II. ANALYSIS OF THE ALTERNATIVE CLEANING AGENTS.

This section presents the results of the tests of the alternative low-VOC cleaning agents. It focuses on four facilities that agreed to participate in the project. Table 2-1 lists the four facilities and describes their UV or EB operation.

Table 2-1
Facilities Participating in the Project

Company	Description of Operation	Type of Adhesive or Coating
Sandberg Furniture	Wood Furniture Manufacture	UV Curable Coatings
Medtronic Diabetes	Medical Device Manufacture	UV Curable Adhesives
DRS Sensors and Targeting Systems, Inc.	Aerospace Facility	UV Curable Conformal Coating
Huhtamaki	Consumer Packaging	EB Curable Coating

Sandburg Furniture, a major wood furniture manufacturer in the Basin, has a flat line that uses UV curable coatings. Medtronic MiniMed is a leader in manufacturing implantable medical devices; the company has several operations that involve the use of UV curable adhesives. DRS, an aerospace facility, applies a UV curable conformal coating to electronic devices. Finally, Huhtamaki manufactures consumer packaging; the company applies an EB curable clear coating over the printed material.

The companies that participated in the project were selected to represent the range of the different types of facilities in the Basin using UV and EB curable inks or adhesives. All of the facilities produce high quality products. This section presents the detailed testing and cost analysis results for the four facilities. No cost analysis or comparison is provided for Sandberg Furniture.

Sandberg Furniture Mfg. Co., Inc.

Sandberg Furniture, one of California's longest standing premier manufacturers of bedroom and entertainment furniture is located in Vernon, California. The company was founded in 1918 and is still owned and operated by the fourth generation of the Sandberg family. The company has 450 employees. Sandberg manufactures medium priced master bedroom furniture, youth bedroom furniture and entertainment wall systems.

The Sandberg property consists of four buildings totaling 300,000 square feet, on 14 acres. The company purchases particleboard and medium density fiberboard and does its own laminating and finishing. The finishes used by Sandberg are applied by spray and roll coating. The coatings are UV cured. The flat line was engineered to use 100 percent solid UV curable coatings; components are finished first and then assembled. A picture of the flat line is shown in Figure 2-1.


Figure 2-1. Flat Line at Sandburg Furniture

After adopting the UV curable coatings, Sandberg reduced their 1990 VOC emissions by 92 percent. According to Phil Sweet, Vice President of Manufacturing, "As far as we know, Sandberg was the first wood production facility in the Los Angeles Basin to implement water-based topcoats, in 1991. And the first woodworking facility to install a 100 percent solid, sprayable zero VOC, UV-cured finishing line, in 1995."

Prior to 1996, when the company purchased eight new Accuspray paint spray guns, the first two sets caused many opportunities; cleanup involved the use of VOC solvents. Originally, the cleanup process included flushing the lines with solvent and taking the guns apart and immersing them in solvent. Once the Accuspray guns were installed, the cleanup routine was simplified to a daily inspection of the filters and a weekly wipedown of the spray guns and roll coaters. The conveyor belt has a built in scraper to recover all excess coating on an ongoing basis. Small amounts of exempt solvents are used during the routine cleanup process. Sandberg performs the higher level of cleaning, with exempt solvents, every few months. When solvent cleaning is required, the company uses a small amount of acetone. An MSDS for acetone is shown in Appendix A. There are no non-exempt VOC emissions from the cleanup process.

VOC emissions at the Sandberg facility this year will be less than five tons. Facility emissions were permitted at 219 tons in 1990.

Medtronic Diabetes

Medtronic Diabetes is a business unit of Medtronic, Inc., the world's largest medical technology company. Located in Northridge, California, Medtronic Diabetes is the world leader in insulin pump therapy and continuous glucose monitoring systems for the treatment of diabetes. Medtronic Diabetes has three types of operations that use UV curable adhesives.

IRTA began work with Medtronic Diabetes as part of a project sponsored by the South Coast Air Quality Management District. The project was designed to investigate whether low-VOC cleanup materials could be used to clean ultraviolet and electron beam curable coatings and adhesives. IRTA worked with Ginger Lichauco, Medtronic's Director of Safety, Security and Environmental Compliance, to test low-VOC alternatives for cleanup of the application equipment used to apply the adhesives.

In the disposable packaging area, Medtronic Diabetes has several machines that are used to apply adhesive to the packaging material.

In another area, the PATCH machine is used to bond polycarbonate sensors to a patch. Medtronic Diabetes wanted to start a new program of regular maintenance using a low-VOC cleaner for the application equipment.

IRTA obtained a sample of the adhesive used in the PATCH machine to conduct preliminary testing of low-VOC cleaning agents. Several alternatives, including plain water, a water-based cleaner made by Mirachem and a soy based cleaner, were tested. The Mirachem cleaner appeared to work well in the preliminary testing at 100 percent concentration without leaving a residue. An MSDS for the Mirachem cleaner, called Mirachem 500, is shown in Appendix A. IRTA provided samples of the Mirachem cleaner to Medtronic Diabetes and the cleaner was tested on the adhesive residue. According to the engineers performing the testing, the cleaner worked well.

For the CAM and TAM machines, which are automated medical device assembly machines, IRTA provided the company with several suggestions for cleaning the adhesive from the application equipment. The cleaner that worked best for this operation was acetone. The company wanted to continue using polywipes in the cleaning operation and polywipes are supplied with both IPA and acetone. Medtronic Diabetes uses 5 cases of clean room wipes containing IPA for cleaning the CAM and TAM application equipment each year. Each case contains 12 rolls of 100 sheets. The cost of each case is $235. On this basis, the annual cost of using the IPA wipes is $1,175. The acetone wipes have the same price as the IPA wipes. Assuming the same amount of wipes would be used, the cost of the acetone wipes is $1,175 annually.

For the PATCH machine, Medtronic Diabetes estimates it will use one gallon per month of the Mirachem to clean and maintain the system. The Mirachem will be used at a one-third concentration in water. At a cost of $18 per gallon including freight for purchases in five gallon quantities, the cost of using the Mirachem would amount to $216 per year.

No cost comparison with other cleaning materials was performed because the regular maintenance program has just been initiated.

Table 2-2 shows the cost comparison for the CAM and TAM equipment cleaning at Medtronic Diabetes. The values show that the cost is the same for using the low-VOC wipes containing acetone and the high VOC wipes containing IPA.

Table 2-2
Annualized Cost Comparison for Medtronic Diabetes

	IPA Wipes	Acetone Wipes
Cleaning Wipes Cost	$1,175	$1,175
Total Cost	$1,175	$1,175

DRS Sensors & Targeting Systems, Inc.

DRS is located in Cypress, California. The company develops and prototypes EO sensors and targeting systems. One of the operations at DRS involves applying a conformal coating to electronic assemblies. The company uses a spray gun to apply a UV curable conformal coating.

IRTA began work with DRS as part of a project sponsored by the South Coast Air Quality Management District. The project was designed to investigate whether low-VOC cleanup materials could be used to clean ultraviolet and electron beam curable coatings and adhesives. IRTA worked with DRS to test low-VOC alternatives for cleanup of the spray gun used to apply the UV curable conformal coating.

DRS uses isopropyl alcohol (IPA) to clean the application equipment. An MSDS for IPA is shown in Appendix A. After the conformal coating is applied, the DRS engineer puts a small amount of IPA into the spray gun cup to remove the uncured UV coating residue from the spraying operation. The engineer swirls the IPA and turns the cup upside down to ensure the IPA reaches all parts of the cup. The engineer uses a wipe cloth to wipe out the sides and bottom of the cup. Finally, the engineer then adds some additional IPA to the spray gun cup and flushes the gun. The cup is inspected under a black light which will show whether there is a residue remaining.

IRTA obtained a sample of DRS's coating from the vendor. An MSDS for the coating is provided in Appendix B. IRTA conducted screening tests to determine which low-VOC alternatives might be suitable for removing the coating. The alternatives that were tested included plain water, acetone, methyl acetate, a water-based cleaner called Mirachem 500 and a vegetable based cleaner called Soy Gold 2500. MSDSs for these materials are shown in Appendix A. IRTA also tested IPA so the cleaning capability of the alternatives could be compared to it. The results of the screening tests indicated that plain water appeared to clean the coating well, the Mirachem 500 cleaned well but was likely to require a rinse, the soy cleaner left a significant residue, acetone did not work as well as IPA and methyl acetate worked better than IPA.

IRTA then conducted field tests at DRS with the engineer in charge of the operation, Ray Salud. The protocol involved testing the cleaner in the cup, swirling it and turning it upside down to get good coverage, wiping the cup, then adding more IPA and spraying the gun into a bucket. After the cup was cleaned, it was inspected under a black light.

The results of the testing indicated that deionized water left a residue before the sides of the cup were wiped. After the sides were wiped, the residue was substantially less but was still evident. The results also indicated that the Mirachem 500 appeared to leave some solid particles in the cup. Acetone did not clean the cup as well as IPA. Methyl acetate was the best cleaner and it cleaned the coating better than IPA. IRTA and the DRS engineer decided not to test the soy based product because it, like the Mirachem cleaner, was likely to leave a residue that would require rinsing which would be an additional step.

IRTA performed a cost analysis of using IPA and using the alternatives that performed most successfully, acetone and methyl acetate. The DRS engineer estimates that the company uses about one-half gallon of IPA annually to clean the coating application equipment. IRTA assumed that the use of acetone or methyl acetate for this purpose would be the same. The company would only purchase one gallon of cleaner at a time, probably from a specialty lab. IRTA obtained costs for the three materials if purchased in one gallon amounts. The price of acetone is the lowest, at $11.30 per gallon. The price of IPA is $16 per gallon and the price of methyl acetate is $35 per gallon. IRTA also obtained prices for the materials from a local chemical supplier that offers all three chemicals. Because the chemicals would be purchased in small one gallon quantities, he indicated he would charge $50 per gallon for all three chemicals because of the handling.

The used IPA from the cleanup operation is shipped off-site as hazardous waste. The acetone and the methyl acetate would need to be handled in the same manner. Acetone and methyl acetate are much more volatile than IPA so emissions could be higher if they were used in the operation. This means that the waste volume of the two low-VOC alternatives might be lower. For purposes of analysis, IRTA assumed that the waste volume and cost of waste disposal would be the same for all three chemicals. The waste disposal cost, accordingly, was not included in the analysis.

Table 2-3 presents the annualized cost comparison for the cleanup solvents for DRS assuming the company would purchase the IPA, acetone or methyl acetate from a laboratory. The values indicate that using acetone is the lowest cost option and that using methyl acetate would more than double the cost of using the IPA baseline chemical. If the materials were purchased from the local chemical supplier, the materials would be more expensive but they would all carry an equal cost.

Table 2-3
Annualized Cost Comparison for DRS Sensors & Targeting Systems

	IPA	Acetone	Methyl Acetate
Cleaner Cost	$8.00	$5.65	$17.50
Total Cost	$8.00	$5.65	$17.50

Huhtamaki

Huhtamaki is located in Los Angeles, California. The company is international and the business entity in Los Angeles makes consumer packaging, primarily for ice cream cartons. Huhtamaki has an eight stage web press with seven color stations and a clear coating station. A picture of the press is shown in Figure 2-2. Huhtamaki is one of the few companies in the U.S. that uses an electron beam curable ink and an electron beam curable coating for the clear coat.

Figure 2-2. Press at Huhtamaki

IRTA began work with Huhtamaki as part of a project sponsored by the South Coast Air Quality Management District. The project was designed to investigate whether low-VOC cleanup materials could be used to clean ultraviolet and electron beam curable coatings and adhesives. IRTA worked with Huhtamaki to test low-VOC alternatives on the clear coating station.

Historically, Huhtamaki used two 55 gallon drums per month of a VOC solvent called EB Wash for cleaning. An MSDS for this cleaner is shown in Appendix A. Half of the EB Wash, one drum per month or 660 gallons per year, was used for off-press cleaning and half was used for on-press cleaning as a blanket wash, a roller wash and a coating cleanup material. Huhtamaki estimates that about 93 gallons are used on-press for cleaning the ink on each printing station annually and about one-tenth as much, or nine gallons per year, was used to clean the coating station annually. Of the nine gallons, one-half gallon was used to clean coating residue on the floor.

The alternative that was most effective in cleaning the coating is a water-based cleaner called Brulin GD 815 MX. An MSDS for this cleaner is shown in Appendix A. Through testing, it was found that plain water was effective in cleaning the coating residue on the floor. Several different concentrations of the Brulin cleaner were tested for cleaning the coating station and a concentration of 50 percent Brulin/50 percent water was found to be as effective as the EB solvent in cleaning the coating. Huhtamaki has converted to the Brulin cleaner for cleaning the coating station and plain water for cleaning the coating residue on the floor.

The cost of the EB Wash solvent is $9.09 per gallon. Assuming that nine gallons of the solvent was used for coating cleanup, the annual cost of the solvent for this purpose amounted to $82. The cost of the Brulin water-based cleaner is $5.75 per gallon. Assuming that 8.5 gallons of the cleaner are used for cleaning the coating station and that a 50 percent concentration of the cleaner is required, the annual cost of the water-based cleaner amounts to $24. The cost of the plain water for floor cleaning was assumed to be zero.

Table 2-4 shows the annualized cost comparison for Huhtamaki. The values indicate that the cost for cleanup with the water-based cleaner is significantly lower than the cost of cleaning with the high VOC solvent.

Table 2-4
Annualized Cost Comparison for Huhtamaki

	EB Wash Solvent	Water-Based Cleaner/ Water
Cleaner Cost	$82	$24
Total Cost	$82	$24