Low-VOC, Low Toxicity Alternatives for Consumer Product Cleanup and Thinning Solvents

Prepared by:
Katy Wolf and Mike Morris
Institute for Research and Technical Assistance

Prepared for:
Cal/EPA's Department of Toxic Substances Control

March 2007

DISCLAIMER

This report was prepared as a result of work sponsored and paid for by the California Environmental Protection Agency's (Cal/EPA's) Department of Toxic Substances Control (DTSC). The opinions, findings, conclusions and recommendations are those of the authors and do not necessarily represent the views of the sponsors. Mention of trade names, products or services does not convey and should not be interpreted as conveying Cal/EPA or DTSC approval, endorsement or recommendation. DTSC, their officers, employees, contractors and subcontractors make no warranty, expressed or implied, and assume no legal liability for the information in this report. The sponsor has not approved or disapproved this report nor has the sponsor passed upon the accuracy or adequacy of the information contained herein.

ACKNOWLEDGMENTS

The analysis in this report benefited considerably from the efforts of many persons within and outside the Institute for Research and Technical Assistance (IRTA). We would particularly like to acknowledge the valuable contributions made by Robert Ludwig from DTSC. We are also grateful to the companies that participated in the testing of alternatives. Finally, we are indebted to Amy Blume of IRTA for her assistance in preparing the document.

EXECUTIVE SUMMARY

The California Air Resources Board (CARB) estimates that emissions from consumer product solvents used for cleaning application equipment thinning paints at about 26 tons per day. These solvents are sold in hardware stores, home improvement centers and paint supply stores and they are used by consumers and small and medium sized industrial firms in operations for painting wood, metal and plastic.

This project was sponsored by Cal/EPA's Department of Toxic Substances Control (DTSC) and the research was conducted by the Institute for Research and Technical Assistance (IRTA), a technical nonprofit organization. The aim of the project was to identify, test and demonstrate low-VOC, safer alternatives to the consumer product cleanup solvents and thinners used today. These solvents include paint thinner, lacquer thinner, mineral spirits, toluene, xylene, methyl ethyl ketone, methyl isobutyl ketone and hexane. All of these solvents are classified as VOCs and many of them are toxic. Consumers, workers and community members are exposed to them when they are used.

IRTA tested a variety of alternative cleanup and thinning materials with companies and in consumer applications where wood, metal and plastic coatings are used. The applications of focus included wood coating, architectural coating, autobody coating and consumer autobody coating. The alternatives that proved effective included acetone, a water-based cleaner and blends of acetone with a glycol ether and soy. Acetone is not classified as a VOC and is lower in toxicity than most other organic solvents. Soy has a very low VOC content and CARB does not classify the glycol ether as a VOC; both materials are also low in toxicity. Table E-1 summarizes the results of the cleanup and thinning alternatives testing.

IRTA conducted a cost analysis to compare the cost of using the current cleanup and thinning solvents and the cost of using the alternatives. In general, the cost of using the alternatives was comparable to or lower than the cost of using the current materials. In a few cases, the cost of using the alternatives was higher.

CARB has the authority to regulate consumer product cleanup solvents and thinners used in California. Based on IRTA's results, the agency could establish a very low VOC limit for these products. Local air districts in California have the authority to regulate cleanup materials and thinners used in industrial facilities. The districts could also adopt more stringent regulations on these materials based on the results of the project.

Table E-1
Alternative Cleanup Materials Testing Results

Application	Successful Alternatives Tested/Used	
	Cleanup	Thinning
Wood Company #1	Acetone	Acetone
Wood Company #2	Acetone	LacquerThinner/Glycol Ether
	Water-Based Cleaner	Acetone
		Acetone/Glycol Ether
		Acetone/Soy
Contractor #1 (general residential)	Acetone	Acetone
Contractor #2 (commercial buildings)	Acetone	Acetone
		Acetone/Soy
Contractor #3 (residential maintenance)	Acetone	Acetone
Safe Manufacturer	Acetone	Acetone
		Acetone/Soy
Autobody Shop #1	Acetone	Acetone
	Acetone/Methyl Acetate	Acetone/Soy
		Acetone/Glycol Ether
Autobody Shop #2	Acetone	Acetone
		Acetone/Soy
	Acetone/Methyl Acetate	Acetone/Glycol Ether
Autobody Shop #3	Acetone/Methyl Acetate	-
Autobody Shop #4	Acetone	-
	Acetone/Methyl Acetate	
Consumer Autobody Test	Acetone	Acetone
Autobody Shop #5 (plastic parts)	Acetone	Acetone
		Acetone/Glycol Ether

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION AND BACKGROUND

The California Air Resources Board (CARB) regulates the solvents sold in hardware, home improvement and paint stores that are used by consumers and businesses to thin paints and to clean the application equipment. This application equipment includes brushes, rollers and spray guns. CARB is currently developing a consumer product regulation that may establish lower Volatile Organic Compound (VOC) content limits for these products in 2007. Table 1-1 shows preliminary estimates of the VOC emissions from some of the categories that encompass the activities of thinning and cleanup of application equipment (CARB, 2006). Note that thinners are variously referred to as thinners, retarders and reducers by the companies and consumers who use them. The total VOC emissions from these categories amount to about 26 tons per day.

Table 1-1
Preliminary Emissions Estimates for 2003 in California

CARB Consumer Product Category	VOC Emissions (tons per day)
Lacquer Thinner	13.271
Multi-Purpose Solvent and Remover	1.937
Paint Thinners and Reducers	10.731
Spray Gun Cleaner and Solvent	0.012
Total	25.951

The Institute for Research and Technical Assistance (IRTA) is a nonprofit organization established in 1989. IRTA assists companies and whole industries in adopting safer alternatives in a variety of applications including cleaning, dry cleaning, paint stripping, adhesives and coatings. IRTA runs and operates the Pollution Prevention Center, a loose affiliation of a large electric utility and several federal, state and local government agencies that are concerned with air, wastewater, hazardous waste and worker exposure. Cal/EPA's Department of Toxic Substances Control (DTSC) contracted with IRTA to identify, develop, test and demonstrate alternative low-VOC, low toxicity materials for consumer products used for thinning coatings and cleaning coating application equipment.

PREVIOUS RELATED WORK

A few years ago, IRTA completed two projects sponsored by U.S. EPA and the South Coast Air Quality Management District (SCAQMD) to investigate and test low-VOC, low toxicity alternatives for cleaning coating and adhesive application equipment (EPA, 2004; SCAQMD, 2003). IRTA found suitable alternative cleanup materials and the SCAQMD established a VOC limit of 25 grams per liter in one of their regulations, Rule 1171 "Solvent Cleaning Operations," as a result of IRTA's demonstration work. This regulation applies to the cleanup materials used in industrial facilities in the jurisdiction of the SCAQMD.

PROJECT ALTERNATIVES STRATEGY

The earlier projects conducted by IRTA did not focus on finding alternatives for consumer product cleanup solvents. During this project, the focus was to find alternatives for consumer product cleanup and thinning solvents. These solvents are classified as VOCs so they contribute to smog formation. Many of the solvents used for these purposes are also toxic and they pose a risk to consumers, workers and community members in California.

The purpose of this project was to test, demonstrate and evaluate safer alternatives for the high VOC and toxic consumer products that are marketed for thinning coatings and cleaning up the coating application equipment used to apply the coatings. Many consumers purchase the products from hardware, home improvement and paint stores when they are renovating, refinishing or making wood, metal or plastic items. Automotive enthusiasts sometimes paint vehicles and use consumer product thinners and cleanup materials in the process. Contractors apply solventborne coatings to wood and metal and they often purchase consumer products for thinning and cleanup. Small and medium sized companies purchase consumer product thinners and cleanup solvents when they paint or refinish wood, metal or plastic substrates.

In this light, IRTA focused the project on finding alternatives for thinning and cleanup when coatings are applied to three types of substrates that would be painted by consumers or small and medium sized companies. These include:

- wood;
- metal; and
- plastic.

IRTA worked directly with five types of operations to find safer alternative thinners and cleanup materials. These operations are meant to represent the range of applications where consumer product thinners and cleanup solvents could be used. They include:

- two companies that refinish wood items with solventborne coatings;
- two contractors that use a metal solventborne coating and a wood solventborne primer;
- one metal safe manufacturer that uses a solventborne coating;
- two autobody shops and one consumer using solventborne autobody color coatings; and
- one facility that paints plastic automotive components with solventborne color coatings.

IRTA also updated and included the analysis from tests of alternative cleanup materials from the earlier work with EPA and SCAQMD. These case studies were one wood coating company, one contractor and two autobody shops.

STRUCTURE OF DOCUMENT

Section II of this document describes the consumer product solvents that are used by consumers and companies for thinning and cleanup activities. It also provides information on the types of operations that tested the alternatives in more detail and describes the classes of alternatives that were tested. Section III presents the testing strategy and the results of the alternatives testing. Section IV evaluates the results of the testing and cost analysis and discusses the regulations that apply to cleanup materials and thinners. Section V summarizes the results of the analysis. Finally, Section VI lists the references.

II. BACKGROUND ON OPERATIONS USING CONSUMER PRODUCT THINNERS AND CLEANUP SOLVENTS

This section presents information on the types of solvents that are used in consumer products for thinning coatings and cleaning up the application equipment. It focuses on the characteristics of the operations where the solvents are used and where the alternatives testing was conducted. Finally, it identifies and describes the alternatives that were tested. Finally, it describes the approach used in the cost analysis.

SOLVENTS USED IN CONSUMER PRODUCT THINNERS AND CLEANUP MATERIALS

The solvents that are currently used for thinning and cleanup of coating application equipment include lacquer thinner, paint thinner, mineral spirits, toluene, zylene, hexane, methyl ethyl ketone (MEK) and methyl isobutyl ketone (MIBK). These solvents are classified as VOCs. All of the solvents are central nervous system depressants and all are respiratory irritants.

Lacquer thinner is a term used for a blend of different solvents of various types. Three Material Safety Data Sheets (MSDSs) or product sheets for lacquer thinner products are shown in Appendix A. The first product, offered by AWC, is a blend of toluene, MEK and MIBK. The second product, DTL10 Lacquer Thinner, is composed of acetone, toluene, glycol ether acetates, isopropyl alcohol and petroleum distillates. The third product, Parks Lacquer Thinner, contains methanol, MEK, toluene and various other ingredients. Other lacquer thinner blends contain a variety of other solvents including hexane, cyclohexane , heptane and naphthas. All of the solvents found in lacquer thinner are central nervous system depressants. All of these solvents, with the exception of acetone, are classified as VOCs. Toluene, xylene, MEK, MIBK and hexane are listed by U.S. EPA as Hazardous Air Pollutants. Toluene is included on California's Proposition 65 as known to the state to cause developmental toxicity. Hexane causes peripheral neuropathy, a nerve disease.

Paint thinner is a term used for petroleum based solvents. Three MSDSs for paint thinner are shown in Appendix A. The first product, Dunn-Edwards Paint Thinner (Bortz), is petroleum distillates. The second product, E-Z Paint Thinner, is Stoddard Solvent which contains trace quantities of 1,2,4-trimethylbenzene. The third product, Allpro Paint Thinner (Metal), is Mineral Spirits which also contains trace quantities of 1,2,4-trimethylbenzene.

Lacquer thinner and paint thinner are the solvents most widely used by consumers and companies for thinning and cleanup. They are sold in one or five gallon containers at hardware, home improvement and paint stores and by paint suppliers. Other solvents that are used for the same purpose that are sold at these locations are mineral spirits, MEK, toluene and xylene.

CHARACTERISTICS OF OPERATIONS WHERE ALTERNATIVES WERE TESTED

Consumers and many small and medium sized companies purchase thinners and cleanup solvents from hardware, home improvement or paint stores or from suppliers where they also often also purchase their coatings. As mentioned in the Introduction, these consumers or companies paint wood, metal or plastic items of various types. Background on the types of operations where testing was conducted is described below.

Wood Refinishing

Consumers often strip and/or refinish wood items like doors, molding, furniture and cabinets at home. There are an estimated 600 furniture stripping companies in California. Furniture strippers are virtually all small businesses and many of them also refinish the items they strip. There are more than 2,000 furniture manufacturers in California and the vast majority of these companies are small businesses. All of these companies refinish wood items. Some contractors offer refinishing services to homeowners or offices for finishing cabinetry in-place. Many furniture strippers, furniture manufacturers, contractors that refinish in-place and consumers purchase their coatings and thinner/cleanup solvents from hardware, home improvement and paint stores. The coatings they use are generally solventborne.

To represent the category of wood refinishing, IRTA worked with two furniture refinishing companies to test alternative cleanup solvents and thinners for solventborne coatings. Wood Company #1 strips and refinishes furniture and other wood items. The company also performs contract stripping and refinishing at homes and offices. The shop purchases lacquer thinner from paint supply stores and uses it for thinning the coatings. For several years, Wood Company #1 has used acetone as a cleanup solvent. Acetone is not classified as a VOC and is lower in toxicity than most other organic solvents. During this project, IRTA worked with Wood Company #1 to test alternative thinners.

Wood Company #2, like Wood Company #1, strips and refinishes furniture and other wood items. This shop purchases lacquer thinner from paint supply stores and uses it for thinning the coatings that are applied to the wood substrates. IRTA worked with this company during the earlier U.S. EPA and SCAQMD projects to find an alternative cleanup solvents. The company has been using a water-based cleaner for this purpose for several years. During this project, IRTA tested alternative thinners with Wood Company #2.

Contractor Refinishing

Architectural contractors use coatings to paint wood surfaces of houses and other structures. The most common types of wood coatings used by architectural contractors are latex coatings which are water-based. Water-based coatings can be thinned with water and water can be used to clean the application equipment so IRTA did not examine alternatives for latex architectural coatings used on wood substrates.

Many architectural contractors use solventborne coatings as wood primers or as metal coatings in the field. These contractors often use thinners and cleanup solvents purchased from hardware, home improvement and paint stores, again in the field.

During this project, IRTA tested alternative cleanup materials and thinners with two contractors. One of these, a general contractor, Contractor #1, tested alternatives for a job where a solventborne wood primer was applied. The other, Contractor #2, tested alternatives for a metal primer applied to steel beams of buildings. In the earlier U.S. EPA and SCAQMD projects, IRTA tested alternative cleanup solvents with one architectural contractor and the results of that testing are included in this report.

Metal Refinishing

Consumers use metal solventborne coatings to refinish metal patio furniture and other metal items. Some companies that make metal products of various types use solventborne coatings on their products. Auto enthusiasts use solventborne coatings to paint vehicles and many autobody shops also use solventborne coatings to paint vehicles and metal parts of vehicles when they are repaired. It is estimated that there are between 4,000 and 6,000 autobody shops in California. These companies and consumers often purchase thinner/cleanup solvents from hardware, home improvement and paint stores.

Companies that make metal items often use powder coating technology. Powder coats are 100% solids and they do not require thinning or cleanup of application equipment. Some companies that make metal items also use waterborne coatings. Again, water can be used for thinning these coatings or cleaning the application equipment. IRTA did not focus on operations using these types of coatings in the project.

To represent the category of metal refinishing, IRTA worked with one metal safe manufacturer, two autobody shops and one operation where consumer product autobody coatings are used to find alternative cleanup materials and thinners. In IRTA's earlier U.S. EPA and SCAQMD projects, IRTA tested alternative cleanup materials. All of the coatings used by these operations are solventborne.

The metal safe manufacturer applies a solventborne coating to safes. IRTA worked with this company in the earlier U.S. EPA and SCAQMD projects and the company has been using acetone as a cleanup solvent for the application equipment for several years. The company uses VOC solvents for thinning and IRTA tested alternatives for the thinning application during this project.

The two autobody shops participating in this project use VOC solvents for thinning. IRTA tested alternative cleanup solvents and thinners with these companies, Autobody Shop #1 and Autobody Shop #2. In the earlier U.S. EPA and SCAQMD projects, IRTA tested alternative cleanup solvents with two other autobody shops, Autobody Shop #3 and Autobody Shop #4. The results of the testing at these two shops is presented here.

IRTA applied typical solventborne autobody coatings purchased at a home improvement store to metal panels using a spray gun. IRTA tested alternative thinners for the coatings and alternative cleanup materials for the application equipment.

Plastic Refinishing

Many companies in California refinish plastic parts with solventborne coatings. Consumers may also refinish plastic items at home. These consumers and some of the companies purchase thinner/cleanup solvents from hardware, home improvement or paint stores.

To represent this category, IRTA worked with an autobody shop, Autobody Shop #5, that refinishes plastic automotive parts like spoilers and fender flares. The company uses solventborne coatings, high VOC thinners and acetone based cleanup solvents.

Summary of Testing and Analysis

Table 2-1 summarizes the types of operations where alternative cleanup materials and thinners were tested, analyzed or documented. The results of the testing and analysis of the thirteen companies or activities are presented later.

Table 2-1
Types of Companies and Operations Documented or Analyzed in Project

Operation	Company/Activity	Alternatives Tested/Analyzed
Wood Refinishing	Wood Company #1	Cleanup, Thinning
	Wood Company #2	Cleanup, Thinning
Contractor Refinishing	Contractor #1	Cleanup, Thinning
	Contractor #2	Cleanup, Thinning
	Contractor #3	Cleanup
	Contractor #4	Cleanup
Metal Refinishing	Safe Manufacturer	Cleanup, Thinning
	Autobody Shop #1	Cleanup, Thinning
	Autobody Shop #2	Cleanup, Thinning
	Autobody Shop #3	Cleanup
	Autobody Shop #4	Cleanup
	Consumer Autobody	Cleanup, Thinning
Plastic Refinishing	Autobody Shop #5	Cleanup, Thinning

CHARACTERISTICS OF COATING OPERATIONS

Many small and medium sized firms that have coating operations use spray guns to apply the coatings. A typical spray gun is shown in Figure 2-1. The spray gun has a cup where the coating is poured and is delivered to the part in a high volume low pressure spray. In most cases, the coating operation is performed in a spray booth. A typical spray booth in

a wood furniture operation is shown in Figure 2-2. The booths contain filters that capture the particulates generated in the painting operation.

Figure 2-1. Typical Spray Gun

Figure 2-2. Typical Spray Booth at Wood Coating Operation

Some smaller industrial operations and many contractors use brushes or rollers to apply the coatings. Consumers applying coatings at home also generally use brushes or rollers but might also use spray guns. Most brush and roller operations do not use spray booths. A typical brush used to apply coatings is shown in Figure 2-3 and a roller is shown in Figure 2-4.

Figure 2-3. Typical Brush

Figure 2-4 Typical Roller

The weather can affect the consistency of the coating. Thinners are generally used to thin the coating so it can be applied properly. Only operations where spray guns are used would require thinner. Some thinners, which are also called reducers or retarders, are classified as slow, medium or fast. Depending on the conditions, painters and consumers dilute the paint with thinner which can range in concentration in the blend from about 10% to 50%.

Cleanup solvents are used after the painting operation to clean the application equipment. Some companies have spray gun cleaning systems that are used to clean a spray gun. A typical spray gun cleaner is shown in Figure 2-5. The reservoir of the cleaning system holds about five gallons of cleanup solvent and some companies purchase the solvent from hardware, home improvement or paint supply stores. The spray gun is placed in the system and the top of the system is closed. The inside and outside of the spray gun are cleaned with the solvent which is pumped from the reservoir. The used solvent runs back into the reservoir for reuse. Some companies with spray gun cleaning systems change out the solvent themselves when it is too contaminated for further use. The spent solvent is shipped off-site as hazardous waste. Other companies contract with a service provider who changes out the unit periodically and disposes of the spent cleaner as hazardous waste.

Figure 2-5. Typical Spray Gun Cleaning System

Some companies that use spray guns use a bucket or other small container to clean the spray gun after the coating operation. Solvent is used to clean the cup of the gun and the outside of the gun, particularly the tip. Solvent is put into the cup and the gun is sprayed into the bucket to clean the inside of the gun. Companies, contractors and consumers who use brushes and rollers generally clean them in a container with cleanup solvent.

LOW-VOC, LOW TOXICITY ALTERNATIVES

For cleanup of application equipment, IRTA tested two categories of alternatives. The major alternative that was effective for many applications was plain acetone. As mentioned earlier, acetone is not classified as a VOC so it does not contribute to the formation of photochemical smog. Acetone is also lower in toxicity than nearly all other organic solvents. In one case, one of the autobody facilities, a blend of 80% acetone and 20% methyl acetate was effective as a cleanup solvent. Methyl acetate, like acetone, is not classified as a VOC. In one other case, one of the wood furniture refinishers, a water-based cleaner was effective as a cleanup solvent.

Finding alternative thinners was more challenging. IRTA tested plain acetone in virtually every case. Acetone has a very high vapor pressure and evaporates very quickly. In some cases, use of plain acetone as a thinner made the coating flash off too quickly, leaving an unacceptable surface. In other cases, it worked well. IRTA also tested a blend of about 99% acetone with about 1% soy as a thinner with several facilities. This thinner performed acceptably in some cases; in other cases, it increased the drying time of the product or part. IRTA tested a blend of about 97.5% acetone and roughly 2.5% of a glycol ether with some of the facilities. This thinner performed acceptably in all cases where it was tested. Soy has a very low vapor pressure and it inhibits the evaporation rate of the acetone. The glycol ether also has a low vapor pressure but not one as low as that of soy. It appeared to inhibit the evaporation of acetone adequately without increasing the drying time of the coating.

COST ANALYSIS

IRTA performed cost analysis for the alternatives that were successfully tested at the facilities participating in the project and updated the cost analysis for some facilities that participated in earlier IRTA projects. The components included in the cost analysis were:

- capital costs where equipment needed to be purchased;
- cleaner or thinner costs;
- electricity costs where there were differences; and
- disposal costs.

For the capital costs, IRTA generally assumed a 10 year useful life for equipment and amortized the capital cost over this period assuming a 5% cost of capital. For the cleaner or thinner cost, IRTA used the cost paid by the facility. Costs of the alternative cleaners or thinners were those charged by home improvement stores or obtained from suppliers of the alternatives. The cost of electricity was assumed to be 12 cents per kWh. The

disposal costs were those paid by the facilities or were estimated through conversations with waste haulers.

III. ALTERNATIVES TESTING PROCEDURE, COST ANALYSIS AND RESULTS

This section presents information on the testing that was conducted for the project. It also presents analysis of the performance of the alternatives and, in most cases, a cost comparison. The operations where alternative thinners and cleanup materials were tested are described below.

WOOD REFINISHING

During this project, IRTA worked with two wood furniture refinishers, Wood Company #1 and Wood Company #2. Wood companies use several types of coatings including lacquers which can be clear or colored, sealers and stains. Application equipment cleaners are used to clean these types of coatings and the lacquer coating is generally the coating that is thinned.

IRTA tested alternative thinners with both companies. Wood Company #1 has used acetone for several years as a cleanup solvent. Wood Company #2 has used a water-based cleaner as a cleanup material for several years. The analysis below analyzes the alternative thinners and cleanup materials.

Wood Company #1

This company strips and refinishes wood furniture, doors and other items. The company also performs contracting services for homes and offices to strip and refinish cabinetry on-site.

About three years ago, Wood Company #1 converted from lacquer thinner to acetone for cleanup of the spray guns used to apply coating in the facility and the spray guns and brushes used to apply coating at home and office sites. The owner of the facility purchased the lacquer thinner and now purchases the acetone from a paint supply store. He estimates that he uses roughly the same amount of acetone for cleanup as lacquer thinner, 52 gallons per year. The cost of the lacquer thinner is $54 per five gallon container; on this basis, the annual cost of using the lacquer thinner was $562 per year. The cost of the acetone is also about $54 gallons per five gallon container so the cost of using acetone for cleanup also is $562 per year.

Table 3-1 presents the cost comparison for the two cleanup solvents. The cost of using the lacquer thinner and the acetone for cleanup is the same.

Table 3-1
Annualized Cost Comparison for Wood Company #1 Cleanup Materials

	Lacquer Thinner	Acetone
Cleanup Solvent Cost	$562	$562
Total Cost	$562	$562

IRTA tested one alternative thinner with Wood Company #1. An MSDS for the coating that was used for the thinning tests, Valspar Black NAA1252, is shown in Appendix B. The company generally applies four coats of the lacquer. The lacquer is currently thinned with lacquer thinner (called a retarder by the facility) in a 75% lacquer/25% lacquer thinner blend.

For the alternative testing, IRTA used the same ratio of lacquer and alternative thinner and four coatings of the lacquer were applied. The alternative that was tested was 99% acetone/1% soy. MSDSs for acetone and a soy product called Soy Gold 2500 are shown in Appendix C. The lacquer thinned with lacquer thinner was applied to four oak panels that had been sanded and the lacquer thinned with the alternative acetone/soy thinner was applied to four similar panels. A picture of the panels is shown in Figure 3-1.

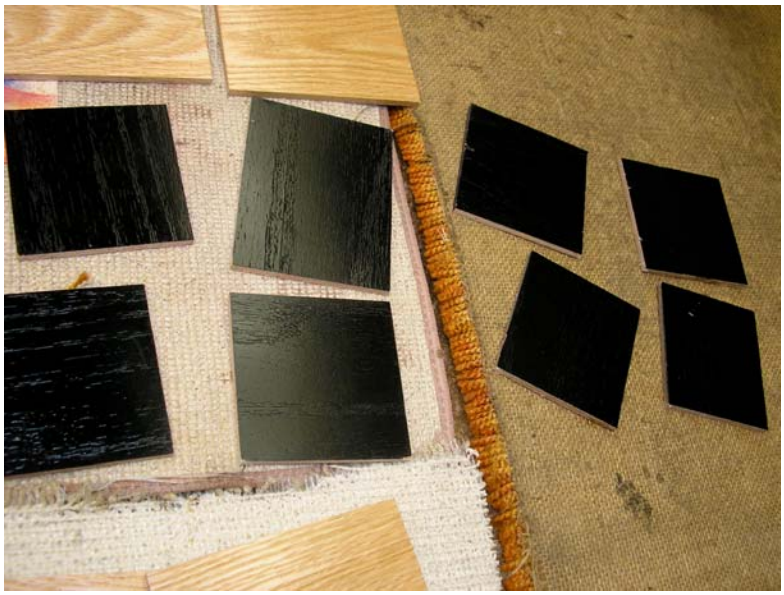

Figure 3-1. Panels Coated at Wood Company #1

The owner visually inspected the panels after the coatings had dried and found no difference between the panels thinned with lacquer thinner and the panels thinned with acetone/soy. He also indicated that the drying times for all coats for the eight panels were the same.

IRTA conducted further testing of the two types of panels to determine if there was any difference in the lacquer thinner thinned coatings and the acetone/soy thinned coatings. IRTA placed glasses of water on all of the panels for a week. The water dripped onto the panels and came in contact with the coating. A picture of the panels with the water glasses dripping on them is shown in Figure 3-2. This is an aggressive test and, if the coatings were not acceptable, a difference in the panels where different thinners were used should be evident. The baseline and alternative thinners withstood this test so their performance was judged to be the same.


Figure 3-2. Panels With Water Glasses

IRTA did not test plain acetone as a thinner with Wood Company #1. The owner did want to reduce his VOC emissions, however, so he conducted tests of plain acetone as a thinner at a later date. The acetone performed well and the company has been using it exclusively as a thinner for almost a year.

Wood Company #1 used 130 gallons of lacquer thinner per year as a thinner. The company uses the same amount of acetone as the thinner. The costs of the acetone and lacquer thinner are the same, $54 per five gallon container. On this basis, the cost of using each of the thinners is $1,404 per year.

Table 3-2 shows the annualized cost comparison for the thinners. The cost of using the two thinners is the same.

Table 3-2
Annualized Cost Comparison for Wood Company #1 Thinners

	Lacquer Thinner	Acetone
Thinner Cost	$1,404	$1,404
Total Cost	$1,404	$1,404

Wood Company #2

This company strips and refinishes wood furniture and other items. Two types of coatings, an acetone based solventborne coating and a water-based coating are used by the facility. IRTA tested alternative cleanup materials and thinners for the solventborne coating. An MSDS for this clear coating, Valspar NUF3302, is shown in Appendix B.

For several years, the company cleaned their spray gun in a bucket with lacquer thinner after spraying the solventborne coating. About five years ago, the company converted from lacquer thinner to acetone for cleanup of the spray gun. About three years ago, the company converted from acetone to a water-based cleaner.

IRTA worked with a vendor to build a small table-top ultrasonic cleaning system that could be tested with water-based cleaners. A picture of this ultrasonic system is shown in Figure 3-3. IRTA and Wood Company #2 tested an alkaline water-based cleaner called Spray Clean 12 in the ultrasonic cleaning unit and this cleaner performed better than acetone for cleaning the spray gun. An MSDS for this cleaner is shown in Appendix C.

Figure 3-3. Ultrasonic Spray Gun Cleaning System

Wood Company #2 used about one-half gallon of lacquer thinner and the same amount of acetone each time the spray gun was cleaned. The company used a total of two gallons of lacquer thinner or acetone per year. At the current Home Depot prices for lacquer thinner and acetone of $13.47 and $13.97 per gallon respectively, the annual cost of purchasing the lacquer thinner for cleanup was about $27; the annual cost of purchasing acetone for cleanup was about $28.

This company did not have to purchase the ultrasonic cleaning system but another company would need to buy it. The cost of the system is about $300. Assuming a useful life for the equipment of 10 years and a cost of capital of 5%, the annualized cost of purchasing the unit is $32. The water-based cleaner is used at a concentration of 25%. Assuming a cost for the cleaner concentrate of $10 and that the cleaner is changed out twice a year, the annual cleaner cost amounts to $5. The ultrasonic unit is heated and it uses 1.2 kW of electricity. Assuming it operates for eight hours (a full day) for the four cleaning cycles per year and assuming an electricity charge of 12 cents per kWh, the annual electricity cost for operating the unit is $4.

The cost comparison for the cleanup materials is shown in Table 3-3. The cost of using the lacquer thinner and acetone is comparable. The cost of using the water-based cleaner is about 46% higher than the cost of using the acetone. Even so, the cost of cleaning for this facility is very low overall.

Table 3-3
Annualized Cost Comparison for Wood Company #2 Cleanup Materials

	Lacquer Thinner	Acetone	Water-Based Cleaner
Capital Cost	-	-	$32
Electricity Cost	-	-	$4
Cleanup Material Cost	$27	$28	$5
Total Cost	$27	$28	$41

Wood Company #2 uses two materials for thinning the coatings. One of these materials, lacquer thinner, is used as a thinner and the other, ethylene glycol methyl ether, is used as a retarder. Depending on the weather, 10 to 30% of the total coating volume is thinner and about one ounce of the retarder is used for every quart of coating.

During the testing, the facility owner used 10% of the baseline thinner and one ounce per quart of the retarder. For the testing, seven oak wood panels were coated with the Valspar clearcoat and the same proportions of the alternative thinners and retarders were used. The panels had been prepped for the testing by sanding. The seven panels included:

- #1--a baseline panel that used lacquer thinner and the currently used retarder;
- #2--a panel with lacquer thinner and no retarder;
- #3--a panel with acetone as a thinner and the currently used retarder;
- #4--a panel with lacquer thinner and soy retarder;
- #5--a panel with acetone as a thinner and soy retarder;
- #6--a panel with acetone as a thinner and no retarder; and
- #7--a panel with no thinner and a soy retarder.

A picture of the panels is shown in Figure 3-4.

Figure 3-4 Panels Coated at Wood Company #2

One of the panels, #5, took longer to dry. The other panels with a soy retarder did not take longer to dry. The owner indicated that the finish with the soy panels was extremely good and all of the panels looked good visually.

IRTA and the owner conducted some tests to see if the coatings were resistant to insult. First, a box cutter was used to make horizontal and vertical cuts in the panels and tape was applied to the panels to check adhesion. In this test, if the tape has a residue after being pulled up from the panel, the coating adhesion is not good. If the coating adhesion is good, the tape will not contain any residue. All of the panels performed well in the adhesion tests. Second, the panels were sanded for recoating and they all performed well. Third, the panels were used as coasters in two households where there were small children for three months. The coatings performed well and there did not appear to be a difference in the panels where alternatives were used.

IRTA performed a cost analysis for the currently used thinner and retarder and compared the cost of using acetone as a thinner with no retarder, acetone as a thinner and the current retarder and acetone as a thinner and soy as a retarder. The shop owner currently purchases 85 gallons per year of the lacquer thinner in five gallon containers from a paint supply store. The price of the lacquer thinner is $50 for five gallons. On this basis, the cost of using the lacquer thinner is $850 annually. The owner purchases six gallons per year of the glycol ether retarder. At a cost of $16 per gallon, the annual cost of the retarder is $96. The total cost of this option is $946.

Wood Company #1 converted to plain acetone as a thinner. Since Wood Company #2 has the same types of operations, it made sense to evaluate plain acetone as an alternative to the company's thinner and retarder. Assuming the use of the acetone would amount to 91 gallons per year (the sum of the thinner and retarder used currently) and assuming an acetone cost of $54 per five gallons, the annual cost of using acetone would amount to $929.

The facility could use acetone as a thinner and the same retarder that is used currently. In this case, the facility would use 85 gallons of acetone at a cost of $54 per five gallons and six gallons of the glycol ether retarder at a cost of $16 per gallon. The annual cost of using this combination would be $1,014.

The facility could use acetone as a thinner and soy as the retarder. In this case, the facility would use 85 gallons of acetone at a cost of $54 per five gallons at a annual cost of $918. Soy is not currently sold in the consumer products market. One company, however, will soon commercialize soy and sell it in one gallon containers at a cost of $25 per gallon. Assuming Wood Company #2 uses six gallons of soy per year, the annual cost of the soy would amount to $150. The cost of using this combination would total $1,068 per year.

Table 3-4 shows the cost comparison for the options. The lowest cost option is using plain acetone as both a thinner and retarder. The next lowest cost option is using the

current thinner and reducer. The acetone/soy option is the highest cost option and is 13% higher than the current option.

Table 3-4
Annualized Cost Comparison for Wood Company #2 Thinners/Retarders

	Lacquer Thinner/ Glycol Ether	Acetone	Acetone/ Glycol Ether	Acetone/ Soy
Thinner Cost	$850	$929	$918	$918
Retarder Cost	$96	-	$96	$150
Total Cost	$946	$929	$1,014	$1,068

CONTRACTOR REFINISHING

Contractors apply a range of different coatings to metal and wood. The coatings are primers and topcoats of various types. The most common types of coatings encountered in architectural coating are latex coatings which are water-based. Latex coatings are cleaned and thinned with plain water. Some wood and metal coatings and primers in the architectural arena are solventborne coatings. These coatings are commonly cleaned up and thinned with solvent.

IRTA worked with two contractors during this project, Contractor #1 and Contractor #2. IRTA tested alternative thinners and cleanup solvents with both of these contractors. In the earlier U.S. EPA and SCAQMD projects, IRTA worked with one other architectural contractor, Contractor #3, to test alternative cleanup materials. The results of the earlier work with Contractor #3 are also included here. All of the tests were performed with solventborne coatings.

Contractor #1

This general contractor routinely has jobs that involve painting houses and buildings. IRTA worked with the contractor to test alternative cleanup and thinning solvents. The contractor purchases paint thinner from a home improvement center and the thinner is used for both cleanup and thinning.

IRTA tested alternatives with the contractor during painting of the trim on a house. A picture of the house after the painting operation is shown in Figure 3-5. The contractor used a solventborne primer on the wood and metal items for the trim. A Technical Data Sheet for this coating, Zinsser High Hide Cover Stain, is shown in Appendix B.

The contractor used brushes to apply the coating and IRTA tested plain acetone for cleanup of the brushes. The painter judged that acetone worked as well as or better than the paint thinner he was accustomed to using. The contractor uses two gallons of paint thinner per year for cleanup. He uses very little paint thinner because most of the coatings he applies are latex which can be cleaned up with water. For purposes of analysis, it was assumed that the same amount of acetone would be used if it were

substituted for cleanup. Assuming the Home Depot prices for the two solvents, $6.38 per gallon for paint thinner and $13.97 per gallon for acetone, the annual cost of using paint thinner is $13 and the annual cost of using acetone would be $28.

Figure 3-5 House With Trim Coated By Contractor #1

Table 3-5 shows the cost comparison for using paint thinner and acetone as a cleanup solvent. The cost of using acetone is about double the price of using paint thinner but the overall cost of cleanup materials is low.

Table 3-5
Annualized Cost Comparison for Contractor #1 Cleanup Materials

	Paint Thinner	Acetone
Cleanup Material Cost	$13	$28
Total Cost	$13	$28

The contractor uses paint thinner for thinning the solventborne coatings he applies. IRTA tested plain acetone as an alternative. The painter judged that the acetone performed as well as the paint thinner for thinning the coating.

The contractor uses one gallon of paint thinner per year as a thinner. He uses a small amount of paint thinner because most of the coatings he applies are latex which can be thinned with water. Assuming a cost of $6.38 for the paint thinner, the annual cost of purchasing thinner amounts to about $6. For the analysis, it was assumed that the same amount of acetone would be used as a thinner. Using a cost of $13.97 per gallon for acetone, the annual cost of using acetone as an alternative thinner would amount to about $14.

Table 3-6 shows the cost comparison for paint thinner and acetone used as thinners. The cost of using paint thinner is less than half the cost of using acetone. The overall cost of thinners is low, however.

Table 3-6
Annualized Cost Comparison for Contractor #1 Thinners

	Paint Thinner	Acetone
Thinner Cost	$6	$14
Total Cost	$6	$14

Contractor #2

This contractor performs work on commercial buildings. The operation involves coating steel beams and rails used in the construction of the buildings. The contractor uses a solventborne red oxide primer for coating the metal beams and rails. An MSDS for this coating, Shopkote Metal Primer, is shown in Appendix B. Figures 3-6 and 3-7 show pictures of the steel beams after coating with the primer.

Figure 3-6. Steel Beam at Contractor #2 Facility

Figure 3-7. Steel Beams Coated by Contractor #2

Contractor #2 applies the coating to the steel beams with a roller and the company uses a spray gun for applying the primer to the rails. The company currently uses paint thinner to thin the primer and to clean the rollers and spray guns.

Contractor #2 purchases 15 gallons per month or 180 gallons per year of paint thinner from a home improvement store. Half of the paint thinner or 90 gallons is used for cleaning the application equipment and half is used for thinning the primer. IRTA tested plain acetone as an alternative cleanup material. According to the painter, the acetone worked a little better than the paint thinner for the cleanup operation.

The cost of the paint thinner is $6.38 per gallon. The annual cost of using 90 gallons of this thinner is $574. The cost of acetone is $13.97 per gallon. Assuming the same amount of acetone is used, the annual cost of using acetone for cleanup would amount to $1,257.

Table 3-7 shows the cost comparison for the paint thinner and acetone. The cost of using acetone as a cleanup solvent is more than twice the cost of using paint thinner.

Table 3-7
Annualized Cost Comparison for Contractor #2 Cleanup Materials

	Paint Thinner	Acetone
Cleanup Solvent Cost	$574	$1,257
Total Cost	$574	$1,257

IRTA tested two alternatives for thinning the red oxide primer with Contractor #2. The first alternative was acetone and the second alternative was a blend of 99% acetone/1% soy. The owner indicated that the coating with the acetone/soy thinner blend did not dry as quickly as the paint thinner or plain acetone thinned coatings. This would not necessarily be a disadvantage since the beams and rails are shipped the following day and the drying time currently is about 30 minutes. The acetone thinned coating dried quickly and both the acetone and acetone/soy thinned coatings looked very good.

The cost of using 90 gallons of paint thinner and 90 gallons of acetone thinner is the same as the cost of using the materials as cleanup solvents. The cost of using the soy/acetone blend is based on purchasing the acetone and soy separately and blending them to the 99% acetone/1% soy formulation. Eighty-nine gallons of acetone would be required and one gallon of soy to make the blend. The cost of acetone is $13.97 per gallon and the cost of soy is $25 per gallon. The annual cost of using the blend is $1,268.

Table 3-8 shows the cost comparison for the thinners. The cost of using the plain acetone is 26% higher than the cost of using the paint thinner. The cost of using the acetone/soy blend is slightly higher than the cost of using acetone.

Table 3-8
Annualized Cost Comparison for Contractor #2 Thinners

	Paint Thinner	Acetone	Acetone/Soy
Thinner Cost	$574	$1,257	$1,268
Total Cost	$574	$1,257	$1,268

Contractor #3

This contractor is a management company that provides painting services on an on-going basis to a large retirement community where 22,000 people live in condominiums, apartments and houses. The contractor has three separate paint crews with 60 employees that repaint the buildings every seven years or so.

The contractor applies latex paint to the buildings and enamel solventborne paint to the front doors, windows, doorframes, railings and other metal hardware. Plain water is used to clean the application equipment when latex paint is used and lacquer thinner is used to clean the application equipment when the enamel paint is used. The lacquer thinner is reclaimed in a still and reused for cleaning.

IRTA tested two alternatives with the company, acetone and soy. Both cleaners worked for cleaning the application equipment but the soy took twice as long as the acetone and the lacquer thinner to perform the cleaning. IRTA updated the analysis for this contractor and analyzed the cost of using lacquer thinner and acetone.

Contractor #3 purchases 55 gallons per month or 660 gallons per year of the lacquer thinner. Using the paint supply store price of $54 per five gallon container, the annual cost of purchasing lacquer thinner amounts to $7,128. Assuming the same amount of acetone would be used and an acetone price of $54 per five gallons, the annual cost of purchasing acetone also would be $7,128.

The still used to reclaim the solvent uses 5 kW per hour and is operated once a week for five hours. Assuming an electricity cost of 12 cents per kW, the annual electricity cost is $156. The cost would be the same if the company used acetone.

The company disposes of one 55 gallon drum of waste per month at a cost of $110 per drum. The annual disposal cost amounts to $1,320. The cost for disposal of the spent acetone would be the same.

Table 3-9 shows the cost comparison for using the lacquer thinner and the acetone. The cost of using the two solvents for cleanup is the same.

Table 3-9
Annualized Cost Comparison for Contractor #3 Cleanup Materials

	Lacquer Thinner	Acetone
Cleanup Solvent Cost	$7,128	$7,128
Electricity Cost	$156	$156
Disposal Cost	$1,320	$1,320
Total Cost	$8,604	$8,604

METAL REFINISHING

Many manufacturers of metal parts use powder coatings which are 100% solids. These coatings do not require cleanup or thinning. Some companies that coat metal use waterborne coatings which are cleaned up or thinned with water. Other companies that coat metal use solventborne coatings which are cleaned up and thinned with solvents.

During this project, IRTA worked with one company that refinishes metal safes. IRTA tested alternative thinners with this company. In the earlier projects sponsored by U.S. EPA and SCAQMD, IRTA worked with this company on alternative cleanup materials. The company converted to acetone and the analysis of the earlier results are updated and presented here. The safe manufacturer uses a primer and a urethane topcoat which requires an activator. The urethane topcoat is thinned with solvent.

During this project, IRTA also worked with two autobody shops to test alternative cleanup materials and thinners and the results are presented here. In the earlier projects, IRTA tested alternative cleanup solvents with two additional autobody shops and the results are updated and included here. Autobody shops generally apply three sets of coatings including primers, base coats or color coats and clear topcoats. The base or color coats are thinned with solvent.

Finally, IRTA conducted testing of alternative cleanup materials and thinners by applying consumer autobody coatings to metal panels. IRTA tested the alternative thinners for the base or color coat. The results of this testing are presented here.

Safe Manufacturer

This company manufactures burglary, fire protection and gun safes and is the largest security safe manufacturer in the country. As part of the manufacturing process, the company paints the safes. MSDSs for some of the coatings used by the company are shown in Appendix B. These include a gray primer, an activator for the urethane topcoat, a black urethane topcoat and a burgundy urethane topcoat.

IRTA worked with the company in the earlier U.S. EPA and SCAQMD projects and reported that the company converted from using lacquer thinner to using acetone for spray gun cleaning. The analysis is updated here.

The company used a spray gun cleaning system for cleaning the coating application equipment. The company originally used lacquer thinner for this activity but wanted to reduce their facility wide VOC emissions. They tested acetone, it worked well and the company converted to the alternative.

The company purchased 10 gallons of lacquer thinner per day for cleaning the spray guns. Assuming the company operates five days per week and 52 weeks per year, the total annual purchases of the solvent amount to 2,600 gallons. The cost of lacquer thinner, purchased in five gallon containers, is $54 or $10.80 per gallon. The cost of using the lacquer thinner was $28,080 per year.

The company converted to acetone and used the same amount of acetone as lacquer thinner. The cost of acetone is $28,080 annually.

Table 3-10 shows the cost comparison of using lacquer thinner and acetone for cleanup. The annual cost of using acetone is the same as the cost of using lacquer thinner.

Table 3-10
Annualized Cost Comparison for Safe Manufacturer Cleanup Materials

	Lacquer Thinner	Acetone
Cleanup Material Cost	$28,080	$28,080
Total Cost	$28,080	$28,080

IRTA worked with the safe manufacturer to test alternative thinners. The company purchases three different types of reducers for the urethane topcoat. These include slow, medium and fast reducers which are selected by the painter based on the weather. MSDSs for the slow, medium and fast urethane reducers used by the company are shown in Appendix B. The company generally blends about 15% of the reducer into the coating.

IRTA conducted preliminary tests with the company by using alternative thinners in the coatings at the same percentage as the current thinner. Six panels were coated with a primer and a black urethane topcoat. The thinners included:

- Panel # 1: the company's current thinner (medium reducer)
- Panel # 2: plain acetone
- Panel # 3: 99% acetone/1% soy
- Panel # 4: 98% acetone/2% soy
- Panel # 5: 95% acetone/5% soy
- Panel # 6: 90% acetone/10% soy

The results of the testing indicated that the first three panels dried in a short period but the last three panels took longer to dry. The results of the preliminary tests provided IRTA with guidance on how much soy to use in the thinner for the additional tests. It's worth noting that all six of the panels had a good appearance. A picture of the panels is shown in Figure 3-8.

Figure 3-8. Black Panels Coated at Safe Manufacturer

In the second set of tests, four panels were coated in the same manner using the slow reducer this time. The primer was applied first and then a burgundy urethane topcoat that was thinned. The panels included:

- Panel # 1: the company's current thinner (slow reducer)
- Panel # 2: plain acetone
- Panel # 3: 99% acetone/1% soy
- Panel # 4: 99% acetone/2% soy

In this case, the first two panels dried in a reasonable period of time and the third and fourth panels took longer to dry. Again, the panels all had a good appearance. A picture of the panels is shown in Figure 3-9.

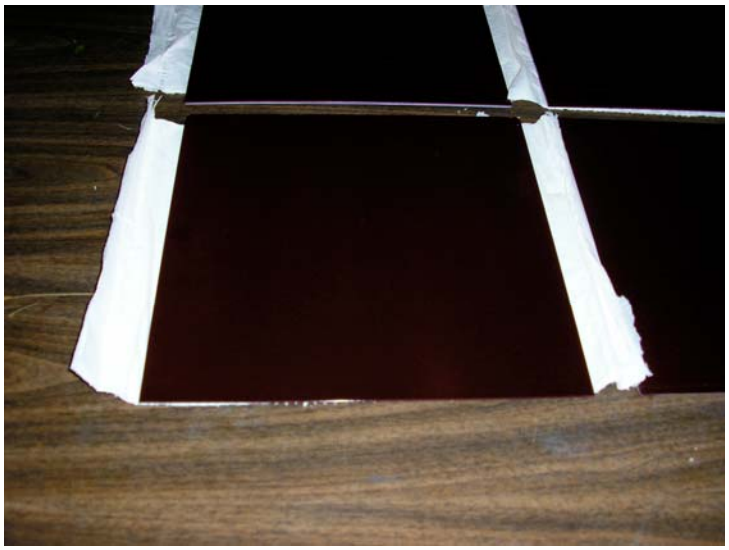

Figure 3-9. Burgundy Panels Coated at Safe Manufacturer

IRTA conducted the cost analysis for the current thinner, the acetone thinner and the 99% acetone/1% soy thinner. The company purchases about 140 gallons of slow, medium and fast reducer each year. The total cost of the thinners is $1,598 annually. IRTA obtained an estimate from a supplier for acetone. The supplier would supply five gallon containers of acetone at $42 per five gallons. The cost of purchasing acetone, assuming the same amount would be required as the reducer, would be $1,176 per year. The same supplier would provide five gallon containers of the 99% acetone/1% soy for $45 for a five gallon container. The total cost of using the alternative thinner would be $1,260 annually.

Table 3-11 shows the cost comparison for the safe manufacturer. The cost of using plain acetone as a thinner is 26% lower than the cost of using the current thinner. The cost of using the acetone/soy blend is 21% lower than the cost of using the current thinner.

Table 3-11
Annualized Cost Comparison for Safe Manufacturer Thinning Materials

	Current Thinner	Acetone	Acetone/ Soy Blend
Thinner Cost	$1,598	$1,176	$1,260
Total Cost	$1,598	$1,176	$1,260

Autobody Shop #1

This shop is a typical small autobody shop that repairs and paints vehicles that have been damaged in accidents. IRTA worked with this company to test alternative cleanup materials and thinners.

The company purchases solvent from a paint supply company and the solvent is used for cleanup of the spray guns and for thinning the base or color coat. IRTA tested two alternative cleanup materials with the company and three alternative thinners.

The company cleans up the application equipment in a small container. The solvent is placed in the container, the spray gun tip is cleaned in the container and solvent is sprayed through the gun. IRTA tested plain acetone and a blend of 80% acetone/20% methyl acetate as alternative cleanup materials. IRTA had tested the acetone/methyl acetate blend in the earlier projects and one of the autobody shops (see Autobody Shop #3 below) had preferred the blend. An MSDS for methyl acetate is shown in Appendix C. The workers who tested acetone indicated that it performed somewhat better than the current cleaner and that the acetone/methyl acetate blend performed about as well as the current cleanup solvent.

IRTA compared the cost of using the current cleanup solvent and plain acetone. The company purchases 54 gallons of the solvent which is used as a cleanup material and a thinner every three months in five gallon quantities. Of the total 216 gallons purchased annually, three-fourths or 162 gallons is used for spray gun cleaning. The cost of the cleaner is $8.17 per gallon. The annual cost of using the current cleaner is $1,324.

If the company converted to acetone as a cleanup material, the shop would purchase acetone from a paint supplier in five gallon quantities. IRTA obtained an estimate from a supplier of $42 for a five gallon container. The cost of the acetone is $8.40 per gallon. On this basis, the cost of using acetone for cleanup is $1,361 per year.

Table 3-12 shows the cost comparison for the current cleanup material and acetone. The cost of using acetone is 3% higher than the cost of using the current cleanup solvent.

Table 3-12
Annualized Cost Comparison for Autobody Shop #1 Cleanup Materials

	Current Solvent	Acetone
Cleanup Material Cost	$1,324	$1,361
Total Cost	$1,324	$1,361

Autobody Shop #1 also uses the cleanup solvent as a thinner for the base or color coat. The three alternatives thinners IRTA tested with the shop were plain acetone, a blend of 99% acetone/1% soy and a blend of 97.5% acetone/2.5% glycol ether. An MSDS for the glycol ether, DPM, is shown in Appendix C. The shop routinely uses a combination of 50% coating and 50% thinner when the base coat is applied. IRTA used the same proportion of the alternatives for the thinning tests.

The painter applied the primer to a scrap part for the testing. The base coat and the current thinner were mixed and applied to the part. The three alternative thinners were mixed with the base coat and applied to the part. The plain acetone thinner did not give a very good finish but the two other thinners gave a good finish, according to the painter.

This shop uses 54 gallons per year of the thinner for thinning coatings. The cost of the thinner is $8.17 per gallon. On this basis, the cost of using the current thinner is $441 annually. According to a supplier, the cost of purchasing the acetone/soy blend or the acetone/glycol ether blend in a five gallon container would amount to $45. The cost of using either blend would amount to $486 annually.

Table 3-13 shows the cost comparison for the current and alternative thinners. The cost of using the two alternative thinners is 10% higher than the cost of using the current thinner.

Table 3-13
Annualized Cost Comparison for Autobody Shop #1 Thinners

	Current Solvent	Acetone/Soy Blend	Acetone/Glycol Ether Blend
Thinner Cost	$441	$486	$486
Total Cost	$441	$486	$486

Autobody Shop #2

This autobody shop is one of a chain of three shops in the Los Angeles area. Like other autobody shops, the company repairs and paints vehicles damaged in accidents. IRTA tested alternative cleanup materials and thinners with the company.

The company purchases a cleanup solvent and a thinner from a paint supplier. An MSDS for the thinner, called Medium Thinner, is shown in Appendix B. The cleanup solvent is used to clean the spray guns the company uses to apply the coatings. The thinner is used in a 50%/50% mixture with the base or color coat. An MSDS for the base coat used by the facility, called Global BC Bases, is shown in Appendix B.

Autobody Shop #2 uses a spray gun cleaning system to clean the application equipment. A picture of the spray gun cleaner is shown in Figure 3-10. IRTA tested two alternative cleanup materials with the facility. These included plain acetone and a blend of 80% acetone/20% methyl acetate. According to the painter, these two alternatives worked about the same as the current cleanup solvent. IRTA provided larger quantities of the plain acetone to the facility for further scaled-up testing.

Figure 3-10. Spray Gun Cleaning System at Autobody Shop #2

IRTA compared the cost of using the current cleanup material with the cost of using acetone. The spray gun cleaning system holds about five gallons of cleanup solvent. The shop uses five gallons of cleaner every two months. The cost of the cleaner is $43.86 per five gallon container or $8.77 per gallon. The annual cost of purchasing the current cleanup solvent is $263. IRTA contacted a supplier that will provide five gallon containers of acetone at a cost of $8.40 per gallon. Assuming that the same amount of acetone will be used as the current cleanup solvent, the annual cost of purchasing the acetone would amount to $252.

The current cleanup solvent and the acetone is changed out every two months or six times a year. This indicates that 30 gallons a year would require disposal as hazardous waste.

Assuming a disposal cost of $2 per gallon, the cost of disposal would amount to $60 per year.

Table 3-14 shows the cost comparison for using the current cleanup solvent and acetone. The cost of using acetone is 3% lower than the cost of using the current cleanup solvent.

Table 3-14
Annualized Cost Comparison for Autobody Shop #2 Cleanup Materials

	Current Cleanup Solvent	Acetone
Cleanup Material Cost	$263	$252
Disposal Cost	$60	$60
Total Cost	$323	$312

IRTA tested the currently used thinner and three alternative thinners with the shop on a scrap part. The alternative thinners were plain acetone, 99% acetone/1% soy and 97.5% acetone/2.5% glycol ether. A picture of the spray booth where the coatings were applied is shown in Figure 3-11. The painter first applied a primer to the scrap part. The baseline thinner and the alternatives were mixed with the base coat in a 50%/50% combination. They were then applied to the part. The coating with the plain acetone thinner dried very rapidly and there was not enough coating to apply three coats. After applying the three base coats, the painter applied two clear coats and the parts were inspected.

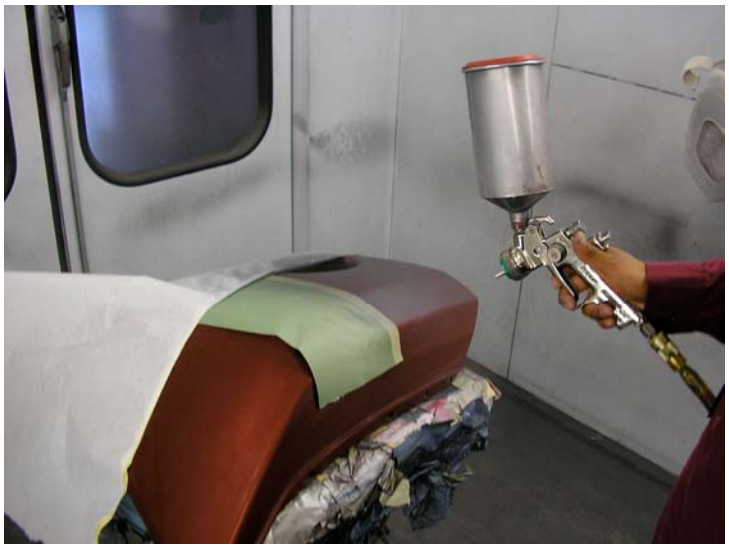

Figure 3-11. Spray Booth at Autobody Shop #2

A picture of the scrap part with the four coating/thinner combinations is shown in Figure 3-12. Even though the plain acetone thinner evaporated too quickly, the coating was acceptable after the clear coats were applied. The acetone/glycol ether combination took longer to dry and it appeared darker after the clear coats were applied. The painter and supervisor indicated, however, that all three of the alternative coatings were acceptable and could be blended on vehicles.

Figure 3-12. Scrap Part Coated at Autobody Shop #2

The shop purchases their thinner at a cost of $47.98 per five gallons or $9.59 per gallon. The company uses 45 gallons per month or 540 gallons per year of the thinner. On this basis, the annual cost of using the current thinner amounts to $5,179. One supplier will provide plain acetone in five gallon quantities for $42 or $8.40 per gallon. Assuming the same amount of acetone would be required for thinning, the annual cost of using acetone would amount to $4,536. The same supplier indicated he would provide the acetone/glycol ether blend for $45 per five gallons or $9 per gallon. On this basis, assuming the same amount of the blend is used, the annual cost of using the acetone/glycol ether would amount to $4,860. The supplier indicated he would provide the acetone/soy combination for the same price as the acetone/glycol ether blend. The annual cost of using the acetone/soy blend is $4,860.

Table 3-15 shows the cost comparison for the current thinner and the three alternative thinners. The cost of using plain acetone is 12% lower than the cost of using the current thinner. The cost of using the acetone/glycol ether or acetone/soy blend is 6% lower than the cost of using the current thinner.

Table 3-15
Annualized Cost Comparison for Autobody Shop #2 Thinners

	Current Thinner	Acetone	Acetone/ Glycol Ether	Acetone/ Soy
Thinner Cost	$5,179	$4,536	$4,860	$4,860
Total Cost	$5,179	$4,536	$4,860	$4,860

Autobody Shop #3

IRTA worked with the autobody shop in the earlier U.S. EPA and SCAQMD projects to test alternative cleanup materials. This body shop is one of a chain of 10 shops in the Los

Angeles Basin area. Like other body shops, the company repairs vehicles and paints them as part of their process.

The company uses a spray gun cleaning unit to clean the spray guns. A picture of this unit is shown in Figure 3-13. A service provider leases the spray gun cleaner to the company, maintains this equipment, supplies the cleaning solvent and disposes of the waste. MSDSs for the coatings used by this shop are shown in Appendix B.

Figure 3-13. Spray Gun Cleaning System at Autobody Shop #3

The shop was using a high VOC cleaner when IRTA began the alternatives work. IRTA tested two alternative cleaners, plain acetone and a blend of 80% acetone/20% methyl acetate with the company. IRTA provided the company with the acetone and acetone/methyl acetate blend for several weeks of testing. The company preferred the acetone/methyl acetate blend.

The shop is currently leasing their spray gun cleaner from a supplier. The company would have to purchase a unit to convert to the alternative. Costs of spray gun cleaning units range from about $600 to $1,500. Assuming a unit would cost $1,000, that it would have a useful life of 10 years and that the cost of capital is 5%, the annualized cost of the system would be $105.

During the earlier project, the company indicated they were paying $2,290 annually for the servicing cost. If the company converted to the new blend, the workers would have to devote about 30 minutes to changing out the cleaner in the system. Assuming the company would change out the cleaner once a month and assuming a labor cost of $10 per hour, the maintenance/changeout cost would be $60 per year.

The cost of the cleaner is currently included in the servicing cost. If the company converted to the blend, they would purchase 12 five gallon quantities of the blend annually at a cost of $9 per gallon. The total cost would amount to $540 per year.

The disposal cost is currently included in the servicing cost. If the company converted to the new cleaner, they would have to dispose of the 60 gallons of hazardous waste per year. Assuming a disposal cost of $2 per gallon, the annual disposal cost would be $120 per year.

Table 3-16 shows the cost comparison for the current operation and for use of the alternative cleanup material. The cost of using the alternative materials is 64% lower than the cost of using the high VOC cleaner.

Table 3-16
Annualized Cost Comparison for Autobody Shop #3 Cleanup Materials

	Current Cleaner	Acetone/Methyl Acetate Blend
Equipment Cost	-	$105
Service Cost	$2,290	-
Maintenance Cost	-	$60
Cleanup Material Cost	-	$540
Disposal Cost	-	$120
Total Cost	$2,290	$825

Autobody Shop #4

IRTA worked with this shop in the earlier projects sponsored by U.S. EPA and SCAQMD to test alternative cleanup materials. The company owns a spray gun cleaning system that is used routinely to clean the application equipment. A picture of the spray gun cleaner is shown in Figure 3-14. The cleaner used by the company is lacquer thinner.

Figure 3-14. Spray Gun Cleaning System at Autobody Shop #4

IRTA provided acetone to the company to test for a few months and the workers indicated it performed very well. Autobody Shop #4 uses about five gallons of lacquer thinner, purchased from a home improvement store, every quarter. Assuming the price of the lacquer thinner is $13.47 per gallon, the annual cost of purchasing lacquer thinner amounts to $269. If the company converted to acetone assuming the same amount of acetone would be required, at a cost of $13.97 per gallon, the annual cost of purchasing acetone would be $279.

The disposal cost for the lacquer thinner and the acetone would be the same. Disposal of the 20 gallons of solvent would carry a cost of $40 annually.

Table 3-17 shows the cost comparison for the lacquer thinner and the acetone. The cost of using the acetone is 3% higher than the cost of using lacquer thinner.

Table 3-17
Annualized Cost Comparison for Autobody Shop #4 Cleanup Materials

	Lacquer Thinner	Acetone
Cleanup Material Cost	$269	$279
Disposal Cost	$40	$40
Total Cost	$309	$319

Consumer Autobody Test

Some consumers or automotive organization groups apply coatings to vehicles themselves. To mimic this activity, IRTA purchased a primer and a base coat from a paint supply store and applied them to metal panels using a spray gun. IRTA first applied the primer to the panels to prepare them for the base coat and then applied the base coat. An MSDS for the base coat used in the testing is shown in Appendix B. The base coat is a gray blue metallic coating.

During the testing, IRTA used acetone as a cleanup solvent. The primer does not require a thinner but the base coat does. IRTA asked the employee at the paint supply store how much thinner should be used in the base coat. He indicated that the makeup of the thinner and base coat should be about 20% thinner/80% base coat. IRTA tested three different thinners in the testing. They included:

- paint thinner;
- plain acetone; and
- a blend of 97.5% acetone/2.5% glycol ether

The results indicated that the acetone cleanup solvent worked well for cleaning the spray gun and other equipment used for mixing the coatings. The three metal panels after the primer was applied are shown in Figure 3-15. The metal panels after the base coat was applied are shown in Figure 3-16. The panel at the left is the panel where thinner was used. The panel in the middle is the panel where plain acetone was used and the panel at the right is the panel where the blend of acetone and glycol ether was applied. The

results indicated that the panels looked very similar to one another and all three thinners seemed to perform well.

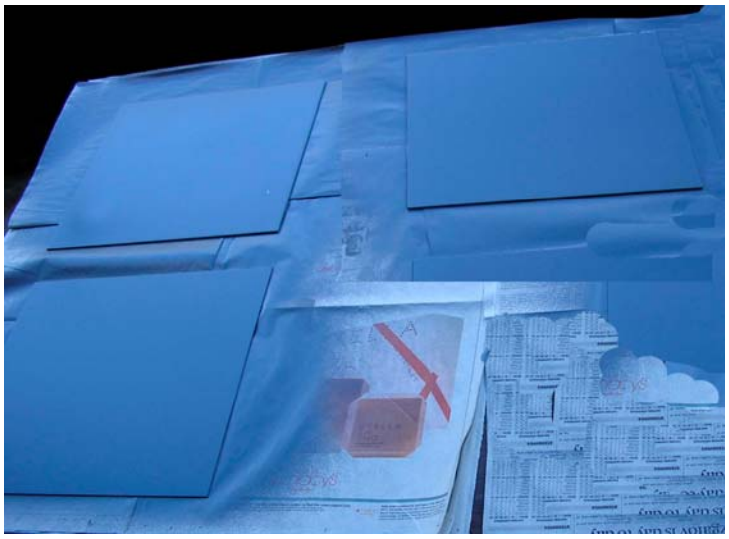

Figure 3-15. Panels After Primer Was Applied

Figure 3-16. Panels After Base Coat Was Applied

PLASTIC REFINISHING

IRTA worked with one company, Autobody Shop #5, that refinishes plastic automotive parts. The company has used acetone as a cleanup solvent for many years. IRTA tested alternatives to the high VOC solvent thinners used today by the company. The coating system used by the company is a primer, a base or color coat and a clear topcoat.

The company prepared four spoilers with a primer. IRTA and the company tested four different thinners with the base or color coat. An MSDS for the blue metallic basecoat, Dupont ChromaBase, is shown in Appendix B. The alternative thinners were used in the same proportion as the current thinner. The thinners that were tested included:

- the current high VOC thinner
- plain acetone
- a blend of 99% acetone/1% soy
- a blend of 97.5% acetone/2.5% glycol ether

The spoilers were coated with the base coat and then with a topcoat which does not require thinner and they were left to fully cure for about 10 days.

After the 10 day period had elapsed, IRTA and the company inspected the four spoilers and noted that the colors of the spoilers where plain acetone and the acetone/soy thinners were applied were a little different from the baseline thinned coating. IRTA and the shop then conducted an adhesion test to determine if the thinners performed acceptably. This test is used routinely by the company for quality control. It involves using a cutter to make cross hatch cuts, four of them horizontally and four of them vertically, in the parts. Tape is applied to the cross hatch area and then removed. If the tape is clean, the parts are acceptable; if the tape is not clean, the parts are not acceptable. Three of the parts with the current thinner, plain acetone and the acetone/glycol ether blend, passed the test. The part with the acetone/soy thinner blend failed this test. This indicates that the plain acetone and the acetone/glycol ether thinners could be used in this facility for thinning.

IRTA analyzed the cost of using the two alternative thinners that passed the adhesion test. The autobody shop purchases the current thinner in one gallon containers from a paint supplier. The cost of the current thinner is $16.50 per gallon. The company uses five gallons per day of the thinner. Assuming the thinner is used five days per week and 52 weeks per year, 1,300 gallons of the high VOC thinner are used each year at a cost of $21,450 annually.

The plain acetone can be purchased at a home improvement store in gallon quantities for $13.97 per gallon. Assuming the same amount of acetone would be required for thinning, the annual cost of using acetone would amount to $18,161.

Wood Refinisher #2 described above purchases ethylene glycol methyl ether which is used as a retarder at a cost of $16 per gallon. IRTA tested a different glycol ether, dipropylene glycol methyl ether, for the thinning tests. This glycol ether is likely to be more expensive than the ethylene glycol ether and, for purposes of analysis, IRTA assumed it would be 25% more expensive or $20 per gallon. The blend that was tested was 97.5% acetone/2,5% glycol ether. Assuming the user would purchase the blend from a paint supplier or supply store, the cost of using this blend annually as a thinner would amount to $18,357.

Table 3-18 shows the cost comparison for using the current and alternative thinners. The cost of using both alternative thinners is lower than the cost of using the current thinner. The cost of using plain acetone is 15% lower than the cost of using the current thinner. The cost of using the acetone/glycol ether is 14% lower than the cost of using the current thinner.

Table 3-18
Annualized Cost Comparison for Plastic Refinishing Thinners

	High VOC	Acetone	Acetone/Glycol Ether
Thinner Cost	$21,450	$18,161	$18,357
Total Cost	$21,450	$18,161	$18,357

IV. EVALUATION OF TEST RESULTS

This section summarizes and evaluates the results of the alternative cleanup materials and thinner testing presented in Section III. It also briefly describes the CARB and SCAQMD regulations that affect the use of cleanup solvents and thinners.

EVALUATION OF CLEANUP SOLVENT ALTERNATIVES

Table 4-1 summarizes the results of the tests that were conducted for alternative cleanup materials. It also includes information on the alternative cleanup materials that are being used by the companies in many cases.

Table 4-1
Alternative Cleanup Materials Testing Results

Application	Successful Alternative Cleanup Materials Tested/Used
Wood Company #1	Acetone
Wood Company #2	Acetone
	Water-Based Cleaner
Contractor #1 (general residential)	Acetone
Contractor #2 (commercial buildings)	Acetone
Contractor #3 (residential maintenance)	Acetone
Safe Manufacturer	Acetone
Autobody Shop #1	Acetone
	Acetone/Methyl Acetate
Autobody Shop #2	Acetone
	Acetone/Methyl Acetate
Autobody Shop #3	Acetone/Methyl Acetate
Autobody Shop #4	Acetone
	Acetone/Methyl Acetate
Consumer Autobody Test	Acetone
Autobody Shop #5 (plastic autobody parts)	Acetone

One of the wood companies has been using acetone as a cleanup material for a few years. The other wood company has been using a water-based cleaner for a few years. The testing with this company indicated that acetone worked effectively as a cleanup material as well.

IRTA tested acetone as a cleanup material with all three contractors and it worked effectively. IRTA also tested a soy based cleaner with one of the contractors but it took a long time to clean and did not work as effectively as acetone.

IRTA tested acetone as a cleanup material with the safe manufacturer and it performed well.

IRTA tested both acetone and an acetone/methyl acetate blend as cleanup alternatives with the four autobody shops. In three cases, the results indicated that acetone performed well. In one case, the autobody shop preferred methyl acetate. IRTA tested acetone as a cleanup material for a consumer autobody application and it worked effectively.

The plastic manufacturer has been using acetone for several years as a cleanup material and it works well.

Cost Comparison of Alternative Cleanup Materials

In almost all cases, acetone proved to be an effective material for cleaning coating application equipment. Both acetone and a blend of 80% acetone/20% methyl acetate were tested at all the autobody shops. Three of the four shops found acetone to be suitable and only one thought the blend was a better choice. One of the wood manufacturers has been using a water-based cleaner as a cleanup material for a few years but acetone is a viable choice.

For the cost analysis, IRTA generally compared the cost of using the cleanup solvent currently used by the company with the cost of using the alternative. In cases where the company was using paint thinner, the cost of using acetone would be higher. Paint thinner is a very low cost material. In cases where the company was using lacquer thinner, the cost of using acetone was generally comparable to the cost of using lacquer thinner. The cost of using the water-based cleaner for the wood manufacturer is higher than the cost of using lacquer thinner; even so, the company has been using the water-based cleaner for the last few years. The cost comparison for the autobody shop that preferred the acetone/methyl acetate blend showed that use of the blend was lower than the cost of using the high VOC solvent. Methyl acetate is more expensive than acetone, however, so if companies can use plain acetone instead of the blend, they should do so. In fact, many of the companies that have used acetone for cleanup for several years have obviously found it to be a cost effective choice.

EVALUATION OF THINNER ALTERNATIVES

Table 4-2 summarizes the alternative thinners that were tested successfully.

Wood Company #1 converted to and has been using acetone as a thinner for about a year. IRTA tested a variety of alternatives with Wood Company #2 which uses a combination of a thinner and a retarder. Since Wood Company #1 routinely uses plain acetone, this material would likely be suitable as a thinner/retarder for Wood Company #2 as well.

Although IRTA tested an acetone/soy blend with one of the three contractors, plain acetone performed well in all three cases.

Table 4-2
Alternative Thinner Testing Results

Application	Successful Alternative Cleanup Materials Tested/Used
Wood Company #1	Acetone
Wood Company #2	Lacquer Thinner/Glycol Ether
	Acetone
	Acetone/Glycol Ether
	Acetone/Soy
Contractor #1 (general residential)	Acetone
Contractor #2 (commercial buildings)	Acetone
	Acetone/Soy
Contractor #3 (residential maintenance)	Acetone
Safe Manufacturer	Acetone
	Acetone/Soy
Autobody Shop #1	Acetone
	Acetone/Soy
	Acetone/Glycol Ether
Autobody Shop #2	Acetone
	Acetone/Soy
	Acetone/Glycol Ether
Consumer Autobody Test	Acetone
Autobody Shop #5 (plastic autobody parts)	Acetone
	Acetone/Glycol Ether

IRTA tested acetone and an acetone/soy blend with the safe manufacturer. The coating containing the soy/acetone blend took longer to dry. This could cause problems for some companies if they need to move the metal items they coat on to the next production step. It might not cause problems for other manufacturers which do not have stringent time constraints. It would not cause problems for consumers who are coating metal items. Even so, plain acetone, since it worked effectively, would be a better choice as a thinner for metal coatings in general.

The best alternatives for the autobody shop applications are plain acetone and the acetone/glycol ether blend. The acetone/soy blend could take longer to dry and most autobody shops have time constraints. Plain acetone worked effectively for the consumer application and would be the best choice for consumer autobody applications.

Both acetone and the acetone/glycol ether blend passed the adhesion test conducted at Autobody Shop #5 which paints plastic parts. Either one would be a good choice as a thinner for coating plastic parts for companies or consumers.

It's worth noting here that many of the coatings tested during the project, particularly the autobody coatings, have been designed for use with high VOC thinners. The

manufacturers could easily tailor the coatings slightly around using acetone or an acetone/glycol ether blend so they could be routinely used. IRTA's thinner testing was conducted by assuming that an alternative thinner had to work effectively with the coatings used today but this is a very stringent test. Since the alternatives worked effectively, slight changes in the coating formulations would make them easy to use.

Cost Comparison of Alternative Thinners

As is true in the case of cleanup materials, the cost of using acetone as a thinner is higher than the cost of using paint thinner which is a very low cost chemical. In cases where companies use lacquer thinner or various other blends of high VOC solvents, the cost of using acetone as a thinner is generally comparable. The cost of using the thinners that are blends of acetone and glycol ether or acetone and soy are also comparable to the cost of using lacquer thinner.

REGULATIONS THAT AFFECT THE USE OF CLEANUP SOLVENTS AND THINNERS

CARB and local air districts have the authority to regulate the use of cleanup materials and thinners used in California. The regulations that are currently in place are discussed below.

CARB Regulations

In the introduction, a CARB preliminary estimate of the 2003 emissions from categories of solvent use that concern cleanup solvents and thinners was presented. Table 1-1 is reproduced here as Table 4-3 for reference purposes.

Table 4-3
Preliminary Emissions Estimates for 2003 in California

CARB Consumer Product Category	VOC Emissions (tons per day)
Lacquer Thinner	13.271
Multi-Purpose Solvent and Remover	1.937
Paint Thinners and Reducers	10.731
Spray Gun Cleaner and Solvent	0.012
Total	25.951

CARB has authority over the regulation of consumer products in California. Consumer products are products sold to consumers and industry in hardware, home improvement and paint supply stores. Every three years or so, CARB updates their inventory of emissions from various consumer product categories. CARB is in the process of updating the emissions information from the categories presented in Table 4-3. According to the information in the table, emissions of lacquer thinner are substantial, about 13 tons per day. The lacquer thinner purchased by consumers and industrial firms

is likely used as a cleanup solvent and a thinner, retarder or reducer when coatings are applied. The table has another category, paint thinners and reducers, that also has very high emissions. The solvents in this category are likely to be used as cleanup materials and thinners as well. Some of the solvent in the category of multi-purpose solvent and remover are likely to be used for cleanup and thinning. Finally, solvents from the category of spray gun cleaner and solvent are probably used in cleanup and thinning.

CARB generally regulates categories of emissions by setting a VOC limit. This limit is commonly a percent by weight. For instance, if CARB were to regulate the categories listed above, the agency might specify a VOC limit of 50% for paint thinners and reducers. This means that the materials in this category would be required to have a VOC content of 50% by weight or lower. This could be achieved by using chemicals that are exempt from VOC regulations like acetone and methyl acetate or Low Vapor Pressure (LVP) materials which are solvents with a very low vapor pressure like soy or the glycol ether tested by IRTA. LVP materials are not classified by CARB as VOCs in the consumer product regulations. The limit could also be satisfied by using blends of VOC solvents and solvents that are exempt from VOC regulation or blends of VOC solvents and LVP solvents.

Based on the results of this project, CARB could establish very low limits, close to zero VOC, for the categories of cleanup materials and thinners shown in the table. IRTA's testing results indicate that consumers and industrial firms could rely heavily on acetone or acetone blends with LVP solvents as alternatives for cleanup and thinning.

Local Air District Regulations

SCAQMD has regulatory authority over so-called stationary sources that emit air contaminants in the South Coast Basin which includes Los Angeles, Orange, Riverside and San Bernardino Counties. This represents about half the state in terms of population and industrial activity. Stationary sources regulated by the District do not include consumers; they include industrial facilities.

SCAQMD regulates the VOC content of cleaners used for cleaning coating and adhesive application equipment like spray guns, brushes and rollers. SCAQMD Rule 1171 limits the VOC content of these cleaners to 25 grams per liter VOC or less. This translates roughly into 2.5% VOC. This limit was established as a result of testing conducted by IRTA in the earlier U.S. EPA and SCAQMD projects (EPA, 2004; SCAQMD, 2003).

SCAQMD does not currently directly regulate the VOC content of thinners. The District does, however, indirectly regulate these products that are used in industrial facilities. SCAQMD has many regulations that restrict the VOC content of coatings and adhesives that are applied to substrates. These regulations set VOC limits for the coatings and adhesives "as applied." This means that a coating containing a thinner that is applied to a substrate must meet the VOC content limit in the rule. In other words, the blend of the coating and the thinner has a VOC limit.

SCAQMD may not have the authority to regulate consumer products sold to consumers. The District does indirectly have the authority to regulate cleanup materials, thinners, reducers and retarders that are used in industrial facilities. SCAQMD already regulates cleanup solvents but only indirectly regulates thinners, reducers and retarders. Based on the testing results in this project, the District could further indirectly restrict the VOC content of thinners. Other air districts in the state could adopt regulations for cleanup materials and could also indirectly regulate thinners more stringently.

V. SUMMARY AND CONCLUSIONS

CARB estimates the VOC emissions from solvents used in consumer products designed for cleaning coating application equipment and thinning coatings before they are applied at 26 tons per day in California. These solvents are sold in hardware stores, home improvement centers and paint supply stores. They are purchased by consumers and small and medium sized industrial firms that use them in their operations. The solvents used for cleanup and thinning include paint thinner, lacquer thinner, mineral spirits, toluene, xylene, MEK and MIBK. These solvents are VOCs, many of them are toxic and the hazardous waste generated from their use is often disposed of improperly.

IRTA undertook this project to identify, test and demonstrate alternative safer cleanup materials and thinners that could substitute for the solvents used today. IRTA focused on cleanup materials and thinners that are used in operations involving wood, metal and plastic. To test and demonstrate alternatives, IRTA worked with two wood refinishing companies, three architectural contractors, one safe manufacturer, three autobody shops and one consumer autobody application. IRTA also updated the results of alternatives testing for cleanup materials from two earlier projects for one architectural contractor and two autobody shops.

In the case of the wood coating operations, the alternatives that were successfully tested for cleanup and/or thinning included acetone, acetone blends with soy and a glycol ether and a water-based cleaner. Acetone is not classified as a VOC and it is lower in toxicity than nearly all other organic solvents. For architectural contracting, acetone for cleanup and acetone blends with a glycol ether or soy for thinning proved effective. Plain acetone was used successfully for cleanup for the autobody shops and thinners composed of acetone and acetone blends with soy and glycol ethers were used successfully for thinning. In the consumer autobody test, acetone worked effectively for both cleanup and thinning. Acetone and an acetone blend with a glycol ether also performed well for cleanup and thinning of plastic automotive parts.

IRTA conducted a cost analysis to compare the cost of using the current cleanup and thinning solvents and the cost of using the alternatives. In general, the cost of using the alternatives was comparable to or lower than the cost of using the current materials. In a few cases, the cost of using the alternatives was higher.

CARB is responsible for regulating consumer product cleanup materials and thinners. The alternatives demonstrated by IRTA during this project have very low VOC content or are not classified as VOCs by CARB. Based on the results of this project, CARB could establish a very low VOC content level for these consumer products.

The local air districts in California regulate consumer product cleanup and thinning solvents used in industrial facilities. Only one local air district, SCAQMD, currently regulates the VOC content of cleanup materials. Other local air district could regulate

cleanup materials based on the results of this project and all of the local air districts could also adopt more stringent regulations on thinners.

VI. REFERENCES

"Preliminary Draft, 2003 Consumer and Commercial Products Survey, California Air Resources Board. (CARB, 2006)

"Development of Safer Cleaning Alternatives in the Aerospace, Printing and Coating Industries," Institute for Research and Technical Assistance, prepared for U.S. EPA, June 2004. (EPA, 2004)

"Assessment, Development and Deminstration of Low-VOC Cleaning Systems for South Coast Air Quality Management District Rule 1171," Institute for Research and Technical Assistance, prepared for South Coast Air Quality Management District, August 2003. (SCAQMD, 2003)