

Memo

Date: May 15, 2015

To: Emily Connor – Abt Associates

From: Katy Wolf – IRTA

Subject: Task 5: Evaluation of Safer Choice Cleaners as TCE Replacements

I. Introduction

In the Safer Choice program, EPA allows suppliers to label certain products that meet criteria that have been established to evaluate whether the product is safe for health and the environment. There are a number of degreasers that meet the criteria and carry the Safer Choice label.

For this task, Abt has provided IRTA with a list of certain Safer Choice degreasers that may be suitable for three of the four TCE applications EPA is considering for risk management (either regulatory or voluntary). The three applications are:

- Open top vapor degreasing
- Cold cleaning
- Aerosol spray degreasing

The list contains 23 degreasers from 13 suppliers and many of them could potentially be used in more than one application.

IRTA is tasked with reviewing the information on the degreasers and using judgement to determine whether the degreasers are appropriate for one or more of the applications of interest. As part of performing the task, IRTA can contact the manufacturers to discuss the characteristics of the cleaners.

This memo summarizes the results of IRTA's analysis. In what follows, IRTA first provides a description of how TCE is currently used in each application. IRTA also discusses how the alternatives might be used as substitutes. As part of this discussion, IRTA presents information on the characteristics of water-based cleaners that influence how they can be used. Finally, IRTA discusses each of the cleaners, their characteristics and whether they would be appropriate alternatives in each of the TCE applications.

II. Description of TCE Applications

In this section, IRTA describes the characteristics of TCE and how it is used in the three applications of interest. Each application is discussed below.

Vapor Degreasing

TCE is used in vapor degreasing to remove oil, grease, particles, dirt and other contaminants, primarily from metal parts of all kinds. In vapor degreasing, the solvent, in this case TCE, is heated to its boiling point in a vapor degreaser. The simplest vapor degreasers are composed of a metal tank with a heater in

the bottom and a set of water cooled coils along the outside perimeter near the top. The solvent is heated to its boiling point and forms a vapor above the liquid. The water cooled coils act to condense the solvent vapors so the solvent doesn't escape from the top of the vapor degreaser. Solvent emissions from a simple vapor degreaser like this are very high and many vapor degreasers have features that restrict emissions further. One option is to use a second chiller, a second set of cooling coils, above the first set to further prevent emissions. Another is to use a refrigerant to lower the temperature further in the coils. Yet another is to raise the height of the degreaser (called the freeboard) to more effectively contain the solvent. There are many other options and types of degreasers that are much tighter than those described here.

The parts are generally placed on a rack and lowered into the vapor degreaser by hand or with a hoist. At times the parts will be put into the liquid and then raised to the vapor zone for a time. In the vapor zone, the hot solvent condenses on the colder parts and carries the contaminants into the liquid. Some degreasers have spray wands that are used to spray liquid solvent onto the parts while they are in the vapor zone. The advantage of vapor degreasing is that the solvent in the vapor zone is always clean since the contaminants end up in the liquid. In effect, the parts are always being cleaned with clean solvent.

Generally the only solvents that can be used in vapor degreasing are solvents without flash points. If you heat a solvent with a flash point to its boiling point, it will exceed the flash point. This means that, if there is a source of ignition or if the vapor concentration exceeds certain limits, the solvent could ignite or explode. Halogens (fluorine, chlorine and bromine) suppress flammability and these materials are used as fire extinguishants. Halogenated solvents which do not have flash points are the only solvents used in vapor degreasing.

Cold Cleaning

In cold cleaning, solvents are generally used at room temperature. Cold cleaning systems for TCE consist of a metal tank for holding the solvent. Some systems have a sink area where the parts can be cleaned with a brush; others are designed simply for immersing the parts in the cold solvent to clean them. Again, these systems might have other features like spray wands for enhancing the cleaning.

Some cold cleaning is done without larger equipment. The solvent might be used for flushing contaminants from the inside of tubes or pipes. Alternatively, TCE might be used in metal cans at table top for handwiping parts. The TCE might also be used in spray bottles on the main manufacturing or rebuilding floor of an operation or at table top. It is sprayed on the parts and wiped with a cloth.

Aerosol Degreasing

In this application, solvents are packaged in an aerosol can. The most common type of aerosol can is made of aluminum and it contains the active ingredient, in this case TCE or a blend of TCE and other solvents, and a propellant. Propellants that are used today include hydrocarbon propellants or carbon dioxide propellants. There are other more expensive propellants but they would not likely be used in TCE based aerosols. The active ingredient and the propellant are combined with air to get a spray with proper characteristics and pointed to the part. A cloth would then be used to wipe away the solvent and contaminants.

III. Use of Water-Based Cleaners in TCE Applications

All of the Safer Choice degreasers in the list provided to IRTA are water-based cleaners. This is important for the discussion that follows on how water-based cleaners can be used as alternatives to TCE in the three applications. The discussion sets the stage for IRTA's evaluation of each of the individual products. The description of how the water-based cleaners are used in each of the TCE applications is presented below.

Vapor Degreasing Alternatives

Water-based cleaners have been used for many years in applications where users originally used TCE or other chlorinated solvents in vapor degreasing. Most of these applications involve cleaning fabricated metal parts of various kinds. The cleaning capability of water-based cleaners (and actually all cleaners) is substantially improved if the cleaners are heated and if agitation is provided. In general, the cleaners used in these applications are alkaline cleaners which means they have a pH higher than 7.

In many manufacturing processes, water-based cleaners are used to clean grease or oil from parts, the parts are rinsed, sometimes with deionized water if a spot free part is required for the next process, and dried. The cleaner concentrate is generally diluted to between about 5% and 20% in the wash bath, depending on the cleaning task and the agitation in the equipment. The wash bath is generally heated to between about 120 to 180 degrees F. The rinse is generally heated as well. The driers are composed of air knives that drive the water from the part. In certain other applications, where gross cleaning is needed, the parts will be cleaned with the heated water-based cleaner and not rinsed or dried.

Cleaning equipment used to replace vapor degreasing is of several different types. Ultrasonic cleaning systems have transducers for generating the ultrasonic action and the cleaning is bath cleaning. There are some immersion systems, called agilit systems, where the parts are placed on a platform and moved up and down in the cleaning agent. Spray cabinets are used with some parts and this involves spraying the parts with pressures of about 60 psi and greater. Conveyorized spray systems where the parts go through high pressure spray at between about 80 and 120 psi are also used in some cases. These systems often have wash, rinse and dry sections.

Water-based cleaners must have a few characteristics in order to be considered replacements for vapor degreasing. Since TCE is used primarily to clean metal parts, the water cleaners often contain rust or corrosion inhibitors so they provide a protective coating on the metals. In some cases, where the parts are not rinsed, the cleaners may not require a rust inhibitor if they go directly on to another operation that protects the surface. Alkaline cleaners can leave enough of a residue on the parts so they do not rust for a time. If they are stored for a long period before use or further processing, however, they will rust if the cleaner does not contain a rust inhibitor. If they are put back into a machine after cleaning so the part is in contact with the lubricant, the parts will not rust. There are literally hundreds of water-based cleaners that have been designed to replace solvents in vapor degreasing applications and they would likely contain the proper inhibitors. Users would definitely select those cleaners over another cleaner that might not be safe for their substrates or processes.

In order to be used in spray equipment, the water-based cleaner must be formulated with a non-foaming surfactant. If a cleaner contains a foaming surfactant, one option is to add a defoamer to the wash bath. Again, however, there are hundreds of water-based cleaner that contain non-foaming surfactants that have been specifically designed for use in spray cleaning equipment. Although adding defoamer is an option, users must make sure they remember to maintain the bath properly and this is not always done

rigorously. Water-based cleaners with foaming surfactants could be used in ultrasonic, agilift or other immersion systems without a problem but users with spray processes would be better served by using a cleaner with a non-foaming surfactant.

Cold Cleaning Alternatives

There are numerous water-based cleaners that have been designed specifically for use in cold cleaning applications where TCE or other solvents have been used historically. These cleaners, like those used as vapor degreasing alternatives, are generally alkaline cleaners. In cold cleaning applications, the water-based cleaners are generally used in simple immersion systems, small agilift systems or parts cleaners which have a sink area and brush for cleaning. In some cases, these systems may also have a spray wand for flushing. In these applications, the cleaning units often have a heater and the water-based cleaner is heated to between about 105 and 115 degrees F. Because the temperature in these systems is lower than for vapor degreasing alternatives, the concentration of the cleaner needs to be higher to provide effective cleaning. Generally, the concentration is in the range of about 15 to 25%.

The cleaners are most often used by workers without gloves so, particularly in the sink units, the cleaners need to be safe for hands. This means the cleaners used for this purpose should not have a very high pH when they are diluted. The cold cleaning water equipment is often used in auto repair facilities, machine shops in industrial facilities or engine and other assembly and rebuilding applications. In cold cleaning operations, the parts are generally not rinsed. Often, the parts are cleaned of the oil and put back into the car or into a machine where they are lubricated and do not rust. In cases where they are stored, a rust inhibitor or protective oil would be applied to protect the parts.

In other cold cleaning applications where TCE may be used, the water cleaners may be used to flush the insides of piping made of metal or other materials. If the parts are made of metal, again, it depends on the particular process but, in some cases, it may be safer to have a rust or corrosion inhibitor in the cleaner.

Aerosol Alternatives

Most water-based cleaners are not packaged in aerosol cans. In traditional aerosol packages, the cleaner is delivered with air to give the desired spray. Virtually all water-based cleaners, even if they contain non-foaming surfactants, will foam in an aerosol can. In some cases, this is desirable but in other cases, especially those where TCE and other solvents are used currently, foaming would not be desirable. Users generally employ aerosols in touchup applications where they just want to quickly remove a contaminant. Although a foaming cleaner might be acceptable in narrow applications, it probably would not be acceptable for most situations where TCE aerosols are used today.

Other types of delivery packages are possible. For example, bladder systems can be used to ensure the separation of the active ingredient (water-based cleaner) and air. These systems, however, are more expensive than traditional aerosol packages so it is likely these would be used only in higher value applications. These types of applications are not generally those where TCE aerosols are used.

Aerosol cans are inherently not "green." They generate a lot of waste and this packaging option is much more expensive than other methods of using water-based cleaners. Companies that use solvent aerosols most often use them for convenience and they are willing to pay the higher price. They are unlikely to want a foaming product in the aerosol package.

IV. Safer Choice Cleaners

The 23 Safer Choice cleaners IRTA is evaluating have generally been designed for household or institutional use. In a few cases, they have been formulated for specific activities, like cleaning diesel engines, for instance. In general, however, they have not been designed specifically for uses where TCE is still employed. Other water-based cleaners have been formulated deliberately for those applications.

All of the Safer Choice cleaners contain foaming surfactants and most do not contain rust or corrosion inhibitors. This does not necessarily preclude their use in all applications where TCE is used but it does restrict their suitability for many operations. Many of the Safer Choice cleaners can be used in pesticide sprayers or pump and trigger spray bottles. In these cases, the cleaners will foam very little since air is not introduced with the cleaner as it is in an aerosol delivery system. In high pressure spray cabinets and conveyorized spray systems used for cleaning industrial parts, foaming is undesirable and these cleaners would not be acceptable. Again, it might be possible to add defoamer to the cleaner. In that case, however, the user would have to monitor the bath to ensure there was always enough defoamer. Furthermore, added defoamer would change the cleaner and it would no longer be considered a Safer Choice cleaner; the suppliers would have to submit the cleaner with a defoamer to the Safer Choice program .

Virtually all of the Safer Choice cleaners, whether they contain foaming surfactants or not, would foam in a traditional aerosol can package. Again, in some narrow instances, a foaming aerosol cleaner may be acceptable but, in most applications for TCE replacement, this would not be acceptable.

The fact that most of the Safer Choice cleaners do not contain rust or corrosion inhibitors means they would not likely be suitable as alternatives to TCE in many vapor degreasing applications. In principle, the suppliers could modify the cleaners to include a rust inhibitor. Again, because another ingredient would be added, the new cleaner with the inhibitor would have to undergo evaluation in the Safer Choice program. Since there are many water-based cleaners that do contain rust inhibitors, users would likely prefer them.

On the other hand, many of the Safer Choice cleaners could be suitable for replacing TCE in cold cleaning applications. In many of these applications, the parts are put back in the machines or vehicles where they will have a protective coating of oil so they will not rust. Foaming is also not an issue in these applications so many of the cleaners would be acceptable on that basis as well.

V. Specific Safer Choice Cleaners

All of the 23 cleaners with the Safer Choice label that are being considered here as TCE alternatives are water-based products. All of them except one, Cleanovations All Purpose Degreaser, are also alkaline cleaners. That cleaner has a pH that is on the acid side but is very close to neutral; when diluted, it is likely to be completely neutral or slightly alkaline. The cleaners have either been designed as general, all-purpose products that might be used in homes on a variety of surfaces or they have been targeted for a specific application, like cleaning diesel engines. Table 1 summarizes certain important characteristics of the cleaners for assessing the TCE applications.

In general, the cleaners have been formulated with foaming surfactants. Some of the suppliers indicate that their surfactants are low foaming or that the foam dissipates quickly but this may not pave the way

for their use in some of the TCE applications. The context they are using to make this statement does not take into account the fact that TCE alternatives applications, like aerosol and spray equipment applications, introduce air into the products. This is materially different from using the cleaner in a pump sprayer or a pesticide sprayer where air is not introduced. Their comments reflect this context so there would likely still be a problem in the TCE applications.

Many of the cleaners in Table 1 have been formulated without rust or corrosion inhibitors. Three groups of the cleaners, N-14 heavy Duty Degreaser and Cleaner and TREO Jel D (which is the same as Transit Jel but with a different name) and CCI 'L-44 ECDB (which is the same as CCI 'L-44 ECD but with a colorant) contain inhibitors.

Table 1
Summary of Safer Choice Listed Cleaners

	pH of Concentrate or Cleaner	Foaming Surfactant	Rust Inhibitor
Eco Green Cleaner Heavy Duty Degreaser	12.6	Yes	No
Cleanovations All Purpose Degreaser	6.6	Yes	No
Clean & Green Super D Degreaser	7.0 – 9.0	Yes	No
SW-4 Heavy Duty Degreasing Solution	8.02	Yes	No
81018	10.0 – 10.6	Yes	No
64000	11.0 – 11.5	Yes	No
65001	11.0 – 11.5	Yes	No
63000	9.8 – 10.8	Yes	No
N-14 Heavy Duty Degreaser and Cleaner	9.5	Yes	Yes
Green All Purpose Cleaner and Degreaser	No response	No response	No response
CCI 'L-44 ECDB' Degreaser	11.2 – 11.4	Yes	Yes
CCI 'L-44 ECD' Degreaser	11.2 – 11.4	Yes	Yes
Degreaser Concentrate	7.1 – 7.6	Yes	No
Degreaser RTU	7.0 est	Yes	No
TREO Jel D	11.2	Yes	Yes
Transit-Jel	11.2	Yes	Yes
GPL 101 Heavy Duty Degreaser	10.1 – 11.1	Yes	No
Naturama Green Cleaner/Degreaser	8.3 – 11.0	Yes	No
Naturama CBD	8.3 – 11.0	Yes	No
Naturama Motive Series	8.3 – 11.0	Yes	No
Naturama Industrial Strength Degreaser	8.3 – 11.0	Yes	No
Krud Kutter Tough Task Remover	less than 12.5	Yes	No
Krud Kutter Concentrated Cleaner/Degreaser Stain Remover	less than 12.5	Yes	No

The Eco-Green Cleaner Heavy Duty Degreaser was designed for cleaning in oil and refinery plants and is suitable for cleaning tar, grease and asphalt. The pH of the concentrate is 12.6. If diluted to about 10%, the pH would be about 11.6. It will foam and it does not contain a rust inhibitor.

Cleanovations All Purpose Degreaser is a slightly acidic cleaner. When it is diluted to about 10%, the pH is near neutral. It is an all-purpose cleaner designed for use on any non-porous hard surface, including

metals. It does not contain rust inhibitors, however, and it has low foaming surfactants. It has been used in parts cleaning applications.

Clean and Green Super D Degreaser has been used in degreasing, heavy duty cleaning, machine and fixture cleaning. It has been used in parts cleaners. It has foaming surfactants and the pH of the ready to use formulation is near neutral. It contains no rust inhibitor.

SW-4 Heavy Duty Degreasing Solution has been designed for parts cleaning operations. It has foaming surfactants and no rust inhibitor. It has been used in parts cleaners but shouldn't be heated to more than about 125 degrees F. The pH is near neutral.

Each of the next four cleaners in Table 1 has a slightly different application. All the cleaners, however, have foaming surfactants and they contain no rust inhibitors. The chemist indicates that steel can be a problem although three of the technical data sheets (the 6000 cleaners) list steel as a substrate they can clean. The 64000 is a general purpose cleaner and has been designed to foam. The 81019 cleaner has been formulated for use in floor scrubbers. The 63000 is also intended for floor cleaning and general purpose cleaning. The 65001 is a general purpose cleaner.

The N-14 Heavy Degreaser and Cleaner does contain a rust inhibitor and a low foaming surfactant. It can apparently remove automotive, industrial and kitchen soils. It has a fairly low pH and would be near neutral after dilution.

IRTA contacted the supplier, Custom Blenders Inc., of the Green All Purpose Cleaner and Degreaser several times. The company does not have a website so it is not possible to obtain information on the cleaner without contacting the company. IRTA spoke with the assistant who answers the phone several times and he indicated they were "vetting" me to see if they should talk with me or provide the information. The company never called back so IRTA could not evaluate the cleaner.

CCI 'L-44 ECDB Degreaser and CCI 'L-44 ECD Degreaser are the same cleaner but a colorant has been added to ECDB to make it blue. This was done so users could better judge the proper dilution. The inhibitor in these two cleaners will protect against aluminum corrosion but would not prevent ferrous metal rusting. The cleaners have been designed for cleaning maritime diesel engines and have been used in parts cleaner. The optimal dilution is about 1 part cleaner to 9 parts water. At this dilution, the pH would exceed 10.

Degreaser Concentrate contains a low foaming surfactant and is not formulated with rust inhibitors. Note that the Degreaser Concentrate is the same cleaner as Degreaser RTU which means Ready To Use. It is diluted to 5 to 7% in the RTU. The pH is estimated by IRTA to be 7 or slightly lower in the diluted form. The cleaner is a general purpose cleaner designed to remove grease and oil from engines and heavy machinery as well as tools.

Treo Jel D and Transit Jel are the same cleaner with two different names for different markets. The cleaners were designed for cleaning hydraulic fluid, oil and grease from vehicles. They are in the form of gels for dwelling on vertical surfaces. The cleaners contain a rust inhibitor which will give a very light flash rust protection for steel substrates after rinsing but does not provide corrosion protection for aluminum, particularly if the dwell time is long before flushing. The product is designed to be diluted to 6 to 10%; this indicates the pH could be as high as 10.5 or so in the as-used formulation.

GPL 101 Heavy Duty Degreaser is formulated with a foaming surfactant and no rust inhibitors. It is intended for use in floor cleaning in an auto scrubber application.

The four Naturama cleaners are all based on the same concentrate. They are diluted specifically for the four target applications. They are designed to foam and do not have a rust inhibitor. The Green Cleaner/Degreaser is a heavy duty cleaner; CBD is a specialty degreaser; Motive Series is designed for removing automotive carbon; and Industrial Strength Degreaser is a heavy duty cleaner. The chemist indicates that all four cleaners are based on the CBD product. The cleaners have been used to clean engine blocks and have been used in parts cleaners. A 10% dilution would lower the pH below 10.

Krud Kutter Tough Task Remover and the Concentrated/Cleaner Degreaser Stain Remover contain a low foaming surfactant and no rust inhibitor. Both of these cleaners have been designed as household cleaners for general purpose tasks. The Tough Task cleaner can be used as a laundry stain remover. It is not clear what the actual pH of the cleaners is because the supplier lists it as less than 12.5.

Cold Cleaning

Many of the cleaners on the Safer Choice list could potentially be used in cold cleaning applications. In most cases, they have been designed for this use. The issue is whether or not the cleaners would be suitable for use in cold cleaning applications where TCE is used today. Some of the cleaners have been designed for removing oil and grease from engines and vehicles and are clearly targeted for industrial rather than household uses. Although the household, general purpose or floor cleaners might be suitable as TCE replacements in cold cleaning, IRTA believes those designed for oil and grease removal would be the better choice. These cleaners are:

- Eco Green Cleaner Heavy Duty Degreaser
- Cleanovations All Purpose Degreaser
- Clean & Green Super D Degreaser
- SW-4 Heavy Duty Degreasing Solution
- N-14 Heavy Duty Degreaser and Cleaner
- CCI 'L-44 ECDB' Degreaser
- CCI 'L-44 ECD' Degreaser
- Degreaser Concentrate
- Degreaser RTU
- TREO Jel D
- Transit Jel
- Naturama Green Cleaner/Degreaser
- Naturama CBD
- Naturama Motive Series
- Naturama Industrial Strength Degreaser

IRTA earlier described the cold cleaning uses of TCE. They generally include applications where the solvent is used in equipment for cleaning parts. IRTA considers two types of cold cleaning equipment below for the cleaners.

Hand Contact Applications. In some of the cleaning equipment, as discussed earlier, there are sink areas with a brush and a flushing wand. With TCE, the workers using this equipment should be using gloves but often, they do not. TCE (and virtually all solvents) defat the skin so this is not a good practice. If water-

based cleaners substitute for TCE for sink cleaning applications, workers would be even less inclined to use gloves. Water-based cleaners are not perceived as being dangerous so workers would clean with their bare hands although these cleaners also can defat the skin. Some of the water-based cleaners have a pH that may be too high to use with bare hands, depending on the dilution level of the cleaner. If the parts cleaners are heated, the concentration would probably be in the range of 20 to 30% at most. It does depend on the specific application, however, and there may be instances where an even higher concentration would be desirable. In some cases, the concentration could be lower.

Table 1 listed the cleaners and their pH. A rule of thumb is that a 10% dilution will reduce the pH by a factor of 10. If the cleaner concentrate has a pH of 12.5, then a 10% dilution of the cleaner in 90% water would reduce it to about 11.5. If the dilution level were 20%, the pH would be higher, perhaps at 11.7. This is definitely not a hard and fast rule but it can be used as a rough guide. It is difficult to decide what the cutoff pH should be for safe use of water-based cleaners with hand contact. A number like 10 would be very conservative.

The cleaners most suitable as TCE replacements in cold cleaning are listed above. Of those, the cleaners that could be used in cold cleaning hand contact applications because the pH is low enough assuming a 10% dilution are:

- Cleanovations All Purpose Degreaser
- Clean & Green Super D Degreaser
- SW-4 Heavy Duty Degreasing Solution
- N-15 Heavy Duty Degreaser and Cleaner
- Degreaser Concentrate
- Degreaser RTU
- Naturama Green Cleaner/Degreaser
- Naturama CBD
- Naturama Motive Series
- Naturama Industrial Strength Degreaser

After the cleaners with too high a pH have been eliminated, the user would have to judge whether the remaining cleaners—which do not contain rust inhibitors with a few exceptions—would be suitable for their applications. In auto repair or rebuilding applications, where the parts are relubricated by the worker or by being put back into equipment, these cleaners could be used. A good candidate for hand contact applications where the parts are relubricated or put back in equipment is SW-4 Heavy Duty Degreasing Solution which has been designed specifically for these types of applications. In applications where the parts are not lubricated or put back in equipment or vehicles, it would be risky to use the cleaners without rust protection. The N-14 Heavy Duty Degreaser and Cleaner would be a good candidate for these applications because it does contain a rust inhibitor and has a reasonably neutral pH.

After the user investigated this issue, they would have to test the cleaners to determine their effectiveness. Since many of the cleaners are not designed for this purpose, different concentrations would have to be evaluated to achieve the optimum point for the application in question.

Non-Hand Contact Applications. In other cold cleaning applications, the parts may be immersed in the equipment or used in an aglift system where hand contact would be less or eliminated. In these cases, workers should still wear gloves for use with TCE and for use with water-based cleaners but they probably would not. In these instances, a higher pH cleaner could be used if the hand contact were eliminated in

the ideal or minimized at worst. In these immersion applications, all of the cleaners listed above as suitable for cold cleaning in general would be potential candidates. The user would have to determine the proper dilution level for their application and determine whether the cleaner could accomplish the cleaning effectively.

In some cases, TCE may be used in applications where a spray system utilizing a water-based cleaner could be substituted. Spray cabinets have a very high spray pressure of at least 60 psi and air is delivered in the system. As Table 1 indicates, all of the cleaners are formulated with foaming surfactants so the cleaners generally could not be used in this type of equipment. Defoamer could be added to all the cleaners, however, and they would be able to be used in spray cabinets. Again, the proviso is that many water-based cleaners have been deliberately designed to be sprayed and it would not be necessary to maintain a concentration of defoamer in the cleaner. It would simply be easier to use a cleaner designed for this purpose. The user would also have to take into account the fact that the cleaners would no longer be Safer Choice cleaners if defoamer were added. In these applications, again, the user would not be able to use cleaners without rust inhibitors if the parts were not relubricated or put back in equipment or vehicles.

The temperature in spray cabinets is generally fairly high, in the range of about 120 to 180 degrees F. It is desirable to have a reasonably high temperature since all water-based cleaner are more effective at higher temperatures. One of the cleaners, the SW-4 Heavy Duty Degreasing Solution, cannot tolerate a temperature above about 125 degrees F. In principle, it could be used in a heated spray application with defoamer but the temperature would have to be set below 125 degrees F.

Other Cold Cleaning Applications. Some of the Safer Choice cleaners are designed for spraying vehicles, engines or auto parts outside. TCE is not used in these applications any longer because of the potential for contaminating the site. IRTA does not believe this type of application would require a TCE substitute so it was not evaluated further.

Summary of Cold Cleaning Applications.

Table 2 lists the cleaners that would be the most promising candidates for use as alternatives to TCE in cold cleaning applications in IRTA’s best judgement. The table shows the 10 cleaners that could be used in hand contact situations and the 15 cleaners that could be used in immersion or flushing or other non-hand contact applications. None of the cleaners would be suitable for spray applications unless defoamer were added.

**Table 2
Best Cleaners for Cold Cleaning Applications**

Cleaner	Hand Contact Applications	Non-Hand Contact Immersion or Other Cleaning
Eco Green Cleaner Heavy Duty Degreaser	No	Yes
Cleanovations All Purpose Degreaser	Yes	Yes
Clean & Green Super D Degreaser	Yes	Yes
SW-4 Heavy Duty Degreasing Solution	Yes	Yes
N-14 Heavy Duty Degreaser and Cleaner	Yes	Yes

CCI 'L-44 ECDB' Degreaser	No	Yes
CCI 'L-44 ECD Degreaser	No	Yes
Degreaser Concentrate	Yes	Yes
Degreaser RTU	Yes	Yes
TREO Jel D	No	Yes
Transit Jel	No	Yes
Naturama Green Cleaner/Degreaser	Yes	Yes
Naturama CBD	Yes	Yes
Naturama Motive Series	Yes	Yes
Naturama Industrial Strength Degreaser	Yes	Yes

Aerosol Cleaning

As discussed earlier, virtually all water-based cleaners foam when they are sprayed in high pressure systems where air is introduced. All the candidate cleaners are also formulated with foaming surfactants and even cleaners without foaming surfactants will foam, to some, extent, when they are packaged in a traditional aerosol can. In some cases, a foaming product is desirable but, in general, in the applications where TCE aerosol products are used, foaming is unlikely to be acceptable.

There are two options where some or all of the Safer Choice cleaners might be used in aerosol applications as TCE replacements. First, the suppliers could examine other packaging options, like bladder systems, where the cleaner is isolated from air. This packaging would be higher cost than traditional aerosol packaging, however, so TCE users might not be willing to pay the increased price. Even if the cleaners were packaged in alternative ways where foaming was not an issue, most of them do not contain rust inhibitors which could be a problem, particularly for ferrous metal compounds which can flash rust.

Second, the suppliers could offer these products in a trigger spray package as alternatives to TCE aerosols. Many of the candidate cleaners are already packaged this way. In general, however, aerosols deliver a fairly high pressure spray which can be directed to a small area. Trigger sprays do not really have the same characteristics. It is not likely users of TCE aerosols would convert to water-based products in a trigger spray delivery system.

In an earlier project, IRTA did test water-based cleaners in spray bottles in auto repair facilities to see if they were acceptable alternatives to chlorinated solvents and VOC solvents used in automotive aerosol cleaning. The California Air Resources Board (CARB) had banned chlorinated solvent use in auto aerosol cleaners and the market had converted to VOC solvents of various kinds. TCE was not widely used in these applications which included brake cleaning, carburetor and fuel injection system cleaning, engine degreasing and general purpose degreasing. Perchloroethylene (PERC) was the solvent of choice for almost all brake cleaners and methylene chloride was used, to some extent, in carburetor and fuel injection system cleaning. Aerosols are often not used for engine degreasing but consumers sometimes purchase solvent aerosol cleaners for engine degreasing. These would not likely contain chlorinated solvents, however, because of the potential for site contamination. During the IRTA project, a few auto repair facilities were willing to use the water-based cleaners in spray bottles for limited activities but most really preferred the solvent aerosols.

A few of the Safer Choice cleaners might be appropriate in very limited manufacturing and rebuilding applications where TCE based aerosols are used today. In cases where engines and other equipment

contaminated with grease and oil require touchup, a water-based cleaner in a trigger spray might be suitable. These would be limited applications, however, and would have to be determined on a case-by-case basis.

Vapor Degreasing

TCE is largely used for gross cleaning applications for metal parts. In some applications, however, it is used in higher technology applications for cleaning parts like electrical contacts. Water-based cleaners that substitute for TCE in all of these applications can be used in spray equipment like spray cabinets or conveyorized spray machines or they can be used in immersion systems like aglift or ultrasonic equipment. The temperature in the different types of equipment can range from about 120 degrees F to 180 degrees F.

High pH water-based cleaners are often used in the different types of equipment and they are diluted to the appropriate concentration which is application specific. The water-based cleaners in Table 1 that contain foaming surfactants could be used in spray equipment if defoamer were added. This would be an extra step for users so they would be more inclined to use a cleaner with non-foaming surfactants. Furthermore, adding defoamer to the cleaners means they could no longer be listed by Safer Choice. The cleaners with foaming surfactants could be used in immersion equipment, however.

None of the suppliers indicated the cleaners should not be heated with one exception. The SW-4 Heavy Duty Degreasing Solution would have to be heated to below 125 degrees F. Since, in many cases, these are not the applications the cleaners were designed for, they may not work well for these purposes.

Only a few of the cleaners are formulated with a rust inhibitor. Many of the companies using TCE in vapor degreasing would want a cleaner with a rust inhibitor to be safe. Again, the other cleaners without rust inhibitors could be used in grosser cleaning applications where the parts are relubricated or put back in equipment.

In evaluating potential alternatives for TCE in vapor degreasing, IRTA assumed that none of the cleaners could be used in spray equipment because they are formulated with foaming surfactants. The cleaners could be used in immersion equipment. The cleaners without rust inhibitors would be risky to use in applications where the parts are not relubricated or put back into a machine with oil. This indicates that it would probably not be prudent to use any of the cleaners in higher technology applications where multi metal protection may be necessary. IRTA made the same selection decision as for cold cleaning. That is that those cleaners best for cleaning oil and grease were the most promising candidates as TCE alternatives. IRTA eliminated TREO Jel and Transit-Jel as candidates for TCE vapor degreasing alternatives because they come in gel form. According to the supplier, the cleaners can be diluted into liquid form. For cold cleaning, this may be acceptable but it might not be appropriate for vapor degreasing. Again, the cleaners would have to be tested carefully to determine the optimal concentration. They would also have to be tested on parts to ensure they could clean effectively.

Table 3
Best Cleaners for Immersion Low Technology Vapor Degreasing Applications

Cleaner	Notes
Eco Green Cleaner Heavy Duty Degreaser	
Cleanovations All Purpose Degreaser	
Clean & Green Super D Degreaser	
SW-4 Heavy Duty Degreasing Solution	Temperature cannot exceed 120 degrees F
N-14 Heavy Duty Degreaser and Cleaner	Contains rust inhibitor
CCI 'L-44 ECDB' Degreaser	Protection for aluminum
CCI 'L-44 ECD Degreaser	Protection for aluminum
Degreaser Concentrate	
Degreaser RTU	
Naturama Green Cleaner/Degreaser	
Naturama CBD	
Naturama Motive Series	
Naturama Industrial Strength Degreaser	

Table 3 lists 13 of the cleaners. The list, in fact, really represents only eight unique cleaners. The two L-44 cleaners are the same except for a colorant. The four Naturama cleaners are based on the same general formula and the Degreaser Concentrate and Degreaser RTU are essentially the same cleaner.

Spotting Chemical Use

One other application where TCE is used currently is in spotting chemicals for the dry cleaning industry. Some of the 23 cleaners examined here would be potential candidates for this application. For more information and background on this application, refer to a memo prepared by IRTA for Matt LaPenta on this and the other TCE applications. In spotting chemical applications, it does not matter whether cleaners have rust inhibitors or not because they are used to spot garments. IRTA did not examine this application further and, again, the cleaners would have to be tested to determine the proper dilution level and whether they would be suitable for garment spotting. One cleaner listed specifically for laundry spotting is Krud Kutter Tough Task.

VI. Summary of Overall Results

IRTA evaluated 23 cleaners on the Safer Choice list to judge whether they would be potential candidates for use as TCE alternatives in vapor degreasing, cold cleaning or aerosol applications. IRTA finds that:

- 13 of the cleaners could potentially be used as alternatives in vapor degreasing in lower technology applications
- 15 of the cleaners could potentially be used in non-hand contact cold cleaning applications
- 10 of the cleaners could potentially be used in hand contact cold cleaning applications
- None of the cleaners could potentially be used in spray applications as alternatives in vapor degreasing or cold cleaning
- None of the cleaners could potentially be used in aerosol applications.

IRTA established certain conditions to evaluate the cleaners and if these conditions were changed, more of the cleaners could potentially serve as alternatives. For example, if defoamer were added to the cleaners, some would be good candidates for spray applications. If supplier were to package their cleaners in bladder systems, they might be appropriate as alternatives in some aerosol applications. In all cases,

however, the candidate cleaners would have to be tested to determine if the optimal circumstances for their use and whether they would clean effectively.