Safer Alternative Thinners, Cleanup Materials, Coatings and Sanding Methods in the Autobody Industry

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EXECUTIVE SUMMARY

There may be as many as 8,000 autobody shops in California. Many of these shops are small businesses with between two and five employees. Autobody shops repair and paint vehicles that have been damaged in accidents or they paint vehicles for aesthetic reasons.

As part of their operations, autobody shops apply coatings with spray guns. The spray guns are generally cleaned with high VOC solvents. High VOC solvents are also used to thin the solventborne coatings. Until recently, the base or color coats used by the industry were high VOC content paints. The cleanup materials, the thinners and the coatings are composed of solvents that often have high toxicity. The industry generates a significant amount of sanding dust from sanding the vehicles during repair. VOC emissions from this industry are significant and lead to smog formation. Workers and community members are exposed to the toxic components of the cleanup and thinning materials and the metals in some of the sanding dust. The sanding dust may be classified as hazardous waste and if improperly managed could lead to contamination of storm water in violation of state and local laws.

Cal/EPA's Department of Toxic Substances Control (DTSC) selected the autobody industry as one of the industries of focus under the Pollution Prevention program authorized under Senate Bill (SB) 1916. As part of this effort, DTSC contracted with the Institute for Research and Technical Assistance (IRTA), a nonprofit organization, to conduct a research project to assist the autobody industry in adopting pollution prevention methods. IRTA identifies, develops, test and demonstrates alternative pollution prevention technologies that reduce VOC and toxic emissions and hazardous waste generation.

IRTA recruited seven autobody facilities to work on pollution prevention measures during the project and used information on two additional shops from earlier projects. The focus was in four areas including:

- demonstrating low-VOC, low toxicity alternative cleanup materials;
- developing and demonstrating low-VOC, low toxicity alternative thinners;
- evaluating emerging alternative waterborne base coats; and
- testing and evaluating an alternative sanding technology.

Table A-1 summarizes the low-VOC, low toxicity alternatives that were tested during the project for cleanup of spray guns and thinning solventborne coatings. Acetone is not classified as a VOC and it is lower in toxicity than virtually all other organic solvents. For those reasons, IRTA tested acetone and, in one case, a blend of acetone and methyl acetate for cleanup of spray guns. For the seven facilities participating in this project, acetone was a viable and cost effective cleanup alternative. Autobody shops in much of the state use high VOC cleanup materials that also contain toxic components. In the South Coast Basin, where there are VOC limits on the cleanup materials, companies use cleanup materials that rely on acetone generally blended with other chemicals exempt from VOC regulations. Some of these other solvents are more toxic than acetone. The results of the testing demonstrate that virtually all shops can convert to plain acetone for cleanup of spray guns used to apply solventborne coatings.

Table A-1
Low-VOC, Low Toxicity Alternatives for Cleanup and Thinning

	Alternative Spray Gun Cleaners	Alternative Thinners/Reducers
Solventborne Coatings	acetone	acetone
	20% acetone / 80% methyl acetate	99% acetone / 1% soy
		97.5% acetone / 2.5% DPM
Waterborne Coatings	tap water	D.I. water
	D.I. water	
	water-based cleaners	

IRTA tested three alternative acetone blends as thinners during the project. The alternative thinner that worked most successfully was an acetone/glycol ether blend. The propylene glycol ether, dipropylene glycol monomethyl ether (DPM), that was used in the blend is fairly low in toxicity. Although DPM is a VOC, the DPM content in the thinner is only 2.5 percent. Suppliers today provide high VOC thinners to the autobody industry for reducing their solventborne coatings. The results of this project demonstrate that the suppliers could reformulate the thinners they supply to their customers to significantly reduce their VOC content and toxicity.

IRTA evaluated the conversion to waterborne base coats for two of the facilities participating in the project. The waterborne base coats were developed in Europe and they are being adopted in the South Coast Basin to satisfy the lower VOC limits specified in a South Coast Air Quality Management District regulation. In general, facilities must learn new methods to use the waterborne base coats but the painters and facilities adapt quickly. The coatings do require a longer drying time but the painters interviewed said they like them better than the solventborne base coats. The cost analysis for one facility indicates the cost of using the waterborne coatings is somewhat higher than the cost of using the solventborne base coats. The cost analysis for a second facility indicates a comparable cost for using the waterborne and solventborne coatings.

IRTA also tested and evaluated an alternative sanding technology that minimizes dust generation. Two of the facilities participating in the project converted to the alternative sanding method and another facility is in the process of converting. All technicians at the three facilities prefer the alternative technology. The cost analysis indicates that use of the technology is lower cost than use of the current sanding methods.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION AND BACKGROUND

Californians are strongly concerned about the quality of their environment and are vitally interested in minimizing the release and generation of toxic and other hazardous materials. In response to continuing concerns about pollution, in 1998, the Legislature augmented the State's Pollution Prevention Program at Cal/EPA's Department of Toxic Substances Control (DTSC) through a bill called Senate Bill (SB) 1916. The program involves selecting two industry targets for pollution prevention outreach and assistance every two years, one of which must be a small businesses category. For the 2004-2006 cycle of SB 1916, DTSC selected the autobody and paint industry as the small business category to promote implementation of source reduction measures. Significant progress has been made in identifying best management practices and pollution prevention strategies and preparing information materials.

The California Air Resources Board (CARB) estimates that there are between 4,000 and 6,000 autobody shops in California. InfoUSA.com estimates are even higher, at 8,000 shops. The industry is comprised of autobody repair/paint shops, production autobody paint shops, new car dealer repair/paint shops, fleet operator repair/paint shops and custom restoration facilities. Most of the shops perform collision repair and refinishing for the passenger car segment and some perform complete paint jobs. The majority of autobody shops are small businesses with between one and five employees. Over 70 percent generate less than one million dollars in annual revenue.

Autobody shops provide a range of services including frame repair, sanding, panel replacement, surface preparation and painting operations. DTSC indicates that the most common hazardous waste generated at these shops is spent solvents mixed with paint waste. Some of the dusts generated from sanding operations are hazardous waste because they contain metals above California regulatory thresholds. Air emissions of VOC or toxic materials from painting operations and from coating application equipment cleaning are perhaps of greatest concern.

The Institute for Research and Technical Assistance (IRTA) is a nonprofit organization established in 1989. IRTA works with companies and whole industries to identify, develop, test and demonstrate safer alternatives. DTSC contracted with IRTA to work with autobody shops in California as part of the SB 1916 effort to address pollution prevention measures for the autobody industry. The research results presented here focus on four areas including:

- alternative coating application equipment cleaners;
- alternative thinners;
- alternative coatings; and
- dust control methods.

Autobody shops typically clean their spray guns with solvents that have high VOC content and many of the components of the cleaners have high toxicity. One air district, the South Coast Air Quality Management District (SCAQMD), adopted a regulation that established a very low VOC content for spray gun cleaners. This regulation applies to many industries with painting operations, including the autobody industry. IRTA performed the technology development project that led to the low SCAQMD VOC limit. During this project, IRTA tested alternative low-VOC, low toxicity cleanup materials with several autobody shops.

Autobody shops use solvent based thinners or reducers in their coatings so they are easier to apply. Most of these thinners have very high VOC content and the solvents they contain often have high toxicity. As part of this project, IRTA developed and tested alternative low-VOC, low toxicity thinners with several autobody shops.

Autobody shops generally apply a set of three types of coatings to vehicles when they paint them. These include a primer, a base or color coat and a clear top coat. SCAQMD recently adopted a regulation that requires autobody shops to convert to lower VOC content base coats. The regulation is based on technology developed in Europe that relies on water-based systems. Suppliers are converting autobody shops in the South Coast Basin to these water-based systems. Other air districts in the state are expected to require autobody shops to make the same conversion over the next several years. As part of this project, IRTA evaluated the alternative water-based coating systems.

Autobody shops perform a significant amount of sanding as part of their repair operations. The shops sand primer which generally contains metals. They also sand plastic filler that is used to smooth the surfaces of the vehicle or parts during repair. Finally, they sand during the painting operation to achieve a smooth, rich finish. As part of this project, IRTA investigated, tested and evaluated an alternative sanding technology that minimizes dust generation.

IRTA recruited and worked with seven autobody shops during the project. This document presents the results of the alternatives testing for cleaning the spray guns for the seven participating facilities and for two additional facilities IRTA worked with in an earlier project. It also presents the results of the tests of alternative thinners for the seven participating facilities. IRTA monitored the conversions and analyzed the costs, advantages and disadvantages of the alternative water-based base coats for two autobody shops that participated in the project. Finally, IRTA tested and analyzed the results of the alternative sanding technology for three of the facilities participating in the project.

Section II of this document focuses on the testing of low-VOC, low toxicity materials for cleanup of the coating application equipment and thinning of the solventborne coatings. Section III presents the results of the analysis of the alternative water-based coating systems. Section IV describes the alternative sanding technology and the results of the tests with autobody shops. Finally, Section V presents the results and conclusions of the research.

II. ANALYSIS OF CLEANUP MATERIALS AND THINNERS

ALTERNATIVE CLEANUP MATERIALS AND THINNERS FOR SOLVENTBORNE COATINGS

A few of the air districts in California have adopted regulations which establish a lower VOC limit for base or color coats used in the autobody industry. Most of the air districts, however, have not adopted alternative regulations but plan to do so over the next several years.

All of the coatings, including primers, base or color coats and top coats, used by autobody shops in areas where the new regulations have not been adopted are solventborne. In the areas where the new regulations have been adopted, the only coatings that have been changed are the base or color coats. In these cases, the base coats are waterborne and the primers and top coats are still solventborne. The waterborne base coats have been used for several years in Europe and they have been adapted for use in the U.S.

High VOC cleanup solvents have been used traditionally for cleanup of application equipment used to apply all of the coatings in the autobody industry. A few years ago, one of the air districts in California, SCAQMD, modified their cleaning rule, Rule 1171, to require the materials used for cleanup of coating and adhesive application equipment have a VOC content of 25 grams per liter or less. This regulation applies to all industries that clean application equipment and the low VOC limit was based on work conducted by IRTA and sponsored by U.S. EPA and SCAQMD. IRTA demonstrated this limit could be met by testing low-VOC alternatives with several companies in a variety of different industries. When the new limit became effective, autobody shops in the South Coast Basin were required to use cleanup materials with a VOC content of 25 grams per liter or less.

High VOC solvents have also been used traditionally for thinning the solventborne coatings used by the autobody industry. In some cases, these solvents are provided to the autobody shops by suppliers; in other cases, autobody shops purchase paint or lacquer thinner from home improvement and hardware stores. Air districts regulate the VOC content of the coatings “as applied” which is the VOC content of the coating with the thinners/reducers. These regulations are generally based on the use of high VOC thinners/reducers.

In this project, IRTA worked with seven autobody shops to test alternative low-VOC cleanup materials for cleaning solventborne coatings. The results of the testing are summarized below. The analysis also includes the results of testing with two additional autobody shops that participated in the earlier studies sponsored by EPA and SCAQMD. During the current project, IRTA also tested alternative low-VOC, low toxicity thinners for thinning solventborne coatings with seven autobody shops participating in this project. The results of this testing are also summarized below.

A Volatile Organic Compound or VOC is any volatile compound of carbon excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and exempt compounds. For the alternative cleanup and thinning materials testing, IRTA formulated several low-VOC formulations and relied on certain existing formulations. For the cleanup materials, as described in the testing below, IRTA relied heavily on acetone, a chemical that has been explicitly deemed exempt from VOC regulations by EPA, CARB and the local air districts. The fact that acetone is an exempt solvent and the fact that it is lower in toxicity than almost all other organic solvents makes it an attractive cleaner and thinner for solventborne coatings. For the thinner testing, IRTA added a glycol ether to inhibit the rapid evaporation of acetone. The glycol ether, DPM, is classified as a VOC but the blend that was tested had a VOC content of about 25 grams per liter. IRTA also formulated a thinner that was a blend of acetone and a soy based material. The soy material has a VOC content of less than 25 grams per liter.

Autobody shops purchase cleanup materials and thinners in a range of quantities depending on their preference. Some purchase the cleaners or thinners in gallon quantities, some in five gallon quantities and a few, in drums. IRTA tested acetone and acetone formulations for the cleanup and thinning activities. In general, IRTA assumed that the low-VOC alternatives that were successful would be purchased in the same quantities as preferred by the facilities. In one case, IRTA assumed that the alternative cleaning solvent would be purchased in drum quantities. The cost of purchasing acetone or acetone blends in small quantities is more expensive on a per gallon basis than the cost of purchasing the materials in a larger quantity. IRTA's cost analysis for the facilities reflects the higher per gallon cost when the facilities purchase smaller quantities.

Autobody Shop #1

IRTA worked with this 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 2-1. A service provider leases the spray gun cleaner to the company, maintains the equipment, supplies the cleaning solvent and disposes of the waste. At the time IRTA worked with the facility, the shop used traditional solventborne coatings consisting of primers, base coats and top coats.

Figure 2-1. Spray Gun Cleaning Unit at Autobody Shop #1

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. Material Safety Data Sheets (MSDSs) for acetone and methyl acetate are shown in Appendix A. IRTA provided the company with the acetone and the acetone/methyl acetate blend for several weeks of testing. The company preferred the acetone/methyl acetate blend.

At the time, the company leased their spray gun cleaner from a supplier. To convert to an alternative, the company would have to purchase their own spray gun cleaner. 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 2-1 shows the annual cost comparison for the current operation and for use of the alternative cleanup material. The cost of using the alternative is 64% lower than the cost of using the high VOC cleaner.

Table 2-1
Annualized Cost Comparison for Autobody Shop #1 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 #2

IRTA also 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 2-2. The cleaner used by the company at the time of the alternatives testing was lacquer thinner. An MSDS for lacquer thinner is shown in Appendix B.

Figure 2-2. Spray Gun Cleaning Unit at Autobody Shop #2

IRTA provided acetone to the company to test for a few months and the workers indicated it performed very well. The shop uses about five gallons of lacquer thinner, purchased from a home improvement store, every quarter. Assuming the price of 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 spent solvent would carry a cost of $40 annually.

Table 2-2 shows the annual 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 2-2
Annualized Cost Comparison for Autobody Shop #2 Cleanup Materials

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

Autobody Shop #3

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 the solvent is sprayed through the gun. IRTA tested plain acetone and a blend of 80%/20% methyl acetate as alternative cleanup materials. IRTA had tested the acetone/methyl acetate in the earlier projects that focused on cleanup and one shop had preferred it so it was included in the testing. The workers who tested the 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 materials 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 2-3 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.

Autobody Shop #3 also uses the cleanup solvent as a thinner for the base or color coat. The three alternative 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. MSDSs for the soy product, called Soy Gold 2500, and the glycol ether, called DPM, are shown in Appendix A. 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.

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

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

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.

The 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 2-4 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 2-4
Annualized Cost Comparison for Autobody Shop #3 Thinners

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

Autobody Shop #4

This autobody shop is one of a chain of 11 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 A. The cleanup solvents 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 C.

Autobody Shop #4 uses a spray gun cleaning system to clean the application equipment. A picture of the spray gun cleaner is shown in Figure 2-3. 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 2-3. Spray Gun Cleaning Unit at Autobody Shop #4

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 would be used as the current cleanup solvent, the annual cost of purchasing the acetone would amount to $252.

The current cleanup solvent 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. The same costs would apply if the company adopted acetone.

Table 2-5 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.

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 in the spray booth where the coatings were applied is shown in Figure 2-4. In all cases, the painter first applied a primer to the scrap part, then applied three thinned base coats and finally, two clear coats. 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 of the thinned base coat.

Table 2-5
Annualized Cost Comparison of Autobody Shop #4 Cleanup Materials

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

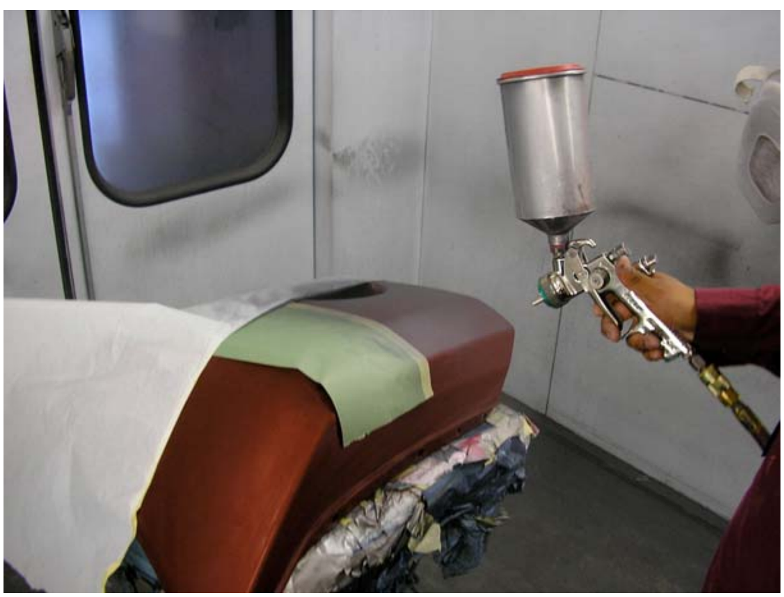

Figure 2-4. Tests of Alternative Thinners in Spraybooth at Autobody Shop #4

A picture of the scrap part with the four coating/thinner combinations is shown in Figure 2-5. 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.

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 for 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.

Figure 2-5. Scrap Part with Four Coating/Thinner Combinations at Autobody Shop #4

Table 2-6 shows the cost comparison for the current thinner and 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 2-6
Annualized Cost Comparison for Autobody Shop #4 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 #5

This company is not a traditional autobody shop. Rather, the company refinishes and provides plastic automotive components to the automobile original equipment manufacturers. 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. Similar to traditional autobody shops, the coating system used by the company on the plastic components is a primer, a base or color coat and a clear top coat.

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 base coat, DuPont ChromaBase, is shown in Appendix C. 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 clear top coat 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 crosshatch area and is then removed. If the tape is clean, the parts are acceptable; if the tape is not clean, the parts are not acceptable. Figures 2-6, 2-7, 2-8 and 2-9 show the results of the tape test for the current thinner, plain acetone, acetone/soy and acetone/glycol ether respectively. Three of the parts--those 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 company 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.

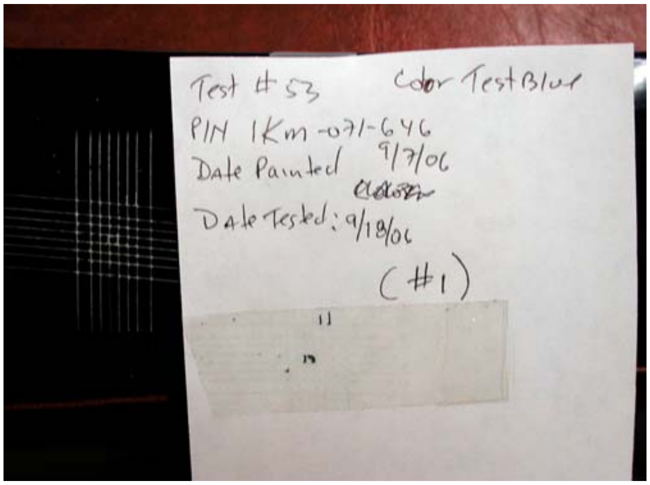

Figure 2-6. Tape Test Results for Current Thinner at Autobody Shop #5

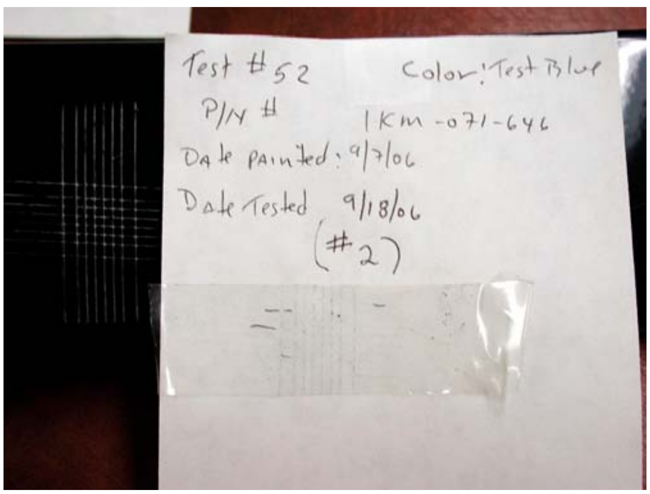

Figure 2-7. Tape Test Results for Plain Acetone Thinner at Autobody Shop #5

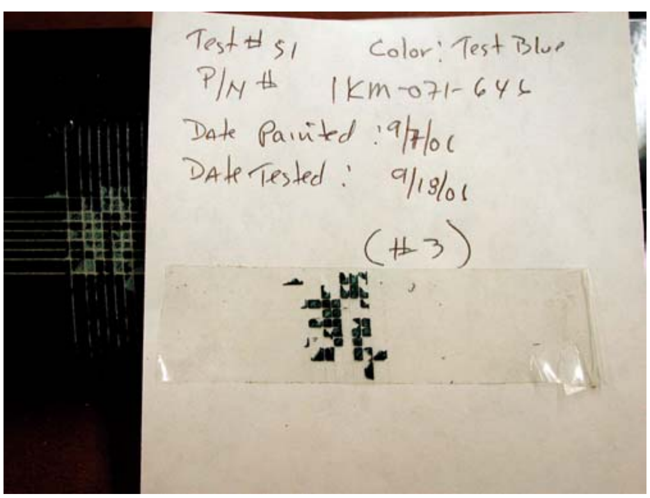

Figure 2-8. Tape Test Results for Acetone/Soy Thinner at Autobody Shop #5

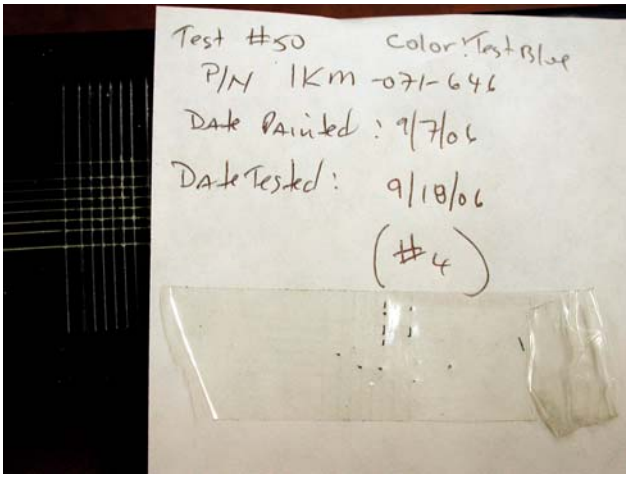

Figure 2-9. Tape Test Results for Acetone/Glycol Ether Thinner at Autobody Shop #5

IRTA estimates that DPM, the glycol ether used in the thinning tests could be purchased for $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 2-7 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 2-7
Annualized Cost Comparison for Autobody Shop #5 Thinners

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

Autobody Shop #6

This company has one larger shop and one smaller shop in the Los Angeles Basin area. Some of the vehicles processed by the shop are high end cars. IRTA worked with the company to test alternative cleanup materials and thinners and analyzed the cost for the smaller shop to convert to the alternatives.

IRTA tested plain acetone as a cleanup material with this facility. The technician indicated that it performed as well as the current cleanup solvent. IRTA analyzed the cost of using acetone in place of the current cleanup material. The company currently uses 523 gallons of the current cleanup material per year in a spray gun cleaning system owned by the facility. The cost of the cleanup solvent is $7.99 per gallon. The annual cost of using the current cleanup material is $4,179. A supplier indicates he would supply the company with acetone in five gallon containers at a price of $8.40 per gallon. Assuming the same amount of acetone would be used, the annual cost of using the acetone in place of the current cleanup material is $4,393.

The company disposes of about 18 gallons per month or 216 gallons per year of waste cleanup solvent. The cost of disposal is $2.99 per gallon or $646 per year. It was assumed that the cost for disposal of the acetone would be the same.

Table 2-8 shows the annual cost comparison for using the current cleanup solvent and substituting acetone. The cost of using the acetone alternative is four percent higher than the cost of using the current cleanup material.

Table 2-8
Annualized Cost Comparison for Autobody Shop #6 Cleanup Materials

	Current Cleanup Solvent	Acetone
Cleanup Material Cost	$4,179	$4,393
Disposal Cost	$646	$646
Total Cost	$4,825	$5,039

IRTA tested the currently used reducer and three alternative reducers including plain acetone, a blend of 1% soy/99% acetone and a blend of 2.5% acetone/97.5% DPM, a glycol ether with the company. The painter prepared a scrap part by sanding and applying the primer. According to the painter, the two alternatives that performed almost as well as the currently used reducer and were acceptable were the blends of acetone with soy and with glycol ether.

The shop purchases reducer from a supplier in five liter quantities which is somewhat more than a gallon. The painter uses about 32 gallons per year of reducer for thinning the base coat. The cost of thinners amounts to $2,148 annually or about $67.13 per gallon.

A supplier indicated he would provide the shop with five gallon quantities of either one of the alternative blends for $45 or $9 per gallon. On this basis, the cost of purchasing the alternative reducers, assuming the same amount would be used, would be $288 annually.

Table 2-9 shows the cost comparison for the currently used reducer and the two alternative reducers. The cost of using the alternatives is more than seven times less than the cost of using the current thinner.

Table 2-9
Annualized Cost Comparison for Autobody Shop #6 Thinners

	Current Thinner	Acetone/Glycol Ether	Acetone/Soy
Thinner Cost	$2,148	$288	$288
Total Cost	$2,148	$288	$288

Autobody Shop #7

This shop is located in Santa Monica, California. It repairs about 100 cars per month, 85% of them high end cars like BMWs and Jaguars. When IRTA worked with the shop, they used an acetone based cleaner which also contained toluene, xylene and isopropyl alcohol and a high VOC thinner. An MSDS for the cleanup solvent is shown in Appendix B.

IRTA and the shop tested plain acetone and a blend of 80% acetone and 20% methyl acetate for cleanup and, according to the shop personnel, the plain acetone worked very well. The company decided to convert to acetone.

In the past, the shop purchased five gallons of cleanup solvent every two weeks at a cost of $355. The annual cost of purchasing the solvent amounted to $9,230. The shop owner decided to purchase acetone in drum quantities and the supplier charges $402 per drum or about $7.31 per gallon. The company uses the same amount of acetone as the original cleanup solvent; the cost of using the plain acetone amounts to $950 per year.

Table 2-10 shows the cost comparison for the original cleanup solvent and the plain acetone. Purchasing the plain acetone is substantially lower than purchasing the original cleanup solvent.

Table 2-10
Annualized Cost Comparison for Autobody Shop #7 Cleanup Materials

	Original Cleanup Solvent	Acetone
Cleanup Material Cost	$9,230	$950
Total Cost	$9,230	$950

IRTA conducted tests of alternative thinners with the painter using a scrap part. The painter prepared the parts with primer. Four alternatives were tested including the current thinner, acetone, a blend of 99% acetone and 1% soy and a blend of 97.5% acetone and 2.5% glycol ether. The thinners were used in a 50%/50% combination with a metallic base coat. After applying two base coats, the painter inspected the parts and indicated that all three of the alternative thinners were acceptable.

The shop currently purchases five gallons of the high VOC thinner for $355 or $71 per gallon every two weeks. On this basis, the annual cost of using the thinner amounts to $9,230. If acetone were used as the thinner, the shop could use the drums of acetone purchased for cleanup solvent for thinning as well. Assuming the same amount of acetone would be required, the cost of using acetone for thinning would be $950 per year.

If the shop converted to one of the other alternative thinners, they would likely purchase it in five gallon quantities. One supplier indicated he would supply the shop with five gallon pails of the acetone/soy blend or the acetone/glycol ether blend for $42 or $8.40 per gallon. The cost of using one of the blends would amount to $1,050 annually.

Table 2-11 shows the cost comparison for the current and three alternative thinners. The cost of using any of the alternative thinners is substantially lower than the cost of using the current thinners.

Table 2-11
Annualized Cost Comparison for Autobody Shop #7 Thinners

	Current Thinner	Acetone	Acetone/ Glycol Ether	Acetone/ Soy
Thinner Cost	$9,230	$950	$1,050	$1,050
Total Cost	$9,230	$950	$1,050	$1,050

Autobody Shop #8

This shop is located in Torrance, California and the company repairs about 300 cars per month. IRTA conducted testing of alternative cleanup materials and thinners at this shop but was not able to obtain cost information on the currently used cleanup solvent and thinners.

The shop used a higher VOC cleanup material for cleaning the application equipment. IRTA conducted testing with the painter and plain acetone worked very well.

The company uses a slow, medium and fast reducer depending on the conditions during application of the basecoat. The painter routinely uses two parts base coat and one part thinner. IRTA tested two alternatives with the company and used the same thinning ratio as the painter uses routinely. The first alternative was plain acetone. In this case, the base coat was a darker color than the color with use of the currently used thinner. On this basis, acetone was judged to be unacceptable as a thinner. The second thinner IRTA tested with the company was a blend of 97.5% acetone and 2.5% glycol ether. This thinner worked well, according to the painter, and the color was the same as the color of the base coat when it is thinned with the currently used product.

Autobody Shop #9

This shop is located in Hesperia, California. The shop repairs 45 to 50 cars per month. IRTA worked with the company to test alternative cleanup materials and thinners.

The company currently uses a high VOC solvent for cleanup of the application equipment. IRTA tested two low-VOC alternatives, acetone and a blend of 80% acetone and 20% methyl acetate. According to the painter, the testing indicated that plain acetone worked as well as the current cleanup solvent. The acetone/methyl acetate blend did not work quite as well as the current solvent.

IRTA analyzed the cost to the facility for using acetone in place of the current solvent. The facility current uses about 180 gallons every six months or 360 gallons per year of cleanup solvent. The cost of the cleanup solvent is $5.99 per gallon or $2,156 annually. The shop has a system with a filter that allows reuse of the solvent. A hazardous waste hauler picks up the solids periodically and disposes of them as hazardous waste.

The company could purchase the acetone alternative in drum quantities for $402 per drum or $7.31 per gallon. Assuming the same amount of acetone would be used for cleanup, the cost of using acetone in place of the high VOC cleaner would amount to $2,632 annually. The hazardous waste disposal cost with acetone would be the same as it is currently so that cost is not included in the analysis.

Table 2-12 shows the cost comparison for using the current cleanup materials and acetone. The cost of using acetone is 22% higher than the cost of using the current cleanup solvent.

Table 2-12
Annualized Cost Comparison for Autobody Shop #9 Cleanup Materials

	Current Cleanup Solvent	Acetone
Cleanup Material Cost	$2,156	$2,632
Total Cost	$2,156	$2,632

IRTA tested two alternative low-VOC thinners with the facility. The shop reduces the base coat 50%/50% with the current reducer. IRTA tested the alternative thinners in the same proportion. The first alternative that was tested on a scrap part with primer was plain acetone. A clear top coat was applied and the part was compared with the baseline coating that used the current reducer. The acetone reduced part was lighter in color than the part coated with the current reducer. This was probably because the acetone has a very high vapor pressure and it evaporated before the coating could be deposited on the part. The second alternative that was tested was a blend of 97.5% acetone and 2.5% DPM. A clear top coat was applied after the application of the base coat. The painter indicated that the acetone/glycol ether blend performed as well as the current reducer and the part looked very good.

IRTA analyzed the cost of using the alternative acetone/DPM blend in place of the current reducer. The shop currently purchase their reducer in five gallon containers and uses about 2.5 gallons per week. The cost of the reducer is $56.72 per gallon or $7,374 annually. One supplier indicated he would provide the acetone/glycol ether blend in five gallon quantities for $42 or $8.40 per gallon. Assuming the same amount of the low-VOC alternative would be used, the cost of purchasing the low-VOC alternative would amount to $1,092 annually.

Table 2-13 shows the cost comparison for using the current thinner and the acetone/glycol ether blend. The cost of using the alternative thinner is more than six times less than the cost of using the current thinner.

Table 2-13
Annualized Cost Comparison for Autobody Shop #9 Thinners

	Current Thinner	Acetone/ Glycol Ether
Thinner Cost	$7,374	$1,092
Total Cost	$7,374	$1,092

ALTERNATIVE CLEANUP MATERIALS AND THINNERS FOR WATERBORNE COATINGS

A few of the companies participating in the project converted some of their facilities to waterborne base coats during the project period. The waterborne base coats are thinned with deionized water (D.I.) which is generally provided by the supplier. The primers and top coats used by the facilities are still solventborne and if they are thinned, they must be thinned with solvents. Autobody shops generally clean the application equipment used to apply waterborne base coats with D.I. water, tap water or water-based cleaners. The shops still clean the application equipment used to apply the solventborne primers and top coats with solvents. Two separate cleanup systems are required for facilities that have made the conversion.

One large service supplier that provides service to many autobody shops in Southern California now offers two cleaning systems. Autobody shops own their own cleaning tanks or can lease the cleaning tanks from the service supplier. This supplier offers a solvent blend that is composed of acetone and other solvents that are exempt from VOC regulation for cleaning the guns used to apply the solventborne coatings. The supplier also offers a formulated water-based cleaner for cleanup of the gun used to apply the waterborne base coat. The company provides two drums to each autobody facility that are used to hold the cleaning formulations when they are spent. The supplier picks up the hazardous waste periodically and changes out the solvent and water-based cleaners.

This service supplier describes the cost of the solvent and water-based cleanup materials and the cost of hauling the hazardous waste. The cost of the cleanup solvent is listed at $7.99 per gallon; the cost of the water-based cleanup material is lower, at $4.95 per gallon. The charge for disposal of the spent solvent cleaner is listed at $2.99 per gallon whereas the cost for disposal of the spent water-based cleaner is higher, at $3.75 per gallon. The spent water-based cleaners are handled as hazardous waste by the service providers. Since the base coats generally do not contain metals, cleanup materials may not actually be classified as hazardous waste.

Autobody shops who own their own cleanup systems or use a bucket to perform cleanup do not have to lease the spray gun cleaning units from suppliers. These shops can purchase plain acetone from their coating suppliers or from a home improvement store at a lower cost than the service company charges. The shops, as demonstrated below, can also use tap water for the majority of the cleanup for the gun used to apply the waterborne coating. There is no need to pay the service company for the more expensive water-based cleaner.

Autobody Shop #4

One of the companies IRTA worked with during the project now uses two separate cleanup systems. A picture of these two cleaning systems is shown in Figure 2-10. One of them contains a solvent and the other contains a water-based cleaner. The solvent is recycled on-site in a recycling system shown in Figure 2-11 but the water-based cleaner is not. The shop has separate drums for the spent solvent cleaner and the spent water cleaner. These drums are picked up periodically by a waste hauler. A company representative indicates that the cost of cleanup has increased because of the need to use two different systems.

Figure 2-10. Solvent and Water Cleaning Systems at Autobody Shop #4

This company purchases two sets of thinners now. Solvent thinners are purchased from the company's coatings supplier for thinning primers and top coats and D.I. water is purchased from the supplier for thinning the new waterborne base coats. The company has not analyzed or compared the cost of the thinning.

Figure 2-11. On-Site Solvent Recycling System at Autobody Shop #4

Autobody Shop #6

Another company IRTA worked with during the project also uses two different cleaning systems. In this case, the company purchases D.I. water from the coating supplier for thinning and cleanup. The painter uses tap water in a five gallon bucket for cleaning the spray gun used to apply the waterborne coating. He then does a final rinse of the gun with a small amount of D.I. water. Figure 2-12 shows the bucket containing tap water for the cleaning process. The painter uses solvent to clean the spray guns used to apply the solventborne coatings in the same manner as before. The solvent is disposed of in a 55 gallon drum and the water is disposed of in a 30 gallon drum. The two drums are shown in Figure 2-13. The waste is picked up by a waste hauler for disposal.


Figure 2-12. Bucket For Cleaning Spray Gun With Tap Water at Autobody Shop #6

Figure 2-13. Drums for Disposal of Solvent and Water for Cleanup at Autobody Shop #6

In Section III below, IRTA analyzes and compares the cost for this autobody shop in converting to the waterborne base coats. As part of that analysis, IRTA estimated the cost of using thinner before and after the conversion and the cost of cleanup of the spray guns before and after the conversion.

The owner of this autobody shop provided IRTA with usage and cost data for the three months prior to the conversion to waterborne base coats and for the three months after the conversion. Materials sales, which includes the cost of all materials used but not labor, for the three month period before the conversion were 1.8 percent higher than the materials sales after the conversion.

For the period January through March 2007, the company used 30 liters of solvent thinner for the base coat at a cost of $537. On an annual basis, the thinner use amounted to 120 liters. The annual cost of purchasing the thinner was $2,148. For the period May through July 2007, the company used 20 liters of D.I. water for thinning and cleanup. This translates into 80 liters per year. Assuming 70 liters were used for thinning, the annual cost of purchasing the thinner is $1,344.

Table 2-14 shows the annualized cost comparison for the solvent and the D.I. water thinner. The values in the table show that the cost of thinning with D.I. water is 36 percent less than the cost of thinning with solvent after adjusting for materials sales.

When the company used the solventborne base coat, the cost of purchasing 216 gallons of cleanup solvent for the base coat was $1,724 per year and the cost of disposal was $108 annually. The cost of purchasing cleanup solvent and paying for disposal related to the base coat amounted to $1,832. After the conversion, the company purchased 10 liters of deionized water annually for the cleanup at a cost of $192. The cost of disposal of the 72 gallons of water waste generated each year amounted to $215. The total cost of purchasing the cleanup material and disposal of the waste was $407 annually

Table 2-14
Annualized Cost Comparison for Autobody Shop #6 Base Coat Thinners Before and After Conversion

	SolventThinner	D.I. Water Thinner
Thinner Cost	$2,148	$1,344
Total Cost	$2,148	$1,344
Adjustment for Material Sales	$2,148	$1,368

Table 2-15 shows the annualized cost comparison for the company for cleanup related to the base coat before and after the conversion. After adjustment for materials sales, the cost of cleanup declined by about 77 percent after the conversion to waterborne base coats.

Table 2-15
Annualized Cost Comparison for Autobody Shop #6 Base Coat Cleanup Materials Before and After Conversion

	Solvent	Water
Cleanup Material Cost and Disposal Cost	$1,832	$407
Total Cost	$1,832	$407
Adjustment for Material Sales	$1,832	$414

III. ANALYSIS OF LOW-VOC BASE COATS

CALIFORNIA REGULATIONS FOR BASE COATS

On October 20, 2005, the California Air Resources Board (CARB) adopted a Suggested Control Measure (SCM) for the autobody industry. The SCM is a template for a regulation that can be adopted by local air districts in California which have the authority to regulate stationary sources like autobody shops. In December, 2005, the SCAQMD, which regulates about half the autobody shops in California, adopted a regulation that is somewhat different from the SCM for the autobody industry. The regulation established new, lower VOC limits for base or color coats based on waterborne coatings that were available in Europe. The lower VOC limit for the color coats becomes effective in July of 2008.

To accommodate the autobody shops in the South Coast Basin, the coating manufacturers have either purchased European companies and acquired the waterborne technology or have developed it over the last few years. Some of the manufacturers have developed coatings that are actually water-based; that is, they actually contain water. Other manufacturers have developed coatings that do not contain water but can be diluted or reduced with water. The thinner used for the waterborne coatings is D.I. water which is provided by the suppliers. As discussed earlier, water is also used for cleanup of the application equipment used to apply the waterborne coatings. Although the manufacturers are providing the new waterborne base coats, the primers and clear top coats are still solventborne.

DESCRIPTION OF WATERBORNE BASE COATS

An MSDS for a LOW-VOC base coat offered by Akzo Nobel is shown in Appendix C. This coating, called Autowave MM 357, does not contain water but is water reducible. It contains an alcohol and a glycol ether and both are miscible with water. Other coatings offered by suppliers that do not contain water are similar. An MSDS for another base coat offered by Spies Hecker, called Permahyd Base Coat, is also shown in Appendix C. This coating is water reducible and it contains water as well. Other suppliers offer similar formulations that contain water.

There are a number of advantages to the new waterborne coatings. First, they are obviously better from a health and environmental standpoint. Second, many painters indicate that the waterborne coatings are easier to color match, particularly on car models made in 2005 or later. Third, some painters claim that less of the waterborne coating is required for a given job. Fourth, painters have a fairly short learning period before they are comfortable using the new waterborne coatings.

The major disadvantage of the waterborne coatings is that they take longer to dry. Autobody shops are enhancing their current drying systems when they make the conversion. There are three options for reducing the dry time. First, companies can purchase hand held portable dryers. A picture of one portable dryer is shown in Figure 3-1. The dryers are on a stand. Sometimes they are placed near the vehicle on the stand and directed to the painted area to dry the coating. At other times, the painter can remove the dryer from the stand and carry it to the vehicle for focused drying. The cost of these portable dryers ranges from about $1,000 to $2,000. They are most suitable for autobody shops that repair four to six cars per day.

Figure 3-1. Typical Portable Hand-Held Dryer

Second, autobody shops can fit their booths with three ceiling fans to increase the airflow. A picture of a booth with the fans is shown in Figure 3-2. The cost of purchasing and installing three ceiling fans in a booth ranges from $7,000 to $9,000.

Figure 3-2. Three Ceiling Fan Drying System

Third, autobody shops can modify their existing booths with auxiliary air movement systems. One such system, called Junair, supplies additional air flow from the corners of the spray booth cabin. The clean, filtered and heated air accelerates the evaporation of water from the coating. The cost of modifying a booth with the system ranges from $18,000 to $20,000. It is most appropriate for larger autobody facilities that repair 10 to 12 cars per day. A picture of this system is shown in Figure 3-3.

Figure 3-3. Junair Drying System

COST ANALYSIS FOR WATERBORNE BASE COATS

Autobody Shop #4

This shop has 11 facilities in the greater Los Angeles area. The company is converting the smaller shops first so the remaining solventborne coating inventory can be passed along to the other shops and used up. IRTA discussed the conversion at one of the shops with the painter. He indicated that he likes the waterborne coatings and that the colors match better. He also estimated that he uses about 30 percent less of the new base coat. He now thins the coating with D.I. water in a 20 percent D.I./80 percent coating mixture. A picture of a car bumper painted with the waterborne base coat at this shop is shown in Figure 3-4. At a second shop which had been converted for two months, the painter indicated he likes the new coatings better because they don't smell, they cover better, the colors are richer and the metallic lays down better. A picture of a car being prepped at this shop is shown in Figure 3-5.

IRTA visited two additional shops operated by the same company that had converted to the waterborne base coats. In both cases, the company purchased portable air flow systems that are used in the coating booth to accelerate drying. Figure 3-6 shows a picture of one of the portable air systems. The painters at both shops also liked the new waterborne base coats. Figure 3-7 shows the painter at one of the shops painting a bumper in the coating booth. Figure 3-8 shows a car and a bumper painted with the waterborne base coats drying in the coating booth.

Figure 3-4. Car Bumper Painted with Waterborne Base Coat at Autobody Shop #4

Figure 3-5. Car Prepped For Application of Waterborne Base Coat at Autobody Shop #4


Figure 3-6. Portable Drying System at Autobody Shop#4


Figure 3-7. Painting Bumper with Waterborne Base Coat at Autobody Shop #4


Figure 3-8. Car and Bumper Painted with Waterborne Base Coat at Autobody Shop #4

The company converted one of their shops in the summer of 2007. IRTA and the company's Director of Development discussed the conversion and the costs after the facility had been converted for three full months. The shop had to purchase a new air compressor for $1,500 to accommodate the new waterborne coatings. The shop also had to purchase four air line dryers for a total cost of $400. The air flow had to be increased to dry the waterborne coatings so the company purchased high flow connectors for $1,000. The energy costs for facilities using the new waterborne coatings are likely to increase because of the higher air flow required for drying.

The company collects and analyzes certain types of information for all the shops. The shop IRTA analyzed made the conversion on July 20, 2007 and operated with the waterborne coatings for the first full month in August. Table 3-1 shows the liquid material cost per car for several months before and after the conversion. This material cost includes the cost of thinner for the coatings. The table also shows the number of cars the shop processed during each month.

A rough indication of costs can be derived through averaging the December 2006 through June 2007 figures and comparing them to the average of the costs for August 2007 through November 2007. The values in Table 3-1 have already been normalized since they represent the cost per car. The average cost per car for the period December 2006 through June 2007 is $65.22. The average cost per car for the period August 2007 through November 2007 is $69.24. Assuming this is a reliable measure of the costs before and after the conversion, the increase in costs to the shop amounted to about six percent.

This cost increase does not include any capital costs the shop had or any increased energy costs so it may underestimate the actual cost increase. On the other hand, there is generally a learning curve for painters in using the new waterborne coatings. The cost per car might be expected to be higher initially and, since there are only four full months included in Table 3-1 for the post conversion, this could lead to an overestimate of the costs. The Director of Development for the company believes the costs have increased at all the shops the company has converted. He also indicates that the conversion has not caused significant problems and that the coatings work well.

Table 3-1
Cost of Liquid Material Per Car at Autobody Shop #4

Date	Number of Cars	Cost/Car
December 2006	92	$59.39
January 2007	114	$70.22
February 2007	96	$72.28
March 2007	134	$70.04
April 2007	93	$56.49
May 2007	147	$68.66
June 2007	126	$59.49
July 2007	121	$56.57
August 2007	124	$60.06
September 2007	91	$76.90
October 2007	127	$60.87
November 2007	97	$79.12

A case study for this facility describing the conversion to waterborne coatings is provided in Appendix D.

Autobody Shop #6

This company has two autobody shops in the South Coast Basin, one of them a small shop that repairs about 75 cars per month and the other a large shop that repairs about 300 cars per month. At both shops, the company has converted to the low-VOC color or base coats as required by SCAQMD Rule 1151. At the smaller shop, the company used small portable air flow systems in the booth to dry the waterborne basecoat. A picture of this system is shown in Figure 3-9. A picture of the painter at the smaller shop inspecting a truck that was painted with the waterborne coating is shown in Figure 3-10. At the large shop, the owner installed new booths that are designed for higher air flow. A picture of the booth is shown in Figure 3-11. A car painted at the larger shop with the waterborne base coat is shown in Figure 3-12. Other parts painted with the waterborne coatings at the larger shop is shown in Figure 3-13.

The company first converted the small shop to the alternative coatings. The shop provided IRTA with usage and cost data for the three months prior to the conversion when the solventborne coatings were used and the three months after the conversion when the low-VOC coatings were used. Data for the month of the conversion were not included in the analysis. The two three month periods that were analyzed had comparable materials sales, according to the shop owner. Materials sales for the three month period before the conversion were 1.8 percent higher than the materials sales for the three month period after the conversion.

Figure 3-9. Portable Dryer at Autobody Shop #6

Figure 3-10. Painter Inspecting Truck Painted with Waterborne Base Coat at Autobody Shop #6

Figure 3-11. New High Air Flow Booth at Autobody Shop #6


Figure 3-12. Car Painted With Waterborne Base Coat at Autobody Shop #6


Figure 3-13. Parts Painted With Waterborne Base Coat at Autobody Shop #6

IRTA analyzed the usage and cost data for the base coats but not for the primers and topcoats since those coatings remained the same. IRTA included the thinners used to reduce the base coats in the analysis since they changed as well.

The company's coatings supplier provided the shop with two portable air dryers at no cost. A picture of one of these portable dryers was shown in Figure 3-9. In other situations, these dryers would be a capital cost incurred by the shop. The cost of each drier is $1,500 for a total cost of $3,000. Assuming the dryers would have a useful life of five years and assuming an interest rate of five percent, the annualized cost of the dryers amounts to $630.

For the period January through March 2007, the company used 77 liters of solventborne base coat and paid $6,132.10 for the coatings. For the same period, the shop used 30 liters of thinner for the base coat at a cost of $537. On an annual basis, the company used 308 liters of solventborne coating and 120 liters of thinner for the base coat. The annual cost of purchasing the base coat and the thinner amounts to $24,528 and $2,148 respectively. The annual cost of using the solventborne base coat and thinner is $26,676.

For the period May through July 2007, the company used 81 liters of low-VOC base coat and paid $6,217.95 for the coatings. For the same period, the shop used 20 liters of deionized water as a thinner and cleanup solvent at a cost of $384. On an annual basis, the company used 324 liters of waterborne base coat and 80 liters of deionized water for thinning and cleanup per year. The cleanup of the spray gun involves using tap water and giving the spray gun a final rinse with deionized water. A picture of the five gallon bucket used for cleaning the guns with tap water is shown in Figure 3-14.

Figure 3-14. Bucket Used For Gun Cleaning at Autobody Shop #6

For purposes of analysis, it will be assumed that 70 of the 80 liters of deionized water are used for thinning and 10 liters are used for cleanup per year. On this basis, the annual cost of purchasing the base coat and thinner amounts to $24,872 and $1,344 respectively. The annual cost of using the waterborne base coat and the deionized water thinner is $26,216.

When the facility used the solventborne base coat, the annual cost of purchasing cleanup materials and disposing of the waste totaled $4,825. The cost of purchasing the cleanup solvent was $4,179 and the cost of disposal was $646. The cleanup material and the waste disposal included the cost of the cleanup solvent and the waste generated from cleaning the spray gun used for the base coat and the spray gun used for the primer and topcoat. When the facility converted to the waterborne base coat, the cost to the company of purchasing the cleanup solvent was lower, at $2,455 annually and the cost of disposing of the solvent waste was also lower, at $538 per year. These values represent the cleanup solvent purchases and the disposal costs of the material used for the primer and topcoat. This indicates that the cost of purchasing cleanup solvent for cleaning the guns used to apply the solventborne base coat is $1,724 annually and the cost of disposal for this solvent is $108 per year. The total disposal cost is $1,832.

Assuming 10 liters of deionized water are used every year in the cleanup process, the cost of purchasing deionized water for this purpose is $192 annually. During a five month period after the conversion, the company disposed of one 30 gallon drum of water waste. This water waste included the tap water from the primary cleaning of the base coat spray gun and the final cleaning of the gun with deionized water. On this basis, the company would need to dispose of six gallons per month or 72 gallons per year of water waste. The cost of disposal of the tap and deionized water amounts to $2.99 per gallon. Thus the annual cost of disposal of the water waste is $215. The total annual cost of purchasing deionized water for cleanup and disposing of the spent water is $407.

Table 3-2 summarizes the cost comparison for the shop before and after the conversion to the waterborne base coat. The table compares the cost of purchasing the solventborne thinner used for the basecoat and disposing of the solvent cleanup material before the conversion and the cost of purchasing the deionized water used to thin the base coat and disposing of the water used in the cleanup after the conversion. The figures include the capital cost for the dryers. Making an adjustment for the slightly higher materials sales for the three month period before the conversion, the total cost of using the waterborne base coat is three percent lower than the cost of using the solventborne base coat.

Table 3-2
Annualized Cost Comparison for Autobody Shop #6 for Solventborne and Waterborne Base Coat

	Before Conversion		After Conversion	
	Amount	Cost	Amount	Cost
Capital Cost	-	-	-	$630
Base Coat	308 liters	$24,528	324 liters	$24,872
Thinner	120 liters	$2,148	70 liters	$1,344
Solvent Cleanup Material	216 gallons	$1,724	-	-
Solvent Disposal	36 gallons	$108	-	-
Deionized Water Cleanup Material	-	-	10 liters	$192
Deionized Water Disposal	-	-	72 gallons	$215
Total Cost	-	$28,508	-	$27,253
Adjustment for Materials Sales	-	$28,508	-	$27,744

The company also converted the larger facility to the alternative waterborne coatings. After a few months of operation, the owner indicates that the costs of using the new system which includes the waterborne base coats is comparable to the cost of using the full solvent borne system. The cost comparison for the larger shop is likely to be similar to the cost comparison for the smaller shop shown in Table 3-2.

A case study for the conversion to waterborne coatings for this shop is shown in Appendix D.

<u>Other Autobody Shops</u>

IRTA worked with and visited other autobody shops that made the conversion to waterborne base coats. One of these companies has several autobody facilities in the Southern California area. Like other companies with multiple shops, the company is converting the shops one at a time so the remaining solventborne base coat can be used up in the other shops.

The shop, located in Santa Monica, has two coating booths and repairs 120 cars per month. When the shop first converted, the painter was concerned that he would not be able to learn the new application methods. In a short time, however, he adapted to the different requirements of the waterborne base coats. In one of the booths, the company installed three fans on the roof which aid in drying. Figure 3-15 shows the booth with the three fans. In the second booth, the shop uses the portable hand held dryers and Figure 3-16 shows this booth with the potable dryers.

Figure 3-15. Coating Booth with Three Ceiling Fans

The painter likes the new waterborne base coats. The color is easier to match with 2005 and newer cars. He indicated that the drying time with the waterborne base coats is longer than with solventborne coatings. He reduces the drying time by using tools provided by his supplier that can be connected to compressed air. The painter, using one of these tools, is shown in Figure 3-17.

IRTA worked with another company with one shop that repairs 300 cars per month. The painter at this shop also indicated that the color matching with newer cars is better with the waterborne base coats. The company purchased hand held portable dryers to enhance the drying in the booth and three new spray guns that are compatible with the waterborne coatings. The painter indicated that the transition to the waterborne coatings was seamless and that he learned the new application and cleaning methods readily.

The company uses less of the waterborne base coats than the solventborne base coats. The coatings are 17 to 20 percent more expensive. The owner indicates that he believes his costs have declined with conversion to the waterborne base coats.


Figure 3-16. Coating Booth with Portable Dryers


Figure 3-17. Painter Using Drying Tool

IV. ANALYSIS OF ALTERNATIVE DUST CONTROL TECHNOLOGY

Autobody shops perform sanding at several steps in the repair process. First, plastic filler is used to fill in dents and crevices in the vehicle body. The plastic filler is sanded to generate a smooth surface for painting. Second, sanding is performed after application of primer. Third, sanding is performed during and after application of the base and top coats. Frequently, the base and top coat painting process can involve wet sanding and it is called color sand and polish. Fourth, some of the autobody paint-only shops sand whole vehicles before recoating.

The sand paper used for plastic filler and primer is usually very coarse, with a grit size of perhaps 80, whereas the sand paper used for sanding after application of base and top coats is finer with a grit size up to 4,000. As part of the dry sanding operations--particularly when plastic filler and primer are sanded--dust emissions in the shop can be significant. Figure 4-1 shows the dust generation during sanding with six hole 80 grit sand paper. Some of the dust is emitted into the breathing zone of the worker and much of it is emitted as particulate matter (PM). There is increasing evidence that PM emissions can cause lung disease in workers and community members. Some of the dust generated in the sanding process falls to the ground as indicated in Figure 4-1. This loose dust may be swept up and disposed of at the end of the day and if it is not contained properly, some of it becomes airborne PM before it reaches the landfill. In many cases, autobody shops also wash down the floor and allowing washwater of any kind to enter the storm drain system violates State and local laws. If the dust is not properly managed and contained, there is a risk that sanding dust could be washed into the stormwater system.

Figure 4-1. Sanding with Six Hole Sanding Disc

The dust from sanding plastic filler does not contain metals but the dust from sanding primer generally contains zinc and several other metals. An MSDS for a typical primer containing zinc is shown in Appendix C. DTSC analyzed the sanding dust from three autobody shops in the Sacramento area and found concentrations of several metals that could result in the dust being classified as hazardous waste. Metals present in the sanding dust at high levels included barium at two facilities, chromium at two facilities, lead at three facilities and zinc at two facilities. Concentrations of lead at one facility and zinc at two facilities were especially high and would cause the sanding dust to be classified as hazardous waste.

ALTERNATIVE SANDING TECHNOLOGY

As part of the project, IRTA worked with a company called Mirka that manufactures an alternative sand paper that substantially reduces sanding dust generation. According to a company brochure, the product, called Abranet, has an aluminum oxide grain with resin over resin bonding and a polyamide fabric backing. The company offers a wide range of grit sizes. According to the company's literature, the surface of a six inch Abranet disc contains 24,000 holes which can be compared with a conventional sanding disc which has six holes. Abranet uses a hook and loop system to attach the grinding disc to the pad and the backing pads have 21 exhaustion holes. The technology is designed to be used with a vacuum and the dust emissions are significantly reduced. Figure 4-2 shows a technician sanding with the Abranet disc with a vacuum. Comparing Figures 4-2 and 4-1 shows the dust generation is much higher with the six hole sanding disc without a vacuum.

Figure 4-2. Sanding with Mirka Sanding Disc

Mirka cites several advantages of the Abranet abrasive. First, it reduces pilling. Pills are dust and thread particles from the paint which are lumped to a pill. Second, it results in better dust extraction than conventional abrasives because of a smaller grinding area and a smaller distance from sanding point to dust extraction. Third, the Abranet leads to less caking than conventional abrasives. When an abrasive disc becomes caked, it is no longer effective and must be discarded.

ALTERNATIVE SANDING METHOD TESTS

During the project, IRTA tested the Mirka product with three facilities. Two of the facilities decided to convert to the product and the third facility is in the process of converting. During the testing and use of the Abranet, it is obvious that less dust is generated with the new alternative discs. All of the technicians that tested or use it prefer it to a conventional abrasive. All of them also report that the discs last longer than six hole abrasive discs. Many technicians report that the Mirka sanding discs last twice to three times as long as six hole sanding discs. One technician reported he used one-fourth as much of the Mirka abrasive. The Abranet discs can also be reused because of a hook and loop attachment system. Most six hole discs are attached with adhesive backing and when they are no longer effective, they are discarded and they cannot be reattached to the sanding device.

The Mirka sanding discs are generally used with a vacuum system. These vacuums are priced at between $200 and $400. Figure 4-3 shows a typical vacuum system used at one of the facilities participating in the project. Some shops have centralized vacuum systems and technicians like using them. Many shops do not have centralized systems and technicians do not like the restriction of carrying the portable vacuums. The technicians that participated in the project, however, do not mind using a portable vacuum system with the Mirka sanding discs.

IRTA analyzed the conversion for the three shops where the Mirka product was tested. One of the companies adopted the Abranet technology in four of their 11 autobody shops. A second company has adopted the technology in one of two shops and has plans to convert to it shortly in the second shop. The third company is in the process of converting to the technology. The testing and/or conversion of each company is discussed below.

Figure 4-3. Typical Vacuum System Used with Mirka Sanding Discs

Autobody Shop #4

This company, as mentioned earlier, operates 11 shops in the Southern California area. Over the last year, four of the shops converted to the new Mirka sanding technology that minimizes dust emissions. In these four shops, the technicians are using the new sanding technology for plastic filler and a small amount of primer. The company has plans to convert the shops for primer sanding at a later time. IRTA discussed the conversion with several technicians at the shops who are using the new technology. All the technicians indicated that they like the alternative technology better than six hole sand paper.

IRTA discussed the Mirka sanding method with the Director of Development at Autobody Shop #4. He indicated that, in general, use of the alternative sanding technology is less costly than use of the conventional sanding technology. IRTA and the Director of Development discussed one of the shops as an example. A detailed cost comparison of the existing and new sanding technologies is not possible because of the differences in use profiles for the materials. For instance, with the new technology, the company purchases the sand paper and then dispenses it to the technicians as needed. With the older technology, the technicians individually dispensed the sand paper they needed. Also, with the new technology, the company uses a hook and loop system where the sand paper can be removed from the tool, stored and reused and then discarded when it is spent. The advantage of this method is that the sand paper can be reused. In the past, the company did not use the hook and loop system. The hook and loop system is a more expensive system and, if the company had used the system with six hole sand paper, it would have been even more expensive than the new Mirka technology.

The new technology is used with vacuums whereas the six hole technology was not. In one of the shops, the company purchased three portable vacuums for $700 and four technicians are using them. Figure 4-4 shows a technician sanding with the six hole sand paper without a vacuum and Figure 4-5 shows a technician using the Mirka sand paper with a vacuum. Note that dust emissions are minimized substantially through use of the technology and through use of a vacuum. In the past, one of the shops had a centralized vacuum system. The Director of Development at Autobody Shop #4 indicates that the new technology paired with the vacuum is essentially 100 percent efficient at dust collection. He estimates the older six hole technology when paired with the centralized vacuum was 65 percent efficient at dust control.

According to the Director of Development at Autobody Shop #4, there are several cost advantages to using the new sanding system. First, the cost of a sanding disc now is more then 20 cents lower than the cost of the older sanding discs. Second, the technicians use one-half to one-fourth as much sanding paper as they did previously. The new sanding discs last longer. Third, with the old adhesive system, when the disc was removed from the sanding tool, it couldn't be reused. With the new sandpaper, because the hook and loop system is now used, the paper can be reused. Again, as mentioned above, if the hook and loop system had been used with the old sandpaper, the traditional process would have been even more expensive. Taking into account the capital cost of the vacuums, the company has reduced their costs of sanding plastic filler by between 25 and 50 percent through the conversion to the new sandpaper.

4-4.	Technician Sanding With Six Hole Sand Paper at Autobody Shop #4

Figure 4-5. Technician Sanding With Mirka Sand Paper at Autobody Shop #4

A case study for this company's conversion to the alternative sanding technology is provided in Appendix D.

Autobody Shop #6

This company has two autobody shops in the southern California area. One of the shops repairs about three hundred cars per month and the other repairs about 75 cars per month. IRTA worked with the company to test the Mirka abrasive in the smaller shop. The company decided to convert to the Abranet product and has been using it for several months.

The painter and two technicians are routinely using the new abrasive. The painter is using the 400 grit Abranet for his dry sanding and he indicates he uses about half as much sand paper as he did when he used the original sanding discs. Two other technicians are also using the Mirka abrasive for sanding primer and plastic filler. They use 40, 80 and 180 grit Abranet sand paper. They indicate the Mirka abrasive lasts about 50 percent longer than the original abrasive.

The company has been using the new sand paper for three or four months and they still use the original sand paper for the very fine grit sanding. It was not possible to perform a detailed cost analysis since the company does not collect data on sand paper purchases separately.

A case study for the shop's conversion to the alternative sanding method is provided in Appendix D.

Autobody Shop #9

This company repairs 50 to 75 cars per month. The shop has four technicians that commonly use 40, 80, 150 and 220 grit sanding discs for sanding primer and plastic filler during body work. The painter uses 80, 180, 400, 600 and 1,000 grit sanding discs for fine detailing during painting.

IRTA tested the Mirka abrasives with one of the technicians for about a month. The technician was provided with 80 grit Mirka sand paper for sanding primer and plastic filler and a portable vacuum unit. Figure 4-6 shows the technician using the abrasive during the testing. The technician preferred the abrasive to the product he used in the past and he indicated he used one-third as much of the Mirka sanding discs compared with the discs used earlier. At the conclusion of the testing, the company decided to convert to the alternative sanding method and the conversion is underway.

IRTA and the company performed a cost analysis that compares the cost of purchasing the currently used sand paper system with the cost of using the Mirka sanding system. The conversion to the Mirka system requires the company to purchase two vacuum cleaners for $400 each. Assuming a useful life for the vacuums of 10 years and a cost of capital of 5 percent, the annualized cost of the capital purchase is $84. The company did not use vacuum systems with the original sanding discs.

Figure 4-6. Technician Testing Mirka Abrasive at Autobody Shop #9

Over a nine month period, the shop spent $3,746 in sand paper purchases. This was the cost for 5,000 pieces of sand paper. Assuming the purchases would be proportional for the additional three months of the year, the company purchased 6,667 pieces of sand paper in one year at an annual cost of $4,995.

Based on the testing phase, the shop owner estimates that once he is fully converted to the Mirka technology, the shop will use one-third as much sand paper or 2,222 pieces per year. The cost of the Mirka sand paper averages $60 per box and there are 50 sheets in a box. On this basis, the cost of purchasing the Mirka paper would amount to $2,666 per year. Although the cost of the Mirka paper is higher than the cost of the original paper, the savings from using less paper is considerable.

Table 4-1 shows the projected cost comparison for the company once the conversion is complete. The values show that the cost is estimated to be reduced by 45 percent. Even if the estimate that one-third the sand paper would be used is optimistic and the actual savings is half as much, the company would still reduce their total cost by 18 percent.

Table 4-1
Annualized Cost Comparison for Sanding for Autobody Shop #9

	Original Sand Paper	Mirka Sand Paper
Cost of Vacuum Cleaners	-	$84
Cost of Sand Paper	$4,995	$2,666
Total Cost	$4,995	$2,750

A case study for this company's conversion to the alternative sanding technology is provided in Appendix D.

V. SUMMARY AND CONCLUSIONS

There may be as many as 8,000 autobody shops in California and the majority are small businesses. These shops repair and paint thousands of cars each year after they have been in accidents or for aesthetic reasons. As part of their operations, autobody shops perform sanding and painting operations. Most of the facilities use high VOC solvents for cleanup of the spray guns used to apply the paint. Virtually all of the facilities use high VOC solvents as thinners for their solventborne coatings. Many of the cleanup solvents and thinners also have toxic components. Some of the autobody shops in California are required to convert to waterborne base coats shortly and the other autobody shops will likely be required to make this conversion over the next several years. As part of the repair process, autobody shops sand coatings and plastic filler. Some of the coatings contain metals and the dust from the sanding operations may be hazardous to workers and community members and it may also be classified as hazardous waste.

IRTA conducted a project sponsored by DTSC that involved developing, testing and analyzing alternative low-VOC, low toxicity cleanup materials, thinners, waterborne base coats and an alternative sanding method. IRTA worked with seven autobody shops in the South Coast Basin during the project. This document summarizes the results of the tests of alternative cleanup materials with the seven facilities and two facilities IRTA worked with in an earlier product. The document also summarizes the results of the tests of alternative thinners with the seven facilities participating in the project. IRTA evaluated and analyzed the conversion of two of the participating facilities to waterborne base coats. IRTA tested and analyzed an alternative sanding method that minimizes particulate emissions with three of the participating facilities.

Table 5-1 summarizes the low-VOC, low toxicity alternatives that were tested during the project for cleanup of coating application equipment and thinning solventborne coatings. IRTA relied heavily on acetone as an alternative cleanup solvent for the solventborne coatings. Acetone is not classified as a VOC and it is lower in toxicity than virtually all other organic solvents. For the seven facilities participating in this project, acetone was a viable and cost effective cleanup material. Autobody shops in much of the state use high VOC cleanup materials that also contain toxic components. In the South Coast Basin, where there are VOC limits on the cleanup materials, companies use cleanup materials that rely on acetone generally blended with other chemicals exempt from VOC regulations. Some of these other solvents are more toxic than acetone. The results of the testing demonstrate that virtually all shops can convert to plain acetone for cleanup of spray guns used to apply solventborne coatings.

IRTA tested three alternative thinners based on acetone during the project. The alternative thinner that worked most successfully was the acetone/DPM blend. Although DPM is a VOC, the DPM content in the thinner is only 2.5 percent. Suppliers today provide high VOC thinners to the autobody industry for reducing their solventborne coatings. The results of this project demonstrate that the suppliers could reformulate the thinners they supply to their customers to significantly reduce their VOC content and toxicity.

Table 5-1
Low-VOC, Low Toxicity Alternatives for Cleanup and Thinning

	Alternative Spray Gun Cleaners	Alternative Thinners/Reducers
Solventborne Coatings	acetone	acetone
	20% acetone / 80% methyl acetate	99% acetone / 1% soy
		97.5% acetone / 2.5% DPM
Waterborne Coatings	tap water	D.I. Water
	D.I. Water	
	water-based cleaners	

Much of the industry will convert to waterborne base coats over the next several years. These base coats either contain water or are reducible with water. Suppliers are providing deionized water for thinning the waterborne base coats. Many suppliers are also providing deionized water for cleanup of the spray guns. Some recycling companies are providing water-based cleaners for this purpose. The project findings indicate that plain tap water can be used for cleanup of the application equipment, perhaps with a final rinse with deionized water. There is no need for autobody shops to pay a higher price for deionized water or water-based cleaners for cleanup.

IRTA analyzed the conversion of two autobody shops to waterborne base coats. There are strong advantages to using the waterborne coatings and all of the technicians using the new coatings adjusted fairly easily. The one disadvantage of the alternative coatings is that they take longer to dry. In one case, a company with multiple shops estimates that their costs increased somewhat after the conversion. In another case, the cost analysis indicates that the cost of using the new coatings is comparable to the cost of using the solventborne base coats. The results indicate that most autobody shops are not likely to experience significant dislocations or cost increases when they convert to the waterborne base coats.

IRTA also tested and analyzed conversions to an alternative sanding technology for three autobody shops. This sanding technology, made by a company called Mirka, substantially minimizes dust generation. The advantage of the technology is that it reduces particulate matter emissions and worker exposure, it reduces the amount of hazardous waste generated and it reduces the loading of the dust to storm water. All technicians at the three facilities that used the alternative sanding discs preferred them over the original sanding discs. The cost analysis demonstrates that, even though the sanding discs may be more expensive, they have a much longer useful life and the costs of using the alternative method are lower.