 963 separate records of solvent usage.

In order to increase the survey response rate, UCR worked with ARB and SCAQMD staff to develop a cross-referenced list of survey respondents vs. facilities receiving the district mailouts. The SCAQMD agreed to provide information from inspections of businesses using solvents in the district. SCAQMD inspectors audited an additional 78 facilities, and provided the results to UCR for inclusion in the database. In addition to supplementing the database, information gathered from the SCAQMD audit was used as a quality control measure to verify information received via the on-line surveys vs. what was reported in the audit. The SCAQMD audit provided information on an additional 303 unique instances of solvent cleaning usage, increasing the database to 1,266 separate records. The records were then analyzed for completeness and erroneous entries, resulting in a valid entry index database of 570 records.

Finally, the survey response database was designed. The primary objective of the database was to compile survey information regarding the types of businesses, the types of solvents, and quantities of solvents used. Additional categories in the database refer to the technologies utilized for the solvent cleaning operations (e.g., heated dip tanks, ultrasonic units, enclosed power washers, vapor degreasers, hand-wipe cleaning). UCR used a workbook format, and formatted the database into additional worksheets built upon the input data worksheet. Data obtained via the online and hard copy survey responses were compiled in the database as they were received.

2.2 Development of Species Profiles for the Solvents

Species profiles were developed for each of the major solvents being used in the marketplace. The major solvents were identified primarily through the field survey. The species profile of each of the solvents was then obtained using the Materials Safety Data Sheet (MSDS) and other sources of information. The species profiles were compiled into the database developed from the business survey. A separate worksheet was devoted to species profile for the various solvents. UCR identified 306 unique solvents from the survey information (Appendix C). The species profile for most (84%) of the solvents listed was determined. Chemical composition of each of the 306 solvent brands was determined, resulting in identification of 538 ingredients. For blends, the predominant species of each solvent brand was used to categorize into one of the 38 solvent categories. The organic compounds identified were grouped and coded for use in subsequent emission inventory calculations (Table II). For consistency, the codes from the 1993 study were used to label the solvent categories.

Table II – Solvent Codes

Solvent Code	Description
0	N/A
101	trichloroethane
102	trichlorotrifluoroethane
103	dichlorofluoroethane
104	acetone
105	ethyl alcohol
106	isopropanol
107	methyl ethyl ketone
108	methyl isobutyl ketone
109	methylene chloride
110	mineral spirits
111	hexane
112	n-methyl-2-pyrrolidinone
113	perchloroethylene
114	Safety Kleen
115	toluene
116	trichloroethylene
117	petroleum distillates
118	xylene
119	n-propyl bromide
120	methanol
121	tetrafluoroethane
122	dichloromethane
199	other pure solvent
201	alcohol blends
202	CFC blends
203	dibasic ester solutions
204	glycols and glycol ethers
205	HCFC blends
206	methylene bromide
207	o-dichlorobenzene
208	other halogenated
209	perfluorocarbon blends
210	terpenes
211	water-based
212	ketone blends
213	other esters
230	xylene blends
299	other blend

2.3 Preparation of Updated Emissions Inventory

Based on the information obtained in the business survey on the types and quantities of solvents used, an updated emissions inventory was developed. The emissions inventory provides separation based on business/source category and the capability to provide inventories for particular equipment/solvent type and for geographical location.

A workbook was developed that incorporates the species profiles into the emissions inventory database. The first step in the process was the determination of total TOG emissions from each facility. Where information was available regarding amounts purchased versus amounts disposed, the calculation was a direct subtraction. In cases where that information was not available, emission estimates were applied. These estimates were developed from average emissions (calculated from purchased minus disposed data) from comparable facilities in the database (where available), and/or published solvent cleaning emissions rates from other sources (e.g., air quality agencies, literature). The second step in the process was to overlay the solvent species profile to the overall TOG emissions to obtain facility emissions for individual solvents. Finally, emission factors were calculated for each solvent in terms of pounds of emissions per employee per year for each facility.

In order to expand the emissions estimates to a statewide inventory, the most recent California employment statistics were obtained from the United States Census Bureau.[3] The database lists the most current total employment numbers for each type of business in California, based on NAICS code. By multiplying the average solvent emission factor (pounds/employee/year) by the total number of California employees in a given industry code, a statewide estimate of emissions was determined.

An important element of the emissions inventory is activity/use estimates. The emissions inventories were developed from the same basic database used for the field survey. The inventories were calculated based on the quantities of solvent used, the type of business, type of equipment or application, and the particular types of solvent in use. Based on the surveys received, UCR broke down the equipment/application methods into the following 11 categories:

[3] U.S. Census Bureau, 2008 County Business Patterns

Table III – Equipment Codes

Code	Description
BLVD	Batch-Loaded Vapor Degreaser
BLCC	Batch-Loaded Cold Cleaner
CCC	Conveyorized Cold Cleaner
RRC	Remote Reservoir Cleaner
CCAE	Cleaning of Coating Application Equipment
HWSPA	Hand Wipe Surface Preparation Activities
HWCA	Hand Wipe Cleaning Activities
ASPP	Aerosol Surface Preparation Process
ACP	Aerosol Cleaning Process
O	Other Process/Equipment
NS	Process/Equipment Not Specified

The emission factors for each combination of solvent and equipment were calculated in terms of pounds of emissions per employee per year. The emission factors were determined according to the following equation:

EPE = (SolvFactor x SolvQty)/NumEmp

Where:
EPE = Emissions per employee (lbs/employee/year)
SolvFactor = Total organic gas emissions (lb TOG/gallon of solvent)
SolvQty = Volume of solvent used (gallons/year)
NumEmp = total number of employees at facility

The SolvFactor was determined for each solvent either directly from the label or by calculating purchased minus disposed volumes and multiplying by the solvent density to obtain lb/gallon. Average statewide species emission factors were determined for each type of facility, grouped by NAICS code.

The emissions inventory calculations were set up in a manner such that inventories of particular solvents can be obtained by cross referencing to an equipment category to obtain an inventory for a specific equipment/solvent combination. The emissions inventory calculations contain macros that allow the user to obtain subsets of information that might be of use for a particular solvent, equipment type, or within a certain business category or region.

A list and descriptions of all workbooks associated with the project (included as electronic attachments) can be found in Appendix D.

3 Results

An analysis was performed on the survey responses in order to determine the representativeness of the data. Figure 1 presents the number of survey responses received from each district.

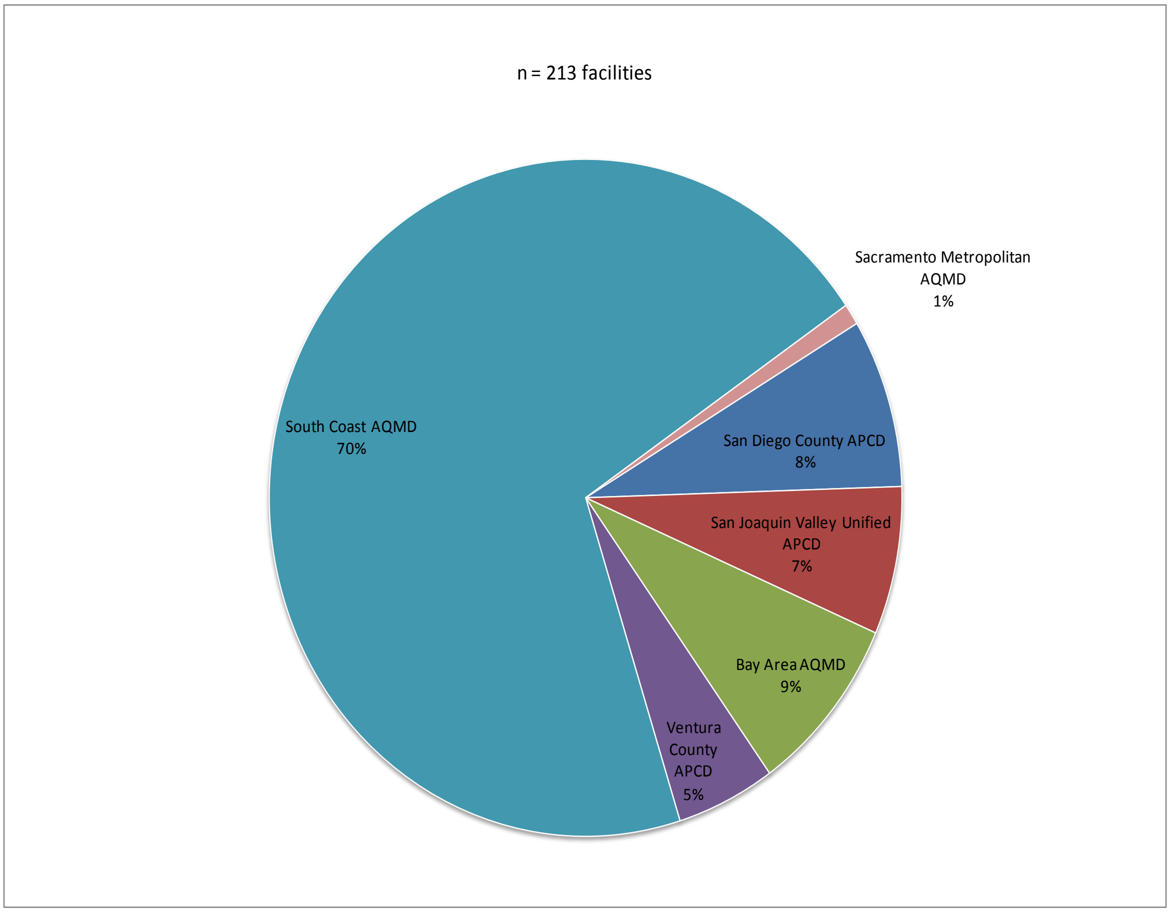

Figure 1 - Survey Responses by District

Over half of the responses were obtained from the SCAQMD, due in part to the additional information received from the inspection audits. 7% of the total surveys were received each from the Bay Area, San Joaquin valley, and San Diego districts. 5% of the surveys were received from Ventura County, and 1% from Sacramento Municipal.

Figure 2 shows the responses by data source.

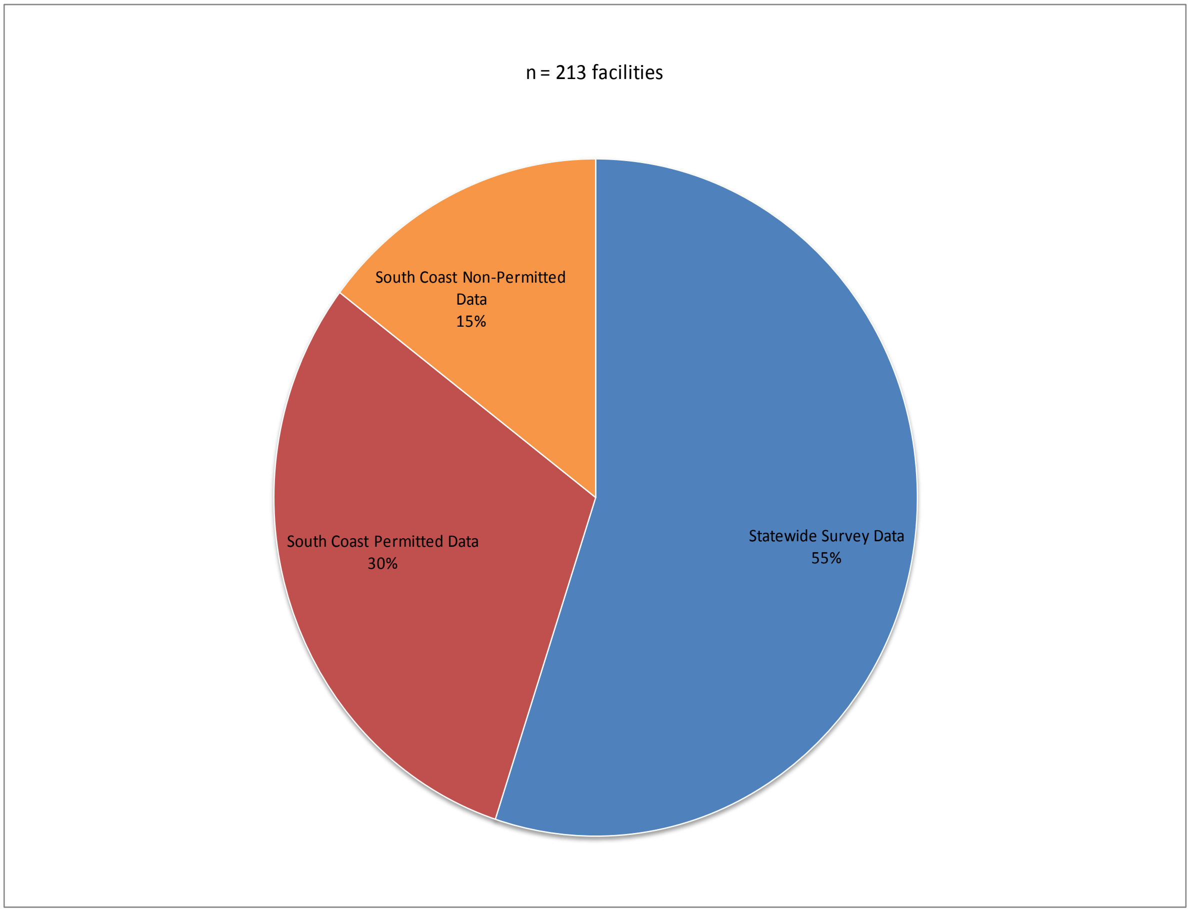

Figure 2 - Survey Responses by Data Source

Over half of the responses were received from the statewide survey data. 30% of the responses came from SCAQMD permitted sources, and the remaining 15% were received from SCAQMD non-permitted sources.

Lastly, the survey responses were broken down by industry group, and are presented in Figure 3.

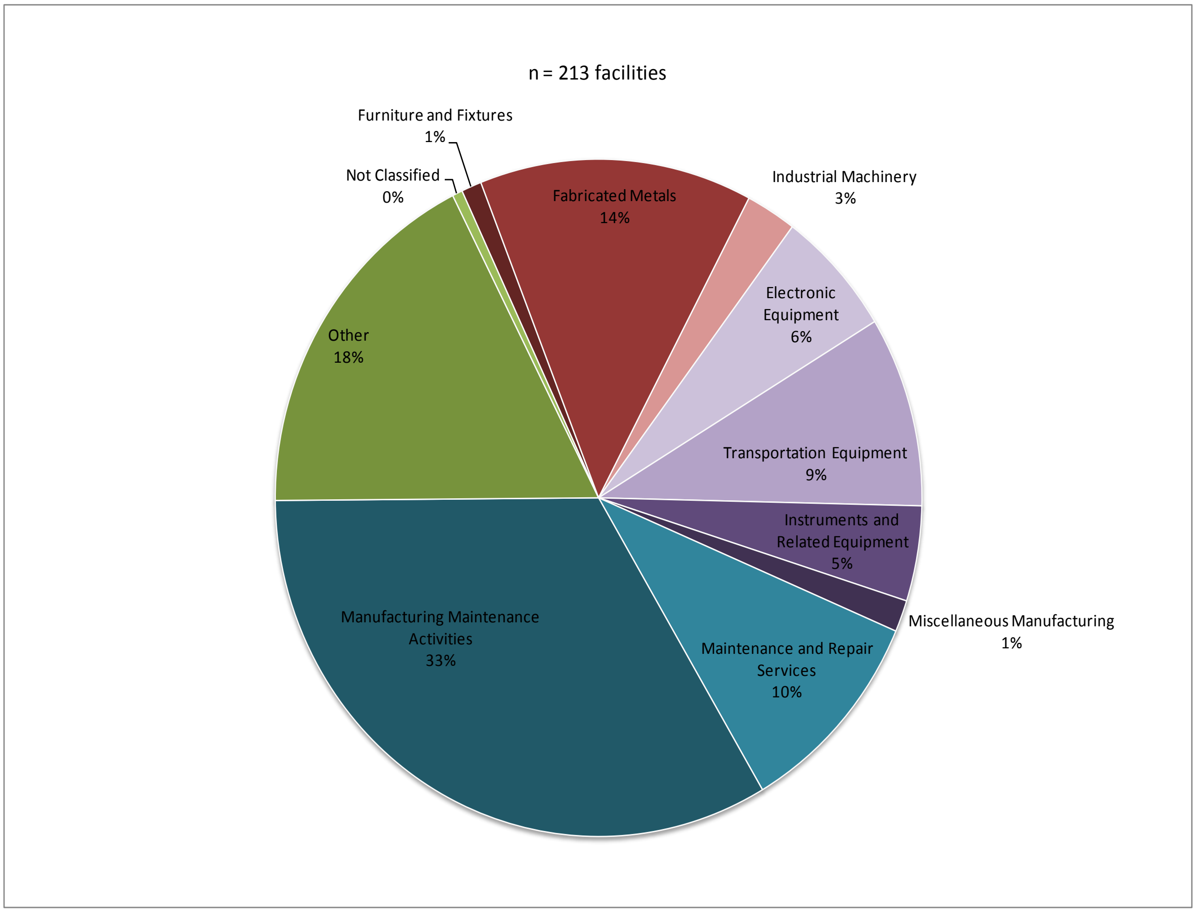

Figure 3 - Facility Responses by Industry Group

The largest number of survey responses (33%) came from facilities with manufacturing maintenance activities. This was followed by "Other" (e.g., research and development, vehicle dealerships, prisons, transit services) at 18%, fabricated metals (14%), and Maintenance/repair services (10%). The remaining responses were received by facilities dealing with transportation equipment, electronic equipment, instruments and related equipment, industrial machinery, and miscellaneous manufacturing.

The first step in developing the current solvent cleaning emissions inventory was the reduction of data into a manageable set of equipment/solvent combinations. The first level of data consolidation involved combining similar solvents into groups. Solvents with similar characteristics (density, evaporation rate, chemical class) were grouped together in a way that does not sacrifice data quality. The 38 solvents listed in Table II were grouped into 18 categories as follows:

Table IV - Solvent Groups

Solvent Type	Original Survey Solvents (Codes)
TCA	TCA (101)
CFC/CFC blends	CFC (102), CFC blends (202)
HCFC	HCFC (103), HCFC blends (205)
Ketones	Acetone (104), MEK (107), MIBK (108), ketone blends (212)
Alcohols	Ethanol (105), IPA (106), Methanol (120), Alcohol blends (201)
Methylene chloride	Methylene chloride (109), dichloromethane (122)
Petroleum distillates	Mineral spirits (110), Safety Kleen (114), Petroleum distillates (117)
Misc. pure solvents	Unlisted pure solvents (199), Hexane (111), NMP (112)
PERC	PERC (113)
N-propyl bromide	N-propyl bromide (119)
Other halogenated	Methylene bromide (206), o-dichlorobenzene (207) other halogenated (208)
Toluene/xylene	Toluene (115), xylene (118), xylene blends (230)
TCE	TCE (116)
Glycol ethers	Glycol ethers (204), water-based solutions (211)
Esters	Dibasic ester solutions (203), other esters (213)
PFC blends	PFCs (209), tetraflouroethane (121)
Terpenes	Terpenes (210)
Misc. blends	Other blends (299)

Some halogenated solvents such as trichloroethane (TCA), methylene chloride, and perchloroethylene (PERC) were not grouped; either because they were well represented in the survey, or to make it easier to compare with previous inventories. Grouping of petroleum distillates, alcohols, and ketones was based on the similarities in physical and chemical properties. For continuity, the solvent codes in this study are identical to those investigated in the 1993 study. Some solvents reported in the earlier study were not found in the current survey. There were no reported instances of solvent usage of trichlorotrifluoroethane (102), tetrafluoroethane (121), dibasic ester solutions (203), HCFC blends (205), methylene bromide (206), and o-dichlorobenzene (207). Therefore, these solvents were not included in the emissions inventory.

Following the model of the previous study[1], the equipment types were grouped into four categories:

(1) Cold Cleaning – batch loaded cold cleaner (BLCC), conveyorized cold cleaner (CCC), remote reservoir cleaner (RRC), and cold cleaning application equipment (CCAE)
(2) Vapor Degreasing – batch-loaded vapor degreaser (BVD), aerosol surface preparation process (ASPP), and aerosol cleaning process (ACP)
(3) Hand Wiping – hand wipe surface preparation activities (HWSPA), and hand wipe cleaning activities (HWCA)
(4) Other – other (O), and not specified (NS)

Updated California Solvent Cleaning Emissions Inventories

Following the grouping of solvents and equipment types, the number of unique equipment/solvent pairings (ESPs) was reduced to 45. These pairings were used to develop the statewide inventory for solvent cleaning emissions.

Many facilities reported solvent usage with more than one ESP combination. Also, facilities with more than one solvent used in the same equipment or different equipment using the same solvent required a composite record. In these instances, weighted average emission factors were determined and summed.

Table V depicts the 2008 solvent cleaning emissions inventory, broken down by solvent and equipment groupings. Total statewide organic gas emissions from this category are estimated to be 39,819 tons per year.

Table V – Current (2008) Statewide Emissions Inventory

Emissions Inventory (tons TOG/yr)					
	Cold Cleaning BLCC/CCC/	Vapor Degreasing	Hand Wiping	Other, Not Specified	
Solvent Type	**RRC/CCAE**	**BLVD/ASPP/ACP**	**HWSPA/HWCA**	**O/NS**	**Total**
TCA	1.9	1.9	1.9	0.0	5.7
CFC/CFC blends	296.5	0.0	0.0	0.0	296.5
HCFC	0.0	0.3	0.0	0.4	0.7
Ketones	5468.9	560.8	1761.7	165.8	7957.0
Alcohols	1584.8	732.1	168.5	5151.8	7637.1
Methylene chloride	0.0	0.0	142.7	22.5	165.2
Petroleum distillates	4853.5	1625.0	3790.9	4254.5	14523.8
Misc. pure solvents	1.5	0.0	0.0	220.4	222.0
PERC	0.0	1.8	0.0	85.8	87.5
n-propyl bromide	0.0	113.4	1.3	46.0	160.7
other halogenated	0.0	0.2	0.0	0.0	0.2
Toluene/xylene	2.0	6.6	28.8	1117.0	1154.4
TCE	0.0	0.8	0.0	0.0	0.8
Glycol ethers	109.9	39.6	7.2	21.8	178.5
Esters	0.0	0.0	1.2	224.4	225.5
PFC blends	0.8	0.0	0.0	0.3	1.0
Terpenes	0.7	3.5	3.6	0.2	8.0
Misc. blends	190.0	23.1	38.1	6943.2	7194.4
Totals:	**12510.5**	**3109.0**	**5945.8**	**18254.1**	**39819.3**

Petroleum distillates account for 36.2% of the emissions, followed by ketones (20.1%), alcohols (19.2%), and miscellaneous blends (18.1%). CFC and CFC blends account for less than 1% of the total inventory. All chlorinated hydrocarbon emissions combined (TCA, CFC, CFC blends, methylene chloride, and PERC) make up only 1.4% of the overall total.

Hand wiping and other/not specified processes accounted for 60.6% of the overall inventory, followed by cold cleaning (31.6%) and vapor degreasing (7.8%).

4 Discussion

The following Table presents the statewide solvent cleaning emissions inventory with previous inventories determined by the ARB for 1993[1] and projected to 2007. The emission values in the projected 2007 inventory are derived from several data sources, including the base 1993 study and ARB Forecasted Emissions by Summary Category. Emissions are then grown in proportion to expected population increase. Population growth is in accordance with estimates in the California Environmental Protection Agency's (Cal/EPA) Statewide Human Population Table found in the Population and Vehicle Trends Report. Emission values from the 1993 survey and estimated emission reductions resulting from the VOC limits approved by the Board are reflected in the projected 2007 inventory.

Table VI – Solvent Cleaning Emissions Comparison

Emissions Inventory (tons TOG/yr)			
Solvent Type	Current (2008) Inventory	ARB 2007 Inventory	ARB 1993 Inventory
TCA	5.7	12944.0	15567.0
CFC/CFC blends	296.5	1725.3	2552.0
HCFC	0.7	112.8	648.0
Ketones	7957.0	1635.0	8071.0
Alcohols	7637.1	1039.3	3974.0
Methylene chloride	165.2	2370.8	1640.0
Petroleum distillates	14523.8	6908.0	39757.0
Misc. pure solvents	222.0	242.9	265.0
PERC	87.5	52.2	446.0
n-propyl bromide	160.7	0.0	0.0
other halogenated	0.2	0.0	0.0
Toluene/xylene	1154.4	127.6	639.0
TCE	0.8	14.9	317.0
Glycol ethers	178.5	124.3	420.0
Esters	225.5	0.0	0.0
PFC blends	1.0	10.5	100.0
Terpenes	8.0	100.6	490.0
Misc. blends	7194.4	7812.4	3694.0
Total:	**39819.3**	**35220.5**	**78580.0**

The current (2008) overall statewide emissions inventory of TOG is 13.1% more than the projected 2007 inventory, and 49.3% less than the 1993 survey. Of particular note is the dramatic reduction of chlorinated hydrocarbon emissions. TCA accounted for 19.8% of the total inventory in 1993 and 36.8% of the total in 2007. This is compared with the current study, in which TCA emissions are virtually eliminated at 0.014%. Other chlorinated hydrocarbons show similar reductions, with the exception of perchloroethylene (PERC), which accounted for 87.5 tpy in the current study vs. 52.2 in the 2007 ARB inventory. These reductions have occurred in spite of a 57% increase in industrial production between 1990 and 2008.[2]

There were discussions with project staff about the reasons for the dramatic reductions in solvent cleaning emissions since 1993. According to the Center for the Continuing Study of the California Economy[2], California lost 471,000 manufacturing jobs between 2000 and 2009. This is a result of a worldwide trend for manufacturers to relocate to lower cost places. A look at the overall solvent cleaning business in California, however, reveals surprising data. The following Table presents results from the 1993 inventory study along with the current study in terms of the number of facilities with less than 50 employees vs. those with more than 50 employees.

Table VII - Solvent Cleaning Facilities in California by Employment

	# of Employees		
	< 50	> 50	total
# of Facilities (2008)	88138	2478	90616
# of Facilities (1993)	31581	3431	35012

Facilities with greater than 50 employees represent primarily large manufacturing businesses. Since 1993, the number of these large facilities in California has decreased by 28%. This corresponds with the drop in manufacturing employment noted above. This is compared with the number of facilities with less than 50 employees, which largely perform maintenance cleaning activities. The number of these facilities has increased by 179% since 1993. The conclusion of this result is that while emissions from solvent cleaning from manufacturing processes has certainly decreased due to the loss of manufacturing jobs and facilities, the emissions from solvent cleaning from maintenance operations have increased as a result of the growth in the number of small businesses in the state.

The decreases in chlorinated hydrocarbon use due to phase-out of these compounds have led end-users to alternative solvent formulations. Compared with the 2007 inventory, there were substantial increases in usage of ketones, alcohols, petroleum distillates, and toluene/xylene. New compounds not reported in the previous surveys include n-propyl bromide and esters. The current (2008) overall inventory of 39,819 tons per year is consistent with the 2007 ARB projected inventory of 35,221 tons per year. This provides a measure of quality assurance, as the two most recent inventories were developed using different methods.

In order to compare emissions by equipment category with previous surveys, the emissions for the “Other/Not Specified” category in the current study were apportioned to the three other categories based on the fraction of the total for each solvent group that was actually reported. Table VIII presents the results of the current study apportioned into the three categories.

Table VIII - Emissions Inventory with Other/Not Specified Category Apportioned

Apportioned Emissions Inventory (tons TOG/yr)				
Solvent Type	Cold Cleaning BLCC/CCC/ RRC/CCAE	Vapor Degreasing BLVD/ASPP/ACP	Hand Wiping HWSPA/HWCA	Total
TCA	1.9	1.9	1.9	5.7
CFC/CFC blends	296.5	0.0	0.0	296.5
HCFC	0.0	0.7	0.0	0.7
Ketones	5585.2	572.7	1799.1	7957.0
Alcohols	4869.9	2249.5	517.7	7637.1
Methylene chloride	0.0	0.0	165.2	165.2
Petroleum distillates	6864.3	2298.2	5361.4	14523.8
Misc. pure solvents	222.0	0.0	0.0	222.0
PERC	0.0	87.5	0.0	87.5
n-propyl bromide	0.0	158.9	1.8	160.7
other halogenated	0.0	0.2	0.0	0.2
Toluene/xylene	61.2	203.9	889.3	1154.4
TCE	0.0	0.8	0.0	0.8
Glycol ethers	125.2	45.2	8.2	178.5
Esters	0.0	0.0	225.5	225.5
PFC blends	1.0	0.0	0.0	1.0
Terpenes	0.8	3.6	3.7	8.0
Misc. blends	5441.3	660.9	1092.3	7194.4
Totals:	**23469.2**	**6284.0**	**10066.1**	**39819.3**

In the apportioned inventory, cold cleaning accounted for 59.2% of the overall emissions, followed by hand wiping (24.9%) and vapor degreasing (15.8%).

A comparison of the three inventories in the cold cleaning category is presented in Table IX.

Table IX – Inventory Category Comparison – Cold Cleaning

Cold Cleaning Emissions Inventory (tons TOG/yr)			
	Current Inventory	ARB 2007 Inventory	ARB 1993 Inventory
	BLCC/CCC/	BLCC/CCC/	BLCC/CCC/
Solvent Type	RRC/CCAE	RRC/CCAE	RRC/CCAE
TCA	1.9	605.7	2319.0
CFC/CFC blends	296.5	1183.6	1280.0
HCFC	0.0	0.0	0.0
Ketones	5585.2	328.0	3803.0
Alcohols	4869.9	439.8	2689.0
Methylene chloride	0.0	14.1	32.8
Petroleum distillates	6864.3	6149.9	35762.0
Misc. pure solvents	222.0	7.0	32.1
PERC	0.0	0.0	0.0
n-propyl bromide	0.0	0.0	0.0
other halogenated	0.0	0.0	0.0
Toluene/xylene	61.2	7.0	35.4
TCE	0.0	0.0	0.0
Glycol ethers	125.2	12.4	66.0
Esters	0.0	0.0	0.0
PFC blends	1.0	0.0	0.0
Terpenes	0.8	98.4	362.0
Misc. blends	5441.3	3858.8	1075.0
Totals:	**23469.2**	**12704.8**	**47456.3**

The overall TOG emissions from the cold cleaning category in the current study are 85.1% greater than the 2007 projected inventory, and 50.4% less than the 1993 study. The majority of reductions between 1993 and 2007 were due to decreased usage in petroleum distillates and chlorinated hydrocarbons. Additional chlorinated hydrocarbon reductions are shown between the 2007 inventory and the current study. These compounds appear to have been replaced in this equipment category to a large extent by ketones, alcohols, and miscellaneous blends. The increased use of closed-loop systems may also contribute to the reductions. This is reflected in a current study identifying acetone, water-based solvents, and alcohol mixtures as effective alternatives.[4]

A comparison of the three inventories in the vapor degreasing category is presented in Table X.

[4] Wolf, K., "*Safer Alternatives in Cleaning and Thinning Applications*," U.S. Environmental Protection Agency Agreement X9-96954401-1, March, 2007.

Table X - Inventory Category Comparison – Vapor Degreasing

Vapor Degreasing Emissions Inventory (tons TOG/yr)			
Solvent Type	Current Inventory BLVD/ASPP/ACP	ARB 2007 Inventory BLVD/ASPP/ACP	ARB 1993 Inventory BLVD/ASPP/ACP
TCA	1.9	6441.2	7813.0
CFC/CFC blends	0.0	396.0	897.0
HCFC	0.7	112.6	642.0
Ketones	572.7	0.0	0.0
Alcohols	2249.5	0.0	0.0
Methylene chloride	0.0	0.0	0.0
Petroleum distillates	2298.2	13.9	0.0
Misc. pure solvents	0.0	0.0	0.0
PERC	87.5	44.5	430.0
n-propyl bromide	158.9	0.0	0.0
other halogenated	0.2	0.0	0.0
Toluene/xylene	203.9	6.4	0.0
TCE	0.8	10.5	249.0
Glycol ethers	45.2	0.0	0.0
Esters	0.0	0.0	0.0
PFC blends	0.0	10.5	100.0
Terpenes	3.6	0.0	0.0
Misc. blends	660.9	2437.9	10.9
Totals:	**6284.0**	**9473.5**	**10141.9**

The overall TOG emissions from the vapor degreasing category in the current study are 33.6% less than the 2007 inventory, and 37.9% less than the 1993 study. The majority of reductions are a result of decreased emissions of chlorinated hydrocarbons. According to a recent study, there were as many as 3000 vapor degreasers in the South Coast Air Basin alone using trichloroethylene (TCE).[5] By 2002, there were only 250 vapor degreasers; primarily using perchloroethylene. Since then, many companies have switched to water-based systems, acetone, and alcohol blends. The current study also reports the first usage of n-propyl bromide and glycol ethers in vapor degreasing operations. These solvents have been adopted by some aerospace companies as a replacement for ozone-depleting solvents TCA and PERC.[6]

A comparison of the three inventories in the hand wiping category is presented in Table XI.

[5] Morris, M., and K. Wolf, "*Alternatives to Perchloroethylene Vapor Degreasing for Plating Operations: Case Study Conversions*," Institute for Research and Technical Assistance, February, 2003.

[6] Hanley, K.W., Dunn, K., and R. Solberger, "*Workers Exposures to n-Propyl Bromide at an Aerospace Components Manufacturer*," National Institute for Occupational Safety and Health, November, 2006.

Table XI - Inventory Category Comparison - Hand Wiping

Hand Wiping Emissions Inventory (tons TOG/yr)			
Solvent Type	Current Inventory HWSPA/HWCA	ARB 2007 Inventory HWSPA/HWCA	ARB 1993 Inventory HWSPA/HWCA
TCA	1.9	5897.1	5436.0
CFC/CFC blends	0.0	145.7	374.0
HCFC	0.0	0.2	6.1
Ketones	1799.1	1307.0	4268.0
Alcohols	517.7	599.5	1285.0
Methylene chloride	165.2	2356.7	1607.0
Petroleum distillates	5361.4	744.1	3995.0
Misc. pure solvents	0.0	235.9	233.0
PERC	0.0	7.6	15.2
n-propyl bromide	1.8	0.0	0.0
other halogenated	0.0	0.0	0.0
Toluene/xylene	889.3	114.2	603.0
TCE	0.0	4.3	68.2
Glycol ethers	8.2	111.9	354.0
Esters	225.5	0.0	0.0
PFC blends	0.0	0.0	0.0
Terpenes	3.7	2.2	128.0
Misc. blends	1092.3	1515.7	2609.0
Totals:	**10066.1**	**13042.2**	**20981.5**

The overall TOG emissions from the hand wiping category in the current study are 24.1% less than the 2007 inventory, and 52.8% less than the 1993 study. Once again, the majority of reductions are a result of decreased emissions of chlorinated hydrocarbons; particularly trichloroethane (TCA). The current study suggests that TCA has largely been replaced in this equipment category with petroleum distillates, and to some extent by alcohols, ketones, toluene/xylene, and esters. This conclusion is reflected in industry literature,[7] describing use of alcohols, ketones, and petroleum distillates in a variety of hand wiping activities.

An overall statistical analysis of the calculated emission factors was performed in order to gauge the precision and consistency of the data. The following figure plots the complete database of emission factors in terms of pounds per employee per year.

[7] Gallagher, M.S., "*Parts Cleaning – Manual Cleaning Relies on Solvent Alternatives*," Precision Cleaning – the Magazine of Critical Cleaning Technology, April, 1995.

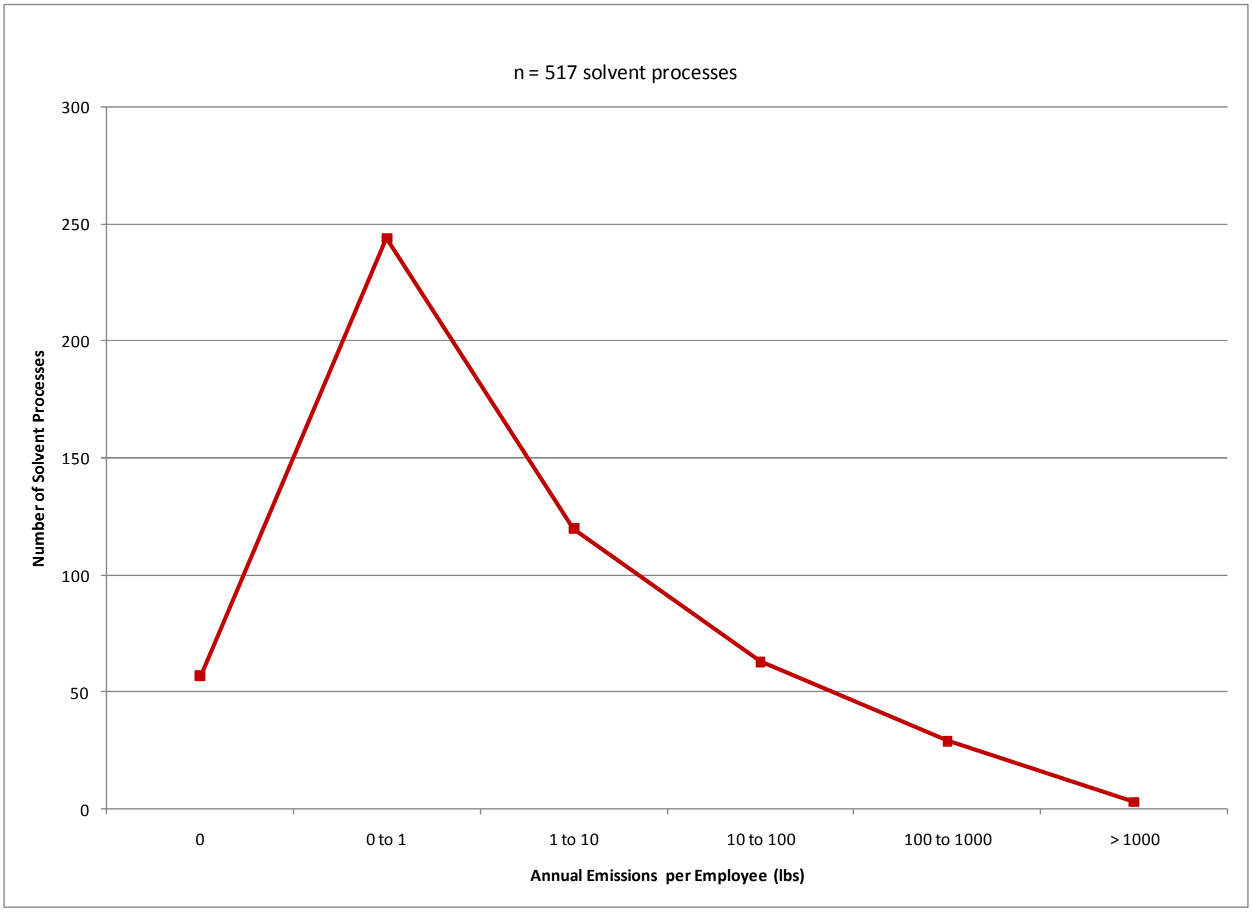

Figure 4 - Overall Solvent Cleaning Emission Factors

The figure shows that almost 50% of the calculated emission factors fall between 0 and 1 pound per employee per year. Approximately 120 processes reported emission factors between 1 and 10 lb/employee/yr., and approximately 60 processes had emissions between 10 and 100 lb/employee/yr. There were 30 processes reported that resulted in emission factors between 100 and 1000 lb/employee/yr.

The following Table shows the averages and standard deviations of emission factors by solvent code:

Table XII - Statistical Analysis of Emission Factors by Solvent Code

		Average (lb/emp./yr.)	Std. Dev.	+/- %
101	trichloroethane	1.00634058	0	0
102	trichlorotrifluoroethane			
103	dichlorofluoroethane	1.13582493	0.578974	50.97387
104	acetone	401.6232475	637.9359	158.8394
105	ethyl alcohol	155.9687447	311.8745	199.9596
106	isopropanol	2020.735831	4673.439	231.2741
107	methyl ethyl ketone	49.53510358	79.83864	161.1759
108	methyl isobutyl ketone	7.962038151		
109	methylene chloride	1.716172795		
110	mineral spirits	90.98641913	88.59457	97.3712
111	hexane	3.218314888		
112	n-methyl-2-pyrrolidinone	24.76339927	33.7833	136.4243
113	perchloroethylene	9.497915183	12.95747	136.4244
114	Safety Kleen	35.40029936	52.84247	149.2713
115	toluene	2.301883891	1.598189	69.4296
116	trichloroethylene	1.236156028	0.914745	73.99919
117	petroleum distillates	676.6707039	1001.383	147.9868
118	xylene	222.2231093	311.7958	140.3076
119	n-propyl bromide	10.43327962	17.23825	165.2237
120	methanol	850.0833173	1693.586	199.2259
121	tetrafluoroethane	0.009619048		
122	dichloromethane	136.3861386		
199	other pure solvent not otherwise specified	43.26445724		
201	alcohol blends	12.06457507	20.53861	170.2389
202	CFC blends	50.5124096	71.39395	141.3394
203	dibasic ester solutions			
204	glycols and glycol ethers	5.624165363	5.588309	99.36246
205	HCFC blends			
206	methylene bromide			
207	o-dichlorobenzene			
208	other halogenated	0.036893204		
209	perfluorocarbon blends	0.696634921	0.649012	93.16383
210	terpenes	0.83766348	0.766289	91.47937
211	water-based	0.272973684		
212	ketone blends	70.71896558	52.32412	73.98881
213	other esters	174.1613529	300.6074	172.6028
230	xylene blends	10.07142857		
299	other blend not otherwise specified	89.0756566	208.7867	234.3925

As most of these solvents are used in different applications (hand wiping, cold cleaning, batch processes), it is expected to see a wide variation in emission factors. The chart does show fairly consistent variation across the range of solvents.

Next, the all of the ESP combinations were filtered to find all that had more than three records. The following Table presents the statistics.

Table XIII - Statistical Analysis of ESP Combinations

Equipment	Solvent	Average (lb/emp/yr)	Std. Dev.	+/- %
BLVD	isopropanol	3.60353221	6.126954	170.0264
ACP	isopropanol	37.647608	74.92239	199.0097
CCAE	acetone	70.3371211	128.0913	182.1106
RRC	acetone	23.1792103	24.18168	104.3249
HWSPA	alcohol blends	0.37469879	0.532637	142.1507
HWSPA	glycols/glycol ethers	1.04257477	1.289063	123.6423
HWSPA	mineral spirits	6.13721044	7.056524	114.9793
NS	mineral spirits	20.6799289	42.4885	205.4577

While Table XIII shows large variances in emission factors, it is misleading. In some cases, one or two entries are very large (or small) compared with the majority of entries for a category. Large emission factors were more frequently reported for facilities with less than 50 employees. In addition, the same ESP combinations used in different industry groups tend to report different emission factors. Once the ESP combinations are separated out by number of employees and industry group, there is not enough data to gauge the statistics on the micro level. The overall results, however, are more precise as the emission factors were multiplied by total employment by NAICS code.

Finally, an estimate of the ozone-forming potential of the current emissions inventory was conducted using maximum incremental reactivity (MIR) factors developed by Carter.[8] Briefly, the reactivity scale is based on calculations of relative ozone impacts, expressed as mass of additional ozone formed per mass of VOC added to the emissions, for various compounds under various atmospheric conditions, given a chemical mechanism for the compounds and other relevant atmospheric species, models for various atmospheric conditions, and a modeling and reactivity assessment procedure.

Among the mixtures added to the current MIR tabulation are the 24 hydrocarbon "bins" used in the current CARB aerosol coatings regulation. These "bins" represent various types of complex hydrocarbon mixtures, defined by composition type and boiling point range. These “bins” were used to approximate the MIR factors for the solvent categories “unspecified pure solvents,” and “unspecified solvent blends.” For the solvent categories with multiple components

[8] Carter, William P.L., “Updated Maximum Incremental Reactivity Scale and Hydrocarbon Bin Reactivities for Regulatory Applications,” California Air Resources Board Contract No. 07-339, June, 2009.

(e.g., "alcohols" and "ketones"), a composite MIR was determined based on the weighted average contribution of individual pure components in each category.

Table XIV depicts the 2008 ozone-forming potential of the solvent cleaning emissions inventory, broken down by solvent and equipment groupings. The data are based on the apportioned inventory (applying weighted average apportionment to account for the "Other/Not Specified" ESP). Total statewide ozone-forming potential from this category is estimated to be 52,016 tons per year.

Table XIV – Ozone-Forming Potential by Equipment/Solvent Combination

Apportioned Emissions Inventory (tons Ozone/yr)					
Solvent Type	**MIR (g O_3/g solvent)**	**Cold Cleaning BLCC/CCC/ RRC/CCAE**	**Vapor Degreasing BLVD/ASPP/ACP**	**Hand Wiping HWSPA/HWCA**	**Total**
TCA	0.005	0.0	0.0	0.0	0.0
CFC/CFC blends	0.000	0.0	0.0	0.0	0.0
HCFC	0.000	0.0	0.0	0.0	0.0
Ketones	0.533	2977.4	305.3	959.1	4241.8
Alcohols	0.761	3707.2	1712.5	394.1	5813.8
Methylene chloride	0.039	0.0	0.0	6.4	6.4
Petroleum distillates	1.688	11585.1	3878.7	9048.7	24512.5
Misc. pure solvents	1.135	251.9	0.0	0.0	251.9
PERC	0.029	0.0	2.5	0.0	2.5
n-propyl bromide	0.400	0.0	63.6	0.7	64.3
other halogenated	0.000	0.0	0.0	0.0	0.0
Toluene/xylene	7.224	442.1	1472.9	6424.3	8339.3
TCE	0.610	0.0	0.5	0.0	0.5
Glycol ethers	1.457	182.3	65.8	11.9	260.0
Esters	0.000	0.0	0.0	0.0	0.0
PFC blends	0.000	0.0	0.0	0.0	0.0
Terpenes	4.200	3.2	15.2	15.5	33.8
Misc. blends	1.180	6420.7	779.8	1288.9	8489.4
Totals:		**25569.9**	**8296.7**	**18149.6**	**52016.2**

Assuming the apportionment of the "Other/Not Specified" category as previously discussed reveals that approximately half of the ozone-forming potential in the current study comes from the cold cleaning category, followed by hand wiping and vapor degreasing. Toluene and xylene are particularly reactive, with significant usage reported. A major contributor to ozone-forming potential in the current study is petroleum distillates, followed by toluene/xylene, alcohols, and ketones.

The following Table presents an estimate of the ozone-forming potential of the current solvent cleaning emissions inventory.

Table XV – Comparison of Ozone-Forming Potential

Solvent Type	MIR ($g\ O_3/g$ Solvent)	Current (2008) Inventory (tons O_3/yr)	ARB 2007 Inventory (tons O_3/yr)	ARB 1993 Inventory (tons O_3/yr)
TCA	0.005	0.0	64.7	77.8
CFC/CFC blends	0.000	0.0	0.0	0.0
HCFC	0.000	0.0	0.0	0.0
Ketones	0.533	4241.8	871.6	4302.5
Alcohols	0.761	5813.8	791.2	3025.2
Methylene chloride	0.039	6.4	91.5	63.3
Petroleum distillates	1.688	24512.5	11658.9	67099.6
Misc. pure solvents	1.135	251.9	275.7	300.7
PERC	0.029	2.5	1.5	12.9
n-propyl bromide	0.400	64.3	0.0	0.0
other halogenated	0.000	0.0	0.0	0.0
Toluene/xylene	7.224	8339.3	921.4	4616.0
TCE	0.610	0.5	9.1	193.4
Glycol ethers	1.457	260.0	181.1	611.8
Esters	0.000	0.0	0.0	0.0
PFC blends	0.000	0.0	0.0	0.0
Terpenes	4.200	33.8	422.5	2058.0
Misc. blends	1.180	8489.4	9218.6	4358.9
Total:		**52016.2**	**24507.8**	**86720.3**

The Table suggests that the current emissions from solvent cleaning operations have the potential of producing up to 52,016 tons per year of ozone. This is more than double the potential projected for the 2007 inventory, but a 40% decrease from the ozone-forming potential calculated from the 1993 inventory. Compared with the 2007 projection, the current study also suggests a more widespread use of alcohols and ketones. The majority of the ozone-forming potential in the current study results from the use of petroleum distillates, miscellaneous blends, and toluene/xylene.

5 Summary and Conclusions

Results from the current study suggest that TOG emissions from solvent cleaning operations are 13.1% greater than the ARB projected 2007 inventory, but 49.3% less than the 1993 inventory. These reductions can be attributed to the implementation of new technologies and the replacement of traditional solvents with alternative materials. These include replacements for phased-out chlorinated solvents and development of effective aqueous-based alternatives.

While there have been significant losses in manufacturing in California over the past two decades, smaller businesses with maintenance cleaning needs have dramatically increased. Facilities with greater than 50 employees represent primarily large manufacturing businesses. Since 1993, the number of these large facilities in California has decreased by 28%.[3] This corresponds with the drop in manufacturing employment noted above. This is compared with the number of facilities with less than 50 employees, which largely perform maintenance cleaning activities. The number of these facilities has increased by 179% since 1993. The conclusion of this result is that while emissions from solvent cleaning from manufacturing processes has certainly decreased due to the loss of manufacturing jobs and facilities, the emissions from solvent cleaning from maintenance operations have increased as a result of a much larger number of small businesses in the State.

The emissions model developed during this project will allow the ARB to develop emissions estimates and allocate them to counties and air districts throughout the state. Following the analysis and recommendation of the previous study[1], the model uses employment data (rather than population) to determine inventories.

Of particular note is the dramatic reduction of chlorinated hydrocarbon emissions. TCA accounted for 19.8% of the total inventory in 1993 and 36.8% of the total in 2007. This is compared with the current study, in which TCA emissions are virtually eliminated at 0.014%. Other chlorinated hydrocarbons show similar reductions, with the exception of PERC, which accounted for 87.5 tpy in the current study vs. 52.2 in the 2007 ARB inventory. The decreases in chlorinated hydrocarbon use due to phase-out of these compounds have led end-users to alternative solvent formulations. Compared with the 2007 inventory, there were substantial increases in usage of ketones, alcohols, petroleum distillates, and toluene/xylene. New compounds not reported in the previous surveys include n-propyl bromide and esters.

The overall TOG emissions from the cold cleaning category in the current study are 85.1% greater than the 2007 inventory, and 50.4% less than the 1993 study. The majority of reductions between 1993 and 2007 were due to decreased usage in petroleum distillates and chlorinated hydrocarbons. Additional chlorinated hydrocarbon reductions are shown between the 2007 inventory and the current study. These compounds appear to have been replaced in this equipment category to a large extent by ketones, alcohols, and miscellaneous blends. The increased use of closed-loop systems may also contribute to the reductions.

The overall TOG emissions from the vapor degreasing category in the current study are 33.6% less than the 2007 inventory, and 37.9% less than the 1993 study. The majority of reductions are a result of decreased emissions of chlorinated hydrocarbons. These compounds appear to have been replaced in this equipment category by ketones, alcohols, and petroleum distillates. The current study also reports the first usage of n-propyl bromide and glycol ethers in vapor degreasing operations. These solvents have been adopted by aerospace companies as a replacement for TCA and PERC.[6]

The overall TOG emissions from the hand wiping category in the current study are 24.1% less than the 2007 inventory, and 52.8% less than the 1993 study. Once again, the majority of reductions are a result of decreased emissions of chlorinated hydrocarbons; particularly trichloroethane (TCA). The current study suggests that TCA has largely been replaced in this equipment category with petroleum distillates.

Estimates of the ozone-forming potential of the current, 2007, and 1993 emissions inventories were developed. Results indicate that the ozone-forming potential of the current inventory is substantially greater than that predicted in the 2007 inventory. The current estimate is more than double the potential projected for the 2007 inventory, but a 40% decrease from the ozone-forming potential calculated from the 1993 inventory. Compared with the 2007 projection, the current study also suggests a more widespread use of alcohols and ketones. The majority of the ozone-forming potential in the current study results from the use of petroleum distillates, miscellaneous blends, and toluene/xylene.

6 Appendix A – Online Survey

University of California Riverside, CE-CERT / California Air Resources Board
Solvent Cleaning Survey

Please complete Sections I and II

Section I

A. Company Description

Name of Company:	
Address:	
Phone:	
Fax:	
Email:	
SIC[1] Code:	
NAICS[2] Code:	

B. B. Operation Description

Description of Operations/Services:	
Total number of employees:	
Facility Square Footage:	
Number of employees using or working with cleaning solvents:	
Do you use any PFC[3] compounds at your facility? (Y/N)	

Notes:

Please provide Product Data Sheets and Material Safety Data Sheets for each solvent reported.

[1] *Standard Industrial Classification*
[2] *North American Industrial Classification System*
[3] *Perflourocarbons (PFCs) are gaseous compounds typically used in semiconductor manufacturing for chemical vapor deposition (CVD) chamber cleaning and plasma etching. Common PFCs include tetrafluoromethane (CF_4), hexafluoroethane (C_2F_6), octafluoropropane (C_3F_8), trifluoromethane (CF_3), nitrogen trifluoride (NF_3), and sulfur hexafluoride (SF_6). If PFCs are used at your facility, you will be receiving (or have received) a separate survey*

directly from the California Air Resources Board covering these operations. Consequently, do not include any PFC operations in this solvent cleaning survey form.

Section II (Please complete Section II for each cleaning solvent or process used. Use additional pages as necessary)

Name of cleaning solvent:		
VOC content (if labeled):		
Equipment or process where this solvent is used (please check item that best describes usage):		
	a.	a. Batch-Loaded Vapor Degreaser
	b.	b. Batch-Loaded Cold Cleaner
	c.	c. Conveyorized Vapor Degreaser
	d.	d. Conveyerized Cold Cleaner
	e.	e. Remote Reservoir
	f.	f. Cleaning of Coating Application Equipment
	g.	g. Hand-Wiping Surface Preparation Activities
	h.	h. Hand-Wiping Cleaning Activities
	i.	i. Aerosol Surface Preparation Process
	j.	j. Aerosol Cleaning Process
	k.	k. Other (please explain)
Description of solvent cleaning operation:		
How long have you used this solvent/process?		
Number of identical devices/processes at this location:		
Average weekly usage (volume):		
Average weekly usage (hours):		
Number of weeks of operation per year:		
Description of ventilation/control (if any):		
Average volume of cleaning solvent purchased per year:		
Name of cleaning solvent supplier:		
Average volume of used solvent disposed of per year:		
Name of used solvent disposer:		

Signatur: ______________________________

Print Name: ______________________________

Title: ______________________________

Date: ______________________________

Thank you for your participation. If you have any questions, please call Mr. Charles Bufalino at the University of California, Riverside (951/781-5784) or via e-mail bufalino@cert.ucr.edu.

7 Appendix B – Example Letters of Request for Participation

Ventura County
Air Pollution
Control District

669 County Square Drive
Ventura, California 93003

tel 805/645-1400
fax 805/645-1444
www.vcapcd.org

Michael Villegas
Air Pollution Control Officer

December 1, 2008

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), has requested the Ventura County APCD to help facilitate the submittal of information from your facility to assist in efforts to update the statewide emissions inventory for both water-based and organic solvent cleaning operations. The objective of this task is to obtain information to estimate the amount of smog-forming organic compounds and perfluorocarbons emitted into the atmosphere from various types of solvent cleaning applications/operations. An accurate statewide inventory relative to other pollution causing activities is important before determining a need for any further regulatory limits.

The information being requested is solely for the use of UCR under their contract with ARB. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. Please see the enclosed ARB letter regarding confidentiality.

UCR staff has prepared an on-line survey which asks for information regarding your cleaning solvent usage. The survey applies to any water-based or organic solvents used at your facility. The questions relate directly to the types and amounts of cleaning solvents, and how they are used.

The Cleaning Solvent Survey Section I form covers general information about your company and/or facility, and only needs to be filled out once. The Section II form is to be repeated for each different solvent and each different application/operation. Identical applications/operations using the same solvent need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at http://www.cert.ucr.edu . Please click on "Cleaning Solvent Survey Section I" and "Section II" under "Quick Links."

Thank you for your participation in this timely and important project. If you have any questions, or would prefer to fill out a paper copy of the survey rather than the on-line forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu. We would appreciate your response by December 15, 2008.

Sincerely,

Terri Thomas

Terri Thomas
Engineering Division

BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT
SINCE 1955

To Whom It May Concern:

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), is requesting information from your facility to assist in efforts to update the statewide emissions inventory for solvent cleaning operations. The objective of this task is to obtain information to estimate the amount of smog-forming organic compounds and perfluorocarbons emitted into the atmosphere from various types of solvent cleaning. An accurate statewide inventory relative to other pollution causing activities is important before any further regulatory limits can be considered.

The information is being requested solely for use under the contract. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. Please see the ARB letter on the reverse regarding confidentiality.

UCR staff has prepared an on-line survey which asks for information regarding your cleaning solvent usage. The questions relate to the types and amounts of cleaning solvents used at your facility, and when these solvents are used.

The Section I form covers general information about your company and/or facility, and only needs to be filled out once. Section II is to be repeated for each different solvent and each different operation. Identical operations using the same solvent need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at: http://www.cert.ucr.edu/. Please click on Cleaning Solvent Survey Section I and Section II under Quick Links.

Thank you in advance for your participation in this timely and important project. If you have any questions, or would prefer to fill out a paper copy of the survey rather than the on-line forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu.

Sincerely,

Daniel Belik

Daniel Belik
Manager, Rule Development
Planning, Rules and Research

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939 ELLIS STREET • SAN FRANCISCO CALIFORNIA 94109 • 415.771.6000 • WWW.BAAQMD.GOV

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

July 11, 2008

To Whom It May Concern:

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), has requested the San Joaquin Valley Air Pollution Control District to help facilitate the submittal of information from your facility to assist in efforts to update the statewide emissions inventory for both water-based and organic solvent cleaning operations. The objective of this task is to obtain information to estimate the amount of smog-forming organic compounds and perflurocarbons emitted into the atmosphere from various types of solvent cleaning applications/operations. An accurate statewide inventory relative to other pollution causing activities is important before determining a need for any further regulatory limits.

The information being requested is solely for use of UCR under their contract with ARB. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. Please see the ARB letter on the reverse side regarding confidentiality.

UCR staff has prepared an on-line survey which asks for information regarding your cleaning solvent usage. The survey applies to any water-based or organic solvents used at your facility. The questions relate directly to the types and amounts of cleaning solvents; and how they are used.

The Cleaning Solvent Survey Section I form covers general information about your company and/or facility and only needs to be filled out once. The Section II form is to be repeated for each different product and each different application/operation. Identical applications/operations using the same solvent product need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at: http://www.cert.ucr.edu/. Please click on Cleaning Solvent Survey Section I and Section II under Quick Links.

Thank you for your participation in this timely and important project. If you have any questions or would prefer to fill out a paper copy of the survey rather than the on-line forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu

Sincerely,

John Adams
Director of Compliance

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4178
(909) 396-2000 · www.aqmd.gov

January 6, 2008

MEL'S AUTO BODY, MELVIN S
3423 JEFFERSON BLVD
LOS ANGELES, CA 90018

To Whom It May Concern:

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), has requested the South Coast Air Quality Management District to help facilitate the submittal of information from your facility in an effort to update the statewide emissions inventory for both water-based and organic solvent cleaning operations. The objective of this task is to obtain information to estimate the amount of smog-forming organic compounds and perfluorocarbons emitted into the atmosphere from various types of solvent cleaning applications/operations. An accurate statewide inventory relative to other pollution causing activities is important for planning purposes.

The information being requested is solely for the use of UCR under their contract with ARB. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. Please see the attached ARB letter regarding confidentiality.

UCR staff has prepared an on-line survey which asks for information regarding your cleaning solvent usage. The survey applies to any water-based or organic solvents used at your facility. The questions relate directly to the types, amounts, and uses of cleaning solvents.

The Cleaning Solvent Survey, Section I form covers general information about your company and/or facility, and only needs to be filled out once. The Section II form is to be repeated for each different solvent and each different application/operation. Identical applications/operations using the same solvent need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at http://www.cert.ucr.edu . Please click on "Cleaning Solvent Survey Section I" and "Section II" under "Quick Links."

Thank you for your participation in this timely and important project. If you have any questions, or would prefer to fill out a paper copy of the survey rather than the on-line

Cleaning the air that we breathe...

forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu. We would appreciate your response by March 1, 2009.

Sincerely,

Naveen Berry
Manager
Planning, Rule Development & Area Sources

SACRAMENTO METROPOLITAN
AIR QUALITY
MANAGEMENT DISTRICT

Larry Greene
AIR POLLUTION CONTROL OFFICER

October 31, 2008

To Whom It May Concern:

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), has requested the Sacramento Metropolitan Air Quality Management District to help facilitate the submittal of information from your facility to assist in efforts to update the statewide emissions inventory for both water-based and organic solvent cleaning operations. An accurate statewide inventory is important before determining any further regulatory limits. Collecting data from companies like yours is essential for preparing an inventory which accurately characterizes various types of cleaning operations. Thus, we request your cooperation in providing information on your cleaning operations to UCR.

The information being requested is solely for use by UCR under their contract with ARB. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. ARB will not divulge or consent to divulge such information to other parties without first affording you the opportunity to declare the information to be trade secret (confidential) according to the law. However, ARB can divulge information to other governmental agencies that legally protect trade secrets as ARB does. In addition, by law, emissions data are not considered confidential. However, information such as production rates or solvent volume, used to calculate emissions, can be considered trade secrets.

UCR staff has prepared an on-line survey which asks for information on your cleaning operations. The survey applies to any water-based or organic solvent cleaning products used at your facility. The questions relate directly to the types and amounts of cleaning products, and how they are used.

The Cleaning Solvent Survey Section I form covers general information about your company and/or facility, and only needs to be filled out once. The Section II form is to be repeated for each different cleaning product and each different application/operation. Identical applications/operations using the same cleaning product need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at http://www.cert.ucr.edu . Please click on "Cleaning Solvent Survey Section I" and "Section II" under "Quick Links."

Thank you for your participation in this timely and important project. If you have any questions, or would prefer to fill out a paper copy of the survey rather than the on-line forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu. We would appreciate your response by December 1, 2008.

Sincerely,

Larry Greene
Executive Director/Air Pollution Control Officer

777 12th Street, 3rd Floor | Sacramento, CA 95814-1908
916/874-4800 | 916/874-4899 fax
www.airquality.org

APCD
AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

UC RIVERSIDE
UNIVERSITY OF CALIFORNIA

April 6, 2009

ROMAN WILLIAMS
TECNICO CORP
206 W 35TH ST STE B
NATIONAL CITY CA 919500000

RE: Facility ID: 9413A

To Whom It May Concern:

The University of California, Riverside (UCR), under contract with the California Air Resources Board (ARB), has requested the San Diego Air Pollution Control District (SDAPCD) to help facilitate the submittal of information from your facility to assist in efforts to update the statewide emissions inventory for both water-based and organic solvent cleaning operations. The objective of this task is to obtain information to estimate the amount of smog-forming organic compounds and perfluorocarbons emitted into the atmosphere from various types of solvent cleaning applications/operations. An accurate statewide inventory relative to other pollution causing activities is important before determining a need for any further regulatory limits.

The information being requested is solely for the use of UCR under their contract with ARB. UCR staff is prevented by the contract from divulging any information obtained from you without the consent of ARB. Please see the ARB letter on the reverse side regarding confidentiality.

UCR staff has prepared an on-line survey which asks for information regarding your cleaning solvent usage. The survey applies to any water-based or organic solvents used at your facility. The questions relate directly to the types and amounts of cleaning solvents, and how they are used.

The Cleaning Solvent Survey Section I form covers general information about your company and/or facility, and only needs to be filled out once. The Section II form is to be repeated for each different solvent and each different application/operation. Identical applications/operations using the same solvent need not be repeated. Please complete as many Section II forms as needed.

The on-line forms can be accessed at http://www.cert.ucr.edu . Please click on "Cleaning Solvent Survey Section I" and "Section II" under "Quick Links."

Thank you for your participation in this timely and important project. If you have any questions, or would prefer to fill out a paper copy of the survey rather than the on-line forms, please contact Chuck Bufalino at University of California, Riverside, at (951) 781-5784 or bufalino@cert.ucr.edu. We would appreciate your response by June 5, 2009.

10124 Old Grove Rd. – San Diego - California 92131 – (858) 586-2600
FAX (858) 586-2601– Smoking Vehicle Hotline – 1-800-28-SMOKE
www.sdapcd.org

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

June 26, 2008

To Whom It May Concern:

The Air Resources Board has a contract with the University of California at Riverside's College of Engineering-Center for Environmental Research and Technology (CE-CERT), entitled "Development of Updated ARB Solvent Cleaning and PFC Emissions Inventory". The objective of this contract is to obtain information that will be used in estimating the amounts of material emitted into the air from both water-based and organic solvent cleaning.

We request that you cooperate with the CE-CERT team so they can determine the amounts and types of both water-based and organic solvents used, and what cleaning equipment is used. Obtaining information from companies like yours is essential to the success of this contract.

The requested information is solely for use for this contract. This contract prevents CE-CERT from divulging any information obtained from you without our consent. We will not divulge or consent to divulge such information to other parties without first affording you the opportunity to declare the information to be a trade secret (confidential) according to the law. However, we can divulge information to other governmental agencies that also legally protect trade secrets as we do. Note that, by law, emissions data are not considered confidential. However, information such as production rates or solvent volume, used to calculate emissions, can be considered trade secrets.

If you have any questions that the CE-CERT team cannot answer, please feel free to call me at (916) 323-1535, or email me at rpropper@arb.ca.gov.

Sincerely,

Ralph Propper

Ralph Propper, Contract Manager
Air Pollution Research Specialist
Research Division

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website: http://www.arb.ca.gov.

California Environmental Protection Agency

Printed on Recycled Paper

8 Appendix C – List of Unique Solvent Formulations

USN	Name
1	Brakleen
2	1,3-dioxolane
3	isopropyl alcohol, unknown percentage
4	409
5	50/50 IPA/toluene
6	MIBK/MEK blend
7	70% IPA
8	acetone
9	Amercoat 10 Thinner
10	Aquaworks MPC
11	petroleum distillates (12)
12	Board Gear Marker Board Cleaner
13	Clippercide
14	denatured alcohol
15	d-Limonene
16	Dow Corning 245
17	Dykem 138
18	Dynasolve CH-6
19	E-3
20	Economist
21	n-propyl bromide
22	ethanol
23	ethyl acetate
24	trichloroethylene
25	ethylene glycol
26	Evergreen Wash
27	0
28	(NULL)
29	Frekote PMC
30	GEM Cleaner
31	Glass Cleaner 21
32	glycol ether
33	Hoppes Elite
34	(NULL)
35	isopropyl alcohol
36	(NULL)
37	methanol
38	methyl ethyl ketone
39	mineral spirits/VM&P naphtha

40 MRC LVP
41 Nalbrite 2624
42 Nalco 62513
43 Nalkleen 2651
44 Nalstrip 12
45 Nalstrip 1702
46 Nason Activators, Reducers, Solvents and Additives/ DuPont MSDS28.3
47 (NULL)
48 Orange Tough 90
49 perchloroethylene
50 Lysol
51 QSOL 300
52 RTU Glass Cleaner
53 Rust-Oleum 333 Thinner
54 QSOL 220
55 Safety Kleen Heavy Duty Aqueous Parts Cleaner
56 Safety Solvent Cleaner Degreaser
57 Safety Kleen Heavy Duty Lacquer Thinner 6782
58 Safety Kleen Water Soluble Parts Washer
59 See Thru Glass Cleaner
60 Simple Green
61 3-2-1 Contact, Industrial contact cleaner
62 Alconox
63 American Industrial Break Away, non chlorinated brake and parts cleaner
64 Aquawash 195-0040
65 AR 2
66 Big Orange E
67 Blue Beast
68 Board Gear Extra Strength Marker Board Cleaner
69 Butyl Cellosolve / Glycol Ether
70 AUTOWASH 142-11
71 Cell Block 64
72 Chemstrip Aresol
73 Chemtronics E-Series Flux-Off II
74 Caustic Soda
75 Cidex Plus
76 Citrikleen Aerosol
77 Citro Clean
78 Cleaner, All-Purpose & Glass, G-Force #70, Command Center, 1.5 Gal
79 Cleaner, Bathroom, G-Force #71, Command Center, 1.5 Gal
80 Clean-R-Carb
81 clorox chlorine free bleach
82 Comet Liquid Bathroom Cleanser

83 D-56 Cleaner
84 Daraclean 121
85 Daraclean 200 (Magnaflux)
86 Deodorant, Inspire #7, Command Center (Waxie)
87 Duplicator Wash (Varn Products)
88 Dupont 2320S Cleaner (Dupont)
89 Dupont Lacquer Thinner (Dupont)
90 Dupont V3921S cleaner (Dupont)
91 Dupont Lacquer Thinner (Dupont)
92 Dykem Thinner and Remover 138 (D&D Tool and Supply)
93 EAZY, Heavy Duty Industrial Foam Cleaner, Part No. 60609
94 Ecoline - Safety Solvent (Ecoline Industrial Supply, Inc.)
95 Ecoloclean (Enovation)
96 Electronics Cleaner (NAPA Auto Parts)
97 Ensolv (Gallade Chemical)
98 Flux Remover G3 (Stanley Supplies)
99 Frekote PMC mold cleaner
100 G3079 Super Power
101 Gel Coat
102 G-Force Washroom Cleaner #71
103 glaze remover
104 Graymills Aquatene GM 330 C5
105 Gum Away, Gum Remover, Aerosol, 6 oz (Waxie)
106 Gunk Brake Cleaner
107 Hydro solv parts washer solvent (Certified Labs)
108 NAPA® Mac's® Ignition & Battery Sealer
109 Industrial Purple Cleaner & Degreaser
110 Ionox
111 Kil-Odor Concentrated Deodorizer with prozyme
112 Klean-Strip Auto Prep
113 klean-strip paint thinner
114 Kodak Aqua-Image Cleaner
115 Kodak Plate Cleaner (PR600)
116 Krud Kutter
117 KW-910 (Grease and Wax Remover)
118 Lacquer and Enamel Cleaner
119 Vista Paint's Laqucer Thinner
120 Lacquer Thinner (Sherwin Williams)
121 Parks Lacquer Thinner
122 Lacquer Thinner (Sunny Side Corp)
123 Lacquer Thinner, Fast
124 Lectra Clean (Aerosol)
125 Litton/Kester Solder Flux #5235 Remover

126 LO-VO E200 Wash
127 Low Odor Base Solvent
128 LPS 3 Industrial Strength Rust Inhibitor
129 LPS CFC-Free Electro Contact Cleaner
130 LPS ZeroTri Spray Degreaser (aerosol can)
131 Magnaflux ZR-10B Hydrofilic Remover
132 Maintenance Power
133 Malco Leather and Plastic Cleaner
134 Mean Green
135 Mega Force
136 Megasol Exchange Brake Cleaner
137 Metering Roller Cleaner G/L
138 MG Chemicals Isopropyl Alcohol aerosol 824-450G
139 Mirachem 500
140 Morado Cleaner
141 Nalkleen 2651
142 Naphtha
143 Naphtha (petroleum)
144 Naphtha (VM&P)
145 Nason 481-18
146 Next Safety Solvent
147 No Sheen Ring Wash
148 Nonflammable White 2000 Mold Cleaner
149 n-Propyl Bromide (EN Solv)
150 Oops multipurpose remover
151 Ozzy Juice Cleaner
152 Ozzy Juice SW-1
153 Ozzy Juice SW-4
154 PCL 1720B
155 PCL 2071B Cleaning Solvent
156 PCL 2085B Solvent
157 PLC 8007 Compliant Cleaning Solvent
158 PCL California VOC compiant Gun Cleaning Solvent
159 Perfect Duster II
160 Pine All
161 Pels Caustic Soda Beads
162 Pine Sol
163 Power Bolt
164 POWER CLEAN Press Wash
165 Pro-Amp Battery Terminal Cleaner
166 Professional Lysol Disinfectant Spray (all scents)
167 Purple Power
168 Pyroil Brake Clean

169 ZEP X-5202
170 ZEP True Blitz
171 ZEP Soy Powder
172 ZEP Sensitive Surface Cleaner Aerosol
173 ZEP Dyna 143 Parts Cleaner
174 ZEP Cold Cleaner Solvent
175 ZEP Big Orange-E
176 WLS Thinner
177 WD-40
178 ZEP Dyna 5202
179 Yumage WSW-60
180 X-Cel 122b-I Soak Cleaner
181 Work Place Orange Pumice
182 Waycoat Negative Resist Developer
183 Westech AR
184 Waxie W-600 Oven Cleaner
185 Watermark Vessel Solution
186 Wash Solvent
187 VWR Alcohol
188 Voltz II Aerosol
189 Voltz
190 VM&P Naphtha
191 Varn Ecolo Clean 3.5
192 Varn Consolidated MW Wash
193 Varn Color Clean Step 1
194 Varn V-120
195 USA Wash
196 USA Paints T0170
197 Universal Solvent
198 United 250 Dirty Fighter
199 UNI-KEM 1000 SE
200 Ultra Clean SP
201 Twister
202 Tronic Kleen 4025
203 trisodium phosphate
204 Toluene ACS Reagent
205 Thinner G2
206 Technic TSC 1509
207 Safety-Kleen PD680 Type II
208 Sprayon Contact and Tuner Cleaner
209 NAPA Spray Adhesive
210 Speedex
211 Spec Concentrate General Purpose Cleaner

212	Sol-Safe 245
213	sodium hydroxide
214	Simply Clean
215	Silane
216	Sequest Soap
217	SCR blend
218	Safety Kleen Heavy Duty 550
219	Safety Kleen Aqueous Hot Water Parts Washer Solution
220	S-1852 Calcium and Surfactant Remover
221	S-1640 Low Odor 100 SC Ultra Low Blanket and Roller Wash
222	S-1633 Gans XF 1171 Blanket Wash
223	Rotanium Citrus Degreaser
224	Ridoline 57
225	Pyroil Brake Clean
226	Pro-Amp Battery Terminal Cleaner
227	PCL 2085B Solvent
228	0
229	2500 Wash - Jet Array
230	3M General Purpose Adhesive Cleaner
231	273 Electric Motor Cleaner (aerosol)
232	723 Spraysolvo (aerosol)
233	Acrysol Body Solvent
234	AKT 225-T
235	ASAHIKLIN AK-225
236	Attack II Solvent Cleaner
237	Axarel 2200
238	Axis Performance Coatings ASC-D440-5
239	Betco Top Flit all purpose cleaner
240	Bio T Max
241	Cee Bee Super 300 LF
242	CITRUSOLVE
243	Contact Cleaner 2000
244	Contax NF
245	D- Greeze 500- LO
246	Brulin 815 GD
247	DT 870 Reducer
248	Lexite NF Aerosol
249	PCL 8007
250	Safety Kleen Armakleen MPC
251	RG2009 Blanket Wash
252	Ozonic117
253	Prisco Power Klene EWS-NW
254	MRC-F

255 SKC-HF Spotcheck Cleaner/Remover (aerosol)
256 prepsol 70
257 Dupont 2320S Cleaner
258 Dupont Nason 48+21 Gun and Equipment Cleaner
259 Dupont V3921S cleaner
260 Windex
261 Release F Green
262 Turbotect 927
263 Turbotect 950
264 SUPER CHEMSOLV AEROSOL
265 STATE 999
266 Bio-D Products (Professional Blanket Wash)
267 DT 860 Reducer
268 KODAK AQUA-IMAGE Cleaner/Preserver
269 Safety Kleen Armakleen MPC
270 DX103
271 Super Spray All
272 Nason 481-21 Low VOC Gun Cleaner
273 ZEP Powersolv 5000
274 Zep Commercial Ammonia Free Glass Cleaner Concentrate
275 Printer Service MRC-F
276 I.C. HYDROBLEND – 99
277 Supreme Clean 1401-100
278 unknown acetone/IPA blend
279 Aromatic 100
280 xylene
281 unknown xylene/PCBTF mix
282 Flexo 9
283 PPG SWX100
284 DT-3000
285 isopropanol, 70%
286 Henkel Sno-Flake
287 87056-115 Prepac
288 87096-090 Prepac
289 70/30 Blend, unspecified solvents, Van Can
290 Water Miscible wash blanket and roller solvent
291 Solvent, 51L
292 Solvent 225, Blend Chevron
293 SS-25 Plus (aerosol)
294 SWR-2 Ink Wash
295 Presswipe CA516G
296 Stabond C-Thinner
297 Glasurit 541-92

298	Cutting Force Degreaser
299	AMVP 2908 - Anchor (Tote)
300	PPG DX103 Solvent-Prep/cleaner
301	Pressroom Solutions Low VOC Wash 6503
302	ethylene glycol monoethyl ether acetate/isopropanol blend, unknown proportion
303	Safety Kleen QSOL, unspecified
304	State 999
305	Hurrisafe Industrial S910
306	Kleanstrip Naked Gun

9 Appendix D – List and Descriptions of Electronic Workbooks

The following is a list and associated descriptions of the electronic workbooks submitted as part of the study:

1) Master_Database_052711.xlsx

This is the compilation of all data received from the on-line survey and supplemental SCAQMD data. It includes a sheet of definitions as well as the raw database. These data, along with solvent composition data in the following workbook were processed to develop the emission factors for updating the statewide emissions inventory.

2) Solvent_Composition_052711.xlsx

This workbook tabulates composition (by % weight) of the solvents identified in the master database as determined from material safety data sheets (MSDS) or product data sheets (PDS). It includes a sheet of definitions as well as the composition database. These data, along with inputs from the master database from the previous workbook were processed to develop the emission factors for updating the statewide emissions inventory.

3) Emission_Factor_Lookup_Tables_052711.xlsx

The two input databases described above were processed in this interactive workbook to develop solvent cleaning emission factors in terms of lbs per employee per year. It includes a reference sheet, lists of solvent and equipment codes, an entry index of data processed from the raw databases, and examples of lookup tables. The lookup tables allow users to sort data according to multiple parameters (e.g., NAICS codes, equipment/solvent combinations, industry group, zip code, etc.). The lookup tables were used to determine emission factors for each equipment/solvent combination by NAICS codes. These processed emission factors were used in the following workbook to determine the statewide emission inventory.

4) State_Final_Inventory_052711.xlsx

This workbook calculates the statewide emissions inventory for the solvent cleaning category by multiplying emission factors from the previous spreadsheet by total employment in each NAICS code. The workbook contains a data entry sheet of employment statistics from the United States Census Bureau, a worksheet that calculates emissions in tons per year for each equipment/solvent combination, and a worksheet of final results containing tables that are presented in this report. For comparison, results from the 1993 emissions inventory and 2007 projected inventory were included in the tables. The inventory calculations and tables were further processed by multiplying annual emissions by Maximum Incremental Reactivity (MIR) factors in order to determine the ozone forming potential of the emissions inventories.

5) Survey_Statistics_052711.xlsx

This workbook provides figures illustrating the breakdown of survey responses by District, data source, and industry group. It also includes a chart showing the emission factor distribution from all data in terms of lbs per employee per year.

6) Emission_Factor_Statistics.xlsx

Updated California Solvent Cleaning Emissions Inventories

This workbook provides tables showing statistical analyses of emission factors by solvent code and by equipment/solvent combinations. In addition, a table showing survey response rates is preented.