A Cooperative Project between the U.S. Environmental Protection Agency and the Printing Trade Associations Nationwide

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SCREEN PRINTING PROJECT BULLETIN 2

SCREEN PRINTING

SMARTER, SAFER SCREEN RECLAMATION
Alternative System Epsilon

The chemicals used for screen reclamation can be some of the most hazardous products in a screen printing facility. Highly volatile solvents are typically used. These cleaners may contain chemicals that are harmful to the health of employees if inhaled, ingested, or absorbed through the skin. If they are not disposed of properly, these products may also harm to the environment.

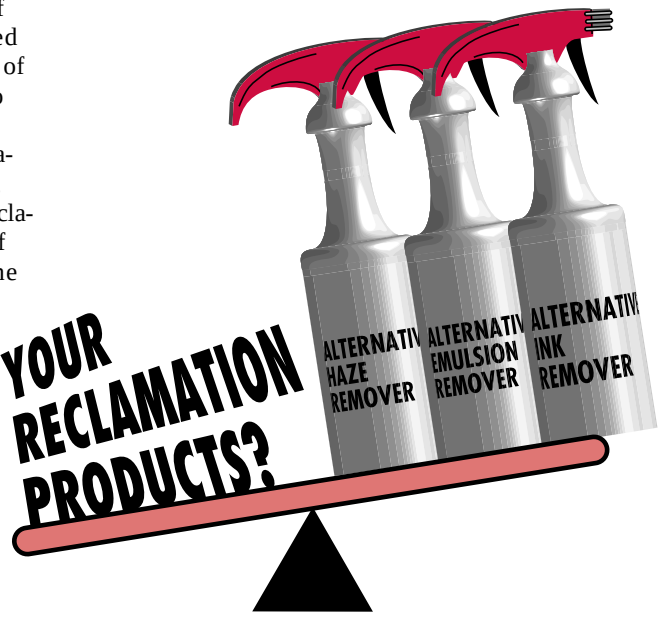
To reduce the hazards of screen reclamation to workers and to the environment, screen printers using solvents for screen reclamation should consider switching to one of the safer substitute products currently on the market. These substitutes often contain less harmful chemicals and have a lower volatile organic compound (VOC) content. With a lower VOC content, the chemical is less likely to be inhaled by employees or released to the air.

This bulletin highlights the characteristics of one type of substitute product system and compares it to a traditional (solvent-based) screen reclamation system. Specifically, this bulletin describes:

- Performance of the alternative screen reclamation system as demonstrated in laboratory tests and at two volunteer printing facilities;
- The health and environmental risks of the alternative system;
- The cost of the alternative system.

Background

Initiated by industry, this project was entirely voluntary and involved almost all sectors of the screen printing industry: manufacturers donated their products for evaluation, staff from Screenprinting and Graphic Imaging Association International (SGIA) coordinated the field demonstrations, the Screen Printing Technical Foundation (SPTF) performed initial product testing, printers nationwide evaluated the products in their facilities, and EPA staff conducted a risk assessment of the products. One advantage of this coordinated effort is that all product systems were evaluated using the same methods. The consistency of the evaluations allows you to compare the results to determine which of the alternatives may be a viable substitute for your current reclamation products.



This bulletin highlights one alternative system, referred to as Alternative System "Epsilon." This system, as with all systems demonstrated in this project, is a real, commercially available screen reclamation system; however, "Epsilon" is a masked name. The actual trade name for this alternative system (or for any of the alternative systems demonstrated) is not used in this bulletin or in the final project report. Trade names were masked for several reasons:

- One of the goals of the DfE project is to illustrate the process of searching for and evaluating cleaner alternatives. DfE hopes to encourage you to incorporate environmental concerns in your facility's decision-making processes and into your discussions with suppliers. By masking trade names, DfE encourages you to discuss the characteristics of the products you use, or are considering using, with your suppliers. This case study and the DfE project help you to know what characteristics to look for in the screen reclamation products you purchase.
- Since every screen printing shop is different, manufacturers recognize that their product's performance may vary greatly depending on the operating conditions; and, moreover, printers' opinions of the products will vary. In order to get their full cooperation before the results were available, the DfE project complied with the requests of some manufacturers that the product names be masked.

To compare the cost and risk of Alternative System Epsilon to a known system, a baseline was established using a traditional solvent-based screen reclamation system consisting of: lacquer thinner as the ink remover, a sodium periodate solution as the emulsion remover, and a xylene/acetone/mineral spirits/cyclohexanone blend as the haze remover. These chemicals were selected because screen printers indicated they were commonly used in screen reclamation. It should be noted that these technologies were evaluated using a case study approach; rigorous scientific testing was not conducted. Instead, much of the information presented here is based on printers' experiences with these products as used at their facilities.

Promising Performance

Performance was evaluated in two phases: 1) performance demonstrations at SPTF's laboratory under controlled conditions; and 2) field demonstrations at volunteer printers' facilities under the variable conditions of production. Since conditions vary greatly, printers felt it would be most valuable to evaluate performance based on the experiences and opinions of the experts: the printers who used the alternative products in their facilities during month-long demonstrations. Each product system was demonstrated in two or three facilities to get a more complete evaluation of performance under a variety of operating conditions.

Laboratory Testing

During laboratory testing, three imaged screens were reclaimed using Alternative System Epsilon: one with a solvent-based ink, the second with an ultraviolet-curable (UV) ink, and the third with a water-based ink. During the laboratory tests, the Epsilon ink remover dissolved the ink quickly, was easy to use, and removed residue from the screens with solvent-based and UV-curable inks. In both cases, a light to moderate ink stain remained on the screen. When the ink remover was used on the screen with water-based ink, more time and effort were needed, but the ink was removed except for a light stain. On all three screens, the emulsion remover dissolved the stencil and there was no emulsion residue on any of the screens after pressure rinsing. In the final step, the Alternative System Epsilon haze remover lightened the ink stains on all three screens.

	Chemical Composition		
	Ink Remover	**Emulsion Remover**	**Haze Remover**
Alternative System Epsilon	Cyclohexanone Methoxypropanol acetate Diethylene glycol Benzyl alcohol Diacetone alcohol Aromatic solvent naphtha Derivatized plant oil	Sodium periodate Sulfate salt Water	Alkyl benzene sulfonates Ethoxylated nonylphenol Phosphate salt Sodium hydroxide Derivatized plant oil Water Ink Remover
Traditional System	100% Lacquer thinner, consisting of: 30% Methyl ethyl ketone 20% Naphtha light aliphatic 20% Toluene 15% n-butyl acetate 10% Isobutyl isobutyrate 5% Methanol	1% Sodium periodate 99% Water	10% Xylene 30% Acetone 30% Mineral spirits 30% Cyclohexanone

[1] Clear concern> Marginal concern> Negligible concern. Concerns are identified because exact risk was not quantified. The information in this table is based on the September 1994 draft document, *Cleaner Technologies Substitutes Assessment: Screen Printing Technical Report*

[2] If the assumption is made that gloves are worn, dermal exposures are assumed to be negligible to none.

On-site Demonstrations

Two different facilities used System Epsilon for a month to evaluate how well it performed in a production situation. The participating facilities recorded the amount of product used, the length of time needed, and their opinion of how well the product reclaimed the screen. Both facilities (referred to as Facility A and Facility B) found the product system worked well, especially the emulsion remover.

Ink Remover Performance: At Facility A, the ink remover worked well, easily removing the solvent-based ink. However, when removing catalyzed inks, some of the workers thought that the ink remover acted more slowly and required extra effort. Facility B used the products on screens with both UV-curable and solvent-based inks. The Epsilon ink remover efficiently removed the inks; it worked especially well on the UV-curable ink. In addition, Facility B found they used significantly less alternative ink remover per screen than their standard product, lacquer thinner.

Emulsion Remover Performance: The emulsion remover worked very well at both facilities, dissolving the stencil quickly and easily.

Haze Remover Performance: Both facilities evaluated the haze remover performance as similar in efficacy to their standard haze removers.

Overall Evaluation: The performance of Alternative System Epsilon was good at both facilities, according to the printers' evaluations. Because the two facilities have very different operations, the fact that System Epsilon performed well at both print shops demonstrates that this system can work well under different operating conditions. Facility A prints banners and point-of-purchase displays on plastic using a variety of solvent-based inks, a dual cure emulsion, and mesh counts of 83 - 280 threads/inch. Facility B prints vinyl and mylar labels using both solvent-based and UV-curable inks. They use a direct photo stencil and screens with a mesh count of 355 threads/inch. Even with these differences, Alternative System Epsilon was successful in reclaiming screens at both facilities. The final proof for the participating printers was that all the reclaimed screens could be reused for future print jobs.

Health Risks[1]	Performance			Cost
	Ink Remover	Emulsion Remover	Haze Remover	
• There are no clear concerns associated with any part of the Epsilon system. There is a marginal concern for developmental toxicity risk from inhalation exposures to cyclohexanone in the ink remover. • If you use the ink or haze remover on a daily basis without wearing gloves, there is a marginal concern for harmful effects from the chemicals (specifically cyclohexanone, benzyl alcohol, and methoxypropanol acetate) being absorbed through your skin. If gloves and safety goggles are worn, the risk is negligible. • There is a clear concern that regular, unprotected contact with the emulsion remover will cause skin and eye irritation and tissue damage. If gloves and safety goggles are worn, the risk is negligible.	In on-site demonstrations, removed ink well. Worked ink well in lab testing.	Quickly and easily removed the stencil during facility demos and lab tests.	Lightened the ink stain and usually removed the haze during both lab testing and facility demonstrations.	Facility A: $3.08/screen or $4,624/year Facility B: $5.29/screen or $7,930/year
• If you use the ink or haze remover on a regular basis, there is a clear concern for harmful health effects from inhaling the chemicals (specifically toluene, methyl ethyl ketone, and acetone). • There is also a clear concern for adverse health effects if your skin contacts the ink or haze remover on a daily basis (also from toluene, methyl ethyl ketone, and acetone). The concern is marginal for contact with cyclohexanone in the haze remover. If gloves and safety goggles are worn, the risk is negligible. • There is a clear concern that regular, unprotected contact with the emulsion remover will cause skin and eye irritation and tissue damage. If gloves and safety goggles are worn, the risk is negligible.	With solvent and UV inks, it removed the ink with moderate scrubbing effort. A gray haze remained on the entire screen. With water-based ink, the ink solidified.	Not demonstrated[2]	Not demonstrated[2]	$6.27/screen or $9,399/year

[2] The ink remover was demonstrated during laboratory tests as a component of a different recalmation system.

Reduced Risk

Environmental releases and occupational risks associated with both the Alternative System Epsilon and the traditional screen reclamation system were evaluated. Review the table for a detailed description of the health risks.

Whether using traditional screen reclamation techniques or an alternative system, chemicals can get into your body either through your skin when you contact the product or through your lungs when you inhale chemical vapors. Some chemicals have a lower tendency to evaporate or to enter the body through the skin; and different chemicals have different effects, some more harmful than others, once in your body. The risks associated with inhalation of the chemicals in Alternative System Epsilon are much lower than those associated with the traditional system. With the traditional system, daily inhalation of toluene and methyl ethyl ketone in the ink remover, and acetone in the haze remover could lead to eye, nose, and throat irritation, headaches, or fatigue.

Applying either the Alternative System Epsilon or the traditional system products regularly without wearing gloves can be harmful to your health. The potential for these harmful effects through skin contact are attributed to chemicals in all the products of the traditional system (ink remover, emulsion remover, and

haze remover) and to chemicals in the alternative ink remover and emulsion remover. If you wear gloves regularly, however, these risks are negligible.

Minimal Environmental Releases

Based on the EPA assessment, none of the chemicals in either the traditional system or Alternative System Epsilon were found to be hazardous to the environment in the quantities used for screen reclamation. However, a reduction in the use of traditional screen reclamation chemicals could cut a facility's air releases. Traditional screen-cleaning solvents often have a high volitile organic compound (VOC) content, contain Hazardous Air Pollutants regulated under the Clean Air Act, or contain a RCRA listed or characteristic waste. Substituting an alternative product system for these traditional screen reclamation chemicals could reduce your facility's regulatory burden. Contact your state and local environmental regulatory authority for information specific to your location.

Cost Savings

The demonstrations showed that both of the participating facilities could reduce their costs for screen reclamation by switching from the traditional system to Alternative System Epsilon. As with the risk comparisons, costs of Alternative System Epsilon were compared to the costs of using the traditional system. The cost estimate is based on the assumption that 6 screens were reclaimed daily and that all screens were approximately 15 ft^2 in size, for both the traditional and the alternative systems. Included in the cost estimate were: labor time spent to reclaim the screen, the cost of an average quantity of reclamation products, and the cost of hazardous waste disposal for RCRA-listed or characteristic (ignitable based on flashpoint) waste. The RCRA-listing applies to the traditional system ink remover, but does not apply to any part of the alternative system.

For Facility A, reclamation cost per screen would drop 51% from $6.27/screen to $3.08/screen for annual savings of $4,775. At Facility B, the reclamation cost of $6.27/screen using the traditional system would drop to 16% to $5.29/screen for the alternative system. Over a year, the savings at Facility B would amount to $1,469. The difference in costs between the facilities is due to differences in the quantity of product used and the labor time required per screen as recorded by each facility's employees.

For More Information...

Although the alternative system described in this case study proved to be a viable alternative in the two printing facilities where performance demonstrations were conducted, it may not be the solution for all types of screen printing operations. If you find that Alternative System Epsilon does not seem like a feasible substitute for your facility, refer to the summary booklet, *Designing Solutions for Screen Printers: An Evaluation of Screen Reclamation Systems*, which includes information on all the alternative product systems and alternative technologies evaluated. When you identify a product system that seems like a potential substitute, contact your supplier, identify the alternative system by its chemical composition, and discuss the characteristics of the products you are looking for.

This bulletin is part of a series of bulletins and case studies that provide screen printers with information on products and techniques that can help them to prevent pollution in their facilities. Information in these bulletins is largely based on the work done by the Design for the Environment Screen Printing Project. For copies of this bulletin, other DfE Screen Printing Project Materials, or more information about the project, contact :

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