III. ALTERNATIVES IN COATING AND ADHESIVE APPLICATION EQUIPMENT CLEANING

SCAQMD Rule 1171 regulates solvent cleaning activities. It establishes VOC content limits for cleaners that can be used to clean coating and adhesive application equipment. Currently, the VOC limit for these cleaners in the rule is 550 grams per liter. Effective on July 1, 2005, the VOC limit for these cleaners declines to 25 grams per liter. The purpose of this project was to determine if the 25 gram per liter VOC limit was feasible for all cleaning categories for coating and adhesive application equipment.

3.1 Preliminary Laboratory Testing

At the beginning of this project, IRTA approached Graco, a spray gun supplier, and requested that the company build a spray gun cleaning system similar to the current Graco enclosed spray gun cleaning system. IRTA requested that the Graco system be modified to contain a heater. IRTA also asked Applied Cleaning Technologies (ACT), located in Anaheim, to build a very small table top heated ultrasonic system that could also be used for testing. IRTA conducted preliminary testing to determine which types of cleaners appeared appropriate for a number of different coatings and adhesives at the ACT test center. The heated Graco unit was used for most of the preliminary testing and it was also provided to certain facilities for testing alternatives during the project. The small heated ultrasonic system was used in the field testing. Graco also provided IRTA with a typical HVLP spray gun to use in the preliminary testing at the ACT test center.

Table 1-3 showed the list of companies IRTA worked with during the project. IRTA obtained samples of coatings from all of these companies in order to conduct the preliminary testing. In some cases, IRTA obtained a variety of different coatings from each of the facilities; in other cases, the company only used one coating or adhesive and IRTA obtained only these samples. IRTA also obtained other coatings from two coatings suppliers so that additional types of coatings possibly not used by the participating companies could be tested. Table 3-1 shows the list of companies that provided coatings and adhesives for the preliminary testing classified into different coating and adhesives categories. Some of the companies listed in the table participated in an EPA project that also involved testing alternative cleanup solvents and these are specified in the table.

The preliminary testing was designed to screen potential cleaners in a laboratory testing situation. The cleaners that worked best on the coatings in the laboratory testing could then be provided to the companies participating in the SCAQMD and EPA projects for testing in the field. IRTA used the spray gun cleaner and the spray gun provided by Graco to test the alternatives. IRTA tested several different water-based cleaners, soy and a soy blended with water and acetone on all of the coatings. If none of the options worked well, IRTA modified the alternatives to find one that did work effectively. Material Safety Data Sheets (MSDSs) for some of the products that were tested are provided in Appendix C.

Table 3-1
Companies Providing Coatings and Adhesives for Preliminary Testing

Company	Type of Coating/Adhesive
Hydro-Aire	Aerospace primers and topcoats
Gulfstream	Aerospace primers and topcoats
California Propeller (EPA)	Aerospace primer and topcoats
Sherwin Williams	Aerospace primers and topcoats
American Security Products	Waterborne and solventborne metal coatings
Metrex (EPA)	Marine solventborne coating
Oakwood	Wood furniture stain, sealer and topcoat
Bausman & Father (EPA)	Wood furniture waterborne and solventborne coatings
AMT	Wood furniture solventborne coatings
El Dorado	Automotive primer, basecoat and topcoat
Holmes Body Shop (EPA)	Automotive primer, basecoat and topcoat
Westway Industries, Inc. (EPA)	Automotive primer, basecoat and topcoat
PCM Leisure World (EPA and SCAQMD)	Latex and enamel architectural coatings
Murphy	Industrial maintenance solventborne architectural primer, intermediate coating and topcoat
Dampney Company, inc.	Industrial maintenance coatings
Hickory Springs	Solventborne foam fabrication adhesive
Vacco	Solventborne thin film laminating adhesive

The results of the preliminary testing are shown in Table 3-2 for categories of cleaning. When the scaled up field tests were performed, most of the results listed in Table 3-2 held up. In a few cases, as described below, the results in the field were different.

Table 3-2
Results of Preliminary Screening Tests

Category of Cleaning	Alternative(s) Selected
Aerospace coatings	acetone
Metal coatings	acetone
Wood furniture coatings	water-based cleaners, acetone
Autobody coatings	acetone, acetone/methyl acetate blend
Architectural coatings	water, water-based cleaners, soy, acetone, acetone/surfactant
Fabrication adhesive	acetone, soy
Thin film adhesive	water-based cleaner, acetone

3.2 Field Testing

For each of the companies participating in the SCAQMD or EPA project, IRTA developed a test plan for testing the alternative cleaning agents. In general, the test plans involved some initial testing at the site to determine if the findings from the preliminary laboratory testing would hold up in the field. If the tests were successful, IRTA asked the company to perform a scaled-up longer term test of the alternatives. In some cases, the companies decided to convert to the alternatives and in other cases, they did not convert. A few companies indicated they might convert to the alternative in the future.

The description of the testing and the cost analysis of the alternatives for each of the facilities is described below. IRTA generally attempted to include all the costs a company would incur in the cost comparison of the alternatives with the cleaning system that is currently used. In instances where companies did convert to an alternative, stand alone case studies that describe the conversion are presented in Appendix B.

3.2.1 Hydro-Aire

Hydro-Aire, an aerospace subcontractor, is a division of Crane located in Burbank, California. The company has 572 employees. Hydro-Aire manufactures braking systems, pumps and airlocking devices. The company also does repair work on the pumps used in military and commercial aircraft like the C-130 transport and the C-17.

Hydro-Aire applies aerospace coatings as part of their manufacturing process. Like other aerospace companies, the company uses a chromated epoxy primer and a polyurethane topcoat. Hydro-Aire also uses some specialized coatings like a fuel tank primer that is difficult to clean. MSDSs of a typical primer and topcoat used by the company are shown in Appendix A. For several years, Hydro-Aire used aero-MEK, a blend of MEK and various other solvents for cleaning their spray equipment.

IRTA conducted initial testing with Hydro-Aire. The first cleaner IRTA tried was acetone since that cleaner worked well during the preliminary screening tests for all of the aerospace coatings. The painter indicated that the initial testing at the facility showed that acetone seemed to work well on the typical primer and topcoat used by the company. IRTA and Hydro-Aire arranged for scaled up testing using the enclosed spray gun cleaner the company currently uses for cleaning. The next time the company changed out the solvent for disposal, acetone was used in place of aero-MEK. Hydro-Aire evaluated the new cleaner on all of their coatings, including the fuel tank primer, and found it effective. The company decided to convert to acetone and has been using it for almost a year. Figure 3-1 shows a picture of the enclosed spray gun cleaner at Hydro-Aire.

IRTA analyzed the cost of using acetone at Hydro-Aire and compared it to the cost of using the aero-MEK. Hydro-Aire purchased six drums of aero-MEK annually for cleaning their spray guns and for handwipe operations. About 60 gallons went toward spray gun cleaning each year. From the scaled up testing, the company estimates that it will use roughly the same amount of acetone. The company paid $4.94 per gallon for

Figure 3-1. Spray Gun Cleaning System at Hydro-Aire

aero-MEK and pays $4.25 per gallon for acetone. On this basis, the cost to the company for purchasing aero-MEK amounted to $296 annually; the cost of purchasing acetone instead amounts to $255 annually.

The SCAQMD emission fees are $345 per ton of VOC emitted. Assuming a density for aero-MEK of seven pounds per gallon, the fee for emitting 60 gallons is $72 per year. There are no fees for acetone since the chemical is exempt from VOC regulation.

The annualized cost comparison is shown in Table 3-3. The cost to the company for purchasing acetone is somewhat less than the cost for purchasing the aero-MEK. In addition, through the use of acetone, the company can avoid paying the VOC emission fees of $72 per year. Hydro-Aire reduced their costs by 31% through the conversion to acetone.

Table 3-3
Annual Cost Comparison for Spray Gun Cleaning for Hydro-Aire

	Aero-MEK	Acetone
Chemical Cost	$296	$255
Regulatory Fees	$72	-
Total Cost	$368	$255

A stand alone case study for the Hydro-Aire spray gun cleaning conversion is provided in Appendix B.

3.2.2 Gulfstream

Gulfstream, located in Long Beach, CA, manufactures and maintains private aircraft. The aircraft are painted with traditional and high VOC aerospace coatings. Gulfstream has an enclosed spray gun cleaner that is leased from a service provider. The company uses lacquer thinner for cleaning the spray equipment after applying the coatings.

In the preliminary tests IRTA conducted, acetone worked well on aerospace coatings. Even though some of the coatings applied by Gulfstream were higher VOC than traditional aerospace coatings, IRTA thought acetone might be suitable for the company. Acetone was tested in a spray gun cleaner provided by IRTA and Gulfstream personnel indicated that it performed well.

Gulfstream is currently leasing a spray gun cleaner. To convert to acetone, the company would have to purchase an enclosed spray gun cleaner. The capital cost of a spray gun cleaner is $5,000. Assuming a life for the equipment of 10 years, the annualized capital cost of the unit is $500.

The company's spray gun cleaner is maintained by the service provider. The cost of the maintenance which includes leasing the unit, the cost of the solvent, the cost of disposal and the cost of maintenance is $225 every two weeks. The annual cost of the service is $5,850. If Gulfstream converted to acetone, the company would have to maintain the spray gun cleaner. Assuming there would be 26 changeouts each year, that it would require 30 minutes to do the changeout and that the labor rate is $20 per hour, the annual cost of maintenance would be $260.

The cost of the lacquer thinner is included in the servicing cost. If the company converted to acetone, the cost of the new cleaner is $2.45 per gallon. Gulfstream would have to change the unit out twice per month. Assuming a five gallon capacity for the unit, the annual cost of the acetone would amount to $294 per year.

The current service provider includes disposal in the servicing cost. If Gulfstream converted to acetone, they would need to dispose of 120 gallons per year. Assuming a cost for hazardous waste disposal of $2 per gallon, the annual disposal cost would amount to $240.

Table 3-4 shows the cost comparison for Gulfstream. The figures indicate that the cost of using acetone is more than four times lower than the cost of using the lacquer thinner.

Table 3-4
Annual Cost Comparison for Spray Gun Cleaning for Gulfstream

	Lacquer Thinner	Acetone
Capital cost	-	$500
Service cost	$5,850	-
Maintenance cost	-	$260
Cleaner cost	-	$294
Disposal cost	-	$240
Total cost	$5,850	$1,294

3.2.3 California Propeller

California Propeller is a small aerospace subcontractor located in North Hollywood. The company purchases government surplus parts and different types of parts that have been used in the field for more than 50 years and refurbishes them. The parts include propellers and intricate governers that are used on aircraft.

The parts arrive at California Propeller and are disassembled, cleaned, inspected, reworked and painted. The company, like other aerospace firms, uses a chromated epoxy primer and a polyurethane topcoat. A spray gun is used to apply the coatings and, when it was cleaned, it was disassembled and cleaned with MEK in a bucket.

IRTA had obtained and tested samples of California Propeller's coatings during the preliminary testing at the ACT test center. During those tests, IRTA found that acetone worked well on the coatings. IRTA and the company performed scaled up testing of acetone at the facility and found that it worked well as an alternative to MEK. The company decided to convert to acetone.

California Propeller used five gallons of MEK every two months for spray gun cleaning. At a cost of $5.12 per gallon, the company was paying $154 per year for the cleaner. The same amount of acetone is now used for spray gun cleaning at a cost of $3.32 per gallon. The annual cost of purchasing acetone is $100.

Table 3-5 shows the cost comparison for California Propeller. The figures show that the company cut their costs by 35 percent by converting from MEK to acetone.

Table 3-5
Annual Cost Comparison for Spray Gun Cleaning for California Propeller

	MEK	Acetone
Cleaner Cost	$154	$100
Total Cost	$195	$100

A stand alone case study for California Propeller is presented in Appendix B.

3.2.4 American Security Products

American Security Products is located in Fontana, CA. The company makes burglary, fire protection and gun safes and is the largest security safe manufacturer in the country. As part of the manufacturing process, American Security Products paints the safes. The company uses a urethane topcoat, a polyester topcoat and primer. Four years, the manufacturer used an enclosed spray gun cleaner and lacquer thinner to clean the equipment used to spray the coatings.

American Security Products began testing acetone for cleaning their coatings that contained solvent. It worked well and the company made the conversion away from lacquer thinner four years ago. There was no additional capital equipment needed since the company could simply use acetone in the enclosed spray gun cleaner instead of lacquer thinner.

The cost of the lacquer thinner used by the company for spray gun cleaning was $5.50 per gallon. The company purchased 10 gallons a day. Assuming the company operates for 260 days per year, the total cost of the lacquer thinner amounted to $14,300.

SCAQMD emission fees for VOCs are $345 per ton. Assuming all of the lacquer thinner was emitted, American Security Products emitted 10 gallons of lacquer thinner per day or 2,600 gallons per year. Assuming a density for the solvent of seven pounds per gallon, this amounts to 18,200 pounds or 9.1 tons per year. The emissions fee was $3,140 per year.

The company uses the same amount of acetone for spray gun cleaning. The cost of the acetone is $4.50 per gallon. On this basis, the purchase price for the acetone cleaner is $11,700 annually. There are no emission fees for acetone because the chemical is exempt from VOC regulations.

Table 3-6 shows the cost comparison of the two solvents for American Security Products. The company reduced their costs for spray gun cleaning by about one-third through the conversion to acetone.

In the past, American Security Products used waterborne coatings for some of their production. The company currently uses waterborne coatings only for touch-up kits provided to the customers. When the company first adopted these coatings, they began cleaning their spray equipment with plain water. They used plain water for this purpose for several years.

Table 3-6
Annual Cost Comparison for Spray Gun Cleaning for American Security Products

	Lacquer Thinner	Acetone
Cleaner Cost	$14,300	$11,700
Regulatory Cost	$3,140	-
Total Cost	$17,440	$11,700

A stand alone case study for American Security Products is presented in Appendix B.

3.2.5 Metrex

Metrex is a small company located in Glendora, CA that has about 25 employees. The company manufactures, rebuilds and refurbishes various types of valves. Many of the valves processed by Metrex are used in a marine environment.

IRTA began work with Metrex on their spray gun cleaning as part of an EPA project. The coating Metrex applies to its cast iron valves must be highly resistant to attack by the harsh marine environment. The paint used by the company is a solventborne coating. An MSDS for the coating is shown in Appendix A.

For many years, Metrex used lacquer thinner for cleaning their spray gun. They flushed the solvent through the spray gun in a small bucket. The company has now converted to acetone for the spray gun cleaning operation. Metrex used about one-fourth of a gallon per month of lacquer thinner or three gallons per year. The cost of the lacquer thinner was $10.85 per gallon so the total cost amounted to about $33 annually. Metrex did not pay any regulatory fees for using the lacquer thinner because the emissions were very small. They now use the same amount of acetone but pay $9.16 per gallon. The total cost of using the acetone is $27 annually.

The cost comparison for Metrex is shown in Table 3-7. The use of acetone reduces the cost of the spray gun cleaning by about $6 per year.

Table 3-7
Annual Cost Comparison for Spray Gun Cleaning for Metrex

	Lacquer Thinner	Acetone
Cleaner Cost	$33	$27
Total Cost	$33	$27

A stand alone case study for Metrex is presented in Appendix B.

3.2.6 Oakwood Furniture

Oakwood is a high end furniture manufacturer with about 400 employees located in Ontario, CA that manufactures oak furniture. Figure 3-2 shows a picture of the type of furniture manufactured by Oakwood. The company has tested a variety of alternative low-VOC coatings for their manufacturing operation and is using coatings with a very low VOC content. The coatings used by the company include two stains, two sealers, a toner sealer, a clear sealer and one topcoat. Oakwood is using a waterborne topcoat that is very low in VOC. The spray equipment for this topcoat is cleaned with plain water. An MSDS for one of the stains used by Oakwood are shown in Appendix A.

Figure 3-2. Furniture Manufactured by Oakwood.

The company has a flat line for coating wood panels and the coatings applied on this line are solventborne but are also very low in VOC content. Oakwood uses an acetone based cleaner for cleaning the spray equipment on the flat line. The blend contains acetone, a glycol ether and a few different petroleum solvents. The VOC content of the cleaner is 96 grams per liter.

Oakwood cleans the automated spray equipment on the flat line once a week by hand. The company does a more thorough cleaning every three months. During the weekly cleaning, the employees clean the spray system, the metal on the conveyor and the rubber conveyor itself. A picture of the flat line coating application equipment during cleaning is shown in Figure 3-3.

IRTA obtained samples of Oakwood's solventborne coatings and conducted laboratory testing with the Graco spray gun cleaner to screen potential alternatives. Plain acetone worked well in the testing but IRTA also found that an alkaline water-based cleaner called Spray Clean 12 worked well in this application.

IRTA tested the water-based cleaner at Oakwood at various concentrations. The cleaner did not perform well at 25 percent concentration but it did perform well at about a 50 percent concentration. IRTA arranged for the company to do scaled up testing with 10 gallons of the water-based cleaner and it performed well on the metal part of the conveyor and the spray system and nozzles. It did not perform well, however, in cleaning

the coating residue from the rubber conveyor. IRTA tested plain acetone for cleaning the rubber conveyor and it worked well.

Figure 3-3. Spray Equipment Cleaning at Oakwood.

Oakwood currently uses 80 gallons per month of the acetone blend for cleaning the application equipment. At a cost of $5.25 per gallon, the total annual cost of the cleaning agent is $5,040. For the cost comparison, it was assumed that 75 percent of the cleaning (equipment cleaning) can be performed with the water-based cleaning alternative and that the remaining 25 percent (conveyor cleaning) can be performed with plain acetone. It was further assumed that the company would use 20 percent less cleaner if they converted to the water-based cleaner since it is obviously less volatile than the acetone blend. It was also assumed that the company would use about 10 percent more plain acetone than the acetone blend. On this basis, about 48 gallons of the water-based cleaner and 22 gallons of plain acetone would be required each month. The water-based

cleaner is diluted to 50 percent concentration with water and it costs about $9 per gallon for the concentrate. The annual cost of the water-based cleaner would be $2,592. Oakwood can purchase plain acetone for $4.24 per gallon. The annual cost of the acetone would amount to $1,119. The total cost of the alternative cleaners is $3,711.

Although it was not tested at Oakwood, plain acetone worked well for cleaning the Oakwood coatings during the screening tests at the ACT test center. For the cost analysis for this option, it was assumed that 10 percent more acetone would be used than the current cleaner. The use of acetone would be 1,056 gallons per year. At a cost of $4.24 per gallon, the annual cost of using plain acetone is $4,477.

Table 3-8 shows the cost comparison for the current cleaner, the water-based and acetone alternative and the plain acetone alternative. The figures show that Oakwood could reduce their costs for spray equipment cleaning by about 26 percent through the conversion to the water-based cleaner and plain acetone. The cost of using plain acetone is 11 percent lower than the cost of using the acetone blend.

Table 3-8
Annual Cost Comparison for Oakwood for Spray Equipment Cleaning

	Acetone/VOC Cleaner	Water-Based/Acetone Cleaner	Plain Acetone
Cleaner Cost	$5,040	$3,711	$4,477
Total Cost	$5,040	$3,711	$4,477

3.2.7 Bausman & Father

Bausman & Father is a very small company with only two employees including the owner. The company, located in Huntington Beach CA, strips and refinishes furniture and other wood items.

Bausman and Father uses two types of coatings: an acetone based coating and a water-based coating. For several years, the company cleaned their spray gun in a bucket after spraying the solventborne coating with lacquer thinner. A few years ago, they converted to acetone. Bausman cleaned their waterborne coating with plain water.

IRTA began working with the company on a project sponsored by EPA. As discussed in an earlier section, ACT contracted with a vendor to build a small table-top ultrasonic cleaning system that could be tested in spray gun cleaning. IRTA provided this cleaning system to Bausman. The preliminary laboratory cleaning tests performed by IRTA indicated that an alkaline water-based cleaner and acetone should both perform well on Bausman's coatings. Bausman began using the water-based cleaner, Spray Clean 12, in the small ultrasonic unit for cleaning the spray gun after spraying both the acetone and waterborne coatings. The water-based cleaner was more effective in cleaning the spray gun than the acetone. A picture of the ultrasonic unit at Bausman is shown in Figure 3-4.

Figure 3-4. Tabletop Ultrasonic Cleaning Unit at Bausman & Father.

Bausman used about one-half gallon of acetone each time the spray gun was cleaned. The company used a total of two gallons of acetone per year. At a cost of $7 per gallon, the total annual cost of the acetone was $14.

Bausman did not have to pay for the ultrasonic system but another company would have to purchase the unit. The cost of the system is about $300. Assuming a useful life for the equipment of 10 years, the annual capital cost is $30. The water-based cleaner is used at a concentration of 25 percent. Assuming a cost for the cleaner concentrate of $10 and that the cleaner is changed out twice a year, the annual cleaner cost amounts to $5. The ultrasonic unit is heated and it uses 1.2 kW of electricity. Assuming it operates for eight hours (a full day) for the four cleaning cycles per year and assuming an electricity charge of 12 cents per kWh, the annual electricity cost for operating the unit is $4.

The cost comparison for Bausman is shown in Table 3-9. The cost of using the water-based cleaner is much higher than the cost of using acetone because of the capital cost of the ultrasonic unit. Even so, the total cost of cleaning is very low.

This analysis did not include the labor cost for cleaning before and after implementing the ultrasonic cleaning system. It was assumed that the labor for cleaning the spray equipment at Bausman & Father is negligible. In other cases where much more cleaning is done, the labor savings for automating the cleaning process could offset some or all of the capital cost from purchasing the unit.

Table 3-9
Annual Cost Comparison for Bausman & Father for Spray Gun Cleaning

	Acetone	Water-Based Cleaner
Capital Cost	-	$30
Electricity Cost	-	$4
Cleaner Cost	$14	$5
Total Cost	$14	$39

A stand alone case study for Bausman & Father is presented in Appendix B.

3.2.8 El Dorado

El Dorado reworks and repairs four buses and airport shuttles per week at their facility in Ontario. The buses range from 20 to 40 feet in length. The company performs touch up painting for the buses. They clean and mask the surface and apply the paint. El Dorado uses HVLP spray guns to apply the coatings which consist of primers and topcoats.

The company currently uses an enclosed spray gun cleaner for cleaning their spray equipment. El Dorado uses a VOC solvent that meets the 550 gram per liter VOC level. IRTA provided the company with the spray gun cleaner designed by Graco and tested two alternative cleaning agents that worked well during the preliminary testing. The first

was acetone and the second was a blend of 80% acetone and 20% methyl acetate. As mentioned earlier, methyl acetate, like acetone, is exempt from VOC regulations. The company reported that the acetone/methyl acetate blend worked more effectively than the plain acetone on their equipment.

El Dorado currently uses a service provider and leases their cleaning equipment. In converting to an alternative, the company would need to purchase an enclosed spray gun cleaner. The cost of the spray gun cleaner is estimated at $5,000. Assuming a useful life of the equipment of 10 years, the annualized capital cost is $500.

El Dorado estimates that the new cleaning solvent requires more time for cleaning than the solvent used currently. Instead of one minute per cleaning job, the new solvent would require five minutes. The workers clean about four times per day and the labor rate is $10 per hour. Assuming a work schedule of 260 days per year, the current annual labor cost for cleaning is $173. The annual labor cost for cleaning with the new solvent would be $867.

The service provider currently performs maintenance on the unit and the total cost of the servicing, including waste disposal and supply of the cleaner, is $180 every six weeks or $1,560 annually. Assuming that the unit is cleaned and changed out every six weeks and that the changeout requires 30 minutes, the maintenance cost with the new solvent would amount to $43.

The service provider used by the company currently includes the cost of the solvent in the service cost. The cost of the new blend of acetone and methyl acetate is estimated at $6.20 per gallon. Assuming that the five gallons require changeout every six weeks, the annual cost of the new cleaner would be $269.

The service provider includes the cost of disposal of the solvent in the servicing cost. For the new cleaner, El Dorado would have to dispose of five gallons of solvent every six weeks. Assuming a disposal cost of $2 per gallon, the annual disposal cost would amount to $87.

Table 3-10 summarizes and compares the costs of using the current solvent and the new cleaner. The annual costs are slightly higher for the alternative cleaner than for El Dorado's current cleaner. Even though the company would need to make a capital investment in equipment, the cost of using the new zero VOC cleaner is only $33 more per year.

Table 3-10
Annual Cost Comparison for Spray Gun Cleaning for El Dorado

	Current Cleaner	Acetone/Methyl Acetate Blend
Capital Cost	-	$500
Labor Cost	$173	$867
Service Cost	$1,560	-
Maintenance Cost	-	$43
Cleaner Cost	-	$269
Disposal Cost	-	$87
Total Cost	$1,733	$1,766

3.2.9 Holmes Body Shop

Holmes Body Shop is located in Santa Monica, CA. It is one of a chain of 10 body shops located from Santa Monica in the west to Riverside in the east. Like other body shops, the company repairs cars and paints them as part of their process. Holmes uses HVLP spray guns and the guns are cleaned in an enclosed spray gun cleaning unit leased by Holmes. A picture of the spray gun cleaner is shown in Figure 3-5. A service provider also maintains the equipment, supplies the cleaning solvent and disposes of the waste. MSDSs for the coatings used by Holmes are shown in Appendix A.

During the laboratory testing phase, IRTA was not able to clean the spray gun contaminated with Holmes' coatings effectively with plain acetone. IRTA was able to clean the coatings with a blend of 80 percent acetone and 20 percent methyl acetate. Because plain acetone worked effectively on Westway's coatings (see below), IRTA provided five gallons of acetone and five gallons of the acetone/methyl acetate blend to Holmes for scaled up testing. The plain acetone did not work for Holmes but the acetone/methyl acetate blend did work well.

Figure 3-5. Spray Gun Cleaning System at Holmes.

If Holmes converted to the acetone/methyl acetate blend, the company would have to purchase an enclosed spray gun cleaning unit. Such units cost about $5,000. Assuming a ten year useful life for the equipment, the annual cost of the unit would be $500.

Currently, Holmes' service provider does the maintenance on the leased spray gun cleaner. The servicing cost, which includes maintenance, the cost of leasing the unit, the cost of the solvent, the changeout cost and the disposal cost, amounts to $2,290 annually. If the company converted to the new blend, the workers would have to devote about 30 minutes to changeout of the cleaner. Currently the cleaner is changed out once a month. Assuming the new blend would also have to be changed out 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 total service cost. If Holmes converted to the new blend, the cost of the cleaner would be $6.20 per gallon. The annual cleaner cost would amount to $372.

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

Table 3-11 shows the costs for the current and new cleaner for Holmes. The figures show that the cost of using the new cleaner are less than half the cost of using the current cleaner.

Table 3-11
Annual Cost Comparison for Spray Gun Cleaning for Holmes Body Shop

	Current Cleaner	Acetone/Methyl Acetate Blend
Capital Cost	-	$500
Service Cost	$2,290	-
Maintenance Cost	-	$60
Cleaner Cost	-	$372
Disposal Cost	-	$120
Total Cost	$2,290	$1,052

3.2.10 Westway Industries, Inc.

Westway is a small body shop located in Santa Monica, CA. The company repairs cars and, as part of that activity, they paint them. Westway uses an enclosed spray gun cleaner that belongs to the facility to clean the HVLP spray guns that are used to apply the coatings. A picture of this spray gun cleaner is shown in Figure 3-6. The cleaner used by the company is lacquer thinner.

IRTA performed preliminary testing on Westway's coatings. The results indicated that the coatings could be cleaned with acetone or an 80 percent acetone/20 percent methyl acetate blend. IRTA tested acetone at the shop because it was likely to be less costly than the acetone/methyl acetate blend. The workers at Westway used the acetone for a few months and indicated that it was effective in cleaning the spray gun.

To make the conversion to acetone, the company could use the new cleaner in their spray gun cleaner so no capital investment in equipment would be required. Westway uses about five gallons of lacquer thinner each quarter. At a cost of $5.20 per gallon, the total annual cost for purchasing the lacquer thinner is $104. The cost of acetone is $4.50 per gallon. Assuming the same amount of acetone could be used, the annual cost of the acetone would be $90. Disposal costs for the 20 gallons of spent acetone or spent lacquer thinner would amount to $40 annually.

Table 3-12 shows the cost comparison of the cleanup solvents for Westway. The cost of cleaning with acetone is about 10 percent less than the cost of cleaning with lacquer thinner.

Figure 3-6. Spray Gun Cleaning System at Westway.

Table 3-12
Annual Cost Comparison for Spray Gun Cleaning for Westway Industries, Inc.

	Lacquer Thinner	Acetone
Cleaner Cost	$104	$90
Disposal Cost	$40	$40
Total Cost	$144	$130

3.2.11. PCM Leisure World

Professional Community Management or PCM is the management company that provides the painting service to Leisure World, a retirement community where some 22,000 people live in condominiums, apartments and houses. PCM has three separate paint crews with 60 employees that repaint the buildings every seven years or so.

PCM uses latex paint for the buildings and an enamel coating for painting the front doors, windows, doorframes, railings and other metal hardware. PCM currently cleans the equipment used to apply the latex paints with a hose and plain water. The company uses lacquer thinner for cleaning the spray equipment that is used to apply the enamel coating. The spent lacquer thinner is reclaimed in a still and reused for cleaning.

During the preliminary testing, IRTA found that two low or zero VOC cleaners seemed promising for PCM. The first was a soy based cleaner called Soy Gold 1000 and the second was acetone. IRTA provided 10 gallons each of the soy based cleaner and acetone to one of the paint crews for scaled up testing. Both cleaners were capable of cleaning the application equipment but the soy cleaner took much longer.

The paint crew indicated that there was no difference in the labor required for cleaning with the lacquer thinner and the acetone. They indicated that it would take twice the amount of time to clean the equipment with soy than it would with the lacquer thinner. The painters spend about 30 minutes per day cleaning. The labor rate is $10 per hour for the 60 painters. On this basis, assuming a 260 day year, the current labor cost and the labor cost for cleaning with acetone are $78,000 per year. The labor cost for cleaning with the soy would be twice as much or $156,000.

PCM purchases one 55 gallon drum of lacquer thinner per month at $4.09 per gallon. The annual cost of the cleaner amounts to $2,699. The company would use 10 percent more acetone because it is used in the open and because less would be recovered in the still (see below). Assuming a cost of acetone of $4.24 per gallon, the annual cost of acetone would be $3,078. PCM would probably use 20 percent less soy but the company would not be able to use their still to recover the material. PCM currently recovers approximately 22 gallons of lacquer thinner from their still each month. The soy use would be 62 gallons per month. At $6 per gallon, the cost of purchasing the soy for equipment cleaning would be $4,464 per year.

The solvent still uses 5 kW per hour and is operated once a week for five hours. Assuming an electricity cost of 12 cents per kW, the annual electricity cost is $156. The cost would be lower or the same if the company used acetone and there would be no electricity cost for soy since the still cannot handle materials with high boiling points. Note that the still is used to reclaim 22 gallons of solvent. It would be less costly to purchase virgin solvent instead of using the still.

PCM currently disposes of one 55 gallon drum of hazardous waste each month at a cost of $110 per drum. The annual disposal cost amounts to $1,320. The cost for disposal of the spent acetone would be the same. More soy waste, some 62 gallons, would require disposal. Assuming the soy disposal cost is $110 per drum, the cost for disposal of the soy is $1,488 per year. The spent soy might cost less to dispose of than the other two cleaners because it might not be classified as hazardous waste. To be conservative, however, IRTA has assumed the soy would be classified as hazardous waste.

Table 3-13 shows the cost comparison for the lacquer thinner and the two alternative cleanup solvents. The total annual cost of converting to acetone is roughly the same as the current cost of using lacquer thinner. Because the labor cost increases dramatically with the use of soy, conversion to this cleaner would approximately double the cost of cleaning.

Table 3-13
Annual Cost Comparison for Spray Gun Cleaning for PCM

	Lacquer Thinner	Acetone	Soy
Labor Cost	$78,000	$78,000	$156,000
Cleaner Cost	$2,700	$3,078	$4,464
Electricity Cost	$156	$156	-
Disposal Cost	$1,320	$1,320	$1,488
Total Cost	$82,176	$82,554	$161,952

3.2.12. Murphy Industrial Coatings, Inc.

Murphy Industrial Coatings is a contractor, located in Signal Hill, that applies industrial coatings to substrates that experience harsh environments. The company provides coating services to facilities like publicly owned treatment works (POTWs) and chemical plants. The company uses industrial maintenance coatings and MSDSs for typical coatings used by Murphy are provided in Appendix A.

IRTA worked with Murphy at one of their POTW sites. The coating system is composed of three coatings including a zinc primer, an epoxy intermediate and a urethane topcoat. All of the coatings, particularly the primer, have a high solids content. For parts that are submerged, like pipes for example, the urethane topcoat is not used.

Murphy uses traditional airless architectural application equipment for applying the coatings. A picture of the equipment is shown in Figure 3-7. When the workers are finished applying the coating, they clean the spray equipment. They use a five gallon bucket containing 2.5 gallons of a cleaner which is flushed through the system. The cleaner used by the company currently is a blend of MEK, xylene and butyl alcohol.

IRTA collected samples of Murphy's coatings for preliminary testing. Acetone seemed to work well in a laboratory situation. IRTA provided acetone to Murphy for testing and, although it eventually cleaned the equipment, it took much too long. IRTA then provided a blend of 80 percent acetone and 20 percent methyl acetate to the company. This blend, like the plain acetone, took much too long to clean. IRTA worked with a formulator to develop a blend of about 95 percent acetone and five percent of a surfactant called dodecylbenzenesulfonic acid. According to the painter, this blend worked very well and was even more effective than the current cleaner on the zinc primer. The surfactant contained about 1.5 percent sulfuric acid, a material used to produce the surfactant.

Figure 3-7. Spray Gun Cleaning Equipment at Murphy.

Sulfuric acid is classified as a toxic so IRTA asked the formulator if there were a way to eliminate it. The formulator made a new blend of a salt of the surfactant and acetone that did not contain even a trace quantity of sulfuric acid. IRTA provided the new blend to Murphy and the painter and the supervisor reported that it worked well in the cleaning. IRTA then gave Murphy 10 gallons of the blend to test and the painter indicated to IRTA that it worked well but that it gelled up after use.

Murphy commonly reuses the cleaner twice before disposing of it. This generally means the cleaner is used two days for the cleaning. The fact that the cleaner gelled meant that it could not be reused the second day. IRTA does not know why the cleaner gelled. One possible explanation is that the cover was left off the container and the acetone selectively evaporated leaving solids. The painter did not report that the formulation used before this one gelled and the formulator could perform additional work on the blend to make sure it does not gel.

IRTA met with Murphy's owner and discussed the results of the testing. The owner talked to the painter and supervisor and indicated that he was told that the cleaners that were tested did not work. The owner indicated that additional testing would be required to make a final determination on the effectiveness of the cleaner.

Murphy indicated that the cost of the cleaner currently used by the company is $3.50 per gallon. This is a very low cost for the blend and other users would not be able to obtain the cleaner at that price. For purposes of analysis, IRTA assumed that the blend was 40 percent MEK, 40 percent xylene and 20 percent butyl alcohol. One formulator indicates that the cost of this blend would amount to $7 to $9 per gallon. Murphy uses five gallons of cleanup solvent per week. The cost of the cleaner to Murphy is $910 per year. The cost to other users, assuming the cleaner costs $8 per gallon, would be $2,080.

The cost of the alternative acetone/surfactant blend is $5.90 per gallon. IRTA analyzed two scenarios for the acetone/surfactant blend. Assuming that the cleaner can only be used once because it gels, 10 gallons of the cleaner would be required each week for an annual cleaner cost of $3,068. If the first acetone/surfactant blend were used and it didn't gel after use, only five gallons of the cleaner would be used each week. Under this scenario, the annual cost of the cleaner would be $1,534.

Murphy currently generates about five gallons per week of spent cleaner. Assuming a disposal cost of $2 per gallon, the annual disposal fee is $520. If Murphy converted to the acetone blend that gels, the annual disposal cost would amount to $1,040. If Murphy converted to the acetone blend that does not gel, the annual disposal cost would be $520.

Table 3-14 shows the cost comparison for Murphy. The first column gives the costs for Murphy at the below market cost of the cleaning solvent. The second column gives the costs for another user who purchases the cleaner at the market price. The third column shows the costs for the alternative cleaner assuming it gels after use. The fourth column gives the costs for the alternative cleaner assuming it does not gel and can be used twice. The figures indicate that the lowest cost option is the cleaner used by Murphy today because of the low cost of the solvent. Other users that would pay the market price would find it more cost effective to use the alternative cleaning agent if it did not gel after use.

Table 3-14
Annual Cost Comparison for Spray Equipment Cleaning for Murphy

	Current VOC Cleaner (low price)	Current VOC Cleaner (market price)	Acetone Blend (gels)	Acetone Blend (doesn't gel)
Cleaner Cost	$910	$2,080	$3,068	$1,534
Disposal Cost	$520	$520	$1,040	$520
Total Cost	$1,430	$2,600	$4,108	$2,054

3.2.13. Hickory Springs

Hickory Springs is a flexible slabstock foam producer located in Commerce, CA. The company also fabricates foam. This process involves applying adhesive to two pieces of foam and bonding them together. The foam is used to manufacture furniture.

Hickory Springs uses an acetone based adhesive to bond the foam in the fabrication operation. An MSDS for a typical acetone based adhesive is shown in Appendix A and a picture of the booth where the adhesive is applied is shown in Figure 3-8. The company uses a spray gun to apply the adhesive and the spray gun was cleaned with lacquer thinner when IRTA began work with the company.

IRTA obtained a sample of Hickory Springs' adhesive and conducted preliminary testing at the ACT test facility. The preliminary testing indicated that both acetone and a soy based product called Soy Gold 2000 worked well for cleaning the adhesive. IRTA took both acetone and soy to the facility and conducted testing on the spray gun. Plant personnel indicated that acetone worked much more effectively than the lacquer thinner for cleaning the spray gun. A blend of 20 percent soy/80 percent water also worked as well as the lacquer thinner for cleaning the spray gun.

Figure 3-8. Adhesive Spray Booth at Hickory Springs.

Hickory Springs decided to convert from lacquer thinner to WD-40 for cleaning their spray guns. The VOC content of WD-40 is probably very high but the company that makes the product was not able to provide the figure. Because IRTA believes the VOC

content is much higher than 25 grams per liter, IRTA did not consider this option to meet the 2005 target VOC limit.

Hickory Springs used about one gallon per year of lacquer thinner to clean their spray gun. At a cost of $8 per gallon, the annual cost of spray gun cleaning was $8. The cost of WD-40 is $13 per gallon and, assuming that one gallon of WD-40 is also used, the annual cost of spray gun cleaning is $13. Assuming Hickory Springs would also use one gallon of acetone per year and a cost of $7 per gallon, the annual cost of acetone would be $7. The cost of soy is about $6 per gallon. Assuming a use of one gallon for the soy/water blend, the annual cost of cleaning with this cleaner would be $1.20.

Table 3-15 provides the cost comparison for the alternatives for Hickory Springs. The cost of cleaning for Hickory Springs is minimal. The lowest cost option is the soy/water blend.

Table 3-15
Annual Cost Comparison for Spray Gun Cleaning for Hickory Springs

	Lacquer Thinner	WD-40	Acetone	Soy/Water Blend
Cleaner Cost	$8	$13	$7	$1.20
Total Cost	$8	$13	$7	$1.20

3.2.14. VACCO Industries, Inc.

VACCO is a diversified manufacturer of commercial and defense products and systems sold to customers worldwide. Located in South El Monte, the company manufactures engineered fluid controls for aerospace, does precision photochemical etching for photofabrication and manufactures valves, filters and manifolds for Quiet and Non-Quiet applications for the Navy.

One of the photofabrication operations involves the manufacture of laminated bonded-core assemblies with thin metal sheets. An adhesive is used to bond the thin metal laminates and an MSDS for this adhesive is shown in Appendix A. This adhesive is used because it doesn't interfere with the magnetic nature of the thin metal foil and it also provides dampening to the thin plastic sheets when it is used for plastic lay-ups. The solventborne adhesive is based on tetrahydrofuran (THF). A spray gun is used to apply the adhesive and the cleaner that is used to clean the HVLP gun after spraying is THF, the same solvent that is used as the carrier in the adhesive.

IRTA tested two alternatives at VACCO for cleaning the spray equipment. One of these was a water-based cleaner and the other was acetone. These cleaners seemed to work well in the preliminary testing. In both cases, however, the cleaners caused the adhesive residue to form a thick gel inside the spray gun. In subsequent testing, IRTA also determined that the gel was formed even when plain water was added to the adhesive. IRTA discussed the problem with 3M, the adhesive manufacturer. 3M indicated that the

adhesive was in a delicate balance and could not offer advice on which low VOC cleaners might be able to clean up the adhesive.

Rule 1168, the District rule that regulates adhesives, provides an exemption from VOC limits for the thin metal laminating operation. In addition to VACCO, one other company in the Basin performs this type of operation using the same adhesive. The manufacturer of the adhesive, 3M, did not want to undertake an R&D effort to formulate a new adhesive with lower VOC content for only two companies in the Basin. During IRTA's current project, IRTA approached 3M again to discuss reformulating the adhesive so a low-VOC cleaning alternative could be used for the spray equipment cleaning. 3M indicated that they do not intend to reformulate the adhesive so that cleanup would be easier.

Until and unless the adhesive is reformulated without the THF, IRTA does not know of an alternative low-VOC cleaner that would effectively clean the adhesive spray equipment. Thus, IRTA did not analyze and compare the cost of any alternatives.