

**AB998 Non-Toxic Dry Cleaning Incentive Program: Demonstrations of Safer  
Technologies for the Textile Cleaning Industry**

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## EXECUTIVE SUMMARY

The California Air Resources Board (CARB) adopted a phaseout of perchloroethylene (PERC) dry cleaning in California by 2023. CARB published guidelines for the Non-Toxic Dry Cleaning Incentive Program, which was established under Assembly Bill 998. The legislation imposes a fee on PERC used in dry cleaning. The proceeds from the fee are used to provide grants to dry cleaners for substituting water-based or carbon dioxide cleaning processes for PERC dry cleaning. The legislation also established a demonstration program, which involves showcasing water-based, and carbon dioxide processes to encourage dry cleaners to adopt them as they convert away from PERC dry cleaning.

The Institute for Research and Technical Assistance (IRTA), a nonprofit organization that focuses on safer alternatives, received a grant from CARB to demonstrate water-based and carbon dioxide technologies. IRTA partnered with the California Department of Toxic Substances Control (DTSC) and Southern California Edison (SCE) to conduct the project.

IRTA featured five textile cleaning facilities that had converted to or adopted water-based or carbon dioxide alternatives to PERC. IRTA developed case studies for each of the five facilities. Mastercraft Cleaners in Fresno converted from PERC dry cleaning to a combination of wet cleaning and the Green Jet system, which is also a water-based technology. Legacy Cleaners in Tustin opened a new cleaning facility with low cost wet cleaning equipment and a Green Jet system. Hangers Cleaners in Torrey Hills opened a new shop with a carbon dioxide cleaning system. Royal Cleaners in Santa Monica converted from PERC dry cleaning to a carbon dioxide system. Finally, Aqua Cleaners in Los Altos opened a new shop with wet cleaning and carbon dioxide cleaning equipment.

IRTA conducted cost analysis for three of the facilities that had been using the alternative technologies for more than one year. In two cases, Mastercraft Cleaners and Royal Cleaners, IRTA compared the cost of using PERC dry cleaning to the cost of using the alternatives. Mastercraft Cleaners reduced their cost significantly in converting from PERC dry cleaning to the Green Jet system. At Royal Cleaners, the cost of using the alternative carbon dioxide system is comparable in cost to using PERC dry cleaning.

IRTA held showcase events at four of the five participating facilities during the project. IRTA mailed more than 5,000 flyers advertising the events and almost 100 people attended the showcases. The owner of one of the showcase facilities, Legacy Cleaners, decided to purchase wet cleaning and Green Jet equipment based on attending an earlier showcase event at Mastercraft Cleaners.

IRTA arranged and held an EXPO at SCE's facility in Irwindale, California. IRTA and SCE mailed out more than 3,000 brochures advertising the events. DTSC arranged for printing the brochures. The EXPO featured speakers from regulatory agencies describing their regulations and grant programs and three of the owners of the showcase facilities

presented details on their decision to select water-based and carbon dioxide technologies. Suppliers of water-based and carbon dioxide equipment and supplies were provided with vendor tables to display literature. There was a demonstration of wet cleaning equipment and the Green Jet system. The EXPO had about 60 attendees.

IRTA developed a fact sheet on safer alternative spotting chemicals based on an earlier project sponsored by DTSC and EPA. It is particularly important to use alternative spotting agents when cleaners employ wet cleaning processes that discharge to the sewer. The fact sheet was printed by DTSC and it was widely distributed at the showcases and the EXPO.

Water-based and carbon dioxide technologies are the best alternatives to PERC dry cleaning from an overall health and environmental perspective. The results of this project demonstrate that several cleaners are successfully using these technologies.

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## I. INTRODUCTION

There are as many as 5,000 dry cleaners in California. At least two-thirds of these cleaners use perchloroethylene (PERC) as the dry cleaning solvent. PERC is a carcinogen, it is a listed Hazardous Air Pollutant (HAP) and it is classified as a Toxic Air Contaminant (TAC) in California. PERC is a listed hazardous waste under the Resource Conservation and Recovery Act (RCRA) and it is commonly found as a contaminant in the soil at dry cleaning facilities and, often, in the groundwater.

In 2007, the California Air Resources Board (CARB) finalized a regulation to phase out the use of PERC in dry cleaning. It requires cleaners to convert to an alternative cleaning method when their equipment is 15 years old. By 2023, all cleaners in the state must use an alternative process. In 2002, the South Coast Air Quality Management District (SCAQMD) also adopted a regulation that concerns PERC use in dry cleaning. It phases out PERC in dry cleaning altogether by 2020.

Alternatives to PERC dry cleaning have been developed and marketed over the last several years. These include:

- Hydrocarbon
- Pure Dry
- Rynex
- Green Earth
- Carbon Dioxide
- Traditional Wet Cleaning
- Icy Water Cleaning
- Green Jet Cleaning

The first three technologies rely on solvents that are classified as VOCs. Green Earth has caused cancer in laboratory animals. From an overall health and environmental standpoint, carbon dioxide and the last three listed systems that are water-based are the best technologies.

Assembly Bill (AB) 998 established the Non-Toxic Dry Cleaning Incentive Program. The program levies a fee on PERC used in dry cleaning that is designed to increase over time. CARB is charged with developing two programs to use the funds that are collected. First, CARB has established a grant program for cleaners to convert from a PERC dry cleaning system to carbon dioxide or water-based technologies. AB 998 does not allow for grants to cleaners that use the other alternatives listed above because they are classified as VOCs or may be toxic. Eligible cleaners who substitute a carbon dioxide or water-based system for a PERC machine can receive grants of \$10,000. Second, CARB has established a demonstration program to showcase and promote carbon dioxide and water-based cleaning processes.

The Institute for Research and Technical Assistance (IRTA) is a nonprofit organization established in 1989. IRTA's mission is to assist companies and whole industries in converting to safer alternatives. IRTA staff have extensive experience in working on

safer alternatives for dry cleaning, a variety of different cleaning applications, paint stripping, coatings and adhesives. IRTA runs and operates the Pollution Prevention Center, which includes members from Southern California Edison and government agencies concerned with regulating air, wastewater, hazardous waste and worker exposure.

As part of the AB 998 implementation, IRTA received a grant from CARB to conduct a demonstration program to showcase carbon dioxide and water-based processes. IRTA partnered with the California Department of Toxic Substances Control (DTSC) and Southern California Edison (SCE), a large electrical utility in Southern California, to conduct the project.

IRTA's work for CARB during the project involved:

- holding showcase demonstrations at four textile cleaning facilities that use water-based and carbon dioxide technologies;
- conducting cost analysis for three of the facilities that had been using the technologies for more than a year;
- developing case studies for five textile cleaning facilities using water-based and carbon dioxide technologies;
- preparing and distributing a fact sheet for cleaners on alternative, safer spotting chemicals; and
- arranging and holding an EXPO featuring carbon dioxide and water-based technologies.

This document summarizes the results of the project. Section II provides background information on PERC dry cleaning and the carbon dioxide and water-based cleaning alternatives. Section III focuses on the showcase facilities and describes the showcase events and the EXPO. Section IV discusses the motivation for developing the fact sheet on alternative spotting chemicals. Finally, section V summarizes the results and conclusions of the project.

## II. BACKGROUND

This section focuses on the PERC dry cleaning technology and the alternative water-based and carbon dioxide systems. It also describes the spotting process that cleaners use to remove stains prior to cleaning.

### PERC DRY CLEANING TECHNOLOGY

PERC is an aggressive solvent for oil based contaminants. It has no flash point and it has a boiling point of 250 degrees F. In the dry cleaning process, PERC is combined with a small amount of water and detergent, which functions as the cleaning agent. The process involves a wash step where the garments are washed, an extraction step where the PERC is extracted from the garments and a drying step at elevated temperature in which the garments are dried. A typical cycle for cleaning with PERC is 45 minutes.

In California, PERC is used in dry-to-dry closed loop machines. A picture of a PERC machine is shown in Figure 2-1. The garments are sorted, weighed and loaded into the wheel of the machine, the door is closed, and the wash, extract and dry cycles are completed. At the end of the cycle, the door is opened and the garments are removed. The closed loop equipment includes a refrigerated condenser; the PERC is routed to the condenser where it is condensed and stored for reuse in the next cleaning cycle. Equipment with secondary control has a small carbon adsorber. When the door is opened at the end of the cycle, the PERC in the wheel is routed to the carbon adsorber. Emissions of PERC generally occur from leaks in the machines and from the wheel of the machine when the door is opened at the end of the cycle.



Figure 2-1. Typical PERC Machine

Equipment for use with PERC has filters that remove the insoluble materials like dirt and hair. Some machines have cartridge filters and the newer equipment uses spin disk filters. The equipment also has a distillation unit, which is used to separate the PERC from the higher boiling materials like body oil. The filters, sludge and still bottoms are disposed of as hazardous waste. Separator water is also generated in the PERC dry cleaning process. Water is introduced into the system with the PERC to clean water-soluble contaminants, water is on the garments and water is generated when the refrigerated condenser operates. This water is put into a separator and the PERC, which is heavier than water, is physically separated from the water. The PERC is reused in the cleaning process and the water, which still contains some PERC, is evaporated or disposed of as hazardous waste.

In PERC dry cleaning, cleaners use spotting agents to remove the spots before, and sometimes after, they dry clean the garments in the machine. PERC is an aggressive solvent, it is easy to use and it is very forgiving. Even when a cleaner is not especially good at spotting, the PERC machine will remove many stains. After the cycle is completed, the garments, which are fully dry, are removed from the machine and finished with standard equipment.

#### PERC DRY CLEANING ALTERNATIVES

As noted in Section I, there are a variety of alternatives that are used by cleaners in place of PERC dry cleaning. This subsection describes the alternative water-based and carbon dioxide processes that are the focus of this project. Each of the water-based technologies and the carbon dioxide technology are discussed below.

##### Traditional Wet Cleaning

Traditional wet cleaning is commonly known as professional wet cleaning. The process relies on computer-controlled washers and dryers. It uses detergents to remove the soils, conditioners to make the garments soft and smooth, and sizing agents, which add body to the garments. In many washers, the water and detergent are mixed before they enter the drum. In order to prevent dimensional change and to make finishing easier, many garments are dried with a residual of moisture. Garments that are dried completely may shrink and are difficult to finish. The dryers can include moisture sensors and the system can be shut off with specified residual moisture content. After they are removed from the machine, the still wet garments are hung and later finished. Some cleaners with wet cleaning equipment finish the garments with tensioning equipment. This equipment helps form garments and restore constructed garments during finishing and helps in preventing shrinkage. Wet cleaning equipment can also be used for processing garments that are laundered. A picture of a typical wet cleaning washer and dryer is shown in Figure 2-2. The washer and dryer both discharge to the drain. Figure 2-3 shows a picture of tensioning equipment.



Figure 2-2. Typical Wet Cleaning Washer and Dryer



Figure 2-3. Typical Tensioning Equipment

Wet cleaning is an aggressive cleaning method and it is effective on both oil based and water-soluble soils when appropriate detergents are used. Although wet cleaning has been adopted fairly widely as a supplementary technology to dry cleaning, only a few cleaners have implemented the technology as a dedicated cleaning method.

Advantages of wet cleaning are that it is an aggressive cleaning method, it eliminates most health and environmental problems, delicate items like wedding gowns and suede and leather garments can be cleaned effectively with the technology and some equipment is less costly than the equipment used with solvents. Disadvantages of wet cleaning are

that cleaners must learn entirely new processing methods, the garments with residual moisture must be hung and this requires space, and the finishing is more difficult and time consuming with certain garments like structured jackets.

### Icy Water Technology

This technology is similar to traditional wet cleaning but incorporates other features. Like traditional wet cleaning, the icy water technology relies on water, detergent and conditioners to accomplish cleaning. There are two types of equipment. One of these is a wash unit and a separate dryer and the other is a combined unit that washes and dries the garments in a dry-to-dry cycle.

Some of the features of the icy water technology have been designed to minimize or eliminate garment shrinkage. Garments shrink if they are not conditioned, if the process involves heat and if they are agitated. With the icy water washer, garments that are commonly dry cleaned are processed in water at a temperature of 38 degrees F. In some cases, the garments are dried in a typical dryer; in others, the garments are partially dried in heated air and cold air, generated with a compressor, can be used to eliminate the residual moisture. The washer has three settings; it can use hot water or tap water for garments that will not shrink and icy water for garments that are generally dry cleaned. The garments are agitated with only one revolution per minute in the washer and only 60 revolutions per minute in the dryer. As with traditional wet cleaning, the washer and dryer discharge to the drain. Tensioning equipment is not necessary for finishing with icy water equipment.

This technology has the same advantages as the traditional wet cleaning technology. In addition, it is more forgiving than traditional wet cleaning. Finishing with the cold air dryer with low agitation is easier than with traditional wet cleaning. The garments can be fully dried in this type of dryer and they do not have to be hung with residual moisture. When the garments are fully dried, however, the drying cycle is quite long.

### Green Jet Technology

The Green Jet Technology cleans and dries the garments in one machine. A picture of a Green Jet machine is shown in Figure 2-4. The process involves using a mist of water and detergent to clean the garments; they are not immersed in liquid. This process is appropriate only for processing garments that are lightly soiled. The machine cycle is shorter than the cycle for PERC. Unlike traditional wet cleaning systems, the Green Jet does not discharge to the drain.

Cleaners who use this technology should use it only as a supplementary technology. It is often used in conjunction with a wet cleaning system and the heavily soiled garments are processed through the wet cleaning system and the lightly soiled garments are processed in the Green Jet. Finishing with the Green Jet is less labor intensive than with wet cleaning because the garments are not immersed in the water. Tensioning finishing equipment is not necessary with this technology.



Figure 2-4. Green Jet Machine

Advantages of the technology are that the equipment is less expensive than the equipment used with solvents and the finishing is easier than with traditional wet cleaning. The disadvantage is that it does not clean aggressively and more spotting is required than with PERC dry cleaning.

### Carbon Dioxide Technology

This technology relies on liquid carbon dioxide under a pressure of about 700 pounds per square inch pressure to clean garments and it does not use heat. Many oil based contaminants are soluble in carbon dioxide. The equipment is pressurized prior to the cleaning cycle and depressurized after the cleaning cycle. The soils are separated from the carbon dioxide, which is now a gas. The cycle time for carbon dioxide equipment is about the same as the cycle time for PERC dry cleaning. The detergent used in the carbon dioxide process is relatively expensive and is reported by some cleaners using the technology as not aggressive enough. More spotting is required with carbon dioxide than with PERC. Because the equipment is pressurized, it is expensive; it is made of stainless steel and must be capable of holding pressure. The equipment includes filters for removing particulate contaminants and a distillation unit for separating the soluble contaminants. A picture of a carbon dioxide machine is shown in Figure 2-5.

Carbon dioxide is a gentle cleaner and is suitable for cleaning a range of delicate items since it does not employ heat. Certain materials, however, like vinyl, rubber or beads can swell during the cleaning process. Once the pressure is released at the end of the cycle, some of the materials do not revert to their original shape. Some acetate materials cannot be cleaned with carbon dioxide and some garments have acetate linings; these materials will undergo dimensional change in carbon dioxide. Triacetate materials can experience

a color change with carbon dioxide. Finishing requirements for the carbon dioxide process are similar to finishing requirements for PERC dry cleaning.



Figure 2-5. Carbon Dioxide Machine

The carbon dioxide used in the process is generally stored in a storage tank. The cleaner most often uses a service, which involves regularly changing out the empty tanks when more carbon dioxide is needed.

### SPOTTING PRACTICES

Regardless of the technology that cleaners employ, they all perform spotting as part of the garment cleaning process. Cleaners use spotting agents to remove stains prior to cleaning the garments in the machine or after the garments have been cleaned in the machine. One type of spotting agent is called a POG spotting agent which is used to remove paint, oil and grease stains. Many of the POG spotting agents historically contained PERC and now, the majority relies on trichloroethylene (TCE). TCE, like PERC, is a carcinogen. It is classified as a HAP, a TAC and is listed on Proposition 65 as a substance known to cause cancer. It is also a listed hazardous waste under RCRA.

In projects conducted earlier, IRTA identified, developed and demonstrated safer alternative POG spotting agents. Many cleaners, even those who have already converted to alternative textile cleaning processes, still use PERC and TCE based spotting agents. Cleaners who use wet cleaning technologies and these traditional spotting agents will discharge PERC or TCE to the sewer in the effluent. Cleaners who use the carbon dioxide process with these traditional spotting agents may have to dispose of the waste streams as hazardous waste and disposal is likely to be more expensive.

### III. SHOWCASE FACILITIES AND EXPO

#### SHOWCASE FACILITIES

IRTA worked with five showcase facilities located in California during the project. These included:

- Mastercraft Solvent Free Dry Cleaning in Fresno;
- Legacy Cleaners in Tustin;
- Aqua Cleaners in Los Altos;
- Hangers Cleaners in Torrey Hills; and
- Royal Cleaners in Santa Monica

One-day showcase events were held at four of the five cleaners. Aqua Cleaners in Los Altos cancelled the one-day event after it had been scheduled and planned.

Table 3-1 shows the facilities and the types of equipment/processes each of the cleaners uses. Two of the facilities have Green Jet machines in conjunction with traditional wet cleaning. Until recently, Mastercraft did not have a humidity controlled dryer nor did the shop use tensioning finishing equipment. This demonstrates that cleaners do not need expensive wet cleaning or tensioning equipment to use water-based processes. Mastercraft has been operating the equipment for at least six years and processes about half of the garments in the Green Jet machine. Legacy cleaners also has a Green Jet machine and uses it with wet cleaning equipment that consists of a small Sears washer and dryer. Again, this demonstrates that low cost wet cleaning equipment paired with the Green Jet is a viable alternative to PERC dry cleaning.

**Table 3-1**  
**Showcase Facility Equipment/Processes**

<u>Facility</u>	<u>Type of Equipment/Process</u>
Mastercraft	Green Jet, traditional wet cleaning
Legacy Cleaners	Green Jet, traditional wet cleaning
Aqua Cleaners	carbon dioxide, traditional wet cleaning
Hangers Cleaners	carbon dioxide
Royal Cleaners	carbon dioxide

Aqua Cleaners has both wet cleaning and carbon dioxide equipment. Hangers Cleaners and Royal Cleaners each have a carbon dioxide machine. Although Aqua Cleaners opened their shop recently, Hangers Cleaners has used carbon dioxide exclusively for several years and Royal Cleaners has used carbon dioxide exclusively for at least two years. Both shops using carbon dioxide are successful which demonstrates that carbon dioxide is a viable alternative to PERC dry cleaning.

#### COST ANALYSIS AND COMPARISON

IRTA analyzed the cost of using the alternative technologies for three of the facilities including Mastercraft, Hangers Cleaners and Royal Cleaners. It was not possible to

analyze the cost for Aqua Cleaners and Legacy Cleaners since the companies have opened their shops so recently; they are still building their businesses.

The cost analyses for Mastercraft and Royal Cleaners includes a cost comparison for the new technologies and PERC. Both facilities used PERC dry cleaning in the past so this comparison was possible. The owner of Hangers Cleaners did use PERC dry cleaning in the past but not at the facility where the cost analysis was performed. Thus, no comparison of the cost of using carbon dioxide and PERC dry cleaning was possible for Hangers Cleaners. The assumptions used in the cost analysis for the three facilities is described in detail below.

### Mastercraft Solvent Free Dry Cleaning

Mastercraft is located in Fresno, California. The store has had a wet cleaning system and a Green Jet machine since 2002. Until recently, the shop used a washer and dryer that was not humidity controlled and also relied on traditional finishing equipment. A few months ago, the owner purchased a humidity controlled dryer and tensioning equipment. The store cleans about 60,000 pieces or pounds of garments per year.

The owner of Mastercraft had two plants until May of 2002. One of the plants, called the Cedar plant, had a PERC dry cleaning machine. The other plant called Fig Garden, had a wet cleaning system comprised of a washer and a dryer that was not humidity controlled. Prior to May 2002, half the garments or 30,000 pounds were cleaned at the Cedar plant in the PERC machine and half were cleaned at the Fig Garden plant in the wet cleaning machine. Mastercraft also has a washer that is used for laundering shirts but not for the dry cleaning.

In 2002, the owner purchased a Green Jet machine for the Fig Garden plant, closed the Cedar plant and stopped using the PERC machine. At that time, half the garments or 30,000 pounds were cleaned in the wet cleaning machine and half in the PERC machine. Currently, half the garments are cleaned in the wet cleaning machine and half are cleaned in the Green Jet machine.

The cost analysis performed here compares the cost of using the wet cleaning equipment and the PERC machine with the cost of using the wet cleaning equipment and the Green Jet machine. Because about half the garments have been cleaned with the wet cleaning equipment over the entire period, the analysis focuses on comparing the cost of using the PERC machine with the cost of using the Green Jet machine.

The capital cost of the Green Jet machine was \$16,500. The installation cost amounted to \$2,000 for a total capital cost of \$18,500. Assuming a 15-year life for the equipment and a cost of capital of five percent, the annualized cost of using the Green Jet machine is \$1,295.

The PERC machine used by the facility was a converted machine or a machine converted from a vented system to a closed loop system. Emissions from such systems are

generally fairly high. The owner estimates that the cost of purchasing PERC amounted to about \$300 per month or \$3,600 annually.

Mastercraft also purchased detergent for use with the PERC machine. The owner estimates that detergent costs amounted to \$25 per month or \$300 per year.

A detergent called DWX 44 is used in the Green Jet machine. The shop uses seven ounces of the detergent per 35 pound load. Based on 60,000 pounds of garments cleaned per year and half of them cleaned in the Green Jet, the shop cleans 857 loads per year in the Green Jet equipment. Mastercraft uses 375 pounds of detergent per year. The MSDS for DWX 44 indicates a density of 8.34 pounds per gallon. On this basis, about 45 gallons of detergent is used annually. A 2.5 gallon container is priced at \$65. The annual cost of the Green Jet detergent is \$1,170.

The owner estimates that the electricity cost has not changed since the conversion from PERC to Green Jet. This cost includes the electricity cost for the lighting, for the wet cleaning equipment and for the PERC machine used previously and the Green Jet machine used today. The electricity cost for the facility is currently about \$8,000 per year and it will be assumed that this was also the cost when the PERC machine was used. For purposes of analysis, it will be assumed that half the electricity cost, or \$4,000 per year, is attributable to the PERC machine or the Green Jet machine and half is attributable to the wet cleaning machine.

When the PERC machine was used, the gas cost amounted to about \$5,000 per year. Assuming half the gas was used for the pressing equipment, the cost of the gas used for the PERC machine amounted to about \$2,500 annually. There is no gas used by the Green Jet machine so it will be assumed that the gas cost today is zero.

One employee spends an average of 3.5 hours per day in spotting. Assuming a six day workweek, the spotting labor amounts to 1,092 hours per year. At a spotting labor rate of \$10.00 per hour, the annual cost of spotting is \$10,920. Mastercraft's owner indicates that overall spotting labor did not change when the shop converted from PERC to the Green Jet. He estimates that half the spotting labor was for garments cleaned in the PERC machine and half for the garments that were wet cleaned. On this basis, the spotting labor cost for the PERC machine was \$5,460. Half the garments are cleaned in the Green Jet machine and half in the wet cleaning machine today. The owner estimates that somewhat more of the spotting labor is devoted to the garments cleaned with the Green Jet. For purposes of analysis, it was assumed that 40 percent of the total spotting labor is for garments that are wet cleaned and 60 percent for garments that are cleaned in the Green Jet machine. The spotting labor cost for the Green Jet machine is \$6,552.

The owner also indicates that the total finishing labor has not changed with the conversion. Employees spend an average of 90 hours per week or 4,680 hours per year finishing the garments. At a labor rate of \$8.75 per hour, the annual finishing labor cost is \$40,950. The owner estimates that about 55 percent of the finishing labor was required

for the wet cleaning finishing and 45 percent when PERC was used and today when the Green Jet is used. The finishing labor cost with PERC and with the Green Jet is \$18,428.

When Mastercraft used PERC, an employee spent four hours every two months or 24 hours per year on routine maintenance activities that involved changing out the filters. Assuming a labor rate of \$10 per hour, the labor cost was \$240 annually. The total annual maintenance labor cost amounted to \$2,040. With the Green Jet machine, the maintenance cost involves cleaning out the air jets. An outside company services the machine and spends two hours every three months or eight hours per year in this activity. At an hourly rate of \$40, the annual cost of this routine maintenance is \$320.

The maintenance equipment cost for the PERC machine was the cost of filter replacement. The owner estimates that six filters were replaced seven times per year for a total of 42 replacements annually. IRTA estimates the cost of a typical filter at about \$35. On this basis, maintenance equipment costs for the facility when the PERC machine was used amounted to \$1,470 per year. With the Green Jet machine, there is no maintenance equipment cost.

When PERC was used, the owner estimates that Mastercraft had compliance costs that amounted to \$370 per year. These costs included daily, weekly and monthly record keeping for the machine, the waste disposal records, the PERC usage records, employee training and preparation of the annual report. There are no compliance costs for the Green Jet.

When Mastercraft used PERC, the facility disposed of filter waste. The waste disposal cost amounted to \$1,839 annually. There are currently no waste disposal costs with the Green Jet system.

Table 3-2 summarizes the cost comparison for the PERC and the Green Jet technologies. The annual cost of using the Green Jet system is about 21 percent lower than the annual cost of using the PERC machine.

**Table 3-2**  
**Annualized Cost Comparison for Mastercraft Solvent Free Dry Cleaning**

	PERC	Green Jet
Annualized Capital Cost	-	\$1,295
Solvent Cost	\$3,600	-
Detergent Cost	\$300	\$1,170
Electricity Cost	\$4,000	\$4,000
Gas Cost	\$2,500	-
Spotting Labor Cost	\$5,460	\$6,552
Finishing Labor Cost	\$18,428	\$18,428
Maintenance Labor Cost	\$2,040	\$320
Maintenance Equipment Cost	\$1,470	-
Compliance Cost	\$370	-
Waste Disposal Cost	\$1,839	-
<b>Total Cost</b>	<b>\$40,007</b>	<b>\$31,765</b>

## Royal Cleaners of Brentwood

Royal Cleaners, located in Santa Monica, California, had a 55 pound PERC machine in the past and now has a 60 pound carbon dioxide machine. When Royal cleaned with PERC, the facility processed 104,000 pounds of garments annually. With carbon dioxide, business has expanded and the shop now cleans 155,000 pounds of clothing per year.

Royal purchased a 60 pound carbon dioxide machine for \$150,000. The cost of a carbon dioxide storage tank was \$5,000. The installation cost was \$25,000. Royal also received a grant from the South Coast Air Quality Management District of \$20,000. Deducting the grant funds, the total capital cost was \$160,000. Assuming a 15 year life for the equipment and a cost of capital of five percent, the annualized cost of the equipment is \$11,200.

When Royal used PERC, the facility used 100 gallons of the solvent per year. At a cost of \$6.50 per gallon at the time, the annual cost of PERC was \$650. Royal purchases carbon dioxide in bulk, at a cost of less than 11 cents per pound. The carbon dioxide purchases amount to \$800 per month or \$9,600 per year.

When Royal used PERC, the shop used one gallon per week or 52 gallons per year of detergent. At a cost of \$25 per gallon, the annual cost of detergent was \$1,300. With carbon dioxide, the detergent cost is \$676 per quarter or \$2,704 per year.

With PERC, Royal's electricity cost was \$400 per month or \$4,800 per year. With carbon dioxide, the electricity cost is \$10,000 annually.

The gas cost when Royal used PERC was \$275 per month or \$3,300 per year. Gas was used for the PERC machine and also for the finishing equipment. The owner estimates that two-thirds of the gas cost, or \$2,200 per year, went toward the PERC machine. With the carbon dioxide, no gas is used in the process.

With PERC, Royal's spotting labor was 12 hours per week or 624 hours per year. Assuming a labor rate of \$13 per hour, the annual spotting labor cost was \$8,112. Royal has substantially increased the labor rate for the spotter and the annual spotting cost with carbon dioxide is much higher, at \$47,000 per year.

When Royal used PERC, the finishing labor was 144 hours per week or 7,488 hours per year. At a finishing labor rate of \$13, the finishing labor cost was \$97,344 per year. When Royal converted to carbon dioxide, the finishing labor cost was the same.

With PERC, the maintenance labor amounted to one hour per week or 52 hours per year. At a maintenance labor rate of \$13 per hour, the maintenance labor cost was \$676 annually. With carbon dioxide, there is no maintenance labor cost.

When Royal used PERC, the shop replaced 12 filters every three months or 48 filters per year. Assuming a cost of \$35 per filter, the maintenance equipment cost was \$1,680 per year. There is a maintenance equipment cost for the carbon dioxide machine of \$200 per year for parts.

When Royal had a PERC machine, the shop spent three hours per week on compliance activities and two hours per month at meetings related to compliance. Assuming a labor rate of \$13 per hour, the annual compliance cost with PERC amounted to \$2,340. There is no compliance cost with carbon dioxide.

With PERC, Royal’s waste disposal costs were \$550 every three months or \$2,200 per year. With the carbon dioxide machine, at the current disposal rate of 30 gallons of waste in four years at a cost of \$600, the annual disposal costs amount to \$150.

Table 3-3 shows the annualized cost comparison for Royal for the PERC and carbon dioxide machines. The first column represents the costs of cleaning 104,000 pounds of garments per year with PERC. The second column represents the costs of cleaning 155,000 pounds of garments per year with PERC. In this column, the PERC costs have been adjusted by the ratio of 1.49 to normalize the numbers for comparison. The third column shows the costs of cleaning 155,000 pounds of garments per year with carbon dioxide. Even with the purchase of the carbon dioxide system, the costs of using the carbon dioxide process are lower than the costs of using PERC.

**Table 3-3  
Annualized Cost Comparison for Royal Cleaners of Brentwood**

	PERC (104,000 lbs)	PERC (155,000 lbs)	Carbon Dioxide (155,000 lbs)
Annualized Capital Cost		-	\$11,200
Solvent/Carbon Dioxide Cost	\$650	\$969	\$9,600
Detergent Cost	\$1,300	\$1,937	\$2,704
Electricity Cost	\$4,800	\$7,152	\$10,000
Gas Cost	\$2,200	\$3,279	-
Spotting Labor Cost	\$8,112	\$12,087	\$47,000
Finishing Labor Cost	\$97,344	\$145,043	\$97,344
Maintenance Labor Cost	\$676	\$1,007	-
Maintenance Equipment Cost	\$1,680	\$2,503	\$200
Compliance Cost	\$2,340	\$3,487	-
Waste Disposal Cost	\$2,200	\$3,278	\$150
<b>Total Cost</b>	<b>\$122,402</b>	<b>\$180,742</b>	<b>\$178,198</b>

### Hangers Cleaners

Hangers Cleaners was first opened in April 2001 in Mission Valley, California. The plant has a 60 pound liquid carbon dioxide dry cleaning machine. The Mission Valley plant also processes laundry and wet cleaning. The Hangers owner opened two drop-stores, the first in downtown San Diego in 2003 and the second in Santaluz in 2005. The owner opened a second carbon dioxide dry cleaning plant in Torrey Hills in 2005. This

plant does not process laundry or wet cleaning. In 2006, about 136,000 pounds of garments in 2,712 loads were cleaned in the Torrey Hills store.

The owner purchased the carbon dioxide machine for Mission Valley from Micell, a company that is no longer active in the dry cleaning industry. Hangers also purchased a chiller and paid a franchise fee for the Mission Valley location, which allows the company to open other facilities in San Diego County. The owner purchased the second machine and chiller for the Torrey Hills store second-hand at less than 50 percent of the cost of a new machine and chiller.

IRTA analyzed the cost of using carbon dioxide at the Torrey Hills store as part of the showcase project. IRTA and Hangers decided not to use the actual equipment cost, since any other cleaner who decides to purchase a carbon dioxide machine would have to pay the price of a new machine. IRTA obtained the cost of a new 60 pound machine and chiller from SailStar USA, a carbon dioxide machine supplier. The cost of the machine is \$143,000 and the cost of the chiller is \$8,000. The installation cost amounts to \$14,000. The total capital cost is \$165,000. On this basis, assuming a useful life for the equipment of 15 years and a five percent cost of capital, the annualized cost of purchasing and installing the equipment is \$11,550.

In 2006, Hangers used 36,326 pounds of carbon dioxide at a cost of \$8,523. The shop also pays \$194 per month or \$2,328 annually to rent the carbon dioxide storage tank, fill and venting system from an industrial gas company. The cost of using the carbon dioxide is \$10,851 per year.

Hangers purchases 127 gallons of detergent for the carbon dioxide process. The total annual cost of the detergent amounts to \$5,285.

In 2006, the electricity cost for the facility was \$17,221. The owner installed air conditioning in August of that year. Assuming the cost of four months of air conditioning was \$2,000, the electricity cost related to the store operation including the carbon dioxide machine is \$15,221 per year. The cost of using gas in the facility is \$10,431 annually.

The owner of Hangers estimates that spotting labor at the facility is 600 hours per year. At a labor rate of \$13 per hour, the annual cost of spotting labor is \$7,800.

The owner estimates the finishing labor cost at about \$3,000 per week. Assuming 52 weeks per year, this translates into \$156,000 annually. This labor cost is fairly high because the owner concentrates on quality, not speed of processing. The average revenue per garment is \$5.52 and the high price dictates a higher level of attention.

The routine maintenance labor at Hangers is estimated at two hours per week or 104 hours per year. Assuming a labor rate of \$13 per hour, the maintenance labor cost amounts to \$1,352.

The owner indicates that the particulate filter on the machine was changed 63 times in 2006 and the carbon cannister was changed nine times. The cost of the new filters and cannister amounted to \$5,200 for the year.

Hangers disposes of the still bottoms from the distillation process as hazardous waste. The owner estimates the annual cost of disposal at \$800.

Table 3-4 shows the annualized cost for Hangers for using the carbon dioxide technology.

**Table 3-4  
Annualized Cost for Hangers Cleaners**

	Carbon Dioxide
Annualized Capital Cost	\$11,550
Carbon Dioxide Cost	\$10,851
Detergent Cost	\$5,285
Electricity Cost	\$15,221
Gas Cost	\$10,431
Spotting Labor Cost	\$7,800
Finishing Labor Cost	\$156,000
Maintenance Labor Cost	\$1,352
Maintenance Equipment Cost	\$5,200
Waste Disposal Cost	\$800
<b>Total Cost</b>	<b>\$224,490</b>

Summary of Cost Analysis

The capital cost of carbon dioxide equipment is high compared with the capital cost of PERC, other solvent or water-based equipment. Considering Royal Cleaners and the cost comparison for cleaning with PERC and cleaning with carbon dioxide, the figures show that the annualized cost of cleaning with PERC and carbon dioxide is comparable. Even though the carbon dioxide equipment is costly, the operating costs for the facility are lower.

Table 3-5 summarizes the total cost and the total cost per pound of garments cleaned for the three facilities. The cost per pound for the facility cleaning with the Green Jet and wet cleaning equipment is lower than the cost per pound for cleaning with carbon dioxide. All three facilities are very successful, thriving businesses.

**Table 3-5  
Total Cost and Total Cost Per Pound for Showcase Facilities**

Facility	Type of Equipment / Process	Total Annual Cost	Total Annual Cost/Pound
Mastercraft	Green Jet/wet cleaning	\$31,765	\$1.06
Royal Cleaners	carbon dioxide	\$178,198	\$1.15
Hangers Cleaners	carbon dioxide	\$224,490	\$1.65

Case studies for each of the three facilities, including the cost analysis, are shown in Appendix A. Case studies for the other two facilities, without cost analysis, are also provided in the appendix.

### ONE-DAY SHOWCASE EVENTS

One-Day events were held at four of the five showcase facilities. As mentioned earlier, Aqua Cleaners cancelled the showcase after it was scheduled and arranged. Mailers, which included the case studies in Appendix A, were sent out to cleaners in the surrounding area. An example of the mailer sent out for Royal Cleaners is shown in Appendix B. The mailers for the other facilities are similar to this mailer.

Table 3-6 shows the number of mailers that were sent out for each of the facilities where showcases were held. For Mastercraft, IRTA obtained the list of dry cleaners in the area that have air district permits from the San Joaquin Valley Air Pollution Control District. For Royal Cleaners and Legacy Cleaners, IRTA used the SCAQMD list of permitted cleaners in Los Angeles, Orange, Riverside and San Bernardino Counties. For Hangers Cleaners, IRTA used the San Diego Air Pollution Control District list of permitted cleaners. For Aqua Cleaners, IRTA obtained the list of permitted cleaners in the BAAQMD; because Aqua Cleaners cancelled the showcase, the 755 mailers that were prepared were not mailed.

**Table 3-6  
Number of Mailers Sent Out for One-Day Showcases**

<u>Facility</u>	<u>Number of Mailers</u>
Mastercraft	950
Royal Cleaners	1,929
Hangers Cleaners	883
Legacy Cleaners	1,893

Table 3-7 shows the number of people who attended each of the one-day showcase events. The number of attendees ranged from 13 at Mastercraft Cleaners to 35 at Hangers Cleaners.

**Table 3-7  
Number of Attendees at Showcase Events**

<u>Showcase Facility</u>	<u>Date</u>	<u>Number of Attendees</u>
Mastercraft	8/10/07	13
Royal Cleaners	10/07/07	31
Hangers Cleaners	9/23/07	35
Legacy Cleaners	1/26/08	18

Figure 3-1 shows a picture taken during the showcase event at Royal Cleaners. Figure 3-2 shows a similar picture for the showcase event at Hangers Cleaners.



Figure 3-1. Showcase Event at Royal Cleaners



Figure 3-2. Showcase Event at Hangers Cleaners

IRTA followed up with several of the cleaners who attended the showcase events to talk about whether they had decided to convert to an alternative technology. A few cleaners had converted to water-based processes and many others had not yet decided on which alternative was best for their facility. After the Mastercraft showcase, one of the attendees decided to adopt wet cleaning in combination with the Green Jet technology. This cleaner opened a new shop, Legacy Cleaners, some months later. Legacy Cleaners later also served as a showcase facility during the project.

## EXPO EVENT

An EXPO was held on May 18, 2008 at Southern California Edison's Customer Technology Application Center (CTAC). IRTA developed a brochure for the event that featured water-based and carbon dioxide alternatives to PERC. The brochure is shown in Appendix C.

The brochures were printed by DTSC at the state printing office. IRTA mailed out the brochures to the 1,929 permitted cleaners listed on the SCAQMD permit list in four counties including Los Angeles, Orange, Riverside and San Bernardino. IRTA also mailed 40 brochures to cleaners in the Mojave Desert. SCE staff translated the brochure into Korean and mailed it to 1,100 cleaners.

About 60 people, including cleaners, vendors and representatives from government agencies, attended the EXPO. There was strong interest in the grant programs and in the water-based and carbon dioxide technologies. There was a lively discussion about the best methods of spotting and finishing for water-based cleaning processes. The EXPO included demonstrations of traditional wet cleaning and tensioning equipment and the Green Jet technology. Literature on the case studies for the five facilities was available at the EXPO. Information on alternative, safer spotting chemicals and on water-based and carbon dioxide systems was provided to the attendees.

A picture of the demonstration of finishing for traditional wet cleaning during the EXPO is shown in Figure 3-3. A picture of the demonstration of the Green Jet equipment during the EXPO is shown in Figure 3-4.



Figure 3-3. Demonstration of Wet Cleaning Finishing During EXPO



Figure 3-4. Demonstration of Green Jet System at EXPO

Many of the cleaners attending the EXPO expressed interest in the water-based and carbon dioxide technologies and using the grant programs that are available for purchasing equipment. The EXPO was a successful event according to comments by many of the attendees.

#### IV. SPOTTING CHEMICAL ALTERNATIVES

IRTA conducted a project sponsored by DTSC and EPA to identify, develop, test and demonstrate alternatives to PERC and TCE based POG spotting agents. As described earlier, cleaners use these spotting agents to remove paint, oil and grease stains from garments before or after the main garment cleaning process. In the earlier work, IRTA estimated that about 40,000 gallons per year of TCE based spotting agents are sold in California annually. The concentration of TCE in these spotting agents ranges from 10 to 100 percent. IRTA estimates that a smaller amount of PERC based spotting agents, 100 gallons annually is used in California.

In an earlier project sponsored by CARB and EPA, IRTA worked with Los Angeles County Sanitation Districts to sample and analyze the effluents from four wet cleaning facilities. For the four wet cleaning facilities, PERC or TCE were found in the wash and/or rinse effluent at three of the facilities that were sampled. IRTA informed the cleaners of the findings and one of the facilities stopped using a TCE spotting chemical. In the second round of testing, PERC and/or TCE was found in the wash and/or rinse effluent at two of the facilities. Publicly Owned Treatment Facilities (POTWs) regulate wastewater discharges from facilities. POTWs generally do not require cleaners using wet cleaning to obtain a permit. They do not want cleaners to discharge halogenated solvents like TCE or PERC to the sewer. The presence of these solvents can make the effluent hazardous waste and it is illegal to discharge hazardous waste to the sewer. In principle, these cleaners should drum up the effluent and ship it off-site as hazardous waste rather than discharging it to the sewer.

The likely origin of the solvents in the wet cleaning effluent was spotting agents. The fact that PERC and TCE were found in the effluents from the wet cleaning facilities was motivation for IRTA to investigate alternative POG spotting agents. If alternative spotting agents were available or could be found and were effective, there would be no need to continue using the PERC and TCE spotting materials.

IRTA's spotting agent project involved working with several cleaners using a range of alternative technologies to test safer spotting agents. These included a wet cleaning facility, an icy water facility and a carbon dioxide facility. IRTA conducted preliminary analysis to test possible alternatives. Various types of stains, including tar, ink, shoe polish, mascara, lipstick, oil-based paint, nail polish and crayon, were placed on a range of garment types obtained from Good Will. IRTA focused on alternatives that are water-based, soy based, acetone and glycol ether based. IRTA then tested the best performing cleaners with garment care facilities. The facilities indicated the alternative they liked the best and larger quantities were supplied by IRTA. IRTA conducted a limited cost analysis and found that most alternatives were likely to be less costly than the TCE based spotting agent that is most widely used.

One of the spotting agents that performed well is a water-based cleaner, called Cold Plus, that was just beginning to be used commercially. Another cleaner, based on soy, was commercialized after the project was completed.

During the current project, IRTA developed a fact sheet for cleaners on the dangers of using TCE and PERC based POG spotting agents and the alternatives that are available. The aim of the fact sheet is to make cleaners, particularly those adopting water-based technologies where the effluent is sewerred, aware of the disadvantages of using PERC and TCE spotting agents. This information should make it easier for cleaners to make a decision to adopt water-based and carbon dioxide alternatives. DTSC printed the fact sheet and it was distributed widely at the showcases and at the EXPO. A copy of the fact sheet is shown in Appendix D.

## V. RESULTS AND CONCLUSIONS

AB 998 established the Non-Toxic Dry Cleaning Incentive Program in California. CARB developed guidelines for the program that consisted of grants to cleaners who substituted water-based or carbon dioxide technologies for a PERC dry cleaning machine. The program also involved developing a demonstration program for showcasing water-based and carbon dioxide technologies to encourage cleaners to adopt them.

IRTA received a grant from CARB under the AB 998 program. IRTA partnered with DTSC and SCE, a large electric utility, to conduct the project. IRTA worked with five textile-cleaning facilities to feature their conversion to or adoption of water-based and carbon dioxide technologies. Mastercraft Cleaners in Fresno converted from PERC to a combination of wet cleaning and the Green Jet technology several years ago. Legacy Cleaners, after attending the Mastercraft Cleaners showcase, opened a new cleaning facility in Tustin with low cost wet cleaning equipment and the Green Jet technology. Several years ago, the owner of Hangers Cleaners decided to adopt the carbon dioxide technology in place of PERC dry cleaning; he was the first cleaner in California to do so. A few years later, Royal Cleaners in Santa Monica adopted carbon dioxide in place of PERC and both facilities have been operating successfully. Finally, Aqua Cleaners in Los Altos opened a new facility and elected to use wet cleaning equipment and the carbon dioxide technology.

As part of the project, IRTA developed case studies that featured the five shops that participated in the project. IRTA analyzed the cost for three of the cleaning facilities that had been operating for more than one year. In two cases, IRTA compared the cost of using the new technology with the cost of using PERC. In one case, Mastercraft Cleaners, the shop reduced their cost considerably through the conversion. In the other case, Royal Cleaners, the cost of using carbon dioxide is comparable to the cost of using PERC.

IRTA held showcases at four of the five facilities participating in the project. IRTA sent mailers to more than 5,000 facilities in the state to advertise the showcases. IRTA also wrote articles advertising the showcases in the dry cleaning trade magazines. Almost 100 people attended the showcases.

IRTA arranged and held an EXPO to feature water-based and carbon dioxide processes at SCE's CTAC facility in Irwindale, California. Representatives from CARB, SCAQMD and BAAQMD described their regulations and grant programs. Owners from three of the showcase cleaners, Mastercraft Cleaners, Hangers Cleaners and Royal Cleaners, gave presentations at the EXPO. IRTA presented information on behalf of Legacy Cleaners, the fourth showcase facility. The EXPO included demonstrations of wet cleaning and Green Jet equipment and related equipment and material suppliers were provided with vendor tables. The EXPO drew about 60 attendees.

IRTA also prepared and distributed a fact sheet for cleaners on alternative, safer spotting chemicals as part of the project. Alternative spotting agents are particularly important for

cleaners using wet cleaning processes because the spotting agents can end up in the effluent that is discharged to the sewer. DTSC printed and distributed the fact sheet and it was disseminated at the showcases and at the EXPO.

**Appendix A**  
**Case Studies for Showcase Facilities**

## Fresno Cleaner Adopts Water-Based Cleaning Technology

Mastercraft® Solvent Free Dry Cleaning, a high-end textile cleaner with 1,750 square feet, is located in the Fig Garden shopping center in Fresno. Steve Berglund, owner of Mastercraft®, has nearly 40 years of experience in the textile cleaning industry. He has a total of seven patents and 13 trademarks. Mastercraft® offers unique personalized services including



Super Shirt which combines a patented collar shaper, sleeve holder and cuff links for laundered shirts and the convenient Handy Hamper®, an express bag designed by Berglund.

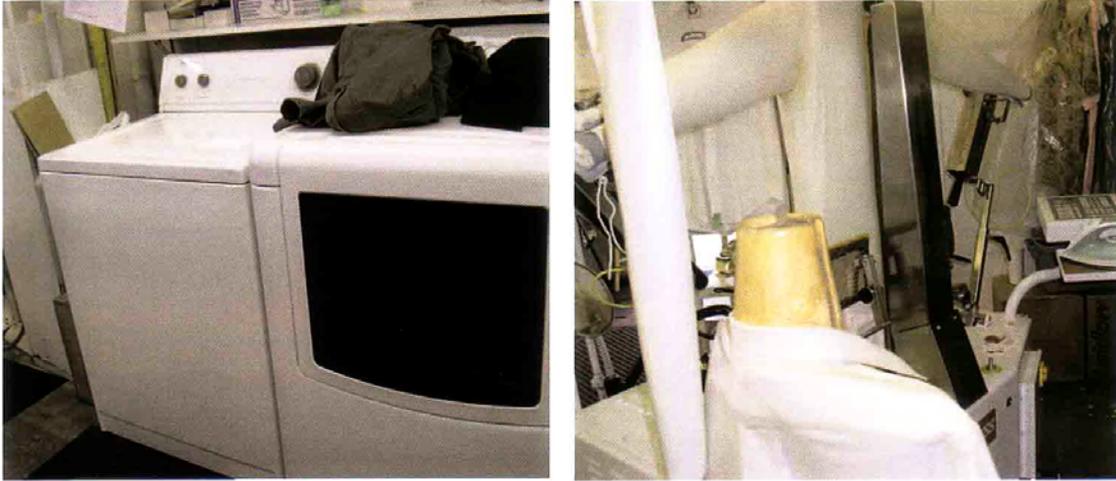
Over the years, Mastercraft® has received several awards. Mastercraft® was honored as best-in-the-nation in design, marketing and promotion by the American Dry Cleaning magazine in 1982. In 2006, the magazine gave the shop the Outstanding Niche Operation award.

In 2002, Mr. Berglund purchased a Green Jet machine which uses a spray of water and detergent to clean garments. He was one of the first cleaners in the nation to adopt this technology. Says Mr. Berglund, "Mastercraft® has always been a leader." He closed down a perchloroethylene (PERC) dry cleaning machine at the same time. "I saw the writing on the wall and thought PERC would be phased out. I wanted to use a safe technology that would reduce the risk to my workers and cus-



tomers," says Mr. Berglund. The California Air Resources Board recently adopted a regulation that will gradually phase out PERC dry cleaning by 2023.

The shop uses both wet cleaning and the Green Jet equipment. Many of Mastercraft's® upscale customers' garments are not heavily soiled so they are easily cleaned in the Green Jet. About half the garments cleaned in the shop are wet cleaned and half are processed through the Green Jet. "Until recently, I didn't have a humidity controlled dryer for the wet cleaning system or tensioning equipment for the finishing," says Mr. Berglund. "The structured garments, like a man's suit jacket, for example, are easily finished if they go through the Green Jet."



The cost of using the Green Jet is lower than the cost of using PERC. "I want to be progressive in terms of the environment and health but I also must have a profitable business," says Mr. Berglund. "I'm saving money and doing the right thing at the same time."

Annualized Cost Comparison for Mastercraft® Natural Cleaning		
	PERC	Green Jet
Annualized Capital Cost	-	\$1,295
Solvent Cost	\$3,600	-
Detergent Cost	\$300	\$1,170
Electricity Cost	\$4,000	\$4,000
Gas Cost	\$2,500	-
Spotting Labor Cost	\$5,460	\$6,552
Finishing Labor Cost	\$18,428	\$18,428
Maintenance Labor Cost	\$2,040	\$320
Maintenance Equipment Cost	\$1,470	-
Compliance Cost	\$370	-
Waste Disposal Cost	\$1,839	-
<b>Total Cost</b>	<b>\$40,007</b>	<b>\$31,765</b>

OSP 07 103303

## Santa Monica Cleaner Pleased With Carbon Dioxide Technology

Royal Cleaners has been located in Santa Monica, California since 1948. In 2003, the owner, Bobby Smerling, moved to a new location in the same area and installed a 60 pound carbon dioxide machine and a carbon dioxide storage tank. The carbon dioxide machine replaced a 55 pound perchloroethylene (PERC) machine which was used to clean 104,000 pounds of garments annually. At this stage, the shop has increased its cleaning volume substantially, to 155,000 pounds of garments per year.



"I made the right decision," says Mr. Smerling. Royal received a grant from the South Coast Air Quality Management District to purchase the new system. "The PERC phaseout in California no longer concerns me because I put in the best alternative." Mr. Smerling plans to open a second plant with a carbon dioxide and wet cleaning machine in the west Los Angeles area in the next year or so.

The carbon dioxide machine operates at 700 to 900 pounds per square inch pressure to keep the carbon dioxide liquified. "The cycle time of my machine is only 35 minutes which is less than the cycle time of the old PERC machine,"





says Mr. Smerling. "When we moved, we didn't have room for a large machine and I decided to purchase a Sailstar system," he says. "It took us only about two months to learn the new features and procedures. The finishing is about the same as it was with PERC but there is more spotting now. We can process delicate garments much more easily with carbon dioxide."

"My customers are upscale," says Mr. Smerling. "They are concerned about health and the environment. The carbon dioxide process has health and environmental benefits, and the costs of using the system are lower than they were with PERC even though I had to buy a new machine."

Annualized Cost Comparison for Royal Cleaners in Santa Monica		
	PERC	Carbon Dioxide
Annualized Capital Cost	-	\$11,200
Solvent Cost	\$969	\$9,600
Detergent Cost	\$1,937	\$2,704
Electricity Cost	\$7,152	\$10,000
Gas Cost	\$3,279	-
Spotting Labor Cost	\$12,087	\$47,000
Finishing Labor Cost	\$145,043	\$97,344
Maintenance Labor Cost	\$1,007	-
Maintenance Equipment Cost	\$2,503	\$200
Compliance Cost	\$3,487	-
Waste Disposal Cost	\$3,278	\$150
Total Cost	\$180,742	\$178,198

OSP 07 103969

## San Diego Cleaner Adopts Carbon Dioxide Technology

Hangers Cleaners, a high end textile cleaning facility, was first opened in Mission Valley near San Diego in 2001. The Hangers owner, Gordon Shaw, opened a second facility in Torrey Hills in 2005. Both facilities have 60 pound carbon dioxide machines.



Mr. Shaw has been a dry cleaner for many years and he operated five different perchloroethylene (PERC) plants before 2001. He did not want to use PERC at the new locations. The solvent poses health and environmental problems and it has been phased out in California. Says Mr. Shaw, "I investigated the carbon dioxide process and decided it was a good technology, particularly for the upscale clientele my shops serve."

The customers at the first Hangers location were enthusiastic about using a "green" alternative like carbon dioxide. The success of the first store prompted Mr. Shaw to open the second cleaning store and two additional drop stores in the San Diego area. Mr. Shaw was one of the first cleaners in the country to use carbon dioxide and he is a pioneer for the industry. In the last few months, Mr. Shaw has been featured by Newsweek in several articles in a series on [www.msnbc.com](http://www.msnbc.com).



The carbon dioxide machine operates at 700 to 900 pounds per square inch pressure to keep the carbon dioxide liquified. The cycle is 44 minutes, about the same as a PERC machine. "Carbon dioxide is a gentle cleaner because the process doesn't use heat and the solvent is less dense than other liquids," says Mr. Shaw. "Finishing is the same with carbon dioxide and PERC and I can now process delicate items that I couldn't clean with PERC." He does indicate, however, that more spotting is required with the carbon dioxide technology.

Many cleaners are concerned about the phaseout of PERC in California. "I would strongly recommend that cleaners in upscale areas look at the carbon dioxide technology," says Mr. Shaw. "It is an effective alternative to PERC."



Annualized Cost for Hangers Cleaners in Torrey Hills	
	Carbon Dioxide
Annualized Capital Cost	\$11,550
Carbon Dioxide Cost	\$10,851
Detergent Cost	\$5,285
Electricity Cost	\$15,221
Gas Cost	\$10,431
Spotting Labor Cost	\$7,800
Finishing Labor Cost	\$156,000
Maintenance Labor Cost	\$1,352
Maintenance Equipment Cost	\$5,200
Waste Disposal Cost	\$800
<b>Total Cost</b>	<b>\$224,490</b>

OSP 07 103303

## Los Altos Cleaner Adopts Wet Cleaning and Carbon Dioxide Technologies

Aqua Cleaners opened in Los Altos in November, 2007. Several dignitaries, including the Mayor, attended the Grand Opening event on December 6. The new facility is located in an upscale shopping area which includes an organic market as an anchor.



The cleaning facility is owned and operated by Kati Heilmann and Yasmina Das. Ms. Heilmann's family owned a textile cleaning shop when she was growing up. The owners decided to use the most environmentally friendly technologies for this new facility. "We wanted to set an example for the industry by using environmentally preferred methods of cleaning," says Ms. Heilmann.

Aqua Cleaners has two cleaning systems and provides laundry services as well. The professional wet cleaning equipment is an aqueous process for cleaning the full range of garments. "It relies on biodegradable detergents and additives," says Ms. Heilmann. The equipment can be programmed and customized for specific fabric types. "It is an extremely gentle cleaning method but it can also be used for heavily soiled fabrics," says Ms. Heilmann.



The facility also has a carbon dioxide dry cleaning system. The carbon dioxide comes from natural sources and is a by-product of industrial processes. While being environmentally safe, carbon dioxide has excellent cleaning properties. It dissolves dirt, fats and oils on all materials currently dry cleaned. Unlike all the other cleaning systems, carbon dioxide does not require drying with heat; as a result it is very gentle on fabrics. Most important, carbon dioxide never leaves harmful residue or odor on garments.

"The carbon dioxide machine cleans the clothes using much cooler temperatures than traditional cleaning methods," says Ms. Das. "Finishing with carbon dioxide is significantly easier and our customers are impressed with the results of how their garments look and feel, especially the absence of chemical odor."

Ms. Das is committed to the high quality cleaning and the superior environmental profile of the wet cleaning and carbon dioxide methods. "We want to use the safest technologies for our employees and customers. We want to offer environmental stewardship to the community," she says.

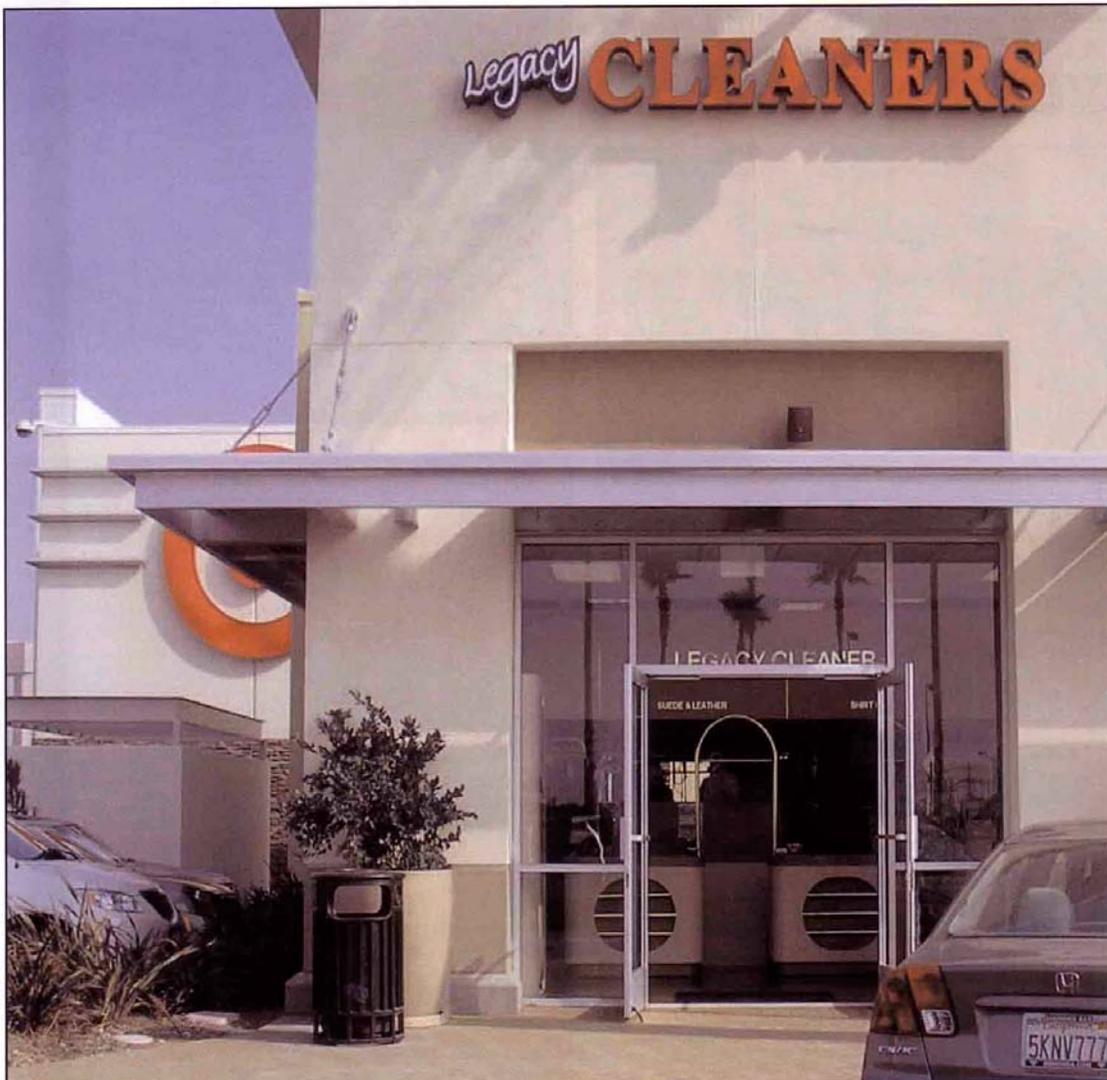


OSP 08 106577

## Tustin Cleaner Adopts Water-Based Cleaning Technologies

Legacy Cleaners opened in Tustin in early November, 2007. The cleaner is in a high end shopping center called Legacy District that opened recently. The shopping center is located at the site of what was formerly the El Toro Air Force Base and has a Target store as an anchor.

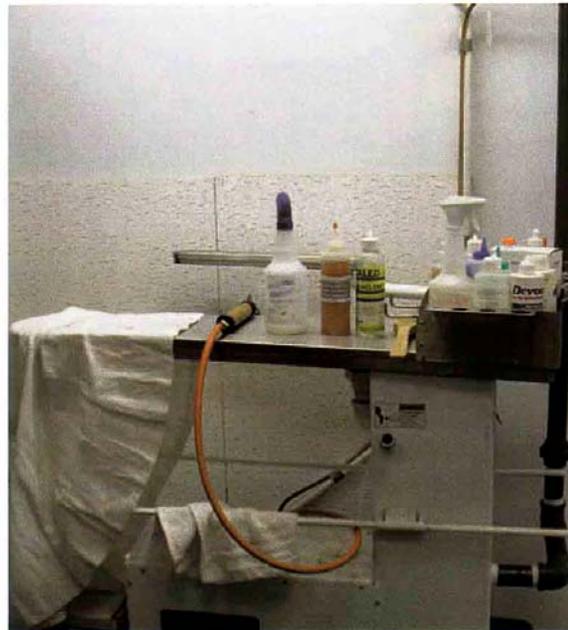
The cleaning facility is owned and operated by David and Jeeni Yoo. The couple is new to the textile cleaning business but they quickly learned the spotting, cleaning and finishing procedures. Says Mr. Yoo, "this is a very good location and our customer base is growing rapidly."



When the couple decided to lease the space, the landlord would not allow the use of any dry cleaning solvents. Mr. and Mrs. Yoo decided to use only water-based processes in the store. The shop has a Green Jet machine which uses a spray of water and detergent to clean garments. Many of the garments in the upscale area are not heavily soiled so they are easily cleaned with this technology. Finishing with the Green Jet is simple; the garments are not immersed in water and are not wrinkled. The shop also has a wet cleaning machine which is used to clean the more heavily soiled garments. The combination of the Green Jet and wet cleaning equipment is ideal for Legacy Cleaners. "I like the water-based processes very much," says Mr. Yoo. "They are good for us and for the environment."



Mr. and Mrs. Yoo are using safe materials to perform their spotting. Two of the POG spotting agents they rely on are water-based materials and the other is based on soy. "We had to learn the process of spotting," says Mr. Yoo. "Our spotting and cleaning operations are green which is a good marketing point."



**Appendix B**  
**Mailer for Royal Cleaners**

The Institute for Research and Technical Assistance Presents:

# Textile Cleaning Sunday Showcase!!

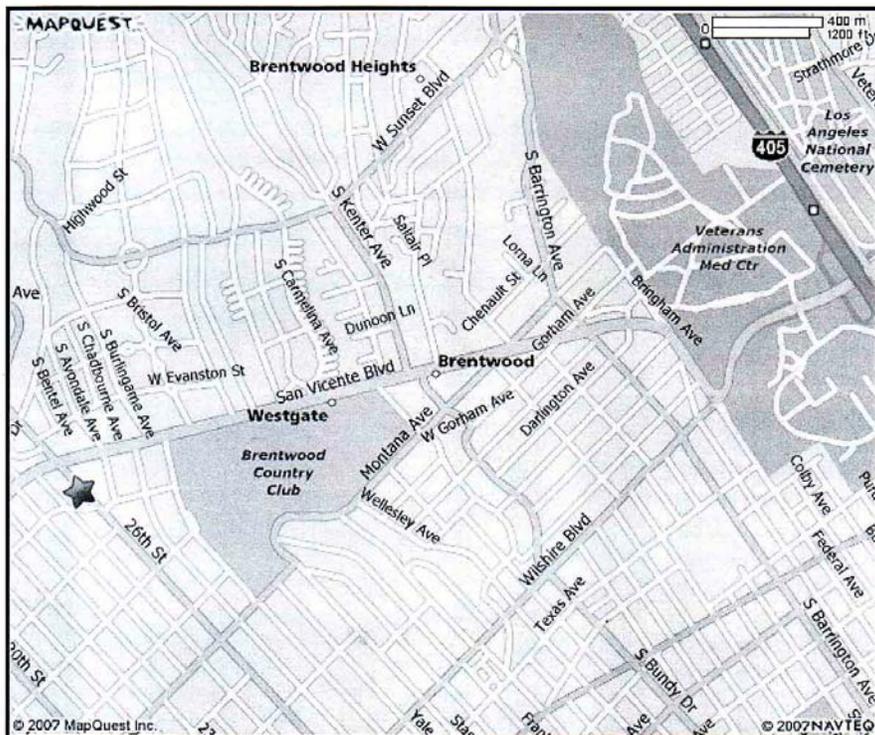
Sunday, October 7, 2007, 9am to 3pm, at Royal Cleaners  
256 26th Street, Santa Monica, CA 90402

The California Air Resources Board (CARB) recently adopted a phaseout of perchloroethylene (PERC) dry cleaning by 2023. Cleaners need to adopt alternative technologies as soon as possible. This showcase is part of the Assembly Bill 998 non-toxic and non-smog forming grant demonstration program. It is fully sponsored by CARB with a contribution from the Department of Toxic Substances Control (DTSC). The grant demonstration program will provide dry cleaners an opportunity to view the operations. It will also provide technical assistance and training, and educate cleaners on the benefits, cost and overall effectiveness of the alternative technologies.

Royal Cleaners has a carbon dioxide cleaning system which relies on carbon dioxide and detergent to clean garments. Royal has been operating for more than four years with this equipment, and the owner was one of the first cleaners to use the carbon dioxide system. The cleaner previously had a facility with a PERC machine.

The owner, Bobby Smerling, and his spotter, who speaks fluent Spanish, will be available to answer questions other cleaners have about spotting, finishing and cleaning with the carbon dioxide technology. A carbon dioxide equipment expert will also be present to answer questions about equipment operation. Representatives of regulatory agencies including CARB, DTSC, U.S. EPA and the South Coast Air Quality Management District will attend to answer questions.

The Institute for Research and Technical Assistance (IRTA), a nonprofit organization, is presenting the showcase. IRTA has worked on PERC dry cleaning alternatives for many years. For information on the showcase or alternatives, please call IRTA at 818-244-0300, email us at [irta@earthlink.net](mailto:irta@earthlink.net) or visit us online [www.irta.us](http://www.irta.us).



MAPQUEST

400 m  
1200 ft

405

Los Angeles National Cemetery

Veterans Administration Med Ctr

Brentwood Heights

Brentwood

Westgate

Brentwood Country Club

26th St

20th St

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Showcase hours:  
9am to 3pm

Presentations  
by owner  
Bobby Smerling  
and his spotter:  
10am, 12pm & 2pm

Complementary  
refreshments will be  
available all day at  
the showcase.

Royal Cleaners  
is located at:  
256 26th Street,  
Santa Monica,  
CA 90402

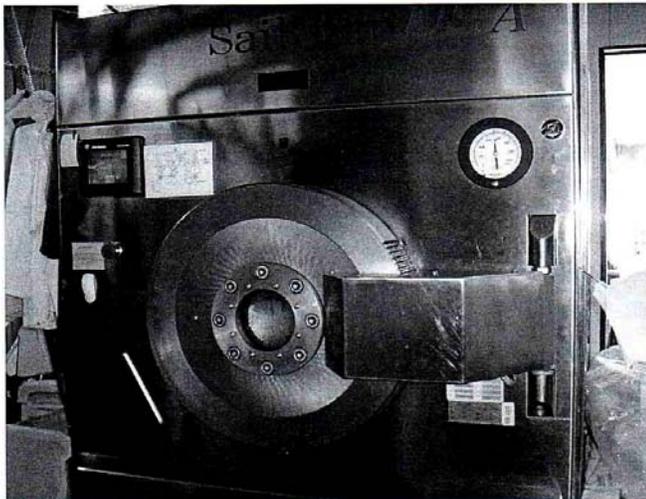
## Santa Monica Cleaner Pleased With Carbon Dioxide Technology

Royal Cleaners has been located in Santa Monica, California since 1948. In 2003, the owner, Bobby Smerling, moved to a new location in the same area and installed a 60 pound carbon dioxide machine and a carbon dioxide storage tank. The carbon dioxide machine replaced a 55 pound perchloroethylene (PERC) machine which was used to clean 104,000 pounds of garments annually. At this stage, the shop has increased its cleaning volume substantially, to 155,000 pounds of garments per year.



"I made the right decision," says Mr. Smerling. Royal received a grant from the South Coast Air Quality Management District to purchase the new system. "The PERC phaseout in California no longer concerns me because I put in the best alternative." Mr. Smerling plans to open a second plant with a carbon dioxide and wet cleaning machine in the west Los Angeles area in the next year or so.

The carbon dioxide machine operates at 700 to 900 pounds per square inch pressure to keep the carbon dioxide liquified. "The cycle time of my machine is only 35 minutes which is less than the cycle time of the old PERC machine,"





says Mr. Smerling. "When we moved, we didn't have room for a large machine and I decided to purchase a Sailstar system," he says. "It took us only about two months to learn the new features and procedures. The finishing is about the same as it was with PERC but there is more spotting now. We can process delicate garments much more easily with carbon dioxide."

"My customers are upscale," says Mr. Smerling. "They are concerned about health and the environment. The carbon dioxide process has health and environmental benefits, and the costs of using the system are lower than they were with PERC even though I had to buy a new machine."

Annualized Cost Comparison for Royal Cleaners in Santa Monica		
	PERC	Carbon Dioxide
Annualized Capital Cost	-	\$11,200
Solvent Cost	\$969	\$9,600
Detergent Cost	\$1,937	\$2,704
Electricity Cost	\$7,152	\$10,000
Gas Cost	\$3,279	-
Spotting Labor Cost	\$12,087	\$47,000
Finishing Labor Cost	\$145,043	\$97,344
Maintenance Labor Cost	\$1,007	-
Maintenance Equipment Cost	\$2,503	\$200
Compliance Cost	\$3,487	-
Waste Disposal Cost	\$3,278	\$150
<b>Total Cost</b>	<b>\$180,742</b>	<b>\$178,198</b>

# Free Textile Cleaning Showcase!

Sunday, October 7, 2007

- Regulations require cleaners to phase out PERC dry cleaning machines and adopt alternative technologies.
- Talk to a cleaner successfully using the carbon dioxide technology for more than four years.
- Talk to a carbon dioxide maintenance person, government agency representatives and IRTA's cleaning alternative experts.
- Get information on performance and cost of showcase cleaner's carbon dioxide systems.
- Get information on safer spotting chemicals.
- Learn how to comply with phaseout regulations cost effectively.



Free Textile  
Cleaning Showcase!!  
Presented by IRTA  
Sunday, October 7, 2007  
9am to 3pm at  
Royal Cleaners  
For more information,  
call IRTA at:  
818-244-0300

Nonprofit Organization  
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**IRTA**  
*Institute for Research and  
Technical Assistance*  
230 N. Maryland Ave., Suite 103  
Glendale, CA 91206  
website: [www.irta.us](http://www.irta.us)



**Appendix C**  
**EXPO Brochure**

## EXPO Features:

- Talk to Regulators
- Talk to Cleaners about their Water-Based and Carbon Dioxide Machines
- Talk to Suppliers about Equipment and Detergents.
- Watch Wet Cleaning Demonstration
- Find out about System Costs
- Find out about Safer Spotting Chemicals

### About the Institute for Research and Technical Assistance (IRTA)

IRTA is a nonprofit organization involved in identifying, developing, testing and demonstrating safer alternatives. IRTA focuses on alternatives used in cleaning, paint stripping, dry cleaning, coatings, adhesives and lubricants. IRTA reaches businesses throughout the country by sponsoring workshops, publishing a quarterly newsletter and providing detailed analysis and testing results in published case studies and reports.

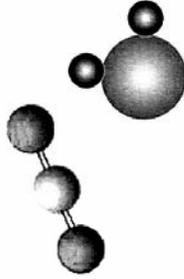
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Southern California Edison  
Institute for Research and Technical Assistance  
California Air Resources Board  
California Department of Toxic Substances Control  
US Environmental Protection Agency, Region 9

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## Free PERC Dry Cleaning Alternatives EXPO

A presentation of cost effective, viable and safer alternatives to PERC Dry Cleaning

### Water-Based Cleaning Processes Carbon Dioxide Cleaning



Sunday May 18th, 2008

Southern California Edison's  
Customer Technology  
Application Center (CTAC)  
Irwindale, CA

Presented by:  
Southern California Edison  
Institute for Research and Technical Assistance  
California Air Resources Board  
California Department of Toxic Substances Control  
US Environmental Protection Agency, Region 9

**IRTA**  
**Institute for Research and Technical Assistance**  
230 N. Maryland Ave., Suite 103  
Glendale, CA 91206  
website: www.irta.us



## PERC Dry Cleaning

### Alternatives Free EXPO

Sunday, May 18, 2008  
9:45 A.M. to 3:30 P.M.

Southern California Edison's  
Customer Technology  
Application Center (CTAC)  
Irwindale CA

A presentation of cost effective,  
viable and safer alternatives to  
PERC dry cleaning.

The Perc Dry Cleaning Alternatives EXPO  
will provide cleaners with information on  
water-based and carbon dioxide alternatives.  
The EXPO will feature speakers from gov-  
ernment agencies who will discuss the PERC  
regulations and grant programs.

Hear from cleaners and who are successfully  
using water-based and carbon dioxide clean-  
ing systems. Talk with water-based and car-  
bon dioxide formulation and equipment sup-  
pliers and manufacturers. Get information on  
the cost to cleaners of using water-based and  
carbon dioxide processes. Get information on  
safer spotting chemicals.

The EXPO is targeted at cleaners and gov-  
ernment representatives who wish to learn  
more about water-based and carbon dioxide  
cleaning.

## EXPO AGENDA

<b>9:45 AM</b>	<b>Registration and Continental Breakfast</b>	<b>Free PERC Dry Cleaning Alternatives EXPO</b>
<b>10:15 AM</b>	<b>Welcome and Introduction</b> <i>Katy Wolf,</i> Institute for Research and Technical Assistance	Southern California Edison's Customer Technology Application Center (CTAC) 6090 North Irwindale Avenue Irwindale, CA 91702
<b>10:30 AM</b>	<b>Government Panel: Regulations and Grant Programs</b> <i>Hafizur Chowdhury,</i> California Air Resources Board  <i>Mark Nash,</i> Bay Area Air Quality Management District  <i>TBD,</i> South Coast Air Quality Management District	Attendance is free. Continental breakfast and buffet lunch will be provided.  To register as an attendee or to reserve a free vendor table:  call (818)244-0300 or email: <a href="mailto:irta@earthlink.net">irta@earthlink.net</a>
<b>11:10 AM</b>	<b>Cleaner Panel</b> <i>Steve Berglund,</i> Mastercraft Cleaners <i>Gordon Shaw,</i> Hangers Cleaners <i>Robert Smerling,</i> Royal Cleaners <i>Katy Wolf for David Yoo</i> Legacy Cleaners	<u>Registration must be received by</u> <u>May 12, 2008</u>  There will be no walk-in registration on the day of the conference.  Space is limited. Please register early.
<b>12:45 PM</b>	<b>Buffet Lunch</b>	
<b>1:45 PM</b>	<b>Wet Cleaning Demonstration Visit Vendor Tables</b>	For more information please call IRTA at (818)244-0300
<b>3:30 PM</b>	<b>Adjourn</b>	

**Appendix D**  
**Spotting Chemical Alternatives Fact Sheet**

# Safer Spotting Chemicals

Best Practices for Textile Cleaning -- May 2007

## Why and how are POG spotting chemicals used?

Paint, Oil and Grease (POG) spotting agents are used to remove spots from garments by professional textile cleaners. They are sprayed on spots before and after garments are processed through the garment cleaning machine.

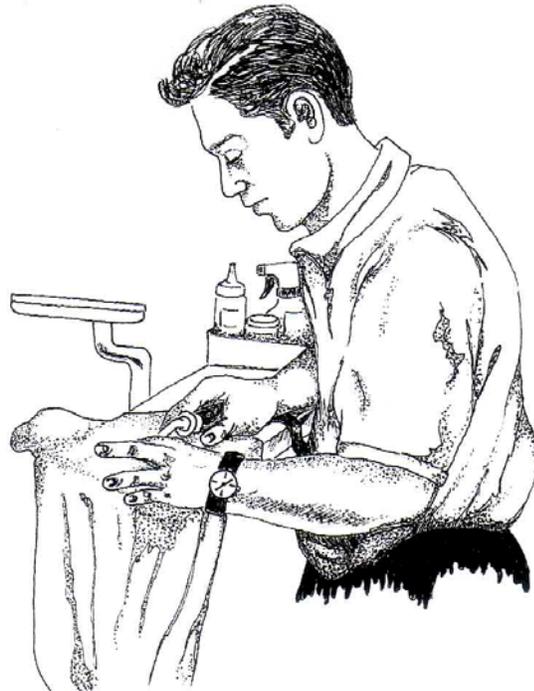


## What are the commonly used POG spotting agents?

POG spotting agents containing trichloroethylene (TCE) and perchloroethylene (PERC) are used widely by the garment cleaning industry.

## What are the toxicity problems with these spotting agents?

TCE and PERC are carcinogens and are heavily regulated in California. Spotters and other employees in garment cleaning plants are exposed to these dangerous chemicals.



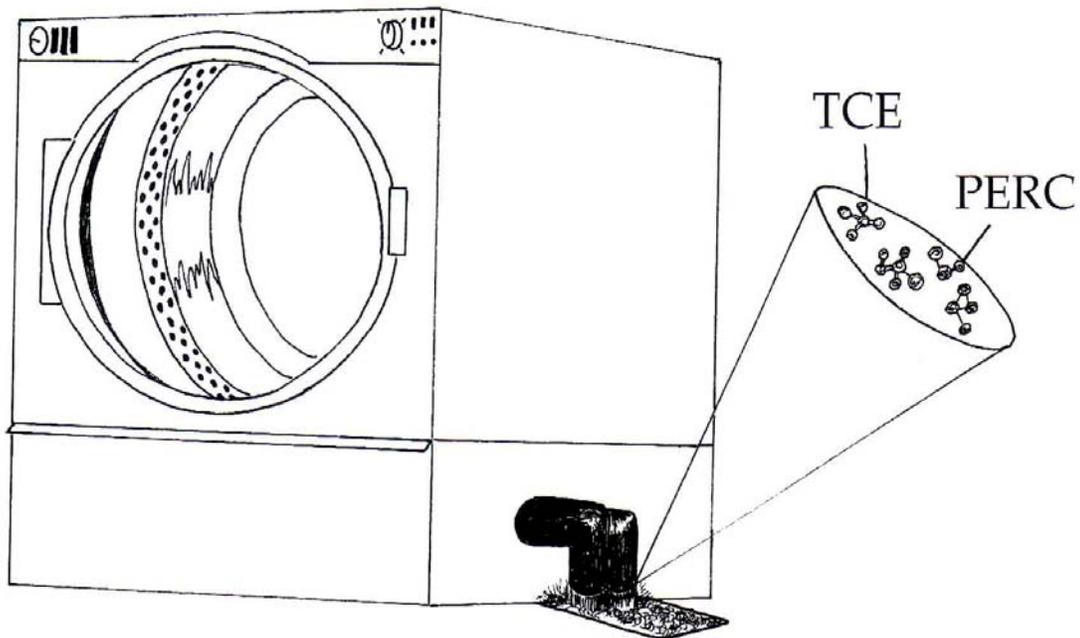
**How do these spotting agents affect non-PERC garment cleaning processes?**

Many cleaners have converted away from PERC dry cleaning to safer alternative processes. A number of them, however, continue to use TCE and PERC spotting agents. Use of these spotting agents will make the waste streams generated by the non-PERC garment cleaning processes hazardous.



**Is there a particular problem with these spotting agents for wet cleaning plants?**

When cleaners pre-spot garments, the TCE and PERC residues are flushed into the sewer when the water from the cleaning process is discharged. It is illegal for cleaners to discharge hazardous waste to the sewer.



## How do I know if my spotting agent contains TCE or PERC?

Ask your spotting chemical supplier for a Material Safety Data Sheet (MSDS) for the spotting agent. If the spotting agent contains TCE or PERC, it should list the chemical under the second section of the MSDS sometimes labeled "Composition / Information on Ingredients" or "Components." The Chemical Abstract Service (CAS) number should also be listed. This is important because suppliers may call TCE and PERC by different names, but the CAS number stays the same. The CAS number for TCE is 79-01-6 and for PERC 127-18-4. The first page of an MSDS containing TCE is shown below. The "Composition / Information on Ingredients" section is circled in blue.

Date-Issued: 08/04/2000  
MSDS Ref. No: P-3  
Date-Revised: 08/08/2000  
Revision No: New MSDS

Picrin

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### 1. PRODUCT AND COMPANY IDENTIFICATION

**PRODUCT NAME:** Picrin<sup>†</sup>  
**GENERAL USE:** For professional drycleaning use only.  
**PRODUCT DESCRIPTION:** Stain Removal Agent  
**PRODUCT CODE:** PIC-US

**MANUFACTURER**

R. R. Street & Co. Inc.  
184 Shuman Boulevard  
Naperville, IL 60563  
**Product Stewardship:** 800-323-7206  
**Transportation:** 800-424-9300

**24 HR. EMERGENCY  
TELEPHONE NUMBERS**

**Emergency Phone:** 800-228-5635

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### 2. COMPOSITION / INFORMATION ON INGREDIENTS

<u>Chemical Name</u>	<u>Wt. %</u>	<u>CAS#</u>	<u>EINECS#</u>
Trichloroethylene	~100	79-01-6	

---

### 3. HAZARDS IDENTIFICATION

**POTENTIAL HEALTH EFFECTS**

**EYES:** Substance may cause substantial eye irritation and possible damage.

**SKIN:** May cause skin irritation.

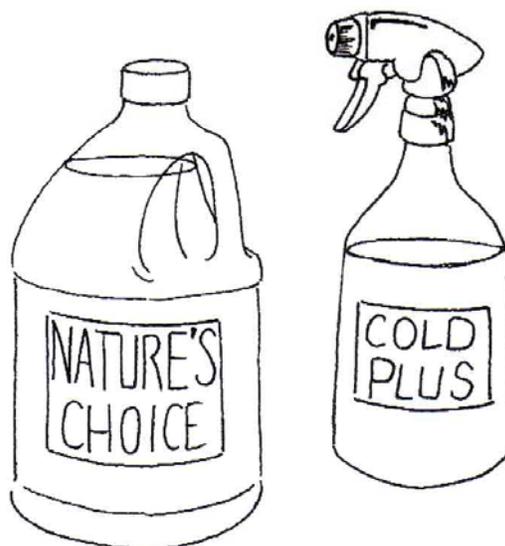
**SKIN ABSORPTION:** Absorption through skin is possible but not a likely route of significant exposure.

**INGESTION:** Low to moderate toxicity. May cause vomiting. Can cause adverse health effects as described under INHALATION.

**INHALATION:** High concentrations can cause central nervous system depression, irregular heartbeat, cardiac arrest, unconsciousness or death.

## Have safer alternative spotting agents been tested?

The Institute for Research and Technical Assistance (IRTA) is a technical nonprofit organization. During a project sponsored by California Environmental Protection Agency's Department of Toxic Substances Control (DTSC) and U.S. EPA Region IX, IRTA tested low-VOC safer alternatives with a number of textile cleaning facilities using a range of different textile cleaning processes. IRTA and the test facilities found that the alternative POG spotting agents worked effectively.



## Are the safer alternative POG spotting agents available?

There are some alternative spotting agents on the market. Many of these contain other ingredients that are toxic or are Volatile Organic Compounds (VOCs) that contribute to smog. The best alternatives from an overall health and environmental standpoint are water-based and soy based products.

## Where can I get more information?

The IRTA report is on IRTA's website at [www.irta.us](http://www.irta.us), the DTSC's website at [www.dtsc.ca.gov/PublicationsForms](http://www.dtsc.ca.gov/PublicationsForms) and the Western Regional Pollution Prevention Network website at [www.wrppn.org](http://www.wrppn.org).

**You can contact IRTA at (818) 244-0300 with questions on spotting agent alternatives.**

### Some Products Containing TCE or PERC

Picrin® -- R.R. Street & Co. Inc.

2-1 Formula® -- R.R. Street & Co. Inc.

Volatile Dry Spotter (V.D.S.) -- Laidlaw Corp.

Wetspo -- Laidlaw Corp.

Fast P.R.® -- Caled Chemical

PURO® -- Adco Inc.

P.O.G. -- Pariser Industries Inc.

TarGo® -- A.L. Wilson Chemical Co.



Mention of trade names, products, or services does not convey, and should not be interpreted as conveying, U.S. EPA, California Department of Toxic Substances Control (DTSC), the California Air Resources Board, or any local government approval, endorsement, or recommendation. This document has not been subject to EPA's required peer and policy review. It does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

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