

**SAFER ADHESIVE AND CLEANUP ALTERNATIVES FOR COUNTERTOP  
MANUFACTURING**

Prepared for:  
Cal/EPA's Department of Toxic Substances Control  
U.S. Environmental Protection Agency Region IX  
Under Contract #02-T2463

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August 2004

## **DISCLAIMER**

The mention of any products, companies, or pollution prevention technologies, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products, companies or technologies.

This project was funded by Cal/EPA's Department of Toxic Substances Control (DTSC) and the U.S. Environmental Protection Agency (EPA). The contents of this document do not necessarily reflect the views and policies of DTSC or EPA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

## **ACKNOWLEDGMENTS**

This analysis benefited considerably from the efforts of many persons within and outside the Institute for Research and Technical Assistance (IRTA). We would particularly like to acknowledge the valuable contributions made by Robert Ludwig, the Cal/EPA's Department of Toxic Substances Control project officer and Eileen Sheehan, the U.S. Environmental Protection Agency project officer. We are especially grateful to the companies that agreed to test alternatives and use their case studies for this project. Finally, we appreciate the efforts of Jon Zavadil of IRTA for assistance and useful discussions and Amy Blume of IRTA for her help in preparing the document.

## TABLE OF CONTENTS

I.	Introduction and Background .....	1
II.	Analysis of Alternative Adhesives and Cleanup Materials.....	4
	Alternative Adhesives .....	4
	Alternative Cleanup Materials.....	6
	Analysis of Alternatives .....	22
	Sani-Top, Inc.....	22
	V-T Industries .....	24
	Architectural Woodworking Company .....	25
	Universal Laminates.....	28
	The Countertop Factory .....	30
	Closet World .....	32
	United Cabinet Company, Inc. ....	34
	Toxicity and Cross-Media Issues .....	36
III.	Results and Conclusions.....	38
	Appendix: Stand Alone Case Studies for Selected Facilities	
	Countertop Manufacturer Makes Environmentally Conscious Decisions	
	Woodworking Company Converts to Safer Adhesive and Cleanup Solvent	
	Small Company Adopts Cost Effective Water-Based Countertop Adhesive	
	Countertop Factory Starts up with “Green” Products	
	Closet Company Converts to Safer Adhesive	
	United Cabinet Company Adopts Safer Adhesive and Cleaner	

## LIST OF FIGURES

Figure 2-1: Typical Countertop.....	4
Figure 2-2: Typical HVLP Spray Gun.....	5
Figure 2-3: Typical Canister Adhesive .....	5
Figure 2-4: Countertop Manufacturing Line at V-T Industries West .....	25
Figure 2-5: Production Line at Architectural Woodworking.....	26
Figure 2-6: Spray Gun Cleaner in Testing at Architectural Woodworking .....	27
Figure 2-7: Spray Booth at Universal Laminates .....	28
Figure 2-8: Countertop Manufactured by Universal Laminates.....	29
Figure 2-9: Countertop Manufactured at The Countertop Factory.....	31
Figure 2-10: Adhesive Line at The Countertop Factory.....	31
Figure 2-11: Countertop Manufactured by United Cabinet Company .....	34
Figure 2-12: Applying New Adhesive at United Cabinet Company .....	35

## LIST OF TABLES

Table 2-1: Annualized Cost Comparison for Sani-Top Adhesive Overspray Cleaning Process .....	23
Table 2-2: Annualized Cost Comparison for Sani-Top Conveyor Line Cleaning Process.....	24
Table 2-3: Annualized Cost Comparison for Architectural Woodworking Company .....	27
Table 2-4: Annualized Cost Comparison for Universal Laminates .....	30
Table 2-5: Annualized Costs for TheCountertop Factory .....	32
Table 2-6: Annualized Cost Comparison for Closet World .....	33
Table 2-7: Annualized Cost Comparison for United Cabinet.....	36

## **LIST OF EXHIBITS**

Exhibit 2-1: Material Safety Data Sheet for Typical Polyvinyl Acetate Adhesive .....	7
Exhibit 2-2: Material Safety Data Sheet for Typical Water-Based Adhesive .....	15
Exhibit 2-3: Material Safety Data Sheet for Typical Acetone Based Canister Adhesive ..	19

## I. INTRODUCTION AND BACKGROUND

There are between 50 and 75 countertop manufacturers in the southern California four county area that includes Los Angeles, Orange, Riverside and San Bernardino. There may be as many as 400 cabinet manufacturers and 1,000 woodworking manufacturers in the same four county area. Most of these companies are small and medium sized businesses.

Many of the countertop, cabinet and woodworking companies manufacture countertops. The companies use adhesives to bond veneer to wood, particleboard and medium density fiberboard. Many manufacturers have post-forming operations where the edges of the countertops are bonded using adhesives.

Several years ago, adhesive formulators used 1,1,1-trichloroethane (TCA) in the adhesives they offered to this industry. TCA production was banned in 1996 because TCA contributes to stratospheric ozone depletion. In the mid to late 1990s, the formulators stopped using TCA and they began formulating with alternatives like methylene chloride (METH) and various types of non-chlorinated solvents including toluene, xylene, methyl ethyl ketone (MEK), hexane and heptane. Companies that manufactured countertops converted to adhesives that relied on METH or the other VOC solvents. They also used many of these same solvents to clean their application equipment.

METH is a suspect carcinogen. It is classified as a Hazardous Air Pollutant (HAP) by EPA and is listed on California's Proposition 65. The chemical is a listed RCRA hazardous waste and it is regulated as a Toxic Air Contaminant in California. Several of the other solvents used in the adhesives also have problems. They are generally classified as Volatile Organic Compounds (VOCs) that contribute to photochemical smog. Toluene, xylene, MEK and hexane are classified as HAPs and are listed on Proposition 65.

Workers in the companies that use adhesives are exposed to the solvents and people who live and work in the communities surrounding the manufacturing facilities are also exposed to them. Most of the spent cleaners used to clean the adhesive spray equipment are classified as hazardous waste and, if they are not handled properly, they can contaminate the sites. Rags are sometimes used in the cleaning process and these rags are often sent to industrial laundries and the solvents they contain are discharged in the wastewater.

The major goal of this project, which was initiated in October of 2002, was to work with seven countertop manufacturers to assist them in adopting adhesives and cleanup materials that are more protective of human health and the environment. The technical assistance was provided by the Institute for Research and Technical Assistance (IRTA), a nonprofit organization. IRTA was established in 1989 to assist companies in converting to low- and non-solvent technologies in a variety of applications including cleaning and



adhesives. IRTA runs and operates the Pollution Prevention Center (PPC), a loose affiliation of several government entities and a large electric utility. Members include:

- EPA Region IX
- Cal/EPA's Department of Toxic Substances Control
- California Department of Health Services Hazard Evaluation System & Information Service (HESIS)
- South Coast Air Quality Management District
- Santa Barbara County Air Pollution Control District
- Los Angeles County Sanitation Districts
- City of Los Angeles Bureau of Sanitation
- Orange County Sanitation District
- Southern California Edison

The South Coast Air Quality Management District (SCAQMD) regulates air emissions in southern California in the four counties listed above. The SCAQMD regulates emissions from adhesive operations in Rule 1168 "Adhesive and Sealant Applications." SCAQMD staff modified Rule 1168 to include a provision that prohibited the sale and use of high VOC adhesives after September 1, 2001. The VOC limit set for contact adhesives was 250 grams per liter. In order to comply with this provision, most of the formulators began reformulating their adhesives with METH, which is not classified as a VOC. Many of the companies manufacturing countertops started using METH based adhesives. At that stage, IRTA began seeking participants for the project.

IRTA began work on this project and became aware of the general conversion away from VOC solvents to METH. IRTA staff informed the SCAQMD of the effect of the regulation to tighten the VOC levels. Because METH is a Toxic Air Contaminant, the District added a new provision to Rule 1168. The new provision prohibited the sale of METH based adhesives after January 1, 2004. It allowed the sales or use of METH based adhesives for an additional year if the product was manufactured before January 1, 2004 and if the date of manufacture was displayed on the product. Thus, by January 1, 2005, METH based adhesives cannot be sold or used in the jurisdiction of the SCAQMD. The SCAQMD also amended the rule to restrict the VOC content of the adhesives even more. On January 1, 2003, the VOC content of contact adhesives used or sold in the Basin was set at 80 grams per liter or less.

SCAQMD Rule 1171 regulates the VOC content of cleaners. The countertop manufacturers IRTA worked with during this project use cleanup solvents for two purposes. First, some of them use materials to clean the spray guns that are commonly used to apply the adhesives. Rule 1171 specifies that the cleaning agents used for this purpose must have a VOC content of 550 grams per liter or less. Beginning on July 1, 2005, the rule requires the cleaners to have a VOC content of 25 grams per liter or less. Second, some of the companies used cleaners to remove small amounts of cured adhesive residue from the countertops before they are shipped to their customers. Rule 1171 has no VOC limit for the cleaners used for this purpose.

During the project, IRTA worked with several companies in the four county area in southern California that converted to adhesives that met the 80 gram per liter VOC level and that did not contain METH. Because the Rule 1171 regulation on spray gun cleaners allows a level of 25 grams per liter in 2005, IRTA tried to test and find alternative cleaners that met this lower level. In addition, for cleaning the cured adhesive residue from the finished countertops, IRTA tested cleaners that met the 25 gram per liter limit even though there is no VOC limit for these cleaners.

The project findings indicate that companies that manufacture countertops can use adhesives that do not contain METH and that have a VOC content less than 80 grams per liter. These adhesives are available, they meet production requirements and they are cost effective. The findings also indicate that cleanup solvents that meet the 25 gram per liter VOC level can also be used effectively for cleaning spray equipment and adhesive residue. The results of the project could be transferred to manufacturers in southern California who have not yet adopted compliant alternatives. The results are also applicable to companies in other parts of the country that do not currently have regulations that restrict the use of VOC and METH based adhesives.

## II. ANALYSIS OF ALTERNATIVE ADHESIVES AND CLEANUP MATERIALS

### ALTERNATIVE ADHESIVES

All of the companies that participated in the project manufacture countertops. These companies sell their countertops to countertop suppliers like Home Depot or to other contractors and custom suppliers. In all cases, the adhesives now used by the companies are low in VOC content and do not rely on METH.

Figure 2-1 shows a typical countertop during the manufacturing process. As is conventional, the manufacturing process involves bonding a laminate (the finish) to a particle board base. Note that the sides of the countertop are unfinished. The manufacturer uses a post forming process called edge banding to bond the laminate to the unfinished particleboard sides.



Figure 2-1 Typical Countertop

Historically, companies used two methods to apply adhesives in the manufacturing process. First, some manufacturers used spray guns to apply the adhesive, which is purchased in containers ranging in size from five gallons to drum quantities. A typical high volume low pressure (HVLP) spray gun for applying adhesive is shown in Figure 2-2. Second, companies used adhesive canisters to apply the adhesive. A typical canister is shown in Figure 2-3. Canisters generally contain about 30 pounds of adhesives and they

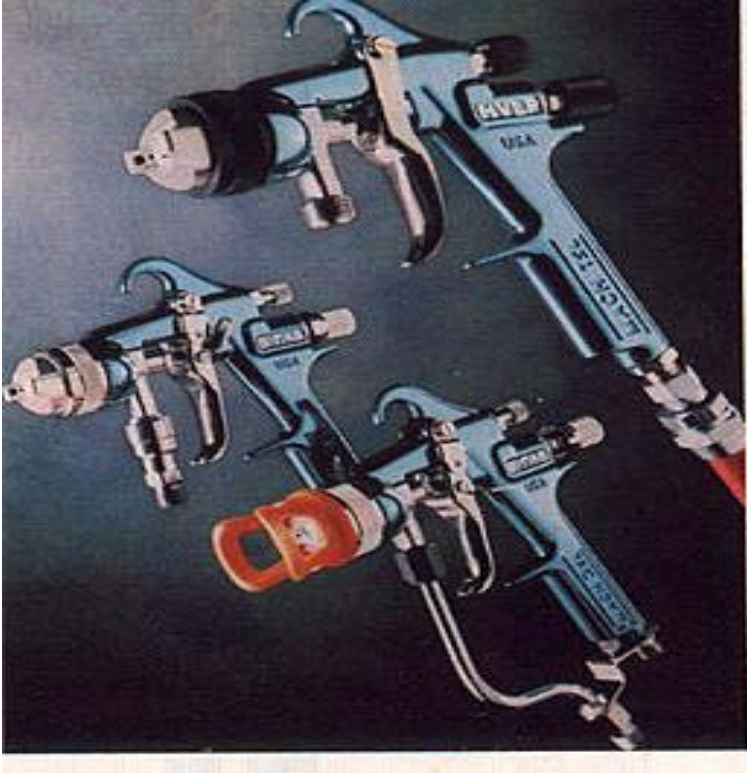


Figure 2-2 Typical HVLP Spray Gun



Figure 2-3 Typical Canister Adhesive

include a spray device attached to the canister. In some cases, the company uses the spray device provided with the canister; in other cases, companies remove this spray device and use a typical spray gun to apply the adhesive from the canister. The canister is discarded after use.

Countertop manufacturers typically use either METH based or high VOC content adhesives. There are three generic alternatives that are now available. These include:

- Polyvinyl Acetate (PVA) adhesives which are based on a water carrier
- Water-based adhesives which are also based on water as a carrier
- Acetone based adhesives that use an acetone carrier

Material Safety Data Sheets (MSDSs) for a typical PVA, Water-Based and acetone-based adhesive are shown in Exhibits 2-1, 2-2 and 2-3 respectively. PVA and water-based adhesives contain no solvents and they are generally applied using a spray gun. Acetone is not classified as a VOC and is low in toxicity. Some of the acetone adhesives that are used today are sold in canister form. Acetone has a very high vapor pressure and most often, it is combined with another solvent in small amounts to reduce the evaporation rate. The other solvent used in the product shown in Exhibit 2-3 is cyclohexane, which is classified as a VOC. This product meets the 80 gram per liter VOC content limit set in Rule 1168.

#### ALTERNATIVE CLEANUP MATERIALS

As discussed earlier, companies that manufacture countertops perform two types of cleaning. First, they clean their spray equipment. Second, they clean the overspray from the finished countertops. When manufacturers use adhesives based on METH or high VOC solvents, they clean the spray guns and the finished countertops with METH or VOC solvents. The companies that converted to PVA or water-based adhesives can clean their spray application equipment with plain water or formulated water-based cleaners. Companies that converted to acetone based adhesives can clean their spray equipment with acetone.

Cleaning the overspray of the adhesive from the finished counter tops is more difficult because the adhesive is generally cured and is difficult to remove. Companies can change their process to remove the adhesive residue earlier in the process before it is cured. In this case, a water-based cleaner would be effective in removing the residue. Acetone is effective in removing some of the cured adhesive residue. IRTA also tested a combination of acetone and water, which was often effective in removing the cured residue.

**EXHIBIT 2-1**  
**Material Safety Data Sheet for Typical Polyvinyl Acetate Adhesive**



# Material Safety Data Sheet

Section 1. Chemical Product and Company Identification			
Common Name	<b>Wilsonart (WA) 3000</b>	Code	USA16381
Supplier	WILSONART INTERNATIONAL INC. P.O. BOX 6110 2400 Wilson Place, Temple, TX 76503-6110 Phone: 800-433-3222 or 254-207-7000	MSDS#	16381
Synonym	Also known as: <b>Lokweld<sup>®</sup> (LW) 3000</b>	Validation Date	05/04/2000
Trade name	Wilsonart (WA) 3000	Print Date	05/15/2000
Material Uses	Spray grade adhesive for laminate.	Responsible Name	Wilsonart International Inc.
Manufacturer	WILSONART INTERNATIONAL, INC. P.O. BOX 6110, Temple, TX 76503-6110 Information Phone: 254-207-7000 or 800-433-3222	In Case of Emergency:	CHEMTREC: 800-424-9300 (USA) 703-527-3887 (International)

Section 2. Composition and Information on Ingredients			
Name	CAS #	% by Weight	Exposure Limits
Trade secret.	NJTSRN 950001	5-15	Not available.
Vinyl Acetate homopolymer	9003-20-7	15 - 40	Not available.
Residual Vinyl acetate monomer	108-05-4	<0.5	STEL: 20 (mg/m <sup>3</sup> ) from ACGIH (TLV) TWA: 10 (ppm) from ACGIH (TLV) TWA: 35 (mg/m <sup>3</sup> ) from ACGIH STEL: 70 (mg/m <sup>3</sup> ) from ACGIH

Section 3. Hazards Identification	
Physical State and Appearance	Liquid.
Emergency Overview	INHALATION MAY IRRITATE RESPIRATORY TRACT. AVOID BREATHING SPRAY MISTS. MILDLY IRRITATING TO THE EYES.
Routes of Entry	Skin contact. Eye contact. Inhalation. Ingestion.
Potential Acute Health Effects	<i>Eyes</i> Mildly irritating to the eyes. <i>Skin</i> Non-irritating to the skin. <i>Inhalation</i> May cause irritation of upper respiratory tract. <i>Ingestion</i> Not an expected route of entry. May cause mild gastric irritation.
Potential Chronic Health Effects	No additional information.
Medical Conditions Aggravated by Overexposure:	Repeated or prolonged exposure is not known to aggravate any medical condition.
Overexposure /Signs/Symptoms	Inflammation of the eye is characterized by redness, watering, and itching.
See Toxicological Information (section 11)	

*Continued on Next Page*

**Section 4. First Aid Measures**

Eye Contact	In case of contact with eyes, rinse immediately with plenty of water. If irritation persists, get medical attention.
Skin Contact	Wash contaminated skin with soap and water. Wash contaminated clothing before reusing.
Inhalation	If symptoms are present, allow the victim to rest in a well ventilated area. Oxygen may be administered if breathing is difficult. If symptoms persist, seek medical attention.
Ingestion	Remove dentures if any. Have conscious person drink several glasses of water or milk. NEVER give an unconscious person anything to ingest. Induce vomiting by giving syrup of ipecac. Lower the head so that the vomit will not reenter the mouth and throat. Seek medical attention.
Notes to Physician	No additional information.

**Section 5. Fire Fighting Measures**

Flammability of the Product	Non-flammable.
Auto-ignition Temperature	Not applicable.
Flash Points	Not applicable.
Flammable Limits	Not applicable.
Products of Combustion	Not applicable.
Fire Hazards in Presence of Various Substances	Not applicable.
Explosion Hazards in Presence of Various Substances	Not considered a product presenting risks of explosion.
Fire Fighting Media and Instructions	Non-flammable.
Protective Clothing (Fire)	Fire fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear.
Special Remarks on Fire Hazards	Non combustible.
Special Remarks on Explosion Hazards	No additional remark.

**Section 6. Accidental Release Measures**

Small Spill and Leak	Absorb with an inert material and place in an appropriate waste disposal container.
Large Spill and Leak	Prevent entry into sewers, basements or confined areas; dike if needed. Absorb with an inert material and put the spilled material in an appropriate waste disposal.


**Section 7. Handling and Storage**

Handling	After handling, always wash hands thoroughly with soap and water. Avoid breathing vapors of this product. Avoid contact with skin and eyes.
Storage	Keep container tightly closed in a cool, well-ventilated place. Do not freeze. Keep out of the reach of children.

Continued on Next Page



**Section 8. Exposure Controls/Personal Protection**

<b>Engineering Controls</b>	Provide exhaust ventilation or other engineering controls to control mists and to keep the airborne concentrations of vapors below their respective threshold limit value.
<b>Personal Protection</b>	<p><i>Eyes</i> Splash goggles or safety glasses with side shields.</p> <p><i>Body</i> No special precautions are necessary if used as intended.</p> <p><i>Respiratory</i> A respirator is not needed under normal and intended conditions of product use. In case of insufficient ventilation, wear an approved (NIOSH) respirator with organic vapor cartridges with dust/mist pre-filter.</p> <p><i>Hands</i> No special precautions are necessary if used as intended.</p> <p><i>Feet</i> No special precautions are necessary if used as intended.</p>
<b>Protective Clothing (Pictograms)</b>	
<b>Personal Protection in Case of a Large Spill</b>	In case of insufficient ventilation, wear an approved (NIOSH) respirator with organic vapor cartridges. Splash goggles. Boots. Full suit. Gloves (neoprene or latex)
<b>Product Name</b>	<b>Exposure Limits</b>
Trade secret.	Not available.
Vinyl Acetate homopolymer	Not available.
residual vinyl acetate monomer	STEL: 20 (mg/m <sup>3</sup> ) from ACGIH (TLV) TWA: 10 (ppm) from ACGIH (TLV) TWA: 35 (mg/m <sup>3</sup> ) from ACGIH STEL: 70 (mg/m <sup>3</sup> ) from ACGIH
Consult local authorities for acceptable exposure limits.	

**Section 9. Physical and Chemical Properties**

<b>Physical State and Appearance</b>	Liquid.	<b>Odor</b>	Pleasant.
<b>Molecular Weight</b>	Not applicable.	<b>Taste</b>	Not available.
<b>Molecular Formula</b>	Not applicable.	<b>Color</b>	pink
<b>pH (1% Soln/Water)</b>	5		
<b>Boiling/Condensation Point</b>	370°C (698°F)		
<b>Melting/Freezing Point</b>	Not available.		
<b>Critical Temperature</b>	Not available.		
<b>Specific Gravity</b>	1.062 (Water = 1)		
<b>Vapor Pressure</b>	Not available.		
<b>Vapor Density</b>	Not available.		
<b>Volatility</b>	42%		
<b>Odor Threshold</b>	Not available.		
<b>Evaporation Rate</b>	Not available.		
<b>VOC</b>	< 20 g/L		
<b>Continued on Next Page</b>			

<b>Wilsonart (WA) 3000</b>		<b>Page: 4/7</b>
Viscosity	2850 cps (Brookfield Viscometer)	
LogK <sub>ow</sub>	Not available.	
Ionicity (in Water)	Not available.	
Dispersion Properties	Not available.	
Solubility	Partially soluble in cold water.	
Physical Chemical Comments	No additional information.	

<b>Section 10. Stability and Reactivity</b>	
Stability and Reactivity	The product is stable.
Conditions of Instability	No additional remark.
Incompatibility with Various Substances	Reactive with oxidizing agents, acids, alkalis, reducing agents.
Hazardous Decomposition Products	Products of combustion include: carbon oxides (CO, CO <sub>2</sub> )
Hazardous Polymerization	Will not occur.

<b>Section 11. Toxicological Information</b>	
Toxicity to Animals	<p>This product may contain small amounts of vinyl acetate, vapors of which have been shown to cause tumors in the thyroid gland, uterus and respiratory tract of laboratory animals. There is no evidence that it has caused cancer in humans.</p> <p>The plasticizer in this product has been tested for potential reproductive and teratogenic effects. When administered orally to rats and mice at doses which produced toxic effects in the mother, tissue and skeletal malformations were noted. However, no effects were seen in the rabbits treated with this compound.</p> <p>This product contains a chemical that is a suspected endocrine disrupter. Endocrine/hormone disrupters are external agents that interfere with the role of natural hormones in the body. While a variety of chemicals have been found to cause endocrine disruption in laboratory animals, adverse effects in humans have not been established. (US EPA Special Report on Endocrine Disruption, February 1997.)</p>
Chronic Effects on Humans	No additional information.
Other Toxic Effects on Humans	No additional information.
Special Remarks on Toxicity to Animals	No additional remark.
Special Remarks on Chronic Effects on Humans	Vinyl acetate is metabolized to acetaldehyde, which has an IARC 2B (possibly carcinogenic to humans) classification, it has also been listed in Category 2B. May contain traces of formaldehyde; formaldehyde is classified 2A by IARC (probable human carcinogen).
Special Remarks on Other Toxic Effects on Humans	No additional remark.

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**Section 12. Ecological Information**

Ecotoxicity	Not available.
BOD5 and COD	Not available.
Biodegradable/OECD	Not available.
Mobility	Not determined.
Toxicity of the Products of Biodegradation	Not available.
Special Remarks on the Products of Biodegradation	No additional remark.

**Section 13. Disposal Considerations**

Waste Information	Spilled, contaminated, or waste material should be put into a suitable container and handled according to local, state/provincial, and federal regulations.
Waste Stream	Not available.
Consult your local or regional authorities.	

**Section 14. Transport Information**

DOT Classification	Not a DOT controlled material (United States).	
Marine Pollutant	Not a Marine Pollutant.	
Special Provisions for Transport	No additional remark.	
ADR/RID Classification	Not controlled under ADR (Europe).	
IMO/IMDG Classification	Not controlled under IMDG.	
ICAO/IATA Classification	Not controlled under IATA.	

**Section 15. Regulatory Information**

HCS Classification	May cause mild eye irritation. May cause slight irritation of upper respiratory tract.
U.S. Federal Regulations	TSCA 8(b) Inventory: All ingredients are listed. SARA 302/304/311/312 extremely hazardous substances: No products were found. SARA 302/304 emergency planning and notification: No products were found. SARA 302/304/311/312 hazardous chemicals: No products were found. SARA 311/312 MSDS distribution - chemical inventory - hazard identification: No products were found. SARA 313 toxic chemical notification and release reporting: NJTSRN 950001 Clean water act (CWA) 307: NJTSRN 950001 Clean water act (CWA) 311: No products were found. Clean air act (CAA) 112 accidental release prevention: No products were found. Clean air act (CAA) 112 regulated flammable substances: No products were found. Clean air act (CAA) 112 regulated toxic substances: NJTSRN 950001

Continued on Next Page

<b>Wilsonart (WA) 3000</b>		Page: 6/7
<b>International Regulations</b>		
EINECS	Not available.	
DSCL (EEC)	R36/37- Irritating to eyes and respiratory system.	
International Lists	No products were found.	
<b>State Regulations</b>	New Jersey RTK: NJTSRN950001  California Prop. 65: This product contains the following ingredients known to the State of California to cause cancer: Formaldehyde (50-00-0) in trace amounts, Acetaldehyde (75-07-0).	

<b>Section 16. Other Information</b>													
<b>Label Requirements</b>	INHALATION MAY IRRITATE RESPIRATORY TRACT. AVOID BREATHING SPRAY MISTS. MILDLY IRRITATING TO THE EYES.												
<b>Hazardous Material Information System (U.S.A.)</b>	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr><td>Health</td><td style="text-align: center;">*</td><td style="text-align: center;">1</td></tr> <tr><td>Fire Hazard</td><td style="text-align: center;">0</td><td></td></tr> <tr><td>Reactivity</td><td style="text-align: center;">0</td><td></td></tr> <tr><td>Personal Protection</td><td></td><td style="text-align: center;">A</td></tr> </table> <div style="display: inline-block; vertical-align: middle; margin-left: 20px;"> <p><b>National Fire Protection Association (U.S.A.)</b></p>  </div>	Health	*	1	Fire Hazard	0		Reactivity	0		Personal Protection		A
Health	*	1											
Fire Hazard	0												
Reactivity	0												
Personal Protection		A											
<b>References</b>	-SAX, N.I. Dangerous Properties of Industrial Materials, Toronto, Van Nostrand Reinold, 6e ed. 1984. -Patty's Industrial Hygiene and Toxicology -Manufacturer's Material Safety Data Sheet. <b>GLOSSARY:</b> ACGIH - American Conference of Governmental Industrial Hygienists ASTM - American Society for Testing and Materials ADR - Agreement on Dangerous Goods by Road (Europe) BOD5 - Biological Oxygen Demand in 5 days CAS - Chemical Abstract Services CEPA - Canadian Environmental Protection Act CERCLA - Comprehensive Environmental Response, Compensation and Liability Act CFR - Code of Federal Regulations DOT - Department of Transportation DSCL - Dangerous Substances Classification and Labeling (Europe) DSL - Domestic Substance List (Canada) EEC/EU - European Economic Community/European Union EINECS - European Inventory of Existing Commercial Chemical Substances HCS - Hazard Communication System HMIS - Hazardous Material Information System IARC - International Agency for Research on Cancer LD50/LC50 - Lethal Dose/Concentration kill 50% LDLo/LCLo - Lowest Published Lethal Dose/Concentration NFPA - National Fire Prevention Association NIOSH - National Institute for Occupational Safety & Health NTP - National Toxicology Program OSHA - Occupational Safety & Health Administration PEL - Permissible Exposure Limit RCRA - Resource Conservation and Recovery Act SARA - Superfund Amendments and Reorganization Act STEL - Short Term Exposure Limit (15 minutes) TDG - Transportation of Dangerous Goods (Canada) TLV-TWA - Threshold Limit Value-Time Weighted Average TSCA - Toxic Substances Control Act WHMIS - Workplace Hazardous Material Information System												
<b>Other Special Considerations</b>	No additional remark.												
<b>Validated by Wilsonart International Inc. on 05/04/2000.</b>	<b>Verified by Wilsonart International Inc.</b>												
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Printed 05/15/2000.

CHEMTREC:  
800-424-9300 (USA)  
703-527-3887 (International)

**Notice to Reader**

*To the best of our knowledge, the information contained herein is accurate. However, neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.*

**EXHIBIT 2-2**  
**Material Safety Data Sheet for Typical Water-Based Adhesive**

# RooTac™

## I. PRODUCT IDENTIFICATION

Trade Name                      RooTac™

Manufacturer                    Roo Products, Inc.  
2475 Progress Way  
Woodburn, OR 97071

Contact                          503-981-5640  
E-mail: rooglue@aol.com  
http://www.rooglue.com

Chemical Family                Modified Polychloroprene latex

DOT Shipping Name            NE

Date/ version                    02/04/03 ver. 1.3  
Originator/contact person    Sheryl Southwell

Health	2
Flammability	0
Reactivity	0
Personal Protection	B

## II. OSHA REGULATED INGREDIENTS

<u>Ingredients</u>	<u>CAS #</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>OSHA STEL</u>	<u>Approx. %</u>
Mineral Spirits	NE	100 ppm	100 ppm	NE	<5 %/wt.
Aqueous Zinc Oxide	NE	NE	NE	NE	<5 %/wt

**NOTE: See section XII for other regulatory information**

## III. PRECAUTIONARY INFORMATION

- Product is not considered hazardous under normal conditions.
- Direct contact of product with eyes may cause irritation and/or tissue damage.
- Prolonged or repeated contact with skin may cause irritation.

## IV. EMERGENCY and FIRST AID PROCEDURES

Eyes	Flush immediately with water for 15 minutes. Consult a physician if irritation persists.
Skin	Wash affected area with soap and water. Wash contaminated clothing before reuse.
Inhaled	Remove subject to fresh air.
Fire	Product is non-flammable in the liquid state. Use water spray, foam, dry chemical or carbon dioxide on dried product.
Spill	Collect and remove using inert absorbent. Contain spill entering sewers. Notify appropriate agencies.

**V. PHYSICAL DATA**

Physical State	Milky liquid
Boiling Point	>200°F
Solubility in Water	Dilutable
VOC Minus Water	68 grams/liter

**VI. PERSONAL PROTECTION EQUIPMENT**

Eyes	It is highly recommended that users wear chemical safety goggles to reduce the potential for eye contact. Eye wash fountain should be available.
Skin	Use impermeable chemical gloves and wear appropriate protective clothing. Launder contaminated clothing before reuse.
Respiratory	Respiratory protection is not normally required. Use NIOSH/MSHA approved respirator if conditions warrant.
Ventilation	Standard industrial ventilation is recommended.

**VII. FIRE PROTECTION**

Flash Point	Non-flammable
Extinguishing media	Non-flammable in liquid state; use water spray, foam, dry chemical. Use carbon dioxide on dried product.
Unusual Fire and Explosion Hazard	Personnel exposed to products of combustion should wear self-contained breathing apparatus and full protective equipment. Containers exposed in a fire should be cooled with water to prevent vapor pressure buildup leading to a rupture.

**VIII. REACTIVITY INFORMATION**

Stability	Stable
Incompatibility	Not Established
Hazardous decomposition	Combustion of the dried product can yield low molecular weight hydrocarbons such as carbon monoxide and carbon dioxide.
Hazardous Polymerization	Will not occur

**IX. EFFECT OF OVEREXPOSURE**

Eyes	Eye contact with liquid may cause irritation.
Skin	Repeated or prolonged skin contact with liquid may cause irritation
Inhalation	No expected effects.



### EFFECT OF OVEREXPOSURE - *Continued*

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Chronic            No anticipated effects. This product does not contain regulated levels of NTP, IARC or OSHA listed carcinogens

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Existing Health Conditions Affected by Exposure - No known effects on other illnesses

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### X. SPILL and DISPOSAL INFORMATION

Small Spills      Should be contained using absorbent material, such as clay, soil or any commercially available absorbent. Shovel reclaimed liquid and absorbent into recovery or salvage drums for disposal.

Large Spills      Should be diked to prevent further movement and reclaim into recovery or salvage drums for disposal.

Disposal           This product **does not** meet the definition of **hazardous waste** under the U.S. EPA Hazardous Waste Regulations 40 CFR 261. Consult your state or local authorities for proper disposal in the event more restrictive requirements apply.

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**XI. STORAGE**      Protect from freezing - product stability may be affected.

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### XII. REGULATORY INFORMATION

TOSCA              This product meets the compositional requirements of the Toxic Substances Control Act and contains only chemical ingredients that are listed on the TOSCA inventory.

SARA Title III, Sec. 313    This product contains toxic chemical(s) at or above the de minimus concentrations subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40 CFR part 372.

California Prop. 65        "WARNING": This product contains detectable amounts of a chemical(s) known to California to cause cancer and/or birth defects or other reproductive harm.

Canadian EPA              This product contains only chemical ingredients that are listed on the Domestic Substance List of the Canadian Environmental Agency.

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### ABBREVIATIONS

NA - Not applicable, NE - Not established, NSR - No special requirement, ND - Not determined

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Roo Products, Inc. believes that the information provided is accurate and reliable as of the date of this material safety data sheet and is given in good faith. No warranty expressed or implied is made as to the accuracy, reliability or completeness of the information. Any use of this data and information must be determined by the user to be in accordance with applicable Federal, State and local laws and regulations. Roo Products, Inc. urges persons receiving this information to make their own determination as to the information's suitability and applicability for an intended use.

Note: This information must be included in all MSDS that are copied and distributed for this material.

**EXHIBIT 2-3**  
**Material Safety Data Sheet for Typical Acetone Based Canister Adhesive**



**MATERIAL SAFETY DATA SHEET**

Westech Aerosol Corporation  
Olympic View Industrial Park  
5405 Constance Drive SW  
Port Orchard, WA 98367

Chemtree Emergency Phone: 800-424-9300  
Westech Emergency Phone: 360-674-2051  
Date Prepared: 5-31-01  
Revised: 3-23-04

**Section 1 - Identity (Canisters)**

Label Name: Westech High Strength & Multi-Purpose  
Trade Name: Westech WT-HSC13 & WT-MPC13

**Section 2 - Hazardous Ingredients**

Components: Hazardous Components 1% or greater.

Chemical Name	CAS Number	Sara III List	OSHA (PPM)	ACGIH TLV(PPM)	Carcinogen Ref. Source
Acetone	67-64-1	No	1000	750	No
Cyclohexane	110-82-7	Yes	300		No

**Section 3 - Physical and Chemical Characteristics**

Propellant: Non-flammable proprietary  
VOC: <80 grams per liter (SCAQMD rule 443.1 and 1168)  
HAP's: 0%  
Boiling Point: 177°F  
Specific Gravity: Concentrate Only 0.6-0.8  
Vapor Pressure: 78mm  
Evaporation Rate: >1  
Solubility in Water: Negligible  
Water Reactive: No  
Appearance and Odor: Clear, organic solvent odor

**Section 4 - Fire and Explosion Hazard Data**

Flammability as per Flame Projection Test (16 CFR 1500.45)

**Flammable**

**Limits:**

LEL: 1.3%

UEL: 8%

Extinguishing Media: Dry Chemical, CO2

Unusual Fire and Explosion Hazards: At elevated temperatures (over 130°F), containers may vent, rupture or burst releasing flammable vapors.

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**Section 5 - Health Hazard Data**

**Primary Routes of Entry:** Inhalation and Skin

**Acute Effects:** Liquid is irritating to eyes and Skin. Prolonged exposure to skin can cause a burning sensation. Breathing vapors may cause lightheadedness, dizziness, headache, and nausea in extreme cases unconsciousness and death.

**Chronic Effects:** Prolonged and repeated exposure may produce depression, fatigue, loss of appetite, vomiting, cough, loss of sense of balance, dermatitis and nerve damage.

**Medical Conditions generally aggravated by Exposure:** Existing eye, skin or upper respiratory conditions.

**Emergency and First Aid Procedures:**

**Eye Contact:** Flush with water for 15 minutes, seek medical attention

**Skin Contact:** Wash with soap and water, if irritated seek medical attention

**Inhalation:** Remove to fresh air. Resuscitate if necessary, get medical attention

**Ingestion:** Do not induce vomiting, get medical attention.

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**Section 6 - Reactivity Data**

**Stability:** Stable

**Hazardous Polymerization:** Will not occur

**Incompatibility:** Strong oxidizing agents

**Conditions to Avoid:** Open flames and high heat.

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**Section 7- Precautions for Safe Handling**

**Use Respiratory Protection:** If vapor concentration exceeds TLV, use respirator approved by NIOSH

**Ventilation:** Use ventilation to keep vapor concentration below TLV.

**Eye Protection:** Safety Goggles Recommended

**Waste Disposal Method:** Dispose of in accordance with all Federal, state, and local regulations.

**Steps to be taken in Case Material is Released or Spilled:** Remove all sources of ignition. Ventilate spill area to allow solvents to evaporate and collect in suitable containers for disposal. Use appropriate person protective equipment.

**Precautions to be taken in Handling and Storage:** Store containers in cool, dry area. Do not puncture or incinerate containers.

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**Section 8 - Control Measures**

**Respiratory Protection:** If workplace exposure is exceeded a NIOSH approved respirator is advised.

**Ventilation:** Provide sufficient mechanical ventilation to maintain exposure below PEL.

**Eye Protection:** Use chemical splash goggles

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**Section 9 - Shipping Information**

**Proper Shipping Name:** Adhesives

**Hazard Class:** 3

**Identification Number:** UN1133

**Packing Group:** III

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*We believe the statements, technical information and recommendations contained herein are reliable, they are given without warranty or guarantee of any kind.*

## ANALYSIS OF ALTERNATIVES

Seven companies volunteered to participate in the project. These companies include:

- Sani-Top, Inc.
- V-T Industries West
- Architectural Woodworking Company
- Universal Laminates
- The Countertop Factory
- Closet World
- United Cabinet Company. Inc.

Sani-Top, V-T Industries West and The Countertop Factory exclusively manufacture countertops. Architectural Woodworking, Universal Laminates, Closet World and United Cabinet Company manufacture different types of wood items including countertops. IRTA worked with these companies on adhesive and cleaning alternatives. In some cases, the companies converted away from METH or high VOC adhesives to one of the alternatives. In one case, the company started a new operation and started up with an alternative adhesive. In another case, the company was bought out by another company when they were in the process of converting to an alternative.

The balance of this section presents the analysis for each of the companies that participated in the project. In most cases, the costs of the METH or high VOC adhesive are compared with the costs of the alternative adhesives. In some cases, a cleaning agent cost comparison is also presented. IRTA developed case studies for most of the companies participating in the project. These case studies are individual stand-alone descriptions of the conversions including the cost analysis. The case studies are provided in the Appendix to this report.

### Sani-Top, Inc.

Sani-Top, Inc. was a counter top manufacturer located in Gardena, California. IRTA began working with the company in early 2002. In June of 2002, the company was acquired by V-T Industries, a company headquartered in Holstein, Iowa. The Sani-Top brand name was later phased out and transitioned to the brand name V-T West, California.

When IRTA began working with Sani-Top, the company produced between 1,200 and 1,800 counter tops each day. Most of the counter tops manufactured by the company were sold to hardware stores like Home Depot where they are purchased by contractors.

Sani-Top had two automated lines for manufacturing the counter tops. The base of the counter top, made of particle board, moved down a conveyor. Adhesive was applied on the conveyor line to bond a veneer to the particle board. When IRTA began work with the company, they were completing a conversion from methylene chloride and high VOC based adhesives to waterborne adhesives for much of the production. The company was still testing alternatives in their touch-up edge banding operation and had not yet

identified a suitable low-VOC, non-METH adhesive. Sani-Top is located in the jurisdiction of the South Coast Air Quality Management District (SCAQMD) and the regulation setting limits on VOC and METH adhesives applied to the company.

IRTA worked with Sani-Top to find alternatives in two cleaning operations. In the first operation, the workers were using perchloroethylene (PERC) to remove adhesive overspray that remained on the finished counter tops. At the end of the process, these counter tops were handwiped with PERC just before they were shipped. Sani-Top used two gallons per week of the solvent at a cost of about \$9 per gallon. The total cost of purchasing the PERC each year amounted to \$936. The SCAQMD charges a fee on emissions of toxic chemicals, including PERC. The annual emissions fee for the PERC totaled \$315. The total yearly cost of using PERC in this operation was \$1,251.

IRTA tested two alternatives with Sani-Top. The first alternative was a blend that contained 80% acetone and 20% water. The second formulation was a water-based alkaline cleaner called Spray Clean 12 diluted to 50% concentration with water. Both cleaners were as effective as the PERC in removing the adhesive overspray. The company estimated, during the testing, that they would use two gallons of each of these cleaners per week. The cost of the acetone blend is \$3.20 per gallon and the cost of the water-based cleaner is \$5 per gallon. The annual cost of using the acetone blend and the water-based cleaner would be \$333 and \$520 per year respectively.

Table 2-1 shows the cost comparison for PERC, the acetone blend and the water-based cleaner. The cost of using both of the alternatives is significantly less than the cost of using PERC. Conversion to the acetone blend would reduce the company’s cleaning cost by about 73%. Conversion to the water-based cleaner would reduce the cleaning cost by 56%.

**Table 2-1  
Annualized Cost Comparison for Sani-Top Adhesive Overspray Cleaning Process**

	PERC	Acetone Blend	Water-Based Cleaner
Cleaner Cost	\$936	\$333	\$520
Emission Fees	\$315	-	-
Total Cost	\$1,251	\$333	\$520

The second cleaning operation at Sani-Top was a weekly cleaning of the adhesive spray system. The whole system was torn down and cleaned each week. The fluid nozzles and caps in the system were cleaned every day. For this operation, the company used 55 gallons annually of a cleaner called Sani-Pine, which was apparently based on a pine terpene, which is a VOC. The cost of this cleaner was \$245 for a 55 gallon drum.

IRTA tested an alternative water-based cleaner with virtually zero VOC content in this operation. Sani-Top tested the cleaner, the same cleaner tested for cleaning the adhesive overspray, at 50% concentration. At this concentration, the cleaner was not strong enough. The cleaner worked well at 100% concentration. Assuming a usage rate of 55 gallons per year, the cost of the alternative cleaner would be \$550 per year.

Table 2-2 shows the cost comparison for the Sani-Pine and the water-based cleaner. The cost of using the low-VOC water-based cleaner is substantially higher than the cost of using the Sani-Pine VOC solvent.

**Table 2-2**  
**Annualized Cost Comparison for Sani-Top Conveyor Line Cleaning Process**

	Sani-Pine	Water-Based Cleaner
Cleaner Cost	\$245	\$550
Total Cost	\$245	\$550

Several months after V-T Industries acquired Sani-Top, the company converted the adhesive operation to use a PVA adhesive. They also adopted a different water-based cleaner for both cleaning operations. Prior to this conversion, Sani-Top used the acetone blend for several months but did not convert to the water-based cleaner for the conveyor line cleaning operation.

If the company had converted the overspray cleaning operation to the acetone blend and the conveyor line cleaning operation to the water-based cleaner, the total cost of cleaning would be reduced from \$1,496 to \$883 annually. Conversion of both processes leads to a net savings of more than \$600 per year.

V-T Industries, Inc.

On August 15, 2002, V-T Industries announced it had acquired Sani-Top, Inc. which is located in Gardena, California. The Sani-Top name was phased out and the company assumed a new identity, V-T West, California. At this stage, the Gardena plant has 55 employees.

V-T Industries' Gardena plant manufactures countertops and it is the only postformed countertop supplier that services all of North America. The countertops are sold to Home Depot and Lowes as well as custom fabricators.

V-T Industries purchases particleboard and bonds high-pressure laminate using adhesive. The company uses a hot melt adhesive, which is 100% solids, and a PVA (Polyvinyl Acetate) adhesive, which is an emulsion of water and vinyl acetate. A Material Safety Data Sheet (MSDS) for the water-based glue was shown in Exhibit 2-1. V-T Industries uses these adhesives at some of their seven countertop manufacturing facilities in the U.S.

The facility in Gardena, California has two manufacturing lines. The first line, a high-speed line, is used to manufacture standard size kitchen cabinets. Countertops run on this line account for about 65 percent of the plant's production. The second line is designed to produce custom size counter tops ranging from 12 to 47 inch for vanities and bars. A picture of one of the lines at V-T Industries West is shown in Figure 2-4.



Figure 2-4 Countertop Manufacturing Line at V-T Industries West

V-T Industries is environmentally conscious. V-T West stopped using solventborne adhesives several years ago. In addition to the hot melt and PVA adhesives, V-T West uses a water-based cleaner to clean the residual overspray on the countertops.

#### Architectural Woodworking Company

Architectural Woodworking Company was established in 1919 and today has about 70 employees. The company, located in Monterey Park, California, is family owned. Architectural Woodworking provides custom manufacturing services to architects, designers and owners of buildings. Products manufactured by the company include desks, counters, workstations, conference tables in a variety of configurations, interior stairs and fine office cabinetry and paneling.

Architectural Woodworking has always been very environmentally conscious. In almost all of their processes, the company has used hot melt and water-based adhesives for many years. In one particular application, bonding metal to wood, the company historically used a methylene chloride (METH) based adhesive. A picture of one of the company's adhesive lines is shown in Figure 2-5.





Figure 2-5 Production Line at Architectural Woodworking

METH is a suspect carcinogen and is classified as a Toxic Air Contaminant in California. South Coast Air Quality Management District (SCAQMD) Rule 1168 has prohibited the sale of METH adhesives by January 2004. The regulation allows adhesives manufactured in 2004 to be sold and used for an additional year.

Architectural Woodworking wanted to eliminate their METH based adhesive. The company tested alternatives and decided to adopt a water-based adhesive for bonding the metal to wood. The company has been using the alternative adhesive for several months and is happy with it.

Architectural Woodworking used about two gallons of the METH based adhesive per month. The adhesive product was a canister, which holds 27 pounds or about three gallons. The price of a canister is \$300. On this basis, the annual cost of purchasing the METH based adhesive was \$2,400 per month. Architectural Woodworking uses the same amount of water-based adhesive today. The price of the water-based adhesive, which is not a canister product, is \$45 per gallon. This leads to an annual cost for the adhesive of \$1,080.

At the end of the day, one of the employees cleans the spray guns used to apply coatings. Several years ago, the company used lacquer thinner in a container for cleaning the guns. It required about 10 minutes and was performed with a small container holding the solvent. The employee disassembled the guns and cleaned them with a brush. The company estimates that 3.5 gallons of lacquer thinner were used to clean the guns each month. At a price of \$6.65 per gallon, the annual cost of cleanup amounted to \$279.

Architectural Woodworking converted from lacquer thinner to acetone which is lower in toxicity and is not classified as a VOC. The same amount of acetone is used for cleaning. The price of acetone is higher than the price of lacquer thinner, at \$9 per gallon. On this basis, the cleanup cost now totals \$378 annually.

IRTA provided Architectural Woodworking with an automated spray gun cleaner. The company is testing the cleaning system using acetone as the cleanup solvent. The testing will show whether using the spray gun cleaning system will reduce the labor cost enough to offset the price of a unit. The price of such units is about \$1,000. A picture of the system being tested is shown in Figure 2-6.



Figure 2-6 Spray Gun Cleaner in Testing at Architectural Woodworking

Table 2-3 shows the annualized cost comparison of the METH and water-based adhesive and the lacquer thinner and acetone cleanup solvents.

**Table 2-3  
Annualized Cost Comparison for Architectural Woodworking Company**

	METH Adhesive and Lacquer Thinner	Water-Based Adhesive and Acetone
Adhesive Cost	\$2,400	\$1,080
Cleanup Solvent Cost	\$279	\$378
Total Cost	\$2,679	\$1,458

## Universal Laminates

Universal Laminates is a small shop that manufactures cabinets and countertops. In the past, the company used a solventborne adhesive as part of the countertop manufacturing process. When the regulations on VOC adhesives were tightened by the South Coast Air Quality Management District (SCAQMD), the company decided to adopt an alternative. They tested an acetone-based adhesive, which did not work well for them. The company ended up adopting a water-based adhesive called Flexweld 301. Universal Laminates continued to test other water-based alternatives and, more recently, decided to convert to another adhesive called Roo Glue. An MSDS for this product was shown in Exhibit 2-2.

Universal Laminates had a spray booth and spray equipment for applying adhesive when they used the solventborne glue. They did not have to make a capital investment when they converted to the water-based adhesives. The same booth and application equipment could be used for the water-based adhesives. A picture of the spray booth is shown in Figure 2-7.



Figure 2-7 Spray Booth at Universal Laminates

Universal Laminates used about 20 gallons per month of the solventborne adhesive. The cost of the adhesive was \$24 per gallon. On this basis, the annual cost of the adhesive was \$5,760. The water-based adhesives have higher solids content than the solventborne adhesive. Universal Laminates used half as much of the Flexweld waterborne adhesive, 10 gallons per month. The cost of this waterborne adhesive is higher, at \$26 per gallon. The annual cost for purchasing the new adhesive is \$3,120. The company uses even less of the Roo Glue, about seven gallons per month. The cost of the Roo Glue is \$28 per



gallon. On this basis, the cost for purchasing the Roo Glue is \$2,352 annually. Figure 2-8 shows a countertop manufactured by Universal Laminates.



Figure 2-8 Countertop Manufactured by Universal Laminates

Universal Laminates has found there is no difference in the labor cost for using the solventborne and waterborne adhesives as long as the waterborne adhesives are used properly. The open time for the adhesive is different and the employees must understand that. The spray gun must also be heated on cold days when the water-based adhesive is used. With both the solventborne and water-based adhesives, one worker applies the adhesive for eight hours per day five days a week. Assuming Universal Laminates' labor rate of \$12 per hour, the annual labor cost amounts to \$24,960.

When the solventborne adhesive was used, it required one hour per month to maintain the spray equipment. Assuming a labor rate of \$12 per hour, the annual maintenance cost was \$144. Maintenance with the Flexweld water-based adhesive increased to one hour every four days. It involved cleaning out the glue that clogged the spray nozzle. Assuming a labor rate of \$12 per hour, the maintenance cost was \$780 per year. The Roo Glue has the same maintenance requirements as the solventborne adhesive. The cost of maintenance labor is now \$144 annually.

Universal Laminates used one gallon a week of lacquer thinner for cleaning up the overspray from the solventborne adhesive. At a cost of \$8 per gallon, the cost for cleanup amounted to \$416 per year. The company used acetone for cleanup of the Flexweld adhesive and used the same amount as the lacquer thinner. At a cost of acetone

of \$9.50 per gallon, the cleanup cost was \$494 annually. With the new Roo Glue, the overspray can be cleaned with plain water, so there is no cleanup cost.

Table 2-4 shows the annualized cost comparison for Universal Laminates. The labor cost, which did not change when the alternative adhesives were adopted, is the dominant cost. Although the cost of the Roo Glue is higher, there is no cleanup cost. The conversion from the solventborne adhesive to the Roo Glue reduced Universal Laminates' cost by about 12 percent.

**Table 2-4  
Annualized Cost Comparison for Universal Laminates**

	Solventborne Adhesive	Flexweld Adhesive	Roo Glue Adhesive
Adhesive Cost	\$5,760	\$3,120	\$2,352
Labor Cost	\$24,960	\$24,960	\$24,960
Maintenance Cost	\$144	\$780	\$144
Cleanup Cost	\$416	\$494	-
<b>Total Cost</b>	<b>\$31,280</b>	<b>\$29,354</b>	<b>\$27,456</b>

The Countertop Factory

The Countertop Factory is a new company that was started up in Santa Fe Springs, California about one year ago. The company manufactures countertops for contractors who install them in new and existing homes and offices. At present, The Countertop Factory makes about 60 countertops per day. Figure 2-9 shows a countertop manufactured by the company.

The President of the company, who has 18 years of experience with companies that manufacture countertops, wanted to start up the company by using so-called green products. The company uses two different water-based adhesives. One of these, an ethylene vinyl acetate (EVA), is used to bond high-pressure laminates to particleboard in a spray booth. The other, a polyvinyl acetate (PVA), is used to bond the high-pressure laminate to the sides of the particleboard. The company also uses a hot melt adhesive for bonding the end caps to the countertops and an acetone based adhesive for edge banding. The Countertop Factory was using lacquer thinner for removing adhesive residue and black marking pencil from the finished countertops. The company changed their process to remove the uncured adhesive residue from the finished countertops earlier; since the adhesive is not cured, it can be removed with plain water. The company is adopting a blend of 90 percent acetone and 10 percent water to remove the marking pencil and markers.

When the company started up, they purchased two adhesive application sprayers and one spray booth in an assembly line configuration. A picture of The Countertop Factory's line is shown in Figure 2-10. The cost of the equipment amounted to \$40,000 and installation and setup cost \$10,000. The company also purchased a hot melt spray gun



Figure 2-9 Countertop Manufactured at the Countertop Factory



Figure 2-10 Adhesive Line at The Countertop Factory

for \$2,000. The total capital cost was \$52,000. Assuming an equipment life of 10 years and a cost of capital of 2%, the annualized equipment and installation cost over the 10-year period is \$5,304.

The Countertop Factory uses 55 gallons of EVA and about five gallons of PVA each week. The price of the EVA and PVA adhesive is \$8.50 per gallon. The company also uses 100 pounds of hot melt adhesive per week; the hot melt is priced at \$1.40 per pound. The Countertop Factory uses a 225 pound canister of the acetone-based adhesive every 1.5 months; the cost of a canister is \$1,000. The total cost of purchasing the adhesive is \$41,800.

Two workers apply the EVA and PVA on the conveyor for eight hours each day. Two workers are required to apply the hot melt adhesive for eight hours per day. Two additional workers apply the acetone based canister adhesive for eight hours per day. Thus a total of six workers apply adhesive eight hours per day five days per week. Assuming a labor rate of \$12 per hour, the total annual labor cost amounts to \$149,760.

The Countertop Factory was using three gallons per week of lacquer thinner for removing the adhesive residue from the countertops. The cost of the lacquer thinner was \$8 per gallon. The total annual cost of using the lacquer thinner was \$1,248. The company is switching to a blend of 90 percent acetone and 10 percent water. The owner has decided to purchase the acetone in drum form so the cost of the acetone is \$4.38 per gallon. Assuming the same usage rate for the acetone as the lacquer thinner, the annual cleanup cost will be reduced to \$615.

The Countertop Factory estimates that two workers spend about one hour per day maintaining the adhesive application equipment. Assuming a labor rate of \$12 per hour, the annual maintenance cost amounts to \$6,240.

The Countertop Factory pays about \$1,600 per month for electricity. The annual electricity cost amounts to \$19,200. There is no gas used for the manufacturing process.

Table 2-5 summarizes the costs of the start-up operation. Note that the labor cost dominates the total cost.

**Table 2-5  
Annualized Costs for Countertop Factory**

	Adhesive and Cleanup Operations
Annualized Capital Cost	\$5,304
Adhesive Cost	\$41,800
Labor Cost	\$149,760
Cleanup Cost	\$615
Maintenance Cost	\$6,240
Electricity Cost	\$19,200
Total Cost	\$222,919

### Closet World

Closet World manufactures wooden bedroom closet organizers and shelving and is the largest closet company in California. The company, located in Whittier, California,

provides comprehensive services for all organizing needs in closets, garages and offices. The products manufactured by Closet World are custom designed and the company offers a large selection of finishes and accessories.

As part of their operation, Closet World uses a variety of adhesives. Most of the adhesives used by the company are hot melt adhesives, which are 100 percent solids. In the manufacturing process for countertops, the company performs laminating operations. Historically, Closet World used a methylene chloride (METH) based adhesive in a canister form for the edge banding in the laminating operation. The South Coast Air Quality Management District (SCAQMD) modified their adhesive regulation, Rule 1168, to phase out METH based adhesives by January 1, 2004. Companies could continue to use METH adhesives until January 1, 2005 if they had been manufactured earlier.

IRTA began working with Closet World to find an alternative to the METH based adhesive. The company tested an alternative canister product, which is based on acetone. During the testing, the employees applying the adhesive indicated that it performed well. Closet World decided to make the conversion to this adhesive.

The company used 12 canisters per month of the METH based adhesive. The cost of each canister was \$313. On this basis, the cost to Closet World for purchasing the adhesive amounted to \$45,072 per year.

The manufacturing manager indicates that the company uses about 25 percent less of the acetone adhesive. This is because the acetone-based adhesive contains higher solids than the METH based adhesive. Under this assumption, only nine canisters per month of the acetone adhesive are required. The price of the acetone-based canisters is \$221. The annual cost of purchasing the new alternative adhesive is \$23,868. A picture of the new adhesive canister was shown in Figure 2-3.

The employees have noticed that the new adhesive dries faster than the METH adhesive. No changes in the production process have been necessary to use the alternative adhesive.

Table 2-6 shows the annualized cost comparison for the METH and acetone based adhesives. Closet World was able to reduce their costs for the adhesive operation by about half through the substitution.

**Table 2-6**  
**Annualized Cost Comparison for Closet World**

	METH Adhesive	Acetone Adhesive
Adhesive Cost	\$45,072	\$23,868
Total Cost	\$45,072	\$23,868



United Cabinet Company, Inc.

United Cabinet Company is a small company located in San Bernardino, California that manufactures commercial cabinets and counter tops. The company has been operating in San Bernardino since 1963 and has been at the present location since 1980. United Cabinet has 10 employees.

United Cabinet's main product is cabinets but the company also manufactures 10 to 50 countertops each week. A countertop manufactured by the company is shown in Figure 2-11. For much of the work, the company uses a hot melt adhesive that is 100 percent solids. For bonding laminate to counter tops, United Cabinet historically used a methylene chloride (METH) based adhesive. The South Coast Air Quality Management District (SCAQMD) has prohibited the sale of METH based adhesives; no more METH adhesives can be sold after January 1, 2005. In anticipation of this ban, United Cabinet began testing alternative adhesives. The company decided to use an acetone-based adhesive that is provided in a canister.



Figure 2-11 Countertop Manufactured by United Cabinet Company

United Cabinet historically used a VOC solvent for removing small amounts of cured adhesive residue from the counter tops after manufacture. IRTA worked with the company to test alternatives. Plain acetone cleaned the residue very well. A blend of 50 percent acetone and 50 percent water works well for this purpose but required the operator to scrub more. The company settled on a blend of 75 percent acetone and 25

percent water. Acetone is not classified as a VOC and it is low in toxicity. Blending it with water makes the mixture less flammable.

United Cabinet used about five gallons per month of the METH based adhesive. The cost of the adhesive was \$27.77 per gallon. This translates into an annual cost for the adhesive of \$1,666. The company has been using the alternative acetone adhesive for several months. United Cabinet purchases a 27 pound canister every month and a half. The cost of each canister is \$221. The annual cost of purchasing the alternative adhesive amounts to \$1,768. Figure 2-12 shows a worker applying the new adhesive.

United Cabinet used a blend of VOC solvents for removing the adhesive residue on the finished countertops. The company purchased five gallons every month and a half. The cost of this cleaner was \$8.16 per gallon. On this basis, the annual cost of the cleaner amounts to \$326. The company has just converted to a blend of 75 percent acetone and 25 percent water. The owner of United Cabinet plans to purchase five-gallon pails of acetone. United Cabinet can purchase a five-gallon pail at \$7.13 per gallon. Assuming the company uses the same amount of the new cleaner and taking into account the dilution, the annual cost of purchasing the alternative cleaner is \$214.



Figure 2-12 Applying New Adhesive at United Cabinet Company

Table 2-7 shows the cost comparison for United Cabinet. The values show that the cost of using the safer alternatives is comparable to the cost of using the METH adhesive and the VOC cleaning solvent.

**Table 2-7**  
**Annualized Cost Comparison for United Cabinet**

	METH Adhesive	Acetone Adhesive
Adhesive Cost	\$1,666	\$1,768
Cleaner Cost	\$326	\$214
Total Cost	\$1,992	\$1,982

### TOXICITY AND CROSS-MEDIA ISSUES

In the past, most companies used METH based adhesives in the countertop manufacturing process. Many companies are still using METH based adhesives. Because METH is a suspect carcinogen, the workers who use the adhesives and the workers and community members surrounding facilities where the adhesives are used are exposed to a carcinogenic risk. The Occupational Safety and Health Administration (OSHA) has set the Permissible Exposure Level (PEL) at 25 ppm and has also specified an action level of 12.5 ppm for METH because it is a carcinogen. Companies that have exposures above 12.5 ppm must institute medical surveillance and monitoring programs. Countertop manufacturers using METH based adhesives would not be able to meet the 25 or 12.5 ppm exposure levels and would have to install expensive engineering controls to achieve compliance. As mentioned in the introduction, California air regulatory agencies consider METH to be a Toxic Air Contaminant (TAC) and EPA lists it as a HAP, again because it is classified as a carcinogen. California's Proposition 65 also lists METH as a carcinogen.

The companies that participated in this project converted from METH based adhesives to acetone based adhesives or water-based adhesives of various types. Acetone is much lower in toxicity than METH. OSHA currently specifies a PEL for acetone of 750 ppm. This is much higher than the PEL of 25 ppm for METH and it reflects acetone's lower toxicity. Acetone is not considered a TAC or a HAP nor is the chemical listed on Proposition 65. One additional advantage of acetone is that it is not considered to be photochemically reactive and therefore does not contribute to smog. Acetone has a very low flash point which makes it very flammable, however. The National Fire Protection Association restricts the amount of acetone that can be stored and used in open containers because of its flammability.

MSDSs for two water-based cleaners that certain of the participating companies adopted are listed in Exhibits 2-1 and 2-2. The first MSDS, for a PVA adhesive, contains trace quantities of vinyl acetate which is a suspect carcinogen. Vinyl acetate is metabolized to acetaldehyde which is a suspect carcinogen as well. The product may also contain very small quantities of formaldehyde which is also a suspect carcinogen. The quantities of

vinyl acetate in the product are very low, less than 0.5 percent. This can be compared with the METH content of the METH based adhesives which is generally in the range of 70 percent.

The MSDS for one of the other water-based adhesives, called RooTac, contains less than five percent of mineral spirits. Mineral spirits is classified as a VOC and can contain trace quantities of benzene, toluene and xylene. Benzene is an established human carcinogen and toluene and xylene can cause reproductive toxicity. Again, these materials would be present in extremely low concentrations compared with the high concentration of METH in METH based adhesives.

When the companies used METH based adhesives, they either used METH or lacquer thinner for cleaning their spray equipment. Lacquer thinner is a combination of several materials including toluene and xylene and is considered a VOC. The companies participating in this project converted to acetone, water-based cleaners and plain water. All of these materials are lower in toxicity than METH or lacquer thinner. Again, acetone must be used with care because of its flammability.

In the past, the participating companies also used METH or lacquer thinner for removing the overspray adhesive residue from the countertops. One company used PERC for this purpose. PERC, like METH, is classified as a suspect carcinogen. Cal/OSHA has established a PEL for PERC of 25 ppm. The companies either began cleaning the residue earlier in the process with plain water or converted to an acetone/water blend or acetone. These alternatives are lower in toxicity than METH, lacquer thinner or PERC.

In general, the carrier material in adhesives is emitted during application of the adhesive. In the case of a METH based adhesive, METH was the carrier. For the companies involved in this project, the carrier is now acetone or water. Companies participating in the project used solvents like METH and lacquer thinner for cleaning application equipment. In some instances, users cleaned the application equipment in small containers using the solvent. In other instances, users applied the solvents with rags. All of the solvent was emitted during the process and no solvent remained that required disposal. When the participating companies converted to acetone, water-based cleaners or water, only small amounts of the cleaners are used and again, no disposal is required. The overspray residue was cleaned with METH, lacquer thinner or PERC on rags by the companies in the past. The companies now apply the alternatives like acetone and water-based cleaners in the same manner. The companies involved in the project generally send their used rags to industrial laundries.

### III. RESULTS AND CONCLUSIONS

There are more than 1,000 businesses in the South Coast Basin that manufacture countertops, cabinets and custom woodworking. Many of these companies are classified as small businesses. Some of these businesses manufacture countertops by using adhesive to bond veneer to wood, particleboard or medium density fiberboard.

Historically, these facilities used TCA based adhesives. When TCA production was banned, the adhesive suppliers offered products that contained METH and high VOC content chemicals as adhesive carriers. Many of the companies using the adhesives also used METH and high VOC content cleaning agents to clean their spray equipment and to remove cured adhesive residue from the finished countertops.

The SCAQMD has implemented a regulation that prohibited the sale and use of adhesives with a VOC content higher than 80 grams per liter and adhesives that contained METH. Companies using these adhesives in the Basin had to identify, test and implement alternative adhesives that have low VOC content and are lower in toxicity.

During this project, IRTA worked with seven companies in the South Coast Basin that adopted alternative adhesives and cleaning agents. The companies included countertop manufacturers, cabinet manufacturers and companies involved in woodworking. The alternative adhesives the companies adopted are PVA adhesives, which rely on water as a carrier, various other water-based adhesives and acetone based adhesives. The cleaning agent alternatives that the companies implemented are plain water, water-based cleaners and acetone. Alternatives that did not contain METH and that met the 80 gram per liter VOC content limit specified in the SCAQMD regulation performed as effectively as the more toxic and higher VOC adhesives and cleaners.

IRTA analyzed the costs of the alternative adhesives for The Countertop Factory, a facility that started up using the lower VOC, low toxicity adhesives. IRTA analyzed and compared the costs of alternative adhesives and cleaners for four other facilities that participated in the project including Architectural Woodworking Company, Universal Laminates, Closet World and United Cabinet Company. In all four cases, the cost of using the alternatives was lower. This demonstrates that alternative adhesives that better protect human health and the environment are available, that they perform well and that their use can reduce costs. The alternatives demonstrated in this project are applicable to manufacturers in southern California that have not yet converted to alternatives and manufacturers in other parts of the country which do not presently have regulations restricting the use of VOC and METH based adhesives.

**APPENDIX**  
**Stand Alone Case Studies for Selected Facilities**

## **COUNTERTOP MANUFACTURER MAKES ENVIRONMENTALLY CONSCIOUS DECISIONS**

V-T Industries, a countertop manufacturer based in Iowa, acquired Sani-Top Inc., located in Gardena, California in 2002. The company, now called V-T West Inc., has 55 employees.

The Gardena plant manufactures many different types of countertops. The company purchases particleboard, laminate and adhesive. The adhesive is used to bond the high-pressure laminate to the particleboard. The plant manufactures the countertops and they are sold to Home Depot and Lowes as well as custom fabricators located as far north as San Francisco and as far east as Utah and Arizona.

“We run two countertop lines at the Gardena plant,” says Scott Albers, Production Manager. “One line is used to run standard countertop sizes and the other runs specialty sizes.”

The company is environmentally conscious and stopped using solventborne glues many years ago. The plant now uses hot melt glues which are 100 percent solid and Polyvinyl Acetate (PVA) glue which is a water-based adhesive. “Many of our plants use these glues,” says Mr. Albers. “We tried water-based contact adhesive but it did not perform as well as the PVA.”

The company uses plain water and a water-based cleaner to clean the application equipment. Says Mr. Albers, “we clean the adhesive overspray with a water-based cleaner. It’s effective and low cost and it doesn’t rely on hazardous chemicals.”

## **WOODWORKING COMPANY CONVERTS TO SAFER ADHESIVE AND CLEANUP SOLVENT**

Architectural Woodworking Company, a small company with 70 employees, is located in Monterey Park, California. The family owned company manufactures desks, counters, workstations, conference tables and interior stairs as well as high quality paneling and office cabinetry. Customers that purchase the company's products include building owners, architects and designers.

According to Leo Heydorff, responsible for business development at Architectural Woodworking Company, "the company has a policy to use materials that are as safe as possible. All of the adhesives we use are either hot melts or water-based."

The company historically used hot melt and water-based adhesives on nearly all of their lines. In one type of operation, bonding metal to wood, the company used about two gallons per month of a methylene chloride (METH) based adhesive packaged in a canister. South Coast Air Quality Management District (SCAQMD) Rule 1168 prohibits the sale of METH adhesives beginning in 2004. Under the rule, vendors are allowed to sell METH adhesives and users may use them as long as they were manufactured in 2004 until January 1, 2005.

IRTA began working with Architectural Woodworking as part of a project sponsored by Cal/EPA's Department of Toxic Substances Control. The company tested alternative adhesives and decided to convert from the METH adhesive to a water-based adhesive for the wood to /metal bonding. "We've been using the adhesive for several months and it performs well," says Mr. Heydorff. The cost of the water-based adhesive is lower than the cost of the METH adhesive.

A number of years ago, the company used lacquer thinner for cleaning the coating application equipment. The spray guns were cleaned at the end of the day in a small container with a brush. The company decided to convert to acetone, which is not classified as a VOC and is lower in toxicity. "We wanted to eliminate VOC products wherever possible in the plant," says Mr. Heydorff.

IRTA provided Architectural Woodworking with an automated spray gun cleaner. The company is testing the unit with an acetone cleaner to determine its effectiveness and whether it will reduce the labor cost of cleanup.

The cost of using acetone as a cleanup solvent is higher than the cost of using lacquer thinner. This cost increase is more than offset by the decrease in cost for using the water-based rather than the METH adhesive. "It's always good when we can save money when we use materials that are safer," says Mr. Heydorff.



### Annualized Cost Comparison for Architectural Woodworking Company

	METH Adhesive and Lacquer Thinner	Water-based Adhesive and Acetone
Adhesive Cost	\$2,400	\$1,080
Cleanup Solvent Cost	\$279	\$378
Total Cost	\$2,679	\$1,458

## **SMALL COMPANY ADOPTS COST EFFECTIVE WATER-BASED COUNTERTOP ADHESIVE**

Universal Laminates is a small company located in the San Fernando Valley near Los Angeles that has been in business for 55 years. The company has three employees, two of them owners. Universal Laminates manufactures cabinets and countertops. The countertops are used in medical and dental offices.

For several years, Universal Laminates used a solventborne adhesive in the manufacture of the countertops. The South Coast Air Quality Management District (SCAQMD) passed a regulation that tightened the VOC limits on adhesives and, at that stage, the company began testing alternative adhesives.

Universal Laminates tested an acetone-based adhesive but it did not work for their purposes. The company ended up adopting a water-based adhesive, called Flexweld, which was used for a few years. More recently, the company converted to another water-based adhesive, called Roo Glue, that performed better.

According to Steve Hall, one of Universal Laminates' owners, "the new glue works better. It doesn't delaminate the countertops when it's hot like the other glue. It's also better for cleanup."

The water-based adhesives are less forgiving than the solventborne adhesive the company used in the past. The water-based adhesives must be used properly. The open time for the adhesive is different and the employees must understand the differences when using the glue. The spray gun must also be heated on cold days for effective delivery. "It's a matter of becoming familiar with the water-based glue," says Mr. Hall. "We like the new adhesive. We're all for doing what's best for the environment, especially when the costs are lower."

### **Annualized Cost Comparison for Universal Laminates**

	Solventborne Adhesive	Flexweld Adhesive	Roo Glue Adhesive
Adhesive Cost	\$5,760	\$3,120	\$2,352
Labor Cost	\$24,960	\$24,960	\$24,960
Maintenance Cost	\$144	\$780	\$144
Cleanup Cost	\$416	\$494	-
Total Cost	\$31,280	\$29,354	\$27,456

## COUNTERTOP FACTORY STARTS UP WITH “GREEN” PRODUCTS

The Countertop Factory started up operation in Santa Fe Springs in 2003. The company manufactures about 60 countertops per day for contractors and they are installed in homes and businesses.

Bruce Smith, President of The Countertop Factory, has 18 years of experience in making countertops. “I saw an opportunity to start a business that could provide same day service to contractors, a market niche that larger manufacturers can’t fill,” he says. “I know there are a lot of regulations and I wanted to do things right from the beginning in a way that is responsible to the environment and the workers.”

South Coast Air Quality Management District (SCAQMD) Rule 1168 regulates the VOC content of the adhesives used in countertop manufacturing. The rule also phases out methylene chloride based adhesives by the end of 2004. Methylene chloride is a suspect carcinogen and it is also regulated by the Occupational Safety and Health Administration. Mr. Smith decided to use only water-based, hot melt and acetone based adhesives so he could be sure the company would comply with the regulations. He also decided to use low-VOC cleanup materials.

The Countertop Factory uses two different water-based adhesives to bond the high-pressure laminate to the top and sides of the countertops. The company uses a hot melt adhesive for bonding the end caps to the countertops. Finally, the company uses an acetone based canister adhesive for edge banding the countertops. The Countertop Factory started out using lacquer thinner for cleaning the adhesive residue and marking pencil from the finished products. The process was changed so the adhesive residue could be removed before it was cured with plain water and IRTA assisted the company in testing alternatives for cleanup of the marking pencil. The alternative that worked best is a blend of acetone and water.

“The low VOC adhesives and cleaner work very well,” says Bruce Smith. “They work just as well as the solvent based adhesives I used in the past.”

### Annualized Costs for Countertop Factory

	Adhesive and Cleanup Operations
Annualized Capital Cost	\$5,304
Adhesive Cost	\$41,800
Labor Cost	\$149,760
Cleanup Cost	\$615
Maintenance Cost	\$6,240
Electricity Cost	\$19,200
Total Cost	\$222,919

**CLOSET COMPANY CONVERTS TO SAFER ADHESIVE**  
**Company Cuts Costs in Half**

Closet World is located in Whittier, California. The largest closet company in California, Closet World manufactures custom designed closet organizers and shelving for organizing needs in closets, garages and offices.

As part of their operation, Closet World uses adhesive to bond laminate to particleboard for countertops. The company historically used a methylene chloride (METH) based canister adhesive in this bonding operation. The South Coast Air Quality Management District (SCAQMD) has phased out METH based adhesives and Closet World needed to find an alternative adhesive.

IRTA began working with Closet World as part of a project sponsored by Cal/EPA's Department of Toxic Substances Control and EPA. The company tested an alternative canister adhesive based on acetone. Acetone is not classified as a VOC and it is low in toxicity. After testing to determine the characteristics of the new adhesive, Closet World decided to adopt it in place of the METH adhesive.

"The employees like the new adhesive better," says Enrique Lopez, Manager of Manufacturing at Closet World. "It dries faster than the old adhesive and we use 25 percent less. We're a progressive company. The conversion saved us money and it's better for the environment and the employees who apply the adhesive."

**Annualized Cost Comparison for Closet World**

	METH Adhesive	Acetone Adhesive
Adhesive Cost	\$45,072	\$23,868
Total Cost	\$45,072	\$23,868

## UNITED CABINET COMPANY ADOPTS SAFER ADHESIVE AND CLEANER

United Cabinet Company, Inc. has been operating in San Bernardino since 1963. The company manufactures commercial cabinets and countertops and has 10 employees.

The South Coast Air Quality Management District (SCAQMD) prohibited the sale of methylene chloride (METH) in adhesives by January 1, 2004. Suppliers are allowed to sell METH based adhesives if they were manufactured before the 2004 deadline for an additional year. United Cabinet uses a hot melt adhesive for many of their operations. The company also used a METH based adhesive and they began examining alternatives that would be suitable substitutes in their operations.

United Cabinet decided to adopt an alternative adhesive based on acetone. The adhesive is provided in a canister form, which contains 27 pounds of adhesive and is convenient to use. Acetone is exempt from VOC regulations and it is low in toxicity. The company has been using the alternative product for several months.

The company was using a high VOC content solvent blend for removing the adhesive residue from the finished counter tops. After testing water-based cleaners and acetone alternatives, United Cabinet decided to use a blend of 75 percent acetone and 25 percent water. Acetone has a low flash point and adding the water raises the flash point and also prevents such rapid evaporation.

The cost of the new adhesive is higher than the cost of the METH adhesive. Because the alternative adhesive contains more solids, however, less of the adhesive is required to do the same job.

“We’re happy with the alternatives,” says Dennis Rice, the owner of United Cabinet. “I look for ways to make the operation better. It turns out I can use alternative adhesives and cleaners that are better for the workers and the environment.”

The cost of using the safer alternatives is about the same as the cost of using the METH based adhesive and the non-VOC cleanup solvent. “We’re committed to using safer materials whenever possible,” says Dennis Rice. “It’s an added benefit when the cost is not higher.”

### Annualized Cost Comparison for United Cabinet Company

	METH Adhesive	Acetone Adhesive
Adhesive Cost	\$1,666	\$1,768
Cleaner Cost	\$326	\$214
Total Cost	\$1,992	\$1,982