

Appendix B
Stand Alone Case Studies for Selected Facilities

TELEDYNE CONTROLS CONVERTS TO LOW-VOC REWORK CLEANER

Teledyne Controls, located in West Los Angeles, has been providing data acquisition equipment and supporting ground data processing stations to operating airlines for over 20 years. The systems are used in aircraft and engine monitoring activities including the flight data recorder. Teledyne Controls also manufactures a wireless groundlink system that transfers data to and from civil transport aircraft and the operator's data processing center. The data transfer starts after the aircraft has landed and is parked at the gate.

The systems built by Teledyne must have high reliability. As part of the manufacturing process, Teledyne assembles printed circuit boards (PC Boards) that are a critical part of the systems. Historically, Teledyne, like many other aerospace companies, used 1,1,1-trichloroethane (TCA) and CFC-113 to remove the flux from PC boards after the components were soldered to them. When the ozone depleting substance ban was announced, Ray Cole, the Teledyne Controls Environmental, Health and Safety Engineer, decided the best option was to conduct testing and convert to a water soluble flux. As a result of the conversion, the company was able to remove flux from the PC boards with plain deionized water.

Teledyne, like other companies that assemble PC boards, must rework some of the boards that fail quality control. During rework, the components are removed from the board, flux is added, the components are again soldered and the boards are cleaned. Generally, these are hand operations and the cleaning agent most commonly used for rework cleaning is isopropyl alcohol (IPA). Teledyne was using a blend of half IPA and half deionized water for the rework cleaning when IRTA approached the company to participate in a project sponsored by the South Coast Air Quality Management District (SCAQMD). The SCAQMD project involves working with companies to find suitable alternatives to IPA for rework of PC boards.

IRTA and Teledyne agreed to test several low-VOC formulations to try to identify an acceptable alternative. The alternatives that were tested at Teledyne included plain deionized water, acetone, various blends of acetone, deionized water and IPA and a saponifier containing no VOC. Although all the potential alternatives appeared to provide visually clean boards, the worker did not like the saponifier or the high acetone content formulations. The other formulations were tested to determine the ionic contamination levels and all of the formulations resulted in low levels.

According to Ray Cole, "we decided to switch to an 80% deionized water/5% acetone/10% IPA cleaner throughout our facility. The workers like it and it allows us to lower the VOC content of the cleaner to about 100 grams per liter." The cost of the alternative is much lower because the company was purchasing the 50% IPA/50% deionized water product in aerosol packages. Says Ray Cole, "we've made a successful conversion. The cleaner is lower VOC and it's also less costly."

**Annual Cost Comparison for Printed Circuit Board Rework Cleaning for
Teledyne Controls**

	Aerosol IPA/ D.I. Water Blend	D.I. Water/Acetone/ IPA Blend
Chemical Cost	\$291	\$41
Total Cost	\$291	\$41

LITTON CONVERTS AWAY FROM VOC SOLVENTS

Litton Guidance & Control Systems is located in Woodland Hills, California. The company makes laser-based guidance systems for space applications. The optical components must meet stringent performance specifications and cleaning is a major part of the operation.

The company historically used ozone depleting solvents, CFC-113 and 1,1,1 – trichloroethane (TCA), for their cleaning. Litton began work several years ago on alternatives when the production bans were announced. All of their operations were converted away from CFC-113 and TCA, primarily to VOC solvents and water-based cleaners with high concentrations of high VOC solvents.

The South Coast Air Quality Management District (SCAQMD) amended Rule 1122 “Solvent Degreasers” in July of 1997. The amendments affected VOC solvents that are used in batch loaded cold cleaning operations. The rule requires companies to use solvents with a VOC content of 50 grams per liter or less or to use the higher VOC solvents in an airless airtight degreaser beginning in January 1999. Since Litton had many operations using VOC solvents, they were strongly affected by this rule.

IRTA began work with Litton in 1998 to assist the company in evaluating their processes and in adopting low and non-VOC solvents so they could comply with the January 1999 deadline. Says Gary Augeri, Member of the Technical Staff at Litton, “our operations might have been covered by one of the exemptions in Rule 1122 so we could have continued to use the VOC solvents. Litton Manufacturing Management wanted to set an example and we decided to make a commitment to switch away from these solvents.”

At this stage Litton Optics Manufacturing has converted virtually all of their cleaning processes away from VOC cleaners in the frame, substrate and prism operations in the optics shop. For frame manufacture, wax was used to plug the frame bores to prevent lapping compound from entering the internal bores. Litton eliminated a cleaning step that employed n-methyl pyrrolidone (NMP) by using plugs with O-rings to block the frame bores as a physical barrier to the lapping compound. The lips of the plugs are now sealed with adhesives which are removed with a Liquinox detergent. Epoxy is used to bond the frames to holding fixtures during lapping and polishing. In the past, NMP was used to remove this epoxy. Very hot detergent is now used to separate the frame from the fixture. The thermal expansion difference between the glass part and the metal fixture causes the debonding.

In the substrate operation, pitch was used to hold the mirror substrates to mounting blocks during lapping operations. NMP, methanol and methylene chloride were used in the past for cleaning. Litton now uses thermoplastic; this is followed by a soak in an Armakleen detergent made by Church & Dwight.

In the prism operation, wax is used to bond the prisms to mounting blocks for lapping

and polishing. A terpene-based cleaning process was used to dissolve the wax and clean the parts. Litton has converted to Daraclean 121, a water-based cleaner made by W.R. Grace for this cleaning process.

All of the parts are put through a final clean either with hot water alone or with hot water and detergent. In some cases, ultrasonics are necessary to achieve the required cleanliness.

“The new process works very well,” says Mr. Augeri. “In some cases, we were able to use different materials in our processes and could avoid cleaning all together. In other cases, we could substitute water-based cleaners. We found we don’t have to rely on solvents for getting the cleanliness we need. The new water-based cleaners are better for the environment and for our workers.”

BURBANK AEROSPACE COMPANY ADOPTS ALTERNATIVE SPRAY GUN CLEANER

Hydro-Aire is a division of Crane located in Burbank, California. The aerospace company has 572 employees. Hydro-Aire manufactures braking systems, pumps and air locking devices and is a Boeing subcontractor. Hydro-Aire also repairs the pumps used in military and commercial aircraft like the C-17 and the C-130 transport.

IRTA began work with Hydro-Aire in 1997 on alternatives to the company's vapor degreasers. The company made a complete conversion away from 1,1,1-trichloroethane (TCA) to water-based cleaners in their manufacturing operations. Hydro-Aire used VOC solvents for repair and maintenance cleaning when they rebuilt units from the field and during manufacture of new components. The company also converted these operations to water-based cleaners. At this stage, Hydro-Aire is using VOC solvents only in handwipe operations and in spray gun cleaning.

More recently, as part of a project sponsored by the South Coast Air Quality Management District (SCAQMD), IRTA worked with Hydro-Aire to test alternatives to the VOC solvent used in spray gun cleaning. The coatings used by the company are typical aerospace coatings that generally consist of an epoxy-based primer and a polyurethane topcoat. A number of the coatings are specialty coatings that meet high performance parameters. Hydro-Aire, like other aerospace companies, historically used an MEK blend for cleaning their paint spray equipment.

IRTA performed testing using a variety of alternatives in laboratory tests using Hydro-Aire's coatings. The aim was to identify one or more alternatives that would prove a suitable alternative to the MEK blend. The cleaner that performed best on the coatings was acetone. Acetone is exempt from VOC regulations and is relatively low in toxicity and is therefore better from an overall human health and environmental standpoint than the MEK blend.

IRTA tested acetone at Hydro-Aire and the preliminary testing indicated that it performed as well as or better than the MEK blend. In scaled up testing for several months, the same conclusion was reached. According to Tommy Jennings, Environmental Manager at Hydro-Aire, "acetone performs every bit as well as our MEK blend. We made the decision to convert to acetone because it reduces our VOC emissions and it is better for the workers."

IRTA compared the costs to Hydro-Aire of using the acetone for spray gun cleaning and compared them to the costs of using the MEK blend. Hydro-Aire has an enclosed spray gun cleaner and the same unit was appropriate for use with acetone. The unit is changed out with the same frequency with acetone as it was with the MEK blend. Says Tommy Jennings, "Acetone is a great solution. It reduces the health and environmental concerns and it's also less costly than the MEK blend."

Annual Cost Comparison for Spray Gun Cleaning for Hydro-Aire

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

SMALL AEROSPACE COMPANY MAKES SPRAY GUN CLEANING CONVERSION

California Propeller, a small 30-employee firm in North Hollywood, was established in 1950 by Cyrus Bearson. The company buys government surplus parts and various other parts that have been used in the field for 10 to 40 years and refurbishes them. The parts are mainly used for control and governing and they include propellers and intricate governors. They are made of many different substrates including aluminum, stainless steel, nickel and brass plating, various ferrous metals and some are anodized.

The parts arrive at California Propeller heavily contaminated with oil, grease, rust, various preservatives, black oxide and carbon from long years of field use. They are disassembled, cleaned, inspected, reworked by filing, sanding or blasting and painted. Several years ago, IRTA assisted the company in converting away from a 1,1,1-trichloroethane vapor degreaser to a water-based cleaning process. Like other aerospace companies, California Propeller uses an epoxy based primer and a polyurethane topcoat to paint the parts after they are reworked. When the spray gun is cleaned, it is disassembled and cleaned with a brush with MEK.

As part of a project with U.S. EPA, IRTA began work with California Propeller to try to identify a suitable alternative for spray gun cleaning. The South Coast Air Quality Management District (SCAQMD) regulates the cleaners that can be used for application equipment cleaning in Rule 1171 "Solvent Cleaning Operations." Historically, the VOC content of spray gun cleaners in Rule 1171 was set at 950 grams per liter and 35 mm Hg vapor pressure. On December 1, 2001, the VOC content of these cleaners declined to 550 grams per liter. In July of 2005, the VOC content of the cleaners is reduced even further, to 25 grams per liter. IRTA and California Propeller wanted to find a technically suitable cleaning alternative that would meet the 2005 VOC content level.

IRTA obtained samples of coatings from California Propeller and various other companies in the Basin to test alternative low-VOC low toxicity cleaning agents in a laboratory setting using a spray gun cleaner provided by Graco. For California Propeller's coatings, it appeared that acetone was the best cleaner in the preliminary testing. Acetone is not considered a VOC and it is relatively low in toxicity. Based on IRTA's initial results, California Propeller conducted scaled up testing of acetone. It worked as well as or better than the MEK cleaner that had been used previously and the company decided to convert to the alternative.

Barrett Bearson, the owner of California Propeller, is very satisfied with the acetone spray gun cleaning alternative. "We are at the cutting edge in aerospace propellers. We would like to be at the cutting edge of environmentally preferable alternatives as well." Says Bearson, "the workers are very satisfied with acetone. It cleans well, it doesn't cause smog, it isn't toxic and it costs less than the MEK. It's a win-win for everyone."

Annual Cost Comparison for Spray Gun Cleaning for California Propeller

	MEK Cleaner	Acetone Cleaner
Chemical Cost	\$154	\$66
Total Cost	\$195	\$66

FONTANA COMPANY ADOPTS LOW-VOC COATING EQUIPMENT CLEANERS

American Security Products is located in Fontana, California. As the name indicates, the company makes burglary, fire protection and gun safes and is the largest security safe manufacturer in the country.

In the safe manufacturing process, American Security Products uses adhesives to bond the velour to shelves in the safe and to the safe walls. The safes are also painted. The company began using waterborne adhesives for their bonding operation several years ago. American Security Products uses a urethane topcoat, a polyester primer and topcoat on the different lines of the safes.

Until four years ago, American Security Products used lacquer thinner for cleaning their coating application equipment. The company performed the cleaning in an enclosed spray gun cleaning unit that they owned. American Security Products did not have to clean their spray equipment for their adhesives at all because the latex residue left in the spray gun can simply be peeled off. For cleaning the solventborne coatings from the spray equipment, the company decided to convert to acetone. This decision was based on the fact that acetone is not classified as a VOC and American Security Products wanted to reduce their overall facility VOC emissions.

American Security Products has been using the non-VOC alternatives for four years and they are very happy with their performance. “We want to do the right thing for the workers and the environment,” says Mike Hassel, Production Manager at American Security Products. “Using water and acetone for cleaning our spray guns has accomplished this and it has saved us money. We paid fees for emitting the lacquer thinner and that cost has been eliminated.”

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

SMALL GLENDORA COMPANY CONVERTS TO LOW-VOC SPRAY GUN CLEANER

Metrex Valve Corp. is a small manufacturer located in Glendora, California with about 25 full time employees. Metrex is an Original Equipment Manufacturer (OEM) that manufactures and rebuilds water regulating valves for the commercial, military and nuclear industries. Some of the valves manufactured by Metrex for the military are made of cast iron; they are used in the marine environment and must be highly resistant to corrosive attack. The coating used by Metrex on its cast iron parts is an extreme high gloss coating that provides the proper protection.

IRTA began working with Metrex as part of an EPA sponsored project. The aim of the project was to work with companies to identify, test and implement alternative low-VOC, low toxicity spray gun cleaners. Metrex agreed to participate in the project.

Metrex uses a High Volume Low Pressure (HVLP) spray gun to apply the coatings to its cast iron valves and paints about one to two days each month. The company cleans the spray gun immediately after spraying so the paint being cleaned does not cure. The gun is disassembled and cleaned in a can. When IRTA began working with Metrex, the company used lacquer thinner as the cleaning agent.

IRTA conducted preliminary testing with the Metrex coating and found that acetone might be a potential alternative. Acetone is not classified as a VOC and is low in toxicity. The chemical has a low flash point and the fire regulations allow storage of 60 gallons and 15 gallons of acetone for open use. The small quantities of cleanup solvent used by Metrex are well below the limit.

Metrex and IRTA conducted testing of the acetone for cleaning the spray gun. The painter indicated that the acetone worked well on the cup and gun; it cut the coating residue very effectively. Metrex performed scaled up testing of acetone over the following weeks and found it to be as effective as their current solvent. The company decided to convert to acetone.

According to Bill Carter, Environmental, Health and Safety Manager at Metrex, “acetone has performed well. We decided to use it instead of the lacquer thinner. Acetone is not a VOC, it is better for the workers and they like it much better than the previous solvent we used. Acetone has also proved to be less expensive. Metrex Valve wants to do its part for the environment.”

Annual Cost Comparison for Spray Gun Cleaning for Metrex

	<u>Lacquer Thinner</u>	<u>Acetone</u>
Cleaner Cost	\$33	\$27
Total Cost	\$33	\$27

**SMALL HUNTINGTON BEACH FURNITURE STRIPPER CONVERTS TO
BETTER SPRAY GUN CLEANING METHOD**

Bausman & Father is a small furniture stripping and refinishing company located in Huntington Beach, California. The owner and one employee provide commercial furniture stripping services. After the furniture and other wood items are stripped, they are refinished. Some of the pieces are antiques that are restored to their original elegance.

IRTA began working with Bausman & Father as part of a project sponsored by EPA. The aim of the project was to assist small companies in identifying, testing and implementing alternative spray gun cleaning solvents. The South Coast Air Quality Management District (SCAQMD) modified one of their cleaning rules, Rule 1171 “Solvent Cleaning Operations” to require lower VOC content spray gun cleaners. The current limit is 550 grams per liter VOC and, in 2005, the limit declines to 25 grams per liter VOC.

Bausman & Father uses a High Volume Low Pressure (HVLP) spray gun to apply acetone and waterborne coatings to the furniture after it is stripped. For many years, like other companies that coat wood, the company used lacquer thinner for cleaning the spray gun. A few years ago, Bausman & Father converted to acetone.

As part of the EPA project, IRTA arranged for a small tabletop ultrasonic cleaning system to be designed and built for testing. IRTA provided this system to Bausman & Father and the company has been using it for spray gun cleaning for more than a year. The spray gun is dismantled and placed in the ultrasonic system. The cleaner used in the system is an alkaline water-based solution. It is diluted to about 25 percent for the spray gun cleaning. The system has a heater which heats the cleaning solution to about 140 degrees F.

Mark Bausman, owner of Bausman & Father likes the water-based cleaner and system. “It cleans the waterborne coatings very well, better than solvents,” he says. “Using the water-based cleaner allows the waterborne coating to release from the spray gun so you can avoid scrubbing. The system also cleans the acetone coatings well. The ultrasonics are very effective.” The ultrasonics allow the water cleaner to penetrate the complex passages of the spray gun.

Bausman & Father did not have to pay for the ultrasonic system but other companies would have to purchase it at a cost of about \$300. The cost analysis presented below reflects this cost.

Annual Cost Comparison for Bausman & Father

	Acetone	Water-Based Cleaner
Capital Cost	-	\$30
Electricity Cost	-	\$4
Cleaner Cost	\$14	\$5
Total Cost	\$14	\$3