

**THE MASSACHUSETTS
TOXICS USE REDUCTION INSTITUTE**

**DEMONSTRATION OF PRINTWISE™:
A "Near-Zero" Lithographic Ink and Blanket Wash System**

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DEMONSTRATION OF PRINTWISE™: A "Near-Zero" Lithographic Ink and Blanket Wash System

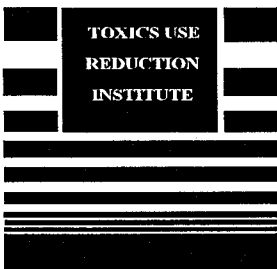
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*Demonstration of "Printwise™ Near-Zero Volatile Organic Compound
Lithographic Ink and Presswash System*

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Key Terms and Definitions

Throughout this report, certain terms are used to convey particular meaning to the study findings. To better understand their context, a brief list of key terms and their definitions are provided here.

This report also uses the term "products" to denote the use ink and presswash used as a system. Therefore, the term "conventional products" refers to both conventional ink and presswash and the term "Printwise™ products" refers to both Printwise™ ink and Printwise™ presswash.

Blanket	The cylinder on an offset lithographic press covered with a elastomer material used to transfer images from the plate cylinder to the substrate.
Blanket Wash (Presswash)	The solvent cleaning product used to clean the press blankets, rollers, and other components.
Blanket Wash - Ease of Cleaning	The ability of the presswash to clean blankets easily, including the amount of time and effort required and the degree of cleanliness achieved.
Byproduct	All non-product outputs of toxic and hazardous substances generated by a production process prior to handling, transfer, treatment, or disposal. Used in this report for the total amount of VOCs generated in printing as distinct from the amount that is only emitted to the environment.
Color Matching and Quality	The ability of the ink color to match a reference hue or the color of the original copy.
Dot Gain	A term used to denote the loss of resolution (in percent) from film to plate to substrate, due to the increase in the size of the dots that make up the image. A higher percentage means a higher loss of resolution.
Drying Characteristics	The ability of an ink to fully dry on the substrate. Printed materials must be dry before they can be bound and shipped.
Duplicators	Small printing presses, typically under 22 inches in sheet width.
Fountain Solution	Also referred to as dampening solution. The solution used to bathe the printing plate in order to confine the ink to the image areas on the plate.

Offset Lithography	The most widespread printing process. Offset lithography is performed by all of the presses evaluated in this report. The lithographic process depends on the ability to make the non-image areas of the printing plate hydrophilic (readily wetted by water) and the image area oleophilic (readily wetted by oil-based inks). The plate is wetted with water-based fountain solution and inked with the oil-based ink. In offset lithography, the ink film is transferred from the printing plate onto a rubber blanket and then offset onto the paper or other substrate.
Pantone Color	Pantone specialty colors are precise premixed colors each of which matches one of the standard colors in the Pantone Matching System ("PMS").
Presswash (Blanket Wash)	A petroleum-based or water-based solution used to clean the press and press components. (Also commonly referred to as the blanket wash.)
Runability	The degree to which the ink performs or "runs" properly on the press in terms of its proper interaction with the fountain solution, plates, and blankets, and ability to produce usable impressions with a minimum of waste sheets.
Set Characteristics	The amount of time required for the ink to "set" (polymerize) so that the printed paper can be handled on press and stacked.
Sheetfed Press	A press designed to print on sheets of cut paper.
VOC Emission	Evaporation of VOCs into the air, either from a stack or general evaporation in a room.
VOC Generation	Used in this report for the total amount of VOC byproduct produced in printing, as distinct from the amount that is emitted to the environment. Used in this report as the equivalent to "byproduct".
Volatile Organic Compound (VOC)	Organic chemical and solvents which evaporate into the air and contribute to air pollution.
Web Press	A press designed to print on a continuous sheet of paper in a roll.

Section 1

**Methodology and Conclusions
of the
Printwise™ Demonstration Project**

1. Executive Summary

1.1 Project Purpose and Scope

This report presents the results of a demonstration of the Printwise™ lithographic ink and water-based presswash printing system, designed to reduce emissions of Volatile Organic Compounds (VOCs) to near-zero levels. The Printwise™ system employs vegetable oil-based ink containing a "solubility conversion mechanism" that reacts with the presswash to become water-soluble. Its use could allow printers to reduce or eliminate their major source of VOC emissions: conventional petroleum-based presswash.

Developed by the Deluxe Corporation and now marketed by SICPA Securink Corporation, the Printwise™ system has had limited market penetration. The purpose of this project was to demonstrate its use under real-world conditions. Printers were asked to dedicate a press to use Printwise™ products under production conditions for the demonstration period to evaluate their technical performance, economic feasibility, and environmental impacts, and changes in material consumption, waste disposal, and VOC generation.

1.2 Project Participants

Participants were recruited through letters, telephone calls, site visits, and demonstrations. Five printers agreed to participate:

- United Lithograph (UL), a commercial sheetfed printer,
- S&A Paramount, a business forms printer,
- Standard Register, a check/financial printer,
- Central Reprographics, a general printer for state agencies, and
- Old Colony, a general printer for state agencies.

1.3 Conclusions

The demonstration provided data on the Printwise™ products regarding printing performance, VOC reductions, economic feasibility, and other advantages or disadvantages.

Key conclusions on the use of Printwise™ under various production scenarios at the five participants are provided below.

Technical Printing Performance

- The demonstration found that printers tend to be pragmatic and results oriented. Their interest in Printwise™ products is not solely motivated by a desire to use an environmentally friendly product, but as part of a continuing effort to print more efficiently. This evidenced by a preference by some to use Printwise™ inks to achieve better print quality. Environmental benefits were considered secondary. Most performance rankings were more positive with Printwise™ products.
- Printwise™ ink performed well during the demonstration. Rankings assigned by printers for individual performance criteria were good or excellent for most of the presses evaluated.
- Most press operators reported that Printwise™ presswash was able to clean rollers, blankets, and ink fountains, but not as quickly or conveniently as conventional presswash. Several reported that Printwise™ presswash sometimes required repeated applications or left a residual soap film on rollers. Press operators with more experience with the product could minimize these problems.
- On five of nine presses tested, press operators developed hybrid cleaning procedures that combined use of Printwise™ presswash with conventional or low-VOC presswash. It was common to use a small amount of conventional presswash at the start or finish of the cleaning, or to rewash a press unit that was not fully clean.

Environment and Safety

- Press operators at all participating firms appreciated their lower exposure to solvent fumes.
- Participating printers experienced reductions of 36-99% in total VOCs due to use of Printwise™ products.

Material Consumption

- Three of five participants experienced reductions of 5-7% in ink consumption with Printwise™. The other two printers had unchanged ink consumption.

- All participants reduced their use of conventional and low-VOC presswash from 25-95%.
- Participating printers disposed of less hazardous waste with Printwise™ (less total presswash was used).

Financial Analysis

- Under the pricing conditions of the demonstration project, use of Printwise™ products was less costly for all participants. A major reason was the lower overall cost of purchasing presswash during the demonstration.
- A likely increase in the cost of Printwise™ presswash to \$5.63/gallon would make Printwise™ products more expensive than conventional products at Standard Register, Central Repro, and Old Colony. At UL and S&A Paramount, Printwise™ products would still be less costly. Future costs would depend on the volume and use for each printer.
- Printwise™ presswash after the price increase would be more expensive than conventional presswashes. However, it is less expensive than the new generation of low-VOC presswashes, despite the anticipated price increase of Printwise™ presswash.

Advantages and Disadvantages of Printwise™ Products

- One-color sheetfed press, raised imprint presses, and web presses without a Quadflo dampening system are likely to work effectively with Printwise™ products. Business form and check printers and government agency job shop printers use these presses and are good candidates.
- Multicolor commercial sheetfed lithographers requiring high-quality process color and extensive use of Pantones will experience a much greater challenge. However, the success of UL for nearly one year shows it is possible.
- S&A Paramount was able to make Printwise™ products work effectively on duplicator presses that are a mainstay of small printing plants.

Obstacles Encountered & Issues Printers Must Consider

- Printers will need to make a management commitment and be willing to experiment and invest additional time to make Printwise™ products

work. Extensive technical support from the manufacturer will be needed.

Further Research and Followup Needs

- The technical performance of Printwise™ products should be examined in a controlled experimental setting.
- Performance on duplicators should be further evaluated.
- The willingness of study participants to serve as ongoing demonstration sites should also be determined.

2. Introduction

2.1 Potential for Reduction in Volatile Organic Compound and Toxic Chemical Use in Printing

Printers have traditionally had little alternative to using products that contain Volatile Organic Compounds (VOCs) and toxic materials in their printing operations. Offset lithography, the most common commercial printing process, is based on the principle that oil and water do not mix. The printed image results from the use of petroleum-based ink on the image area of a printing plate. When the plate is bathed with an aqueous fountain solution, the ink and fountain solution repel each other, and the ink is confined to the image area of both the plate and printed material. The petroleum-based ink is not soluble in water and, consequently, needs to be cleaned from the press using a solvent-based presswash solution.

Nearly all conventional presswashes contain VOCs. The use of presswash is the largest source of VOC emissions in non-heatset printing. A variety of manufacturers have developed reduced-VOC presswash, but nearly all these products still are solvent-based.

The Deluxe Corporation, a major national check printing company, developed the Printwise™ system in an effort to reduce the amount of press cleaning it conducted and VOCs it emitted. The Printwise™ system is a radical and promising departure from conventional offset lithographic printing methods. It consists of a printing ink and presswash formulated to provide standard print quality with the advantage of a water-based presswash. The primary purpose of this system is the reduction of VOCs that are associated with petroleum-based presswashes for non-heatset offset lithography.

The Printwise™ system is a "near-zero" VOC emitter. The presswash has 0% VOCs by volume and the inks have 0.8% VOCs by volume by EPA Test Method 24. By contrast, conventional presswash is often 70-100% VOC by volume and reduced-VOC presswash may be 30-70% VOC by volume. Typical non-heatset inks range from 3-8% (soy-based) to 25% (petroleum-based) VOC by volume.

If used at a large number of printing plants, the Printwise™ system would offer potential for major reductions in both VOC emissions and use of toxic chemicals. It also has the potential to provide printers with a more healthy working environment.

2.2 Description of Printwise™ Near-Zero VOC Printing System

The Printwise™ printing ink and presswash have been formulated to take advantage of the simple concept that a soap can dissolve hydrophobic mixtures in water. Essentially, the Printwise™ printing ink, which is soy-based, contains proprietary mixtures of organic acids and other compounds which under normal printing conditions act like conventional petroleum-based or soy-based inks. This allows the use of standard offset printing plates on unmodified presses.

For press washup, the highly alkaline Printwise™ presswash, a specially formulated water-based solution, reacts with the printing ink additives, much in the way soap emulsifies dirt. The emulsified mixture of printing ink and presswash can then be rinsed away with water. Once the blanket and roller surfaces are dry, the press is ready for another production run.

More technical information on Printwise™ is found in Appendix A.

2.3 Market Penetration and Manufacturer Participation in Demonstration

The Deluxe Corporation initially developed and refined the Printwise™ products for use in its own printing plants. It then decided to enter the commercial market with a line of inks and presswashes. Between 1993 and 1995 it developed and marketed a line of web inks for business forms and web printers, followed by a line of sheetfed inks.

In 1995, the Printwise™ system was in use in over 50 Deluxe plants nationwide, but had been slow to develop market penetration to commercial printers on a national basis. A number of business forms and book printing operations, primarily in the Midwest, had adopted the system at that time. Deluxe was just beginning to acquire its first commercial sheetfed customers.

2.4 Project Purpose and Issues

As Deluxe was beginning to market the Printwise™ inks and presswash, The United States Environmental Protection Agency (EPA) New England and The Toxics Use Reduction Institute (TURI) became interested in developing a pollution prevention and toxics use reduction demonstration project in the printing industry. Recognizing

that printers are skeptical about trying new technologies because they lack the resources to test them, EPA and TURI decided to fund a study of new ink and presswash technologies. It was hoped that this study would provide solid technical and economic information on forward-thinking technologies that could help the industry as well as remove the stigma of avoiding those technologies because of limited printer resources.

TURI, in collaboration with Goldman Environmental Consultants (GEC), designed the study to include Deluxe and other available ink/presswash technologies. A market survey was performed to ascertain if the Printwise™ process was unique, or if other lithographic ink and presswash systems with "near-zero" VOCs existed. No comparable systems were found, and the project thereafter focused exclusively on Printwise™ products. The demonstration was designed to examine the use of Printwise™ products under real-world conditions by testing the process over several months at four to eight printing plants, representing a variety of press types.

The project was designed to help address the following issues:

- The effectiveness of the water-based presswash.
- The technical printing quality of the ink on a range of press types.
- The cost of Printwise™ products compared to conventional products.
- The changes in material consumption and VOC emissions that would result from use of Printwise™ products.

2.5 Formation of Advisory Committee

An advisory committee was formed to guide the demonstration project. Invited to serve on the advisory committee were representatives of:

- the EPA NEEAT Team;
- EPA's Design for the Environment Program;
- the Graphic Arts Technical Foundation (GATF);
- the Massachusetts Department of Environmental Protection;

- the manufacturer of Printwise™ ink (first the Deluxe Corporation, and then SICPA Securink);
- the Massachusetts Office of Technical Assistance (OTA);
- Printing Industries of New England; and
- printers participating in the demonstration project.

The Advisory Committee met prior to the project to provide guidance on the project scope and direction. Its members also were contacted for individual advice and assistance, and to review the draft report.

2.6 The Sale of Printwise™

In December 1995, Deluxe shifted its market focus. It decided to focus on its core check printing business and to sell its Printwise™ ink manufacturing operations. Throughout the transition period, Printwise™ products continued to be supplied to existing customers and participants in the demonstration project.

In May 1996, the sale of the Printwise™ operation to SICPA Securink Corporation (a specialty ink manufacturer that supplies inks used in currency and other security printing operations) was completed. SICPA agreed to support the demonstration project and supply ink to new participants in the demonstration on the same terms agreed by Deluxe. The demonstration project was completed with SICPA's continuing cooperation.

SICPA is now serving existing Deluxe clients and participants in the demonstration, but has not extensively marketed the system to new clients.

3. Selection of Printing Systems and Printers

3.1 Market Survey of Ink Manufacturers

At the outset of the demonstration project, the type of printing system to be tested was defined. The advisory committee agreed that the focus of the study should be on "near-zero lithographic ink and presswash systems". This included the Printwise™ ink and presswash system and any other comparable products or systems specifically formulated to significantly reduce VOC emissions by at least 50% without compromising print quality, productivity, and costs. Low-VOC ink or presswashes that could be used universally with ink products of other suppliers were not considered. Those product types were part of previous studies on the performance low-VOC presswash by TURI and EPA; this demonstration focused on unique printing ink and presswash systems.

The ink and presswash needed to be used in specific combination and have been or could be marketed as a system to significantly reduce VOC emissions. The manufacturer also needed to agree to supply any ancillary equipment needed to run the system at no cost to printer participants and to supply them with the ink and presswash at a cost comparable to products currently purchased. A copy of the criteria for supplier participation is included in Appendix B.

Major ink and presswash manufacturers were contacted by letter to inform them of the project and invite their participation. The understanding was that the Printwise™ system would be one of two systems tested. One other system would be selected for the demonstration if a manufacturer fitting the criteria could be identified and agreed to participate. An example of the invitation letter used for this market survey and a list of the companies contacted are included in Appendix B.

Results of Market Survey

No other willing participants that met the criteria for participation were identified through the market survey. Two ink manufacturers sought further information about the demonstration. However, no detailed information was provided by them on whether an appropriate system existed that met the criteria, possibly due to confidentiality concerns. These manufacturers did not request to participate and based on the lack of response, it was decided to demonstrate only Printwise™ products.

The market survey concluded that no other "near-zero lithographic ink and presswash system" other than the Printwise™ system was currently available to printers. It is possible that research is being conducted on such systems, but no information is available to confirm this conclusion.

3.2 Demonstration of Printwise™ System and Selection of Printers

The initial intent of the demonstration was to test eight printers - one each of four types of printer, if two printing systems were tested. The initial plan was to test:

- one heatset web commercial printer;
- one coldset web commercial printer;
- one sheetfed commercial printer; and
- one heatset web book printer.

This initial plan was modified based on two things: 1) only one ink/wash system was evaluated; and 2) Deluxe decided not to heavily market its heatset web ink products. The decision was made to solicit participation by as many different printers as possible without adherence to a fixed number of sites or printing methods.

Obtaining Printer Participants

Obtaining printer participants for the demonstration proved to be a challenging and time-consuming task. Beginning in August 1995, printers known to be interested in pollution prevention issues were contacted directly. Advisory committee members assisted in identifying interested printers. They suggested potential candidates for participation, based on prior outreach and technical assistance activities. PINE informed its membership about the demonstration in its newsletter. It also identified candidates individually and sent them a memorandum about the project. Deluxe suggested potential participants, based on its prior marketing activities. The Massachusetts Office of Technical Assistance staff involved in pollution prevention technical assistance and marketing of green products were also contacted to identify candidates. The emphasis was placed on Massachusetts, but participants in other New England states were also solicited.

A list of potential printer participants and their participation status was developed. This list was periodically updated throughout the project, forming a database on printer interest in Printwise™ products. See Appendix C.

Throughout the fall 1995, letters were sent to candidates inviting their participation. The letters included a description of the demonstration project, Printwise™ products, and conditions for participation. See Appendix D for an example. They were followed up with telephone calls in an attempt to arrange for Deluxe to demonstrate its products at their facility. In total, 200 to 300 printers were invited to participate.

Many printers responded, however, a pattern emerged that soon became familiar: most printers declined participation due to production time constraints or lack of interest. Many indicated that they might be interested in a period of several weeks or months and asked for a followup contact.

While many printers had heard of the Printwise™ process and were curious about it, they had many questions about its effectiveness and economics. They had an interest in reducing the amount of toxic chemicals they use, but they were skeptical about trying new technologies because they lacked detailed knowledge of their effectiveness, and had limited time and resources available to test them. Since the process was so new, many printers were also reluctant to trust the results of a brief demonstration on their press.

To overcome these obstacles, several approaches were tried. One printer, United Lithograph (UL) of Somerville, expressed strong interest in participation. An initial one-day trial of Printwise™ products was arranged at this facility. The test results were favorable and UL agreed to participate, beginning in November 1995. It also agreed to serve as a demonstration site for other potentially interested printers.

Onsite Demonstration of Printwise™ Products

Due to the difficulty in obtaining commitments from printers to participate or have Deluxe test Printwise™ products on their presses, candidates were invited to four onsite demonstrations at UL.

These onsite demonstrations proved to be an effective means of increasing the

awareness of potential participants. Printers were able to speak directly to their counterparts and obtain information important to them. They critically examined the quality of printed samples and the effectiveness and ease of the press washup operation.

Selection of Participants

Followup phone calls were made to printers that attended demonstrations and expressed interest in participating. Meetings were held with interested printers to explain the demonstration and address any concerns that printers had about participation. An effort was made to address these concerns by making modifications to the data collection approach in order to make the demonstration more amenable to the printers (easier to accommodate) while still providing good data.

The following five printers were selected to participate in the demonstration:

- United Lithograph;
- S&A Paramount;
- Standard Register;
- the Central Reprographics Unit of the Massachusetts Department of Operational Services; and
- an inhouse print shop at the Old Colony Correctional Center.

Section II provides a complete description of these printers and the presses tested.

Standard Register and S&A Paramount were already using Printwise™ products, and were included in the demonstration project because it was felt that their more lengthy experience would be helpful. They had tested Printwise™ products on a variety of different press types, adding to the scope of the demonstration project.

The addition of Old Colony and Central Reprographics to the list of participants was not finalized until August 1996 due to an interruption between December 1995 and June 1996 resulting from the sale of the Printwise™ operations. The interim period resulted in a longer period of testing at UL, S&A Paramount, and Standard Register, which continued to use Printwise™ products during this time period.

3.3 Testing Agreements with Manufacturer and Participating Printers

As an incentive for printers to participate, Deluxe agreed to provide cost adjustments during the demonstration so that the cost of its ink and presswash was the same as current printer costs for these items. It also agreed to provide technical support throughout the project. This included being present at initial tests of the system at potential participants; making additional site visits if needed to trouble-shoot problems; and responding to questions as needed. SICPA also agreed to these conditions.

Participating printers were asked to dedicate a single press or group of presses exclusively to use of Printwise™ products for the duration of the demonstration. They were asked to supply information on material consumption and productivity before and after using Printwise™ products. They were also asked to complete technical evaluation forms describing the performance of Printwise™ products.

A three month trial period was originally planned for the demonstration project. However, operating conditions and the limited selection of inks offered (i.e., the lack of a wide selection of premixed Pantone colors) made the complete dedication of a single press for this time period impractical for some of the printers. The plan was modified to permit participants to use Printwise™ products as much as possible during the time period of the demonstration.

3.4 Pricing of Printwise™ Products

As part of the printer agreements with Deluxe, and then SICPA, printers purchased Printwise™ products at comparable costs of conventional inks and presswashes in use at the time. Deluxe also provided the Printwise™ presswash at a significant discount because its Printwise™ inks were typically sold at a 10-20% premium over conventional inks. With the exception of Standard Register and S&A Paramount, the two participants previously using Printwise™ before the demonstration, each printer made its own agreement with Deluxe at the start of the demonstration. Standard Register and S&A Paramount were already purchasing Printwise™ products and, therefore, the financial analyses used in the demonstration reflect their true purchase costs.

When the Printwise™ product line was later sold to SICPA, SICPA agreed to continue supplying the products under the original agreements - whether or not the pricing

agreement reflected SICPA's true costs as a supplier. Product prices were dependent on volume purchased, the original price agreement, and where the products were delivered in New England (transportation costs). Although the variability in pricing agreements makes comparison of financial data among printers more difficult, the demonstration data still offer printers a method of evaluating economic feasibility of Printwise™ products.

4. Conduct of Demonstration

4.1 Description of Participants and Presses Tested

The list of the five participating printers was finalized:

- United Lithograph (UL), a commercial sheetfed printer in Somerville, Massachusetts. It had not previously used Printwise™ products.
- S&A Paramount, a commercial printer specializing in business forms, located in Lincoln, Rhode Island. It had used Printwise™ products since fall 1995.
- Standard Register, a printer specializing in check, financial, and business forms, located in Tolland, Connecticut. The firm had used Printwise™ products since July 1995.
- The Central Reprographics unit (Central Repro) of the Massachusetts Department of Operational Services. This is a job shop printer doing general printing for state agencies. This shop had not previously used Printwise™ products.
- The inhouse Print Shop of the Old Colony Correctional Center (Old Colony), a major state prison in Bridgewater, Massachusetts. This is a job shop that does a variety of general printing and forms printing for state agencies. This shop had not previously used Printwise™ products.

Presses Tested During Demonstration

At the five participating printers, evaluations of Printwise™ products were conducted on five different press types and 32 presses/duplicators over a period of three months to one year. These presses fell are as follows:

- United Lithograph - one Komori 40 "six-color sheetfed press using process and Pantone colors (UL).
- S&A Paramount - Heidelberg one-color sheetfed press, eight West & Gear web presses (one, two, three colors) and five AB Dick duplicators.
- Standard Register - eight Heidelberg on-color sheetfed presses, three Innovative Nail imprint presses, five Superweb presses, one Whittaker JT7 envelope press, and one Holm JT8T Jet Crash Imprint press.

- Central Reprographics - one Diddie Superweb web press.
- Old Colony - Heidelberg one-color sheetfed press.

While the number of printer participants was smaller than originally planned (five rather than eight), the number of press types tested was diverse and larger than planned. The participating printers had diverse operations. The range of participants is considered sufficient to give a good cross-section of several of the most common types of printing commonly conducted in New England and the nation (especially at smaller facilities).

One-Time Press Trials

Through the process of considering the printers and presses to be tested, one other commercial sheetfed printer, Bassette Printers of Springfield, Massachusetts, conducted a one-time press trial of Printwise™ products on a six-color Heidelberg sheetfed press using process colors in July 1996. This facility, comparable to UL, does high-quality process color printing. It decided not to participate in the demonstration project after the press trial. At Old Colony, a one-time press trial was conducted on a four-color Diddie web press with a Quadflo auto dampening system.

While not providing as much information as the longer-term tests, these one-time tests are discussed in Section 4.2 because they provide useful information on conditions where the Printwise™ system may work effectively or encounter problems.

Including one-time tests, the Printwise™ system was tested at a total of six printers on eleven separate printing presses or groups of presses during the project.

4.2 Results of Initial Press Trials

At all printer participants and at Bassette, an initial press trial was conducted under the supervision of a Deluxe or SICPA technical representative. The printer selected one job to be tested, which was an actual job for a client, typical of everyday operations. Printers were asked to deep-clean the trial press to remove any trace of residual conventional ink which may not be removed by the Printwise™ presswash. The press operator was then instructed in the use of the presswash. Ink and presswash were supplied free of charge by Deluxe or SICPA.

Printwise™ products performed to the satisfaction of the printers at all of the initial trials, with two exceptions: Bassette and the test of the Diddie web press at Old Colony. In general, the printers concluded that the ink and presswash could perform well enough so that they could meet customer requirements without affecting productivity. This was the basis for the decision to participate in the demonstration.

Bassette Press Trial

Printwise™ inks performed well on the press at Bassette Printers and produced usable impressions, but the production supervisor had difficulty with color matching for magenta. (According to Deluxe's technical representative, this may have been due to adjustment of this tone to meet the needs of a specific facility owned by Deluxe that is the largest purchaser of their sheet-fed process colors.) Bassette also was concerned that a varnish supplied by Deluxe had an amber tinge, which did not fit their needs.

Bassette considered the drying time of the Printwise™ ink excessive. Bassette does a large amount of two-sided printing and high color coverage with a rapid turnaround time, so drying time was a significant issue.

Though some blankets and rollers were washed well by the Printwise™ presswash, the cleaning of ink fountains was slightly more time-consuming. Additionally, other blankets were not cleaned effectively, possibly due to the presence of old ink on the blankets. An example of the customer feedback form completed by the Deluxe technical representative is included in Appendix E.

Bassette concluded that they probably could have experimented further with the Printwise™ process to make it fit their needs, but the process would be lengthy, and participation was declined.

Old Colony Web Press Trial

During a single test run of the web press at Old Colony, Printwise™ inks did not achieve a proper balance with fountain solution and failed to produce usable impressions. This problem was attributed to the Quadflo dampening system installed on this press. Also, no technical representative from Deluxe or SICPA was present at this press trial, and the quality of the web ink used was questioned. It had been sup-

plied to Old Colony several months earlier. Further discussion on this test run may be found in Section 9.2.

4.3 Data Collection and Evaluation Forms

A set of three evaluation forms was developed to collect information from printer participants during the study. These forms are included in Appendix F. For each press tested, they were intended to determine:

- Form 1** Average monthly material consumption, waste disposal and related costs (for paper, ink, presswash, shop towels, and other inputs to the printing process) prior to use of Printwise™ products.
- Form 2** Technical printing performance of Printwise™ products during an individual press run. This form, entitled the "Feedback Form", was based primarily on a subjective evaluation by the press operator or production supervisor, based on specific performance criteria defined below. Limited estimation by press operators of quantities of ink, presswash, shop towels, and other materials used on the press run was also requested.
- Form 3** Average monthly material consumption, waste disposal and related costs for the period after use of Printwise™ products. The information collected was similar to that on Form 1.

In initial orientation meetings, the forms were supplied and explained to the participating printers.

4.4 Constraints & Selection of Feasible Evaluation Methods

The major constraint in developing the study methodology was to develop a set of data that printers could supply without excessive time demands. The study intent was to evaluate Printwise™ products under real-world conditions. It was not necessary to extensively measure material use during production, or to set up new material accounting systems for the sake of the project. It was also not possible to require recording data on printing performance that would not be collected under ordinary production conditions.

Accordingly, methodologies for material consumption and financial evaluation were developed that relied primarily on accounting data and productivity information

commonly available and tracked by printers, or which they could estimate with reasonable accuracy. These included material purchase records and productivity based on monthly impressions.

Often printers had incomplete records for material purchases, or records were not available for an individual press. To address this problem, all available information was reviewed with each printer, and an estimate developed of material consumption for the individual press based on informed judgment. This procedure, similar to that commonly used in evaluating the economic and technical feasibility of toxics use reduction, was sufficient to develop an estimate to compare differences before and after use of Printwise™ products. In cases where printers did not feel that they could develop a reasonably accurate estimate, the factor was eliminated from the analysis.

Methodology for Evaluating Technical Printing Performance

Form 2 was used by the press operators/supervisors to record printing performance. The rankings on the form were tabulated to determine an average for each printer over the period of the demonstration.

The evaluation was based on ordinal rankings (excellent, good, fair, or poor) of the performance of Printwise™ products by press supervisors or operators for specific factors. Use of such a scale is straightforward for printers to use. The evaluation factors were developed with the aid of the participating printers and the Advisory Committee. They included factors typically used by printers to determine the performance of a print job. For further explanation of these factors and key terms, refer back to the section - Key Terms and Definitions.

Methodology for Evaluating Material Consumption, Waste Disposal, and VOC Emissions

The overall intent of the evaluations of material consumption, waste disposal, and VOC emissions was to perform a "before and after" average monthly comparison of conventional and Printwise™ products on an individual press. Wherever possible, an attempt was made to collect actual data based on measurement or accounting records of the facility.

Forms 1 and 3 were designed to structure all of the data needed into an organized form. Since the printers were not always able to assemble all of the data into this format, raw purchasing records or measurements were converted for them by the project investigators as necessary. The quantities consumed in a particular month were added over the entire period of use and divided by the number of months to determine an average monthly amount. The primary intent of the material consumption analysis was to determine actual use whenever possible.

Methodology for Financial Analysis

The financial analysis was based on a comparison of monthly operating costs "with and without" Printwise™ products. Because no capital investments were required to use Printwise™ products, the comparison of operating costs alone was sufficient.

The financial analysis differed from the material consumption analysis in that its intent was to compare the impacts of Printwise™ products assuming an unchanged production level. Consequently, the analysis started with the average monthly material consumption amounts before and after Printwise™ for each material (ink, presswash, etc.) and unit costs for each (such as the price per pound of ink). It then used production level data, the ratio of impressions per month before and after Printwise™, for the press to adjust these amounts to assume an unchanged production level.

These adjusted consumption rates were multiplied by the purchase costs to estimate the cost of material consumption. These amounts were added to determine a total material cost "with and without" Printwise™. This calculation was performed only for those materials that changed following use of Printwise™ products.

5. Comparison of Facilities & Conclusions

The demonstration indicated that Printwise™ products can work effectively for several different types of presses and printers. However, Printwise™ products do not work equally well under all production conditions. Their use raises technical, environmental, financial, and market issues.

5.1 Technical Printing Performance

Range of Presses and Types of Printers Evaluated

Including one-time tests, the Printwise™ system was tested at six printers on a total of eleven separate printing presses or groups of presses during the demonstration. Extended tests were performed on nine separate presses or groups of presses. Additionally, two one-time tests were conducted at Bassette Printers and Old Colony.

Comparison of Rankings by Press Type and Class

Table 5-1 compares the technical printing performance of the Printwise™ products on each press or group of presses evaluated on a long-term basis according to each performance factor.

- Dot gain for black ink was ranked excellent on all press types except the Heidelberg press at Old Colony and the web at Central Repro, where it was ranked good.
- Dot gain for color ink was ranked excellent for the process color press at UL and the web press at S&A Paramount, and good for the sheetfed one-color and duplicator presses at S&A Paramount.
- Color matching and quality was ranked only at Standard Register. All presses at this facility were ranked good for both black and Pantone colors. Bassette Printers reported some problems with color matching on a process color sheetfed press.
- Runability was ranked good for all presses except the process color press (ranked excellent) and the web press at S&A Paramount (ranked excellent for black and good for Pantone colors).
- Set characteristics were ranked excellent on the process color and web presses at Central Repro, and good for all other presses.
- Drying characteristics were ranked excellent on the process color press, fair at the Old Colony sheetfed one-color, and good for all other presses.
- Overall ink performance was ranked excellent on the process color press, fair at the Old Colony sheetfed one-color, and good for all other presses.

Table 5-1
Comparison of Technical Performance Ratings for Printwise™ Products

	United Lithograph	Old Colony	S&A Paramount				Standard Register		Central Repro
	Komori Sheetfed Process Color	Sheetfed One Color	Heidelberg Press	Sheetfed Duplicator	Diddie Web Presses	5 Super Web Presses	Jet Crash Imprint	Innovative Nail Raised Imprint	Diddie Web Press
Performance Factors									
Dot Gain - black	E	G	E	E	E				G
Dot Gain - color	E		G	G	E				G
Color Matching Quality - Black						G	G	G	
Color Matching Quality - Pantone Colors						G	G	G	
Runability	E	G	G	G	E/G ¹	G	G	G	G
Set Characteristics	E	G	G	G	G	G	G	G	E
Drying Characteristics	E	F	G	G	G	G	G	G	G
Overall Ink Performance	E	F	G	G	G	G	G	G	G
Blanket Wash - Ease of Cleaning	F	G	G	F	G	F	G	G	G
Roller Wash - Ease of Cleaning	F to P ²	G	G	F	F	G	E	G	G
VOC Emissions									
% Reductions	62	99	90				36		90

Key to Rankings

- E - Excellence
- G - Good
- F - Fair
- P - Poor

Notes:

- 1 Excellent - black; good - Pantone Colors
- 2 Fair - 11 of 21 ranks on forms; poor - 10 of 21 ranks on forms

- Ease of blanket wash was ranked good on the raised imprint presses, the one color sheetfed presses, and the web presses at S&A Paramount and Central Repro. It was ranked fair on the process color press, the duplicator, and the web at Standard Register.
- Ease of roller wash had variable rankings. It was ranked excellent on the Jet Crash Imprint press, fair to poor at the process color press, fair on the duplicator and the web press at S&A Paramount, and good on all other presses.

Overall Ink Performance

Printwise™ ink performed well during the demonstration. On eight of nine presses, the rankings were consistently good or excellent. Only the Old Colony sheetfed one-color press was ranked fair, and this press was the least used of any press during the demonstration. The rankings at this facility might have improved with more experience with Printwise™ products.

At the two facilities where one-time tests were conducted, the results were less favorable.

- Printwise™ inks performed acceptably at Bassette Printers and produced usable impressions, but the production supervisor had difficulty with color matching for the magenta colors. Bassette also concluded that the ink drying time was excessive for their needs.
- During a single test run of the web press at Old Colony, Printwise™ inks did not achieve a proper balance with the fountain solution and failed to produce usable impressions. This problem was attributed to the Quadflo dampening system on this press.

Printer Willingness to Use Printwise™ Ink Only

One of the more surprising and unanticipated findings of the demonstration was that participating printers had a tendency to compare Printwise™ inks to their conventional inks without using the Printwise™ presswash. They showed a willingness to use Printwise™ ink if it performed well, even if they had concerns about the performance of the Printwise™ presswash. At both Standard Register and S&A Paramount, Printwise™ inks are being routinely used on presses where they are cleaned with conventional presswash.

This finding reflects the fact that printers tend to be pragmatic and results-oriented. Their interest in Printwise™ products is not solely motivated by an idealistic desire to use an environmentally friendly product, but as part of a continuing effort to print more efficiently. The fact that any environmental benefits may be achieved were secondary. At most of the participating printers, the performance rankings were more positive for the Printwise™ ink than the presswash.

Ease of Press Cleaning

The ability of Printwise™ presswash to clean presses effectively under normal production conditions is key to achieving the potential environmental benefits of the product. Press operators reported that Printwise™ presswash was able to clean rollers, blankets, and ink fountains on the presses tested, but not as quickly or conveniently as conventional presswash. Their individual reactions and rankings varied widely. Several reported that the Printwise™ presswash worked, but often required repeated applications. UL and S&A Paramount reported occasional problems with a residual soap film on rollers. Press operators with more experience with the product could avoid these problems through modified work practices and unique presswash combinations.

The use of presswash varied among participating printers:

- On four of the nine demonstration presses (the one-color sheetfed Heidelberg presses at Old Colony and S&A Paramount, Innovative raised imprint press at Standard Register, and duplicators at S&A Paramount), Printwise™ presswash was used exclusively.
- On the other five presses tested, press operators developed hybrid cleaning procedures that combined use of Printwise™ presswash with conventional or low-VOC presswash. However, hybrid cleaning procedures were not consistent from printer to printer.

Reasons for Press Cleaning Problems

There are so many variables in the printing process that it is not easy to explain reported problems with press cleaning. Operator experience and the initial condition of presses prior to cleaning influences decisions. For example, Deluxe and SICPA technical representatives noted that if press rollers and blankets were not deep-cleaned to remove residual conventional ink before using Printwise™ ink, a residue could remain that could not be removed by the water-based Printwise™ presswash. This prob-

lem may have occurred during initial trials at some of the participating facilities. It was suspected as the cause of the problem experienced at Bassette Printers during the one-time blanket-cleaning demonstration at this site. Further testing under controlled conditions would be helpful in addressing these issues.

5.2 Environmental, Health, and Safety Benefits and Impacts

The potential environmental, health, and safety benefits and impacts from Printwise™ products are similar for all printers. They include:

- Reduction in the emissions of VOCs and hazardous air pollutants from conventional presswash and petroleum-based ink.
- Reduction in employee and public exposure to conventional presswash containing organic solvents that may contain hazardous or toxic ingredients.
- Less effort devoted to compliance issues associated with air emissions, cleaning shop towels, and disposing of hazardous waste.
- If waste Printwise™ presswash is discharged to sewer, there may be an increased pollutant loading for ink and presswash components to the sewer. More effort may also be needed for compliance with wastewater discharge requirements. While Printwise™ inks are soy-based, their impact on pollutant loadings in the wastewater discharge varies according to types and quantities of inks used by the printer. This raises concerns regarding sewer discharge standards in different municipalities. Although the metal-based pigments in some of the Printwise™ inks their impact cannot be ascertained without further data or wastewater sampling at each printer location.

The extent to which these benefits and impacts occur depends on the quantity of Printwise™ products used and the corporate decisions made regarding waste disposal.

- Participating printers all experienced VOC emission reductions.
- Two printers experienced toxics use and emission reductions by using Printwise™ presswash. UL reduced their toluene use and Central Repro reduced their perchloroethylene use.
- Press operators at all participating printers noted and appreciated their reduced exposure to solvent fumes. Several commented on feeling

better at work and liked being able to more freely handle the water-based Printwise™ presswash.

- The participating printers did not experience a change in effort devoted to environmental compliance. The primary reason was that their use of Printwise™ products was too limited to result in a change in compliance requirements for air emissions, hazardous waste disposal, or wastewater disposal. However, their staff felt that in the long term, the use of Printwise™ products would simplify compliance.
- Two of the printers may be able to reduce their environmental compliance efforts.
 - UL incorporated Printwise™ products in its Toxics Use Reduction (TUR) Plan, and has the potential for dropping below the filing threshold. If it converts more presses to Printwise™ products, it may also become eligible for the Massachusetts Printers Partnership (a simplified multimedia compliance program for printers) and eliminate mandatory reporting of toluene under federal Toxics Release Inventory and Massachusetts TURA requirements.
 - Standard Register's environmental staff felt that use of Printwise™ products would help them avoid higher permit and compliance fees as production levels increase.
- The participating printers did not discharge waste Printwise™ presswash to the sewer, choosing instead offsite disposal as a hazardous waste. The Deluxe Corporation was able to help printers in other municipal jurisdictions attain approval for their wastewater discharges. The participating printers did not pursue this option, in part because of the lack of definitive data and short demonstration period. Hence, they did not experience more wastewater testing requirements or permitting issues.

5.3 Material Consumption

Table 5-2 below compares the changes in material consumption, waste disposal, and VOC emissions with and without Printwise™ products at the participating printers. The estimates have been adjusted to display the average changes that would occur at a constant level of production.

Table 5-2

Changes in Average Monthly Material Consumption¹, Waste Disposal and VOC Emissions with Printwise™ Products Compared to Conventional Products Before the Demonstration

Product	United Lithograph	S&A Paramount	Standard Register ²	Central Repro	Old Colony ³
Black & Color Ink Use	-14 lb	-23 lb			-0.6 lb
Total Presswash Use (includes Conventional and Printwise™ Presswashes)	-46 gal	-20 gal	-11 gal	-1.8 gal	+0.8 gal
Shop Towel Use (number)	+1,270 twl	-340 twl			+36 twl
Waste Ink Disposal	-7 lb.				
Conventional & Low-VOC Presswash Disposal	-534 lb		-180 lb		-0.6 gal
Total Presswash Disposal (also includes Printwise™ Presswash)	-403 lb		-84 lb		-0.6 gal
Change in VOC Emissions (% reduction using Printwise™ products)	-386 lb(62)	-215 lb(90)	-181 lb(36)	-21.6 lb(90)	-8.2 lb(99)

¹ Material use amounts are adjusted to reflect production levels during demonstration period based on monthly impressions, unless otherwise noted.

² Standard Register estimates are averaged over the entire period of Printwise™ use (8/1/95 - 6/30/96).

³ Based on average quarter at Old Colony.

The comparison of participants indicates that:

- Three of five participants experienced reductions of 5-7% in ink consumption with Printwise™. The other two have unchanged ink consumption levels.
- All participants reduced their use of conventional and low-VOC presswash, except Old Colony. The quantity varied widely, from a 60 gallons per month reduction at UL to an increase of 0.8 gallons per quarter at Old Colony. This range reflected both the wide range in the productivity of the presses tested, and the extent to which Printwise™ presswash was used. Only one of the four printers (Old Colony) used Printwise™ presswash alone. The others used a combination of Printwise™ presswash, conventional, and/or low-VOC presswash for particular press cleaning tasks.
- Two participants (UL and Old Colony) increased their use of shop towels and S&A Paramount's use declined; data were unavailable at the others. Part of this difference is probably due to S&A Paramount's practice of washing and reusing the shop towels. Other participants did not follow this practice. Operator experience may also play a role since S&A Paramount had two years of previous use.

- The participating printers disposed of less hazardous waste with Printwise™, primarily because the total volume of presswash was reduced.

In interpreting these results, it is important to remember that:

- Most of the participating printers only partially converted their presses to test the Printwise™ system, due to operational constraints or managerial preferences.
- Two of the participating printers (Central Repro and Old Colony) tested Printwise™ products for a relatively short period of time.

Reductions in material consumption were greatest for the participants that made the largest substitutions of Printwise™ for conventional products. This suggests that the maximum benefits of use of Printwise™ products will not be achieved until a facility can completely change over its operations to use of this system.

5.4 VOC Generation

Significant reductions in VOC generation were achieved by all participants in the demonstration. This suggests that use of Printwise™ products can be considered as one component of an overall VOC reduction strategy. Printers obtained VOC reductions between 36 and 99%.

5.5 Financial Analysis

Table 5-3 compares the changes in the cost of material consumption and waste disposal with and without use of Printwise™ products at the participating printers. The estimates reflect the average changes that would occur at a constant level of production. As discussed below, it also displays the possible impact of the likely increase in the price of Printwise™ presswash.

The comparison of participants indicates that:

- Under the pricing conditions of the demonstration project, use of Printwise™ products was less costly for all of the participants. A major reason for the lower overall cost was the lower cost of Printwise™

presswash supplied during the demonstration. This cost difference would change after the Printwise™ price increase.

- Three printers (UL, S&A Paramount, and Old Colony) also had lower ink costs due to improved ink mileage. Standard Register had higher ink costs due to higher unit costs for Printwise™ inks.
- Three printers (UL, Standard Register, and Old Colony) had lower costs for disposing of hazardous waste.

Table 5-3

Financial Comparison of Changes in Average Monthly Cost of Production¹ with Printwise™ Products Compared to Conventional Products During the Demonstration

Product	United Lithograph	S&A Paramount.	Standard Register ²	Central Repro	Old Colony ³
Black & Color Ink Cost	-\$65	-\$129	+\$79	\$0	-\$2
Total Presswash Cost	-\$227	-\$139	-\$68	-\$28	-\$11
Shop Towel Cost	+\$115	-\$34	\$0		+\$2
Waste Ink Disposal Cost	-\$3				
Total Presswash Disposal Cost (also Printwise™ Presswash)	-\$142		-\$27		-\$1
Total Cost	-\$322	-\$302	-\$16	-\$28	-\$12
Total Cost with Printwise™ Presswash Price Increase	-\$228	-\$240	+\$22	-\$18	\$0

- ¹ Material use amounts are adjusted to reflect production levels during demonstration period based on monthly impressions.
- ² Standard Register estimates are based on period of Printwise™ use and conventional presswash only (8/1/95 - 1/31/96)
- ³ Because of the small quantities used, the Old Colony results are by quarter.

Possible Impact of Price Increases for Printwise™ Products

The estimates for the pricing conditions of the demonstration project do not reflect the likely increase in the cost of Printwise™ presswash. Unspecified changes in Printwise™ ink costs may also be incurred by some participants (UL, Central Repro, and Old Colony) that were not using Printwise™ products prior to the demonstration.

S&A Paramount and Standard Register are unlikely to experience post-demonstration cost increases and plan to continue using Printwise™ products. Whether the other participating printers will continue to use Printwise™ products is uncertain.

Table 5-3 displays the impact of an assumed cost increase of up to \$5.63 per gallon of Printwise™ presswash after the demonstration. It indicates:

- The likely impact of the post-demonstration cost of Printwise™ presswash will result in no savings for three participating printers (Standard Register, Central Repro, and Old Colony) and a possible increased cost to Standard Register when compared to conventional products.
- For two participants, UL and S&A Paramount, use of Printwise™ products will still be less costly.

5.6 Printwise™ Successes and Difficulties on Different Press Types

- The demonstration suggests that three press types - the one-color sheetfed press, raised imprint presses, and web presses without a Quadflo dampening system - are likely to work effectively with Printwise™ products with a limited amount of experimentation and fine-tuning.
 - Business form and check printing operations are relatively simple operations that use these presses and appear good candidates for success with Printwise™ products. This is the application for which the system was first developed and where it has had the most use.
 - State agencies also commonly perform job shop printing on these press types and do not usually require a wide variety of colors or highly precise color matching. These facilities appear to be good candidates for Printwise™ products.
- Multicolor commercial sheetfed lithographers employing high-quality process color and extensive use of Pantones will experience a much greater challenge in using Printwise™ products. However, the success of UL in using the products for nearly one year shows it is possible for them to do so. A major question for these printers will be the willingness of production staff to experiment and the degree of technical support offered by suppliers - especially the availability of blended Pantone colors with a quick delivery time, and willingness to adjust the inks to meet printer needs.
- S&A Paramount was able to make Printwise™ products work effectively on duplicator presses that are the mainstay of small printing plants in New England and throughout the United States. While SICPA does not promote Printwise™ products to this market, it is worth further evaluation and testing.

5.7 Obstacles Encountered

- It was more difficult than anticipated for printers to attend demonstrations of the Printwise™ system, and to participate in the demonstration project. A significant investment of time was required from potential participants, because a long-term demonstration was planned. Many printers were reluctant to make this commitment.
- Several printers who agreed to participate were subsequently unable to commit the time for press operators to fill out technical evaluation forms on a daily basis.
- Demanding production schedules made it impossible for several of the participating printers to measure the quantity of conventional and Printwise™ products used on an individual pressrun or shift basis.
- Data available from the printers on the quantity of products used on a specific press or for the plant as a whole were often inconsistent and sometimes unavailable.
- The corporate sale of the Printwise™ division imposed an unavoidable delay in the project schedule. Between December 1995 and May 1996, no new printers could be recruited to participate in the demonstration because of the unavailability of technical support and Printwise™ products to new customers.

How Obstacles were Overcome

Many of these obstacles were related to the amount of time and effort requested from printers. To overcome these obstacles, an effort was made to lessen this commitment as much as possible while still obtaining good data. For example, rather than requesting completion of daily evaluation forms, a single average form was completed. The best data available on material consumption were used for each participant. Press operator estimates of material consumption rates were used in some cases rather than actual measurement. The difficulty of obtaining commitments from printers to test new products was addressed by obtaining participation from two printers that were already using Printwise™ products.

While these changes in methodology resulted in a research design that was different than originally planned, the modified methodology was sufficient to develop estimates of material consumption and financial impacts and to draw reasonable conclusions.

5.8 Issues Printers Must Consider

In comparing the results of the technical evaluation of printing performance at the participating printers, three key factors appeared to strongly influence the success of the Printwise™ system.

- The complexity of the type of printing conducted:

Printers with more complex tasks (e.g., double-sided process color printing, precise color matching, extensive use of specialty Pantone colors, and rapid reproduction time) faced a greater challenge and had more difficulty adapting the Printwise™ system to their needs.

- The type of press tested and inks routinely used:

Simpler presses and printing jobs requiring black or basic Pantone colors experienced less difficulty.

- The degree of management commitment and length of use of Printwise™ products:

Printers willing to make a management commitment to use Printwise™ products and employ them for a longer period of time had better success.

Issues printers must consider in testing and using Printwise™ products include:

- A long-term management commitment and willingness to invest time to resolve problems is needed for success.
- Extensive technical support from the ink supplier is needed.
- Some adjustments in printing procedures and training of press operators will probably be needed.
- Inks may need to be "fine-tuned" in hue or tack to meet printers' needs and this may require additional technical support.

The participants varied substantially from those testing Printwise™ products only once or for a limited number of times (Central Repro and Old Colony) to those testing it for over a year (Standard Register and S&A Paramount). The latter two printers expressed the most comfort with continuing to use it on a long-term basis. These printers had time to become familiar with use of Printwise™ products. They both experimented to

solve problems as they arose and found ways of selectively using the products where they worked successfully. Conversely, those printers using Printwise™ products the least (Old Colony and Central Repro) had more unresolved issues.

5.9 Market Issues

In order to effectively use Printwise™ products, a printer must solve two interrelated production issues - dealing with both the ink and the presswash. Using a new ink and presswash system is complex and time-consuming, and it requires a number of market issues to be resolved:

- Many printers need premixed Pantone colors, often in small quantities, because they do not blend Pantone colors onsite. SICPA currently does not supply premixed sheetfed Pantone colors, with the exception of Pantone base colors. It also supplies premixed Pantone web inks.
- SICPA does not presently have local blending facilities or ink distributors and ships its inks from the point of manufacture (Chicago and Virginia). Local blending facilities or ink distributors would increase the availability and market attractiveness of Printwise™ products.
- At present, printers must acquire the Printwise™ ink from SICPA and the presswash from a separate manufacturer, Quality Formulations, which involves more effort by the printer.
- Technical support from the manufacturer and a commitment to actively serve a particular market (such as sheetfed process color printers) are needed. SICPA has only recently purchased the Printwise™ technology, and its largest customer is the Deluxe printing facilities. It has not yet determined which sectors of the commercial printing industry it intends to pursue.

5.10 Suggestions for Interested Printers

- Attend a demonstration of the technology. Visit a facility where Printwise™ products are in routine use, or talk with a printer now using them, to learn firsthand their advantages and disadvantages.
- Be prepared to experiment to find the right application of Printwise™ products at your facility.
- In testing Printwise™ products at your facility, have a manufacturer's representative present, and follow all recommended procedures. Deep-

clean the press in advance to remove any trace of conventional ink that would not be removed by Printwise™ presswash.

- Be willing to accept that the Printwise™ presswash may not clean as rapidly as conventional presswash, and press operators may need to be retrained. This is an important issue for printers with production time constraints.
- Invest the time to explore potential economic benefits from changed printing and waste disposal practices. These include contacting the local sewer authority for approval to discharge waste Printwise™ presswash to the sewer, and determining if shop towels can be washed and re-used onsite.
- If a decision is made to work with Printwise™ products, be prepared to make a management commitment and devote the necessary staff and managerial time.
- The demonstration suggested that Printwise™ ink may not function effectively on web presses with the Quadflo auto dampening system, but the one test conducted is not definitive. Further testing of this type of press and dampening system could be undertaken, but may require experimentation.
- Printers could test the "near-zero VOC" Printwise™ products on duplicator presses, which has been successful at S&A Paramount. This could result in even higher reductions in overall facility VOC emissions compared to conventional products.
- Printers interested in obtaining more information should refer to the Resource List in Appendix G.

5.11 Suggestions for Interested Government Regulatory and Technical Assistance Staff

- Onsite demonstrations at printing facilities using Printwise™ products were the most effective way of introducing other printers to the technology. It should be determined if one or more of the participating printers would be willing to serve as a demonstration site on an ongoing basis.
- Assistance from a trade association such as Printing Industries of New England (PINE) should be sought to publicize the results of this demonstration project in publications, exhibitions, or seminars.

- Printwise™ products can be considered in BACT or RACT analysis as part of state and federal air quality permitting. Printwise™ products may prove to be a cost-effective method of reducing VOC emissions that can help printers restrict their emissions to stay under permitting thresholds.
- The use of Printwise™ products may not be a universally applicable solution, but one of several options that can help printers reduce VOC emissions or toxics use. Printers can be encouraged to explore this option as part of a coordinated pollution prevention strategy.
- Long-term field tests of new technologies can be difficult to perform and must be adapted to interfere with production as little as possible.
- State-operated facilities are potentially important demonstration sites for use of the Printwise™ technology. State and federal agencies interested in providing outreach on effective pollution prevention options and use of environmentally friendly products in the printing industry may wish to explore this possibility further.
- Agency and technical assistance staff interested in obtaining more information should refer to the Resource List in Appendix G.

5.12 Further Research & Followup Needs

- The technical performance of Printwise™ products should be examined in a controlled experimental setting, possibly by a trade association, where measurements of technical parameters, such as dot gain and drying characteristics can be made.
- Data should be collected on the content of Printwise™ ink to determine if the discharge of waste presswash to the sewer is permitted by the local authority.
- Further evaluation of Printwise™ products on duplicator presses should be performed.
- Followup should be performed with the participating printers to determine if they have continued to use Printwise™ products, and any issues encountered. Their interest in participating in public outreach should also be considered.

Section 2

**Printwise™ Demonstrations
at
Five Printing Companies**

1. Evaluation at United Lithograph

United Lithograph (UL) was the first printer to participate in the evaluation of the Printwise™ process, and has been highly supportive of the testing program as part of its overall strong corporate effort to reduce toxics use and prevent pollution. The company is a high quality sheet-fed printing firm, located in Somerville, Massachusetts. It has a current press inventory consisting of six duplicators and six large sheet-fed presses:

- a Heidelberg eight-color 40-inch;
- a Heidelberg six-color 40-inch;
- a Heidelberg five-color 20-inch waterless press;
- a Komori six-color 40-inch;
- a Miller two-color 40-inch; and
- a Heidelberg two-color 20-inch.

1.1 Scope of Testing

UL dedicated the six-color Komori press, primarily used for process color jobs, to Printwise™ inks and presswash for the duration of the demonstration. Prior to use of Printwise™ ink and presswash, this press used primarily petroleum-based process colors, petroleum-based "Pantone" specialty colors, and conventional solvent-based presswash. During the demonstration, UL used only Printwise™ process color ink on four of the six press units and used Printwise™ presswash as much as possible for all cleaning tasks (blanket, roller, cylinder, and ink fountain cleaning). The remaining two press units were reserved for conventional petroleum-based Pantone color inks and presswash for the duration of the demonstration.

Time Frame of Demonstration

Full-scale use of the Printwise™ ink and presswash began at the end of November 1995. The testing program continued through the end of April 1996, and covered a period of five months. Data on material consumption and technical performance were collected during this period. Though no further data was collected, UL continued to use Printwise™ ink and presswash through mid-September 1996, except in July 1996 due to a brief interruption of Printwise™ ink deliveries.

1.2 Technical Printing Performance

UL's press foreman for the Komori press on the day shift and other press operators periodically completed technical evaluation forms for the first press run of the day during the last three months (February through April 1996) of the demonstration period. A total of 24 evaluation forms were completed, resulting in an average sampling frequency of two forms per week. This was dependent on the actual production runs and the time constraints placed on the press operators. UL averages 5-10 production runs per week on the Komori press (120-240 jobs in three months) - so in total 10-20% of all production runs were evaluated. This frequency provides a representative sample of the range of variation of ink and presswash performance.

This summary is based on average rankings from the evaluation forms and shown on Figure 1 in Appendix H. Additional written comments on performance and an exit interview with the press operator are summarized and discussed below.

Overall Ink Performance

The rankings were consistently excellent in terms of ink performance - covered by the parameters of dot gain, runability, set characteristics, drying characteristics, and overall ink performance.

Drying characteristics

Drying characteristics of the ink were consistently ranked as excellent, about the same as with conventional inks. UL consistently met customer requirements for rapid job delivery with a variety of paper types. Drying time, a concern frequently raised by printers, was not identified as a problem at UL during the demonstration period. This represents a significant finding of this study.

Ease of Press Cleaning

The ease of press cleaning using Printwise™ water-based presswash was ranked separately for cleaning blankets and rollers. The ease of cleaning blankets was consistently ranked as "fair" (Figure 1), with an average cleaning time of eight minutes. Cleaning press rollers or "units" was the greatest cleaning problem experienced, ranked "fair" on

11 of 21 completed forms and "poor" on the other 10 completed forms. Comments indicate that the press operator found that the Printwise™ presswash cleaned the rollers and blankets, but not as quickly as conventional solvent-based presswash. The ease of using Printwise™ presswash for blanket and roller wash was acceptable for production printing, but could be improved.

Residual Soap Film and Ink Scumming

The press operator reported occasional problems with the presence of a residual soap film on the rollers, requiring rewashing the unit with Printwise™ presswash or (occasionally) conventional presswash. The operator recommended that the presswash solution be reformulated as a stronger solution to address this periodic problem. (This could be due to a number of variables, including water hardness in the presswash and/or the fountain solution. It may be addressed by supplying presswash as a stock solution and allowing printers to mix it themselves.) Operator experience with Printwise™ products is also an important part of this issue. The head press operator indicated that as the demonstration progressed and experience was gained, operators were able to avoid problems with soap buildup in washing up the presses.

A different problem noted on two of the 24 forms was "scumming" of the magenta ink during printing. Ink scumming involves formation of suds or blotches on the plate because the ink is partially dissolving into the fountain solution. It generally results from a pH imbalance in the fountain solution. In one case, the press run was stopped and the water balance (fountain solution) adjusted for pH before continuing the run.

Color Density

In the opinion of the press operator, the cyan, magenta, and yellow process inks exhibited good strength (density) and color matching characteristics. While rated as high as the other inks for the ranked evaluation factors, the density of the black Printwise™ process ink was considered to be somewhat "weak" for UL's purposes, sometimes requiring adjustments (e.g., increasing the amount of Printwise™ black ink used or substituting a conventional petroleum-based black ink).

Technical Performance Summary

The technical performance of Printwise™ products on the press are provided below:

- Printwise™ process color inks worked well during the demonstration period.
- With the exception of the black ink density issue, color matching was not a problem.
- The fountain solution and the rate of its use did not change - an important factor since printers resist fountain solution changes. Water balances did require adjustment, but this was not noted as a significant problem.
- Press cleaning was somewhat more labor-intensive and time-consuming, but could be accommodated within the normal range of time for UL production on the shift. It is not known if this would be acceptable at higher levels of productivity and press runs per shift.
- Using Printwise™ inks over the period of evaluation, the press operator was able to fulfill all customer requirements as efficiently as with the conventional ink and presswash.

1.3 Material Consumption

UL supplied data on its plant-wide monthly purchases and use of products including conventional ink, presswash, and press cleaning solvents for September 1995-April 1996. These data were grouped to determine use of products before and after use of Printwise™. The period from September 1, 1995 through November 23, 1996 was prior to use of Printwise™ products. This period was selected to permit a reasonable average of long-term material use so that purchases could be assumed to be equal to use. Inventory information (unused product before and after the period) was unavailable. The period from November 24, 1995 through April 30, 1996 was the "after" period.

Purchases during each month in the "before" and "after" time periods were available only on a plant-wide basis. UL does not collect data on the use of each product (e.g., fountain solution, ink, or presswash) on an individual press. Many materials are used on all the presses and no accounting method was in place for recording long-term use on an individual press. This type of accounting would be impractical in the production environment and during the demonstration project. The press operator conducted

limited measurement and estimation of material use during the demonstration. Average use of shop towels and conventional and Printwise™ presswash were periodically measured and averages developed. It was accordingly necessary to find other ways to estimate the amount of each material used before and after Printwise™ on the Komori six-color press.

Table 1-1
Average Monthly Material Consumption and VOC Emissions
Before and After Printwise™ Use at United Lithograph

Material Consumption	Before Printwise™	After Printwise™
Conventional Ink -Process Color	238 lb	0
Printwise™ Ink- Process Color	0	224 lb
Prisco HO Presswash	58 gal	29 gal
Other Press & Presswash	40 gal	7 gal
Printwise™ Presswash	0	16 gal
Fountain Solution	26 gal	26 gal
Shop Towel Use (number of towels)	3,180 twl	4,450 twl
Other Conventional Ink Use - Pantone,	112 lb	112 lb
Waste Generation		
Waste Ink	167 lb	160 lb
Waste Presswash	731 lb	372 lb
VOC Byproduct & Emissions		
HO Presswash (6.58 lb VOC/gal)	382 lb	191 lb
Other Press wash (5.77 lb VOC/gal)	231 lb	39 lb
Conventional Ink	5 lb	2 lb
Total VOC Byproduct	618 lb	232 lb
Onsite VOC Emissions (69%)	426 lb	160 lb
Productivity		
Average Charged hr/month	293	225
Average Impressions/month	576,000	464,000
VOCs/10,000 Impressions	10 lb	5 lb

Two basic approaches are possible:

- start with plant-wide information and estimate material use on the individual press as a portion of the total; or
- measure or estimate use of materials on the press during typical production runs or shifts, and average them to estimate long-term use.

All the available data were reviewed and the most appropriate one of these two approaches was used for a particular material (ink consumption, paper, fountain solution, presswash, etc.). This takes into account the unchanged use of conventional products on two of the six press units. Table 1-1 displays the results of the analysis.

Cylinder-Inch-Hour Method

To estimate material consumption on the Komori based on plant-wide data (employing the first approach above), UL suggested the use of a unit of product, the "cylinder-inch-hour", that it uses to estimate emissions of Volatile Organic Compounds (VOCs). This unit is based on multiplying the number of cylinders (press units or colors) on each press times its width (in inches) times the number of hours of press use over a year or other time period. This unit incorporates all of the factors (size of press and the amount it is used) that influence material use. Hence, the number of cylinder-inch-hours from each press is divided by the total cylinder-inch-hours from all presses to represent the percentage of each material used on that press. Using this method and 1995 data, it was estimated that the Komori six-color press uses 23.5% of all materials that are used at a rate that is directly proportional to the size and amount of use of the press.

Presswash Use

Using the cylinder-inch-hour method, average monthly presswash use for the six-color Komori press was estimated for the "before" period. See Table 1-1. In late November 1995, UL eliminated use of conventional presswash on the four press units used for Printwise™ inks; the two used for PMS colors continued to use conventional presswash. Accordingly, to estimate conventional presswash use for the "after" period the cylinder-inch hour method and percentage of plant-wide conventional presswash purchase figures were used. The evaluation indicated that use of conventional presswash declined significantly, from 98 gallons to 36 gallons per month on the Komori press. Use of Printwise™ presswash, 16 gallons per month, was based on the actual purchase quantities averaged over the time period (84 gallons in 5 months). Fountain solution use in both periods was taken as the same, since the press operator judged that it did not change.

Ink Use

The cylinder-inch-hour method was also used to estimate ink use. This method did not work as well for ink consumption, probably since the type of ink used on each press varies and is not a consistent percentage of the plant-wide total. Average monthly ink purchases estimated using this method varied widely before and after Printwise™ use. However, actual purchase amounts were available for Printwise™ ink and presswash for the period October 1995-May 1996. These inks were used only on the Komori six-color press. The press operator was able to estimate that Printwise™ process ink provided on average 5-7% more mileage than conventional inks, based on partial measurement and observation during the demonstration. He estimated that the rate of use of PMS colors remained the same before and during the demonstration. He also noted that presswash use remained unchanged because of a standard press cleaning schedule each shift, regardless of the number of impressions of the job. Ink use varies with coverage and number of impressions.

Since conventional ink used 5-7% more ink than Printwise™ ink to print the same job, the quantity of conventional process color ink used before Printwise™ was estimated as 106% of the total average monthly use of Printwise™ ink. The use of other inks (PMS, metallic, and mixing) on the other two press units were estimated as equal before and after, using plant-wide ink purchases and the cylinder-inch-hour method. Data for the period after Printwise™ use were used for consistency with demonstration dates.

Shop Towel Use

Use of shop towels was estimated based on the press operator's estimates of the number of towels used to clean the press before and during the demonstration and the number of cleaning operations. The use of shop towels rose significantly following Printwise™ use, from an average of 3,180 to 4,450 per month, reflecting the extra time and effort required for press cleaning.

Waste Ink and Presswash Disposal

Waste ink and presswash quantities shipped offsite for calendar year 1995 were available. These were used to estimate monthly "before" rates. Waste ink was estimated to decline slightly (by 4%) after use of Printwise™, based directly on the amount

of ink used. Waste presswash declined significantly, from 731 to 197 lb/month. This reduction could have been larger, however, UL elected to dispose of spent Printwise™ presswash as a hazardous waste due to concern about its inks. Consequently, all 16 gallons (131 pounds) of Printwise™ presswash was disposed as hazardous waste each month.

The cylinder-inch-hour method was used to estimate the amount of conventional presswash disposed as hazardous waste before Printwise™ (23.5% of the plant-wide average monthly volume for 1995). The amount of conventional presswash disposed as hazardous waste after Printwise™ was determined by multiplying the "before" estimates by the ratio of conventional presswash used before and after Printwise™.

1.4 Volatile Organic Compound (VOC) Generation

Volatile Organic Compounds (VOCs) generated before and after Printwise™ use were estimated by multiplying the average monthly quantity of ink and presswash by the VOC content of each ink and presswash product. Table 1-1 displays the quantities and VOC content of each presswash product. Consistent with USEPA guidance documents for calculating VOC emission from nonheat offset lithographic operations, VOC generation from ink has been adjusted to reflect the low percentage (5%) that is not absorbed by the paper and volatilized into the air.

Total VOCs generation has been considered in two ways:

- as a "byproduct" (i.e., resulting directly from the production process, whether recycled, treated on or offsite, or released as a pollutant); and
- as a pollutant emission onsite (as done for air emission calculations in state and federal air quality regulations).

Reduction of VOC Generation

Total VOCs from the Komori press is estimated to fall from 618 to 232 lb/month after Printwise™ use. Total VOC air emissions from the press, exclusive of offsite recycling of waste presswash, are estimated to decrease from 426 to 160 lb/month. This is a significant reduction from use of the Printwise™ process.

Reductions in VOCs are a result of two factors:

- Printwise™ process inks are soy-based as compared to the petroleum-based inks previously used on the Komori.
- Use of conventional presswash containing solvents has been reduced.

UL uses three conventional presswash products on the Komori and other sheetfed presses: Prisco H.O. (for blankets and back cylinders), Prisco Powerklene and Superklene (for rollers), and Prisco Powerklene (for ink fountains). The 37% reduction (from 98 to 36 gallons per month) in combined use of these products on the Komori after Printwise™ use accounted for nearly all of the VOC reductions. These estimates are derived from actual presswash purchase amounts before and after Printwise™ use. They correspond quite closely to the two-thirds reduction expected from eliminating conventional presswash use on two of six press units.

1.5 Financial Analysis

Table 1-2 presents the estimated average monthly operating costs of the Komori six-color press with and without Printwise™. The table includes only cost factors that changed following use of Printwise™. Hence, it does not reflect the total cost of operating the press, but rather changes in likely operating costs. For each item, the average monthly quantity of product used or waste disposed before and after Printwise™ (from Table 1-1) was multiplied by the unit cost. The net increase or decrease (dollars/month) associated with each item displays which cost items were most significant. The quantities used are based on the assumption that the production levels were the same with and without use of Printwise™.

The analysis indicates that use of the Printwise™ system was actually less expensive than use of conventional ink and presswash under the pricing arrangements of the demonstration project. Use of Printwise™ products totaled \$1,843 per month, a reduction of \$283 per month in the pre-Printwise™ cost of \$2,126 per month. This reduction was largely due to three factors:

- a slight decrease in ink purchase cost (due to better ink mileage);
- a significant reduction in the presswash purchase cost, due to the reduced use and cost; and

- a significant reduction in the volume and cost of disposing spent presswash.

These factors outweighed the higher cost of using more shop towels.

Table 1-2
Average Monthly Financial Analysis for United Lithograph

Product	Without Printwise™ Use ¹			With Printwise™ Use ¹			Monthly Cost Difference ²
	Monthly Use	Unit Cost	Cost	Monthly Use	Unit Cost	Cost	
Conventional Purchases							
Process Black Ink	38 lb	\$3.75/lb	\$143				
Process Color Ink	200 lb	\$4.75/lb	\$450				
Presswash	58 gal.	\$4.29/lb	\$249	29 gal.	\$4.29/gal	\$124	-\$125
Other presswash	40 gal.	\$4.38/lb	\$175	7 gal.	\$4.38/gal	\$31	-\$144
Shop Towels							
Shop Towels (number)	3,180	\$0.09/twl	\$286	4,450	\$0.09/twl	\$401	+\$115
Printwise™ Purchases							
Black Ink				36 lb	\$3.75/lb.	\$135	-\$8
Color Ink				188 lb.	\$4.75/lb.	\$893	-\$57
Presswash				16 gal.	\$2.60/lb	\$42	+\$42
Waste Disposal							
Waste Conventional Ink Disposal	167 lb.	\$0.39/lb.	\$62	160 lb.	\$0.37/lb	\$59	-\$3
Waste Presswash Disposal	80 lb.	\$0.83/lb.	\$66	40 lb.	\$0.83/lb	\$33	-\$33
Other Presswash Disposal	65 lb.	\$0.30/lb	\$195	157 lb.	\$0.30/lb	\$47	-\$148
Printwise™ Presswash Disposal				131 lb	\$0.30/lb	\$39	+\$39
Total			\$2,126			\$1,843	-\$283

¹ Material use amounts are adjusted to reflect normalized production levels before and after Printwise™.

² Savings or costs in dollars per month.

Cost Impact of Ink Mileage

For the purposes of the demonstration, Printwise™ inks were supplied at the same cost as conventional inks. Because of the estimated five to seven per cent increase in Printwise™ ink mileage, the cost of process color ink was estimated as six percent (\$65 per month) less. If no improvement in ink mileage with Printwise™ is assumed, the total related operating costs for use of the Printwise™ system would have increased to \$1,908, still less expensive than the conventional system.

Cost Impact of Increasing Presswash Cost

SICPA does not intend to maintain the product costs provided during the demonstration. It intends to offer the Printwise™ presswash to customers through a subcontractor, Quality Formulations of Minneapolis. Due to this change the Printwise™ presswash will increase in price from \$1.00 per gallon (plus freight) to \$2.15 per gallon, plus \$200 shipping for a 55-gallon drum. This will increase the effective cost of the Printwise™ presswash from \$2.60 to \$5.79 per gallon (including freight). This increase in presswash cost, (considered independently of possible cost changes due to ink mileage or sale price) would raise the monthly price of Printwise™ presswash from \$42 to \$97 and the total monthly cost after Printwise™ to \$1,898 (compared to \$2,126 per month for conventional ink and presswash).

Cost Impact of Changing Ink Price

If the Printwise™ ink price is significantly increased, the economic comparison will be even closer. The Deluxe Corporation often offered Printwise™ inks at a 20% premium over the cost of conventional inks, believing a difference that was supportable when considering the savings related to reduced presswash and ink disposal costs. For purposes of comparison, if Printwise™ ink prices are increased by 20%, the estimated total monthly Printwise™ process color ink cost of \$1,028 would increase to \$1,236. This would raise total associated monthly operating costs to \$2,106 (including the higher presswash price), or about the same as the \$2,126 cost of conventional ink and presswash.

Other Potential Savings

Several other areas of potential economic savings or increased cost include less roller and blanket wear, lower regulatory compliance costs (permits and fees), and changes in labor costs (reduced time on compliance or more effort for press cleaning). Discussions with UL staff indicated that actual changes in these areas were either hard to quantify or unlikely at this time. UL staff felt that although Printwise™ products appear to be easier on the blankets, they would probably continue to change the blankets with the same frequency. The reduced VOC emissions from one press were not sufficient to exempt UL from any state or federal air permit or Massachusetts Toxics Use Reduction Act (TURA) reporting and planning thresholds. (If the product is used on more

presses, these exemptions may be realized depending on production levels.) While more effort was required to clean the press, it did not result in an overall change in productivity.

1.6 Conclusions

The technical evaluation at UL suggested that Printwise™ products can work effectively in a demanding production environment. However, quality control and technical support are important issues. While Printwise™ products worked well for most of the demonstration, UL experienced quality control problems with its last ink batch that influenced its decision to stop use of the product.

The economic comparison is encouraging for further use of Printwise™ at UL and other high-quality sheet-fed lithographic printers. It suggests that:

- there is some margin to permit pricing above the arbitrary levels of the demonstration; and
- the benefits of reduced VOC emissions from Printwise™ can be obtained with neutral savings.

The suggested price increase for the presswash and the Printwise™ inks had a negative psychological impact on UL. Even though other costs are likely to outweigh this cost increase, UL and other printers are very sensitive to cost increases and tend to look first at raw material costs. It will be necessary for SICPA to carefully explain the full economics of use of its products to remain competitive.

Possible Future Savings

There are several areas of possible savings not realized during the demonstration.

- UL could have explored discharge of spent Printwise™ presswash to the sewer rather than disposing of it as hazardous waste. MWRA had given provisional approval for this practice. This would have saved hazardous waste disposal costs.
- If Printwise™ is considered as a means of VOC reduction (for example in a Best Available Control Technology Evaluation for air emissions), the economics may be more favorable than other control mechanisms.

- Emission reduction credits, if made available in Massachusetts on a free-market basis as is presently being discussed, could generate additional economic credits for UL and other comparable printers.

Likelihood of Future Use

The likelihood that UL will use Printwise™ in the future is unclear at this point. UL has committed in its Toxics Use Reduction Plan to converting additional presses to use of Printwise™. However, at present it is not using the product due to cost and technical concerns. The demonstration showed that the basic Printwise™ product is sound and can be cost-effective. Greater technical, environmental, and financial benefits would be realized at UL from expanded product use. However, continued efforts on the part of both UL and the supplier are required for successful use in the future.

2. Evaluation at S&A Paramount

S&A Paramount Printing is a business forms printer that was among the first users of the Printwise™ process in New England. It has a current press complement of:

- eight West & Gear web presses (three 3-color, three 2-color, and one 1-color);
- five AB Dick sheet-fed two-color duplicators (with T-heads);
- one 11" x 17" Itek duplicator with Crestline auto dampening system; and
- one Heidelberg one-color sheet-fed press.

S&A Paramount began using Printwise™ ink and presswash in November 1994 on several of its web presses. As the process worked out well, it gradually began using Printwise™ inks on all of its web presses, its duplicator presses, and the Heidelberg one-color press during 1995. In July 1996 the firm agreed to participate in the demonstration. It agreed to supply available data on its past use of Printwise™ products, and to collect additional data as needed for the demonstration.

Current Ink and Presswash Use

S&A Paramount uses a mixture of black ink and a wide range of Pantone colors on all of its presses. As its satisfaction with Printwise™ inks increased, the firm gradually began ordering a higher percentage of Printwise™ inks for all of its presses. Deluxe supplied both Pantone bases and premixed Pantone four digit colors to the firm. S&A Paramount mixed some Pantone colors on site from Printwise™ bases. However, the firm still had a considerable inventory of conventional inks (many premixed Pantone colors) which it continued to use, planning to continue until the supply was exhausted. The use of these inks required the use of conventional presswash, and thus the firm's use of Printwise™ presswash has been variable.

At the start of the demonstration (July 1996), S&A Paramount had nearly depleted its inventory of conventional colors for the web presses and the sheetfed Heidelberg. The firm now uses Printwise™ inks and presswash almost exclusively on these presses. However, on the duplicator presses, it still maintains an inventory of conventional ink and uses both Printwise™ and conventional ink interchangeably. Because Printwise™ presswash does not clean up the conventional ink, the firm generally uses conventional petroleum presswash on the duplicators.

2.1 Scope of Testing

S&A Paramount agreed to use the prepared forms to evaluate the performance of Printwise™ presswash on the duplicators when only Printwise™ ink was used on a job. Printwise™ presswash was used on the duplicators 40 to 50 times over the past year, providing enough experience for a reasonable evaluation of its performance.

The technical evaluation of printing performance began in July 1996, and covered a period of four months. On the web presses, evaluation forms were filled out on an average of once a week. S&A Paramount averaged these forms to determine a composite for each evaluation factor, and aggregated the data on waste sheets, ink coverage, and other technical data. For the duplicator and one-color Heidelberg presses, an average long-term technical evaluation form was completed.

S&A Paramount had limited records of material consumption before Printwise™, so data collected during the demonstration was combined with historical accounting data as explained below. S&A Paramount has continued to use Printwise™ ink and presswash through December 1996.

2.2 Technical Printing Performance

Composite technical performance rankings and average material consumption for use of Printwise™ ink and presswash on the web, duplicator, and one-color sheetfed Heidelberg presses are found on Figures 2 through 4 in Appendix H. The forms were modified to address production-specific activities and accounting methods used at S&A Paramount. Additional comments on ink and presswash performance are discussed below.

Performance Issues with Printwise™ Presswash and Ink

Press operators noted that cleaning blankets with Printwise™ presswash "just takes a little more elbow grease, and on long runs, takes longer to remove paper dust". For roller washups, S&A Paramount usually combines Printwise™ presswash with a small amount of conventional petroleum presswash. The press operator's memo noted that "generally, we can get away with a 3/4 washup with Printwise™ roller wash and a 1/4 washup (finish it off) with a petroleum-based solution, because Printwise™ only takes

off the bulk, and you get a filmy substance left in the rollers." On one evaluation form, the press operator said, "I like Printwise™ ink, but it does not wash up (press roller) units well or fountains."

Through its two-year history using Printwise™ on the web presses, S&A Paramount has found ways to make the product work, which has required some experimentation. In the early stages, S&A Paramount had problems keeping the non-image area clear of ink after it switched from a deeper-grain plate to a smoother Anco plate on the 14" three-color West & Gear web press. Changing fountain solutions and working with its press operators has solved this problem and helped to make the Printwise™ press cleaning operation work. The typical cleaning solution consists of Printwise™ press-wash supplemented by a small amount of conventional presswash for rollers and performs acceptably in the production environment.

Technical Performance Summary

The technical performance of Printwise™ products on each press type at S&A Paramount are provided below:

Web Presses

- Dot gain was ranked as excellent for both black and Pantone colors.
- Runability was excellent for black and good for Pantone colors.
- Set and drying characteristics was ranked as good.
- Overall ink performance were ranked as good.
- The ease of cleaning blankets was ranked as good.
- The ease of cleaning rollers was only ranked as fair.

Duplicator Presses

- Black Printwise™ inks were ranked excellent for dot gain. Pantone color Printwise™ inks were ranked good for this factor.
- All other factors for ink were ranked good.
- Ease of cleaning the press using Printwise™ presswash was ranked fair

for cleaning both blankets and rollers. Comments indicate that the Printwise™ presswash cleaned both rollers and blankets. However, color tended to stay on the main ink roller and required more washup mats when cleaning the duplicators. About six washup mats were used for a Printwise™ roller cleaning as compared to three for conventional presswash.

Sheetfed One-Color Heidelberg Press

- Printwise™ ink and presswash consistently performed very well on this press.
- Dot gain was ranked excellent for black ink and good for Pantone colors.
- All other ink performance factors were ranked good.
- The ease of cleaning both blankets and rollers was ranked good.
- The squeegee system used for cleaning rollers on this press distributes the Printwise™ presswash evenly and cleans the press well.

2.3 Material Consumption

The evaluation was conducted for the eight web presses that were considered a single production unit. Better data were available for these presses than for the sheet-fed side of the operation. Table 2-1 displays the results of the analysis.

S&A Paramount supplied available data on its plant-wide monthly purchase and use of products including conventional ink and presswash, for the period before and after Printwise™ use (which began in November 1994).

Because of the accounting and material tracking methods used by S&A Paramount, monthly ink consumption for each press could not be calculated. However, the amounts of Printwise™ ink and presswash purchased over the period of use was known, as was the amount of conventional presswash purchased for use on the web presses. Total presswash purchase was available for a total of 13 months before and after Printwise™ to determine average monthly usage. August through September 1994 was considered the "before" period, while the 11-month period of January through November 1996 was used as the "after" period.

Table 2-1
Average Monthly Material Consumption and VOC Generation
Before and After Printwise™ Use, S&A Paramount (Web Presses)

Material Consumption	Before Printwise™	After Printwise™
Conventional Black & Color PMS Ink	369 lb	
Printwise™ Black & Process Color Ink		387 lb
Conventional Presswash - Autowash 6000	37 gal	4 gal
Printwise™ Presswash		13 gal
Shop Towels (number of towels)	600 twl	340 twl
VOC Byproduct & Emissions		
Conventional Presswash (6.48 lb VOC/gal)	240 lb	26 lb
Conventional Soy Ink (5% VOC wt/wt)	1 lb	
Total VOC Byproduct/Emissions	241 lb	26 lb
Productivity		
Average Impressions/month	9,960,000	10,956,000

Presswash Purchases

Conventional presswash purchases declined from 37 to 4 gallons per month after Printwise™. About 13 gallons per month of Printwise™ presswash was used. Less total presswash by volume is used (17 versus 37 gallons), perhaps because the operators were liberal in their use of a solvent that quickly evaporated. These presswash estimates are derived from actual purchase amounts before and after Printwise™ use. They correspond well to the press operator's estimate that the firm has reduced conventional presswash use to one-quarter of the previous amount on the rollers on average, and eliminated it on blankets and ink fountains.

Ink Purchases/Ink Mileage

Total Printwise™ ink purchases were averaged over the period of June 4, 1996 to August 3, 1996. A total of 774 pounds of Printwise™ ink were consumed over this two month period. To help compare the consumption of conventional and Printwise™ inks, the firm ran a controlled test of ink consumption on one web press. The press operator filled the ink fountains with five pounds of Printwise™ red 106 Pantone ink and ran until they were empty, producing 25,000 - 9.5" x 11" sheets. The ink fountains were then filled with five pounds of Kohl & Madden ink of the same color and run until empty, producing 23,500 sheets. This limited experiment indicated a 6% increase in ink

mileage with Printwise™. To determine consumption of conventional inks before Printwise™, the average monthly consumption of Printwise™ ink was multiplied by 1.06.

Shop Towel Use and Waste Disposal

Use of shop towels was compared using the data evaluation forms for use of conventional ink, Printwise™ ink, and presswash. The press operators estimated that only about half as many shop towels were used to clean the press with Printwise™ ink. With conventional ink, the shop towel became dyed by the ink color when saturated. If reused, it would not function effectively on another color. With Printwise™, the shop towels can be rinsed to remove the still soluble ink residues and reused. Before Printwise™, two shop towels were used per press unit per day. There were a total of 15 press units (three three-color, two two-color, and two one-color presses), and 20 days of production per month. This resulted in an estimate of 600 shop towels used per month before Printwise™. After Printwise™, one shop towel has been used per day per press unit. There are now a total of 17 press units (one two-color web press was added) and 20 work days per month. This results in a reduction from 600 to 340 shop towels per month "after Printwise™ even though production capacity increased.

S&A Paramount does not accumulate or ship offsite any hazardous waste (all solvents evaporate as fugitive emissions), and is now holding waste ink for subsequent disposal, so these factors did not enter the analysis.

As shown in Table 2-1, overall material consumption declined following use of Printwise™. This is even more striking since average monthly productivity (impressions per month) rose from 9.96 million to 10.956 million impressions per month.

2.4 Volatile Organic Compound (VOC) Generation

VOC generation (emissions) from the web presses before and after Printwise™ use were calculated by multiplying the monthly average amount of ink and presswash used from Table 2-1 by the VOC content of each source (pounds per gallon for presswash and percentage for inks). Consistent with USEPA guidance, ink VOC generation has been adjusted to reflect the low percentage (0.05) that is not absorbed by the paper. Table 2-1

shows the values used in the calculations. Total VOCs from the web presses is estimated to fall from 241 to 26 lb/month (about 90%) after Printwise™ use. This is a significant reduction from use of the Printwise™ process.

2.5 Financial Analysis

Table 2-2 presents the average monthly operating cost of the web presses as a single production unit. The table includes only cost factors that changed following use of Printwise™. Usage amounts have been adjusted to reflect the production level (determined from monthly impressions).

Table 2-2
Average Monthly Financial Analysis for S&A Paramount

Product	Without Printwise™ Use			With Printwise™ Use			Monthly Cost Difference
	Monthly Use	Unit Cost	Cost	Monthly Use	Unit Cost	Cost	
Conventional Black & PMS Color Ink	410 lb	\$5.63/lb	\$2,308				-\$2,308
Printwise™ Black & PMS Color Ink	0			387 lb	\$5.63/lb	\$2,179	+\$2,179
Conventional Presswash - Prisco Autowash 6000	37 gal	\$4.63/gal	\$171	4 gal	\$4.63/gal	\$19	-\$152
Printwise™ Presswash				13 gal	\$1.00/gal	\$13	-\$13
Shop Towels (number)	600	\$0.10/twl	\$68	340	\$0.10/twl	\$34	-\$34
Total			\$2,547			\$2,245	-\$302

Note: Material use amounts are adjusted to reflect normalized production levels before and after Printwise™.

The analysis indicates that use of the Printwise™ system was less expensive than use of conventional ink and presswash under the pricing arrangements in effect during the demonstration project. Use of Printwise™ products totaled \$2,245 per month, as compared to the cost of \$2,126 per month without Printwise™. This reduction was largely due to three factors:

- a slight decrease in ink purchase cost (due to better ink mileage);
- a significant reduction in the amount and cost of presswash; and
- a 50% reduction in the cost of shop towels (fewer towels are needed for the same job).

There was no cost difference for Printwise™ inks during the demonstration compared to pre-demonstration purchases by S&A Paramount. Because Printwise™ products were used before the demonstration, conventional ink costs and usage were not available and had to be estimated. S&A Paramount indicated that the prices were comparable for both conventional and Printwise™ inks. Printwise™ ink mileage at S&A Paramount increased by six per cent over conventional inks (based on a controlled test). The overall monthly cost of the Printwise™ inks was calculated to be lower (\$129) because six per cent less ink was used. However, even if no improvement in ink mileage is assumed, the total related operating costs for use of the Printwise™ system were lower than for conventional products.

Cost increases are likely at S&A Paramount for the Printwise™ presswash, but not the ink, according to SICPA. The new price of the presswash will increase to \$5.79 per gallon (including freight), more than a doubling of the previous total \$2.60 cost per gallon (also including freight). This increase would raise the monthly price of Printwise™ presswash from \$13 to \$75, and the total monthly cost after Printwise™ to \$2,243. This total is still less than the \$2,543 monthly cost of conventional ink and presswash.

Discussions with S&A Paramount staff indicated that other possible areas of savings or increased costs either could not be quantified or appear unlikely at this time. The staff felt that although Printwise™ products appear to be easier on the blankets, they would probably continue to change them with the same frequency. While more effort was required to clean the press, it did not result in an overall change in productivity.

2.6 Conclusions

Overall, S&A Paramount believes that the Printwise™ inks and presswash have worked well. Ink performance rankings were good or excellent on all press types. Rankings for press cleaning were generally lower, but at least fair for all press types.

Printwise™ Experience

S&A Paramount has, over a two-year period, learned to make Printwise™ products work effectively. It has been able to use Printwise™ presswash effectively on web presses, although it still uses some conventional presswash to help clean ink rollers. This experience is typical for a business forms printer. What is unusual is its success in

using Printwise™ ink and presswash with duplicator presses, even with the slower cleanup. Neither Deluxe nor SICPA has promoted use of Printwise™ for these smaller sheet-fed presses, due to concerns that they would require rubber-based ink formulations that would be hard to clean with a water-based presswash. The success of S&A Paramount shows that the Printwise™ process can work well for duplicator presses under certain conditions.

VOC Reductions

The analysis indicates that Printwise™ products resulted in significant VOC emissions reductions (90%) and when the current inventory of conventional inks is depleted, these reductions will be even higher. There were strong indications that Printwise™ ink resulted in better ink mileage for one type of ink. This 6% improvement in ink mileage was used in the financial analysis because it was the only data available. To confirm this initial finding, tests for more ink types and more controlled tests would be desirable, perhaps in a laboratory setting. The press operators also found a way to use less shop towels than with conventional ink (by washing the towels), and reported less use of Printwise™ presswash than with conventional. The use of Printwise™ products actually was less expensive than conventional inks and presswash.

Corporate Commitment

Overall, the record of S&A Paramount indicates the improvements that a dedicated printer can make with this product. In order to make Printwise™ products work consistently in a demanding production environment, some adjustments and compromises (such as the continued use of conventional presswash in small quantities to clean ink rollers) are likely. They show that with commitment and investment of energy, very positive results are possible for Printwise™ products.

3. Evaluation at Standard Register

Standard Register is a large financial and check printer. Like S&A Paramount, it was one of the first users of the Printwise™ products in New England. It began using Printwise™ products in August 1995, around the same time as the initiation of the demonstration project. The firm has specialized production characteristics and presses due to its heavy emphasis on check printing. Most of the ink it uses is magnetic ink. It is used to print the variable imprints (numbers) on checks and other financial forms. The average press run is small. It fills 15-2,100 different orders per day.

Current Use of Printwise™ Products

Standard Register has a wide variety of presses - 29 presses in total. The use of Printwise™ inks and presswash on each depends on the press and production run. Table 3-1 summarizes the use of Printwise™ by press. Printwise™ ink and/or presswash are used on the following presses:

- five Superweb web presses;
- eight of nine Heidelberg one-color sheetfed presses (one 18.5", one 25"; rare use on six Heidelberg 20.5" GTOs);
- three "Innovative/Nail" raised imprint presses;
- one Whittaker JT7 envelope press; and
- one Holm JT8T "Jet Crash Imprint" raised imprint envelope press.

Printwise™ inks are used for black and Pantone colors, often to print the bank and customer name on a check or form. Pantones are mixed onsite from Printwise™ Pantone bases supplied by Deluxe and SICPA; some standard Pantone colors such as Reflex Blue are used directly as supplied. Conventional soy and petroleum magnetic inks are used in numbering heads or other press units to print the variable imprint.

In an effort to reduce VOC emissions, Standard Register converted to Printwise™ products in place of its conventional presswash, Posco A-6 Press Wash in August 1995. The Posco product is approximately 100% VOC. However, in February 1996 Standard Register began using a low VOC presswash, Tower Lo-Vo (~50% VOC), in place of some of its conventional presswash. This reduced the need to use more Printwise™ presswash as a near-zero VOC alternative. The current use of Printwise™ presswash varies with the press type and the preferences of the press operators. For example, on the web presses, the operators use Printwise™ presswash for cleaning all parts of the press ex-

cept the blankets, on which they use Tower Lo-Vo. The press operators have the perception that Printwise™ presswash does not clean blankets as effectively.

Table 3-1
Current Press Inventory and Printwise™ Product Use at Standard Register

Press Type & Size	Printwise™ Ink Use	Printwise™ Presswash Use
5 - Superweb presses - 3, 3-color with numbering unit, 1 2-color with numbering unit, 1 1-color with numbering unit	Yes - Regular use of Printwise™ Black & Pantone Colors (mixed on site); with conventional magnetic ink	Ink fountains; conventional presswash for blankets
6 - GTO Heidelberg sheet-fed 20.5" one-color presses	Yes - but rare	Yes - but rare
3 - Heidelberg one color sheet-fed presses 1- 18.5", 1 - 25", 1 - 20"	Yes - Pantone colors on 18.5" & 25"; no on 20"	Yes - frequency unknown
1 - JT8Tx sheet-fed 11" envelope press - Jet Crash Imprint	Yes - mostly Pantone	Yes - but rare (mostly Tower LoVo)
1 - Whittaker JT7 13"X 20" sheet-fed offset envelope press	Yes - Some Printwise™ Use for Pantone & Black	Yes - Occasionally use Printwise™ presswash
3 - Innovative raised variable imprint presses and 2 with Nail encoders	Yes - Printwise™ for Innovative Section of press (individual names)	Yes - Printwise™ presswash used exclusively on Innovative Unit
1 - 17" envelope Jet Press - 2 - color sheet-fed duplicator	No (use rubber base ink)	No
2 - Multi 1650's pin feed lithographic presses	No (use ultraviolet ink)	No
5 - Itek sheet-fed duplicators	No	No
2 - Heath turret 22" check presses"	No	No

3.1 Scope of Testing

Standard Register agreed to participate in the demonstration project in July 1996. It supplied available data on plant-wide material consumption. The technical evaluation of printing performance began in July 1996 and covered a period of four months. However, due to the small size of an average job, a dramatic increase in the productivity of the firm during that time period, and management directives to maximize productivity as much as possible, it was not possible for press operators to take the time to regularly complete the technical data evaluation on a daily basis as originally planned.

Consequently, a different evaluation procedure was developed in cooperation with the pressroom supervisor at Standard Register. Evaluation forms were distributed to the operators of the web and raised imprint presses for completion as time permitted. An average technical ranking for these two press types was developed based on interpretation of the forms and discussions with the pressroom supervisor of Standard Register.

This procedure was considered reasonable because the interpretation of long-term experience with the Printwise™ products provided as much or more insight as completion of daily forms.

3.2 Technical Printing Performance

Standard Register varied the evaluation criteria to fit its press types, eliminating the criterion of dot gain and adding "color matching". Figures 5 and 6 in Appendix H summarize the technical performance rankings and average consumption of Printwise™ products on the web and raised imprint presses, respectively. Additional comments on performance supplied by the press operators and by the pressroom supervisor are also summarized on the figures and discussed below.

Web Presses

- Color matching was ranked good for both black and Pantone colors.
- Runability, set and drying characteristics, and overall ink performance were ranked good overall.
- Ease of cleaning blankets and press units (rollers) with Printwise™ presswash were both ranked good on the few forms completed by the press operator. However, the average ease of cleaning blankets has been ranked as fair, based on the long-term perception of the press operators that Printwise™ presswash did not clean blankets as effectively. They continued to use conventional presswash for the blankets. A longer test of cleaning the blankets might have improved this ranking.

Raised Imprint Presses

- Color matching (for both black and Pantone colors), runability, set and drying characteristics, and overall ink performance were ranked good.
- Ease of blanket washing was ranked good.
- Ease of roller washing was ranked excellent for the Jet Crash Imprint press and good for the Innovative/Nail presses on the forms completed by the press operators; these ranks were used as the long-term average.

Printwise™ inks generally are perceived to work well at Standard Register on presses where they are technically appropriate. Standard Register currently uses a combination

of Printwise™ presswash, conventional presswash, and low VOC presswash, depending on the press and the preferences of the press operator. This approach fits the production needs of the company.

3.3 Material Consumption and Emissions

The evaluation was conducted for the Standard Register facility as a whole rather than for an individual press or group of presses because:

- a large number of presses use some Printwise™ products;
- better data on material consumption were available on a plant-wide basis; and
- it was not possible to determine production levels or material use for individual presses.

Table 3-2
Average Monthly Material Consumption Before and After
Printwise™ Use at Standard Register (Plant-Wide)

Material Consumption	Before Printwise™	After Printwise™
Conventional Ink	270 lb	369 lb
Printwise™ Ink		103 lb
Conventional Blanket Wash	73 gal	38 gal
Low VOC Presswash		15 gal
Printwise™ Presswash		9 gal
Metering Roller Cleaner (MRC)	5 gal	5 gal
Shop Towels (number)	7,129 twl	7,378 twl
Waste Generation		
Waste Ink		
Waste Presswash	466 lb	400-478 lb
VOC Byproduct & Emissions		
MRC (2.76 lb/gal)	14 lb	14 lb
Conventional Presswash (6.7 lb/gal)	489 lb	255 lb
Low VOC Presswash (3.5 lb. gal)		53 lb
Total VOC Byproduct/Emissions	503 lb	322 lb
Productivity		
Average Impressions/month	10,684,000	12,889,000

Table 3-2 displays the results of the analysis. Standard Register supplied available plant-wide data on plant-wide monthly purchases and use of products (including conventional products, low-VOC presswash, Printwise™ products, shop towels, and waste disposal) for the period before and after Printwise™. The data began in January 1995 and continued through June 1996. (Printwise™ use started in August 1995.)

It was possible, on a plant-wide basis, to determine average monthly purchases of conventional and Printwise™ products, shop towels, and waste disposal before and after Printwise™. The seven months from January 1995 through July 1995 were used as the "before" period, while the 11 months from August 1995 through June 1996 were used as the "after" period. To evaluate changes in VOC generation, separate calculations of presswash use and VOC generation were also made for the periods of August 1995 through January 1996 (prior to use of low-VOC presswash) and February 1996 through June 1996, when conventional, low-VOC, and Printwise™ presswashes were all in use.

Productivity

Standard Register also supplied productivity data as impressions per month over the same time period. Average monthly productivity rose from 10.684 million impressions per month before Printwise™ to 12.899 million impressions per month after Printwise™. At the beginning of 1996, the firm started doing significantly more double-sided jobs, added several web presses, and heavily emphasized production increases.

Ink and Presswash Consumption

Total ink consumption increased from 168 to 302 lb/month after Printwise™ use. This probably reflects several factors including more double-sided jobs, higher overall productivity, and more conventional ink held in inventory because of the switch to Printwise™ ink. Purchases of conventional high-VOC presswash declined from 73 to 38 gallons per month after Printwise™. Use of metering roller cleaner (MRC) remained constant at 5 gallons per month. Use of low-VOC presswash averaged 15 gallons per month during the period after Printwise™. About 9 gallons per month of Printwise™ presswash was used during this period.

Shop Towel Use

The use of shop towels increased from 7,129 towels per month before the use of Printwise™ to 7,378 after conversion. Though the absolute number increased, when the increase in production is accounted for, this is actually a reduction in the number of towels used per 10,000 impressions.

Hazardous Waste Disposal

Standard Register shipped 466 pounds of waste presswash offsite as a hazardous waste before Printwise™ use. The average monthly quantity of hazardous waste shipped offsite after Printwise™ was 478 pounds, a slight increase that is due to productivity increases. When the quantity of hazardous waste shipped offsite is adjusted to reflect the 21% productivity increase, the adjusted quantity sent offsite would have been reduced to 400 lb/month after Printwise™.

3.4 Volatile Organic Compound (VOC) Generation

Plant-wide VOC generation before and after Printwise™ was calculated by multiplying the monthly average quantity of each type of presswash by the VOC content of each product. Ink VOC generation was not considered due to the low emission factor of 0.05% for non-heatset offset lithography. Table 3-3 details the values used in the calculations. Total VOCs during the entire 11-month period of Printwise™ use decreased to 322 from 503 lb/month. This is a significant reduction. However, it also reflects use of both the Printwise™ products and the low VOC presswash.

Impact of Use of Low-VOC Presswash

To further evaluate changes in VOC emissions, the six-month period of August 1995 through January 1996 was separately considered to determine the impacts of using Printwise™ and the conventional presswash. Total VOC generation in this period was 400 lb/month. The five-month period of February 1996 through June 1996 was separately considered to evaluate the combined use of Printwise™, high-VOC presswash, and low-VOC presswash. In this period the total VOC emissions were reduced to 226 lb/month. These estimates are presented in Table 3-3. Standard Register achieved its highest level of VOC reduction by use both low VOC and Printwise™ presswash.

Table 3-3
VOC Byproduct/Emissions at Standard Register on a Monthly Basis

Presswash	With Printwise™ Use and Conventional Presswash (8/95-1/96)				With Printwise™ & Low VOC Presswash Use (2/96-6/96)		
	lb VOC /Gal	Total Use in Period (gal)	Average Monthly Use (gal)	lb VOC/month	Total Use in Period (gal)	Average Monthly Use (gal)	lb VOC/month
Posco A-6	6.7	330	55	369	55	11	74
Prisco MRC	2.76	24	4	11	36	7.2	20
Nat'l Offset	6.7	18	3	20	12	2.4	16
Printwise™	0	50	8		50	10	
Tower Lo-Vo	3.5				165	33	116
Total		372	62	400	236	47	226

3.5 Financial Analysis

Table 3-4 presents the average monthly operating costs for the Standard Register facility as a whole. The analysis compares adjusted usage rates for ink, presswash, and shop towels before and after Printwise™, when Standard Register was using only conventional presswash and Printwise™ products. This method avoids confusing the analysis with the effects of use of low-VOC presswash which began in February 1996.

Table 3-4
Average Monthly Financial Analysis for Standard Register

Product	With Printwise™ Use and Conventional Presswash (8/95-1/96)			With Printwise™ & Low VOC Presswash Use (2/96-6/96)			Monthly Cost Difference
	Monthly Use	Unit Cost	Cost	Monthly Use	Unit Cost	Cost	
Printwise™ Presswash		\$1.00/gal		8 gal	\$1.00/gal	\$8.00	+\$8.00
Conventional Presswash (Posco A-6)	73 gal	\$4.20/gal	\$307	55 gal	\$4.20/gal	\$231	-\$76.00
Shop Towels	7,164	\$0.10/twl	\$716	7,164	\$0.10/twl	\$716	
Printwise™ Ink				103 lb	\$7.73/lb	\$796	+\$796
Conventional Ink	103 lb	\$6.96	\$717				-\$717
Waste Presswash	529 lb	\$0.53/lb	\$280	478 lb	\$0.53/lb	\$253	-\$27.50
Total			\$2,020			\$2,004	-\$16.00

Note: Material amounts are adjusted to reflect normalized production levels before and after Printwise™.

Ink Cost

Ink consumption has been assumed to remain constant at 103 lb/month, based on the observations of Standard Register pressroom staff. The firm indicated that Printwise™ inks cost 5-15% more on average than comparable conventional inks. The purchase cost for Printwise™ ink over the time period was an average of \$7.73 per pound. The cost of conventional ink has been estimated as 90% of this amount, or \$6.96 per pound.

Shop Towel and Hazardous Waste Cost

Shop towel use was estimated as unchanged (7,164 towels/month) based on plant-wide data supplied by Standard Register.

Four hundred and seventy eight pounds of hazardous waste was generated each month with Printwise™. This was averaged over the entire 11-month time period of Printwise™ use because the longer period provided a more accurate estimate of waste generation. The amount of hazardous waste disposal is directly proportional to the total amount of presswash used. A total of 73 gallons of presswash were used without Printwise™ and 63 gallons with Printwise™, a reduction of 11%. Therefore, the quantity of hazardous waste without Printwise™ was estimated at 529 pounds, 11% more than when Printwise™ presswash was used.

Overall Cost Comparison

Use of the Printwise™ system at Standard Register was slightly less expensive than use of conventional ink and press wash under the pricing arrangements of the demonstration project. However, the comparison was closer at Standard Register than at United Lithograph or S&A Paramount. The cost of Printwise™ products totaled \$2,004 per month, a 1% reduction from the monthly cost without Printwise™. This difference was influenced by:

- a higher purchase cost with Printwise™ ink;
- a reduction in the quantity used and the cost of purchasing Printwise™; and
- the disposal of waste presswash.

An increase in the cost of Printwise™ presswash from \$1.00 to \$5.79 per gallon would increase monthly Printwise™ presswash costs from \$8 to \$46 per month, and the total monthly cost with Printwise™ to \$2,042. This total would be slightly more than the \$2,020 cost without Printwise™.

Quantitative data were not available on any other potential savings or increased costs with Printwise™. However, Standard Register's environmental staff felt that over time the use of Printwise™ products will help them avoid higher air quality permit and compliance fees as production levels increase.

3.6 Conclusions

Standard Register is satisfied with the technical performance of Printwise™ inks. In terms of ink performance, the rankings were good or excellent on all press types. Rankings for press cleaning were lower, but at least fair for all press types. Most revealing is the fact that the firm is very comfortable continuing the use of Printwise™ products for the long term. It plans to use Printwise™ presswash on certain operations and presses in combination with low VOC presswash.

Standard Register has used Printwise™ products as part of an overall effort to reduce VOC emissions that also includes use of a low-VOC presswash. The press operators use their discretion regarding when and how to use these products. While this made it difficult to evaluate the effectiveness of Printwise™ products, it provides a very good case study of how these products are used in the real world.

Overall, the Printwise™ products appear to have been successfully integrated into the operations of Standard Register. However, the extent of their use is limited by the large amount of magnetic ink used at Standard Register. At present, SICPA does not manufacture a Printwise™ magnetic ink. If one is developed, the use of Printwise™ products could be substantially increased resulting in further reductions in VOC emissions.

Impacts of Longer Cleaning Time

Consistent with the other printers, the testing conducted at Standard Register indicated that Printwise™ presswash will clean blankets, rollers, and other press components, but not always as quickly as conventional presswash. It will also not wash up conven-

tional ink, while conventional presswash will wash up Printwise™ ink. Press operators favor Printwise™ presswash when the longer cleaning time will not affect the rate of production. However, they often reverted to conventional presswash if the Printwise™ presswash was known or perceived to take longer. Production pressures were particularly acute at Standard Register as compared to the other printers evaluated. Press operators were less willing to experiment on a long term basis than at other firms. For example, they discontinued use of Printwise™ presswash on the web blankets after a short trial period.

Reductions in VOC Generation

The analysis indicates that Printwise™ products resulted in significant reduction of VOC emissions during Printwise™ use. When used along with low-VOC presswash, even larger reductions were achieved. VOC generation declined from 503 to 400 lb per month with Printwise™ alone, and to a low of 226 lb/month with Printwise™ combined with low VOC presswash. The latter results were also achieved at a period of sharply increasing productivity.

The progressive improvement in reductions in VOC generation over time suggests that Standard Register has learned to effectively implement a pragmatic approach to VOC reduction that includes both Printwise™ products and low-VOC presswash where each is appropriate. (While not reflected in the calculations, Standard Register's pressroom supervisor and environmental manager report that the firm has recently eliminated the use of metering roller cleaner (MRC) - another environmental benefit.)

Financial Impacts of Use of Printwise™ Products

The use of Printwise™ products was slightly less expensive than conventional products. It appears unlikely that an increase in use of the Printwise™ presswash would influence Standard Register's continued use of the product.

4. Evaluation at Massachusetts Division of Operational Services, Central Reprographics

The Massachusetts Division of Operational Services Central Reprographics unit (Central Repro) is an in-house print shop that does general printing for state agencies. It is located in the John W. McCormack State Office Building at One Ashburton Place in Boston. The Central Repro unit has:

- a single Diddie 11" x 17" Superweb web press;
- a large production copier; and
- five AB Dick duplicators.

Central Repro performs a wide variety of different types of printing, including production of single and multicolor brochures, business cards, reports, and forms. Before the demonstration, Central Repro used conventional web and sheet-fed duplicator inks. On the two-color web press, the most commonly-used ink was soy-based black ink. Reflex Blue (the state color) is also frequently used on the web; other premixed Pantone colors are used less often. Conventional presswash (Multigraphics Blankrola, 8.09 pounds VOC per gallon) and low-VOC presswash (Varn Ecoloclean QD, 3.4 pounds VOC per gallon) were used on the web and duplicator presses.

4.1 Scope of Testing

As part of an effort to encourage pollution prevention and purchase of environmentally-friendly products by state agencies, the Coordinator of the Operational Services Division (OSD) identified the facility as a possible candidate for the demonstration project. The production managers of Central Repro agreed to participate in the project in July 1996. The web press, the most heavily-used press, was selected for the demonstration.

Use of Printwise™ Products

The first test of Printwise™ products occurred on August 15, 1996, and proved successful. Over the next three months, Central Repro continued to use Printwise™ products on an intermittent basis. When an order of Printwise™ ink was received (10 to 20 pounds at a time) it was used until fully consumed. Through mid-November 1996, Printwise™ products were used for a total of six weeks on the web press by a

single press operator. Printwise™ presswash was primarily used on the press, supplemented by a small amount of conventional and low-VOC presswash.

Evaluation Procedure

Central Repro supplied data on plant-wide material consumption. The technical evaluation of printing performance covered the six weeks of use between mid-August and mid-November 1996. It was not possible for the press operator to take the time to complete the data collection form on a daily basis as originally planned. The six weeks of use gave the operator significant experience with the product. In an exit interview at the end of the demonstration, the press operator filled out an average evaluation form considered to be a reasonable reflection of product performance.

4.2 Technical Printing Performance

Central Repro's press operator and production supervisor considered the standard evaluation criteria used at other facilities to be reasonable for their web press. Figure 7 in Appendix H summarizes the technical performance rankings for use of Printwise™ products on this press only. Additional comments on performance by the press operator are discussed below.

Ink Performance

The press operator and production supervisor were quite pleased with the overall performance of the Printwise™ system.

- Dot gain was ranked good for both black and Pantone colors.
- Set characteristics were ranked excellent. The press operator felt that the Printwise™ inks were superior to conventional soy-based inks for this criterion; they appear to absorb onto the paper more readily.
- Runability, drying characteristics, and overall ink performance were ranked good.
- Ink mileage seemed to be about the same as with conventional ink.
- The ease of cleaning blankets and press units (rollers) with Printwise™ presswash were both ranked good.

Press Cleaning with Printwise™ Presswash

The press operator commented that the Printwise™ presswash rejuvenated the rollers, removing a persistent coating so that he could see that their original green color. Used alone, the Printwise™ presswash took somewhat longer to complete the entire washup (about 15 minutes) and it was perceived that the extra time would adversely affect production if the product was used on a long-term basis.

During the Deluxe and SICPA transition, the press operator continued to use conventional inks on an intermittent basis, but developed a modified press cleaning method to reduce cleanup time. Printwise™ presswash was combined with a small quantity of conventional presswash for press cleaning. If necessary, a low VOC presswash was also used to remove any residual ink or film left behind by the Printwise™ and conventional presswashes.

The press operator noted that Printwise™ ink tended to stick to the metering roller more than conventional ink, a minor problem in cleanup. However, when the same ink was used on multiple jobs, as occurred frequently, the Printwise™ ink could be left in the press longer without drying out, reducing press cleaning efforts. With Printwise™ ink, press cleaning occurred once per week as compared to two or more times with conventional ink. This resulted in less time devoted to cleaning and use of presswash overall, and was perceived to be a significant advantage of the Printwise™ system.

4.3 Material Consumption and Emissions

The evaluation was conducted for the web press only. Table 4-1 displays the results of the analysis.

The Central Repro staff supplied available purchasing records for products on a plant-wide basis, for the period before and after Printwise™ use starting in August 1996. The data were available for state fiscal year (FY) 1996 (July 1, 1995, to June 30, 1996) and for part of FY 1997 beginning July 1, 1996.

Data from FY96 was used to determine conventional product use prior to use of Printwise™ products. Material consumption after Printwise™ was determined using

data from mid-August 15, 1995 through November 30, 1996. About 300,000 impressions per month were determined to be made on the web press, a production rate that remained about the same before and after Printwise™.

Table 4-1
Average Monthly Material Consumption Before and After
Printwise™ Use at Central Reprographics

Material Consumption	Before Printwise™ Use	After Printwise™ Use
Black & Color PMS Ink	57 lb	
Printwise™ Black & Color PMS Ink		57 lb
Conventional Presswash	4.2 gal	0.4 gal
Printwise™ Presswash		2 gal
VOC Byproduct/Emissions		
Blankrola Presswash (8.09 lb/gal)	17 lb	1.7 lb
Varn Ecoloclean Presswash (3.4 lb/gal)	7 lb	0.7 lb
Total VOC Emissions	24 lb	2.4 lb
Productivity		
Average Impressions/month	300,000	300,000

Ink Consumption

Certain inks were known to be used only on the web press. Web ink consumption in FY 1996 totaled 650 pounds of black ink and 27.5 pounds of Reflex Blue, resulting in an average monthly ink consumption of 55 pounds of black and 2.3 pounds of Reflex Blue before Printwise™. Since the press operator indicated that ink mileage did not change with Printwise™ over a long period, this rate of ink consumption was also used after Printwise™. It corresponded reasonably well to the quantity of Printwise™ ink (about 54 pounds) supplied and used by Central Repro during the demonstration. (Printwise™ was not the only ink used during this period.)

Presswash Consumption

The press operator determined that about three gallons of Printwise™ presswash was consumed over the six-week period, an average of two gallons per month. The consumption of conventional and low-VOC presswash was not measured. However, he indicated that on average he used about 40% less Printwise™ presswash than conventional presswash to do the same cleaning job.

The Blankrola and Ecoloclean presswashes are used on the web and duplicator presses. The production supervisor estimated that before Printwise™ about 75% of these presswashes were used on the duplicator presses and only 25% on the web press. After using Printwise™ products, the quantity of conventional and low VOC presswash used on the web press was reduced dramatically (approximately 90%). Plant-wide data was used to estimate the amount of conventional and low-VOC presswash used before and after use of Printwise™. It was estimated that total use of Blankrola and Ecoloclean was 2 gal/month for each before Printwise™, and 0.2 gal/month after Printwise™.

Data were not available on shop towel use and hazardous waste disposal.

4.4 Volatile Organic Compound (VOC) Generation

VOC emissions before and after Printwise™ use from the web press was calculated by multiplying the monthly average quantity of presswash by the VOC content of each source (pounds per gallon). VOC emissions from the inks were not estimated because they represented a very small fraction of the total VOCs emitted compared to the presswash. Table 4-1 presents values used in the calculations.

Total VOC generation significantly decreased from 24 to 2.4 lb/month with Printwise™ use.

4.5 Financial Analysis

Table 4-2 estimates the average monthly operating costs for the web press at the Central Repro facility.

Ink consumption was assumed to remain constant at 57 lb/month. Printwise™ inks were supplied at no cost during the demonstration. GEC assumed that Printwise™ ink cost the same as conventional ink, to be consistent with the financial analysis for the other printers. As a result, the switch to Printwise™ ink was estimated to have no financial effect. All cost differences in this demonstration were due to changes in the amount used and price of presswash.

The Printwise™ presswash was assumed to cost \$1 per gallon (with no shipping charge), the standard price offered to other printers during the demonstration. Central

Repro used proportionally less Printwise™ presswash than conventional and low VOC presswash, and Printwise™ presswash was less expensive. (Blankrola presswash costs \$5.21 per gallon, and Ecoloclean costs \$10.60 per gallon.) Consequently, use of Printwise™ presswash at \$1.00 per gallon would result in savings of \$28 per month.

Table 4-2
Average Monthly Financial Analysis for Central Reprographics

Product	Without Printwise™ Use			With Printwise™ Use			Monthly Cost Difference
	Monthly Use	Unit Cost	Cost	Monthly Use	Unit Cost	Cost	
Conventional Purchases							
Black Ink	55 lb	\$4.20/lb	\$231				-\$231
Color Ink	2 lb	\$8.60/lb	\$20	0	\$8.60/lb	0	-\$20
Press-wash (Blankrola)	2.1 gal	\$5.21/gal	\$11	0.2 gal	\$5.21/gal	\$1	-\$11
Presswash (Ecoloclean)	2.1 gal	\$10.60/gal	\$22	0.2 gal	10.60/gal	\$2	-\$20
Printwise™ Purchases							
Black Ink				55 lb	\$4.20/lb	\$231	+\$231
Color Ink				2.3 lb	\$8.60/lb	\$20	+\$20
Presswash				2 gal	\$1.00/gal	\$2	+\$2
Total			\$284			\$256	-\$28

Note: Material use amounts are adjusted to reflect normalize production levels before and after Printwise™.

Consistent with other printers, use of the Printwise™ system at Central Repro was less expensive than use of conventional ink and press wash under the assumed pricing arrangements of the demonstration project. Use of Printwise™ products totaled \$256 per month, a reduction of \$28 per month in the cost of \$284 per month without Printwise™.

As previously indicated, SICPA does not intend to maintain product costs provided during the demonstration. GEC was informed that the Printwise™ presswash will increase in price from \$1.00 per gallon to approximately \$5.79 per gallon (including freight). Prices for Printwise™ ink after the demonstration are not presently known. For purposes of illustration, an increase in the cost of Printwise™ presswash from \$1.00 to \$5.79 per gallon would increase monthly Printwise™ presswash costs from \$2 to \$12 per month and total monthly cost after Printwise™ to \$266 per month, still less than the total without Printwise™. If this presswash price increase were to be combined with an increase in the average cost of Printwise™ ink of 5% above current ink prices,

this would raise the total monthly cost with Printwise™ would increase to \$279. This total would be marginally less than the \$284 per month cost without Printwise™.

Quantitative data were not available on any other potential savings or increased costs with Printwise™.

4.6 Conclusions

Central Repro has been pleased with the overall performance of Printwise™ products. In terms of ink performance, the rankings were good or excellent. Rankings for press cleaning were also good. Central Repro's production manager has indicated his strong interest in purchasing the Printwise™ products on a regular basis and dedicating the web press to their use. The press operator has indicated that he would be willing to use Printwise™ presswash exclusively on the web press, if Printwise™ products are consistently available. Central Repro discontinued Printwise™ product use after this demonstration.

Reduction in VOC Generation and Presswash Use

The analysis indicates that Printwise™ products resulted in significant reductions of VOC emissions while also reducing the volume of presswash used. Total VOC generation is estimated to decrease from 24 to 2.4 lb/month after Printwise™ use. This reduction occurs because of the Printwise™ presswash and the need to clean the press less frequently. It is particularly important from an environmental perspective since the conventional Blankrola presswash has a particularly high VOC content, and contains a listed toxic ingredient (perchloroethylene). The significant reduction in Blankrola use in a heavily-used government office building is a real environmental benefit.

Potential Effect of Price Increases

The use of Printwise™ products was less expensive than use of conventional products under the assumed pricing arrangements of the demonstration. SICPA has not yet indicated its plans for pricing the ink, but an increase in Printwise™ presswash cost is likely. There is some flexibility to permit price increases in the products. However, the

impact of any future price increases on the willingness of Central Repro to use the product is unclear.

Overall Effectiveness

Overall, the Printwise™ products have worked effectively at Central Repro because of the relatively straightforward nature of the printing performed on the web press.

Factors that influenced the successful demonstration:

- only black ink and standard Pantone colors was used;
- no complex color matching was used; and
- there was little need for technical support.

This experience suggests that general and business form printing on web presses at state facilities is a good application for Printwise™ products.

5. Evaluation at Old Colony Correctional Center Print Shop

The Old Colony Correctional Center (Old Colony), a major state prison located in Bridgewater, Massachusetts, houses an in-house Print Shop. This facility is operated by the Department of Correction Industries of the Massachusetts Department of Correction. It does job shop printing for state agencies, including single and multipart forms, reports, and brochures. Inmates trained as operators run the presses and do other production tasks under the supervision of a professional shop manager. Old Colony has:

- a Diddie 17.5" x 22" Model 860 four-color web press with Quadflo integrated dampening system;
- several duplicator presses; and
- one Heidelberg Kord 62, 24 inch, one-color sheetfed press.

Most of the production printing is done on the web and duplicator presses.

5.1 Scope of Testing

As with the Central Repro facility in Boston, the Coordinator of the Operational Services Division (OSD) first identified the facility as a possible candidate for the demonstration project. The production managers of Old Colony agreed to participate in the project in November 1995, and the demonstration was initiated in July 1996 after the sale of Printwise™ to SICPA was complete. The Heidelberg press, the least heavily-used press, was selected for the demonstration. The production managers also agreed to test the Printwise™ products on the web press.

Before the demonstration, Old Colony used conventional web and sheetfed inks. On the Heidelberg press, the most commonly-used ink was soy-based black ink. Reflex Blue and other premixed Pantone colors are used less often. Several types of conventional presswash, of which the most commonly used is Varn-120, were used interchangeably on all of the presses.

The demonstration of Printwise™ products on the Heidelberg press occurred in early July, 1996 and proved successful. During the next four months, Old Colony had black and blue Printwise™ products available for this press.

The Heidelberg press is used intermittently according to production needs. The press may be idle for a month or be required for runs over 200,000 impressions. The pressroom shop manager planned to use Printwise™ products on this press whenever he had jobs that were appropriate in terms of the ink color and delivery schedule. However, relatively few such jobs were received during the period of the demonstration. Printwise™ products were used for one long production run of 52,000 impressions extending over three to four days. Printwise™ presswash was used exclusively to clean the press whenever Printwise™ ink was used. In total, Printwise™ inks were used on six to seven days of production on the Heidelberg press. While shorter than planned, the shop manager felt that this time period was long enough to evaluate the technical performance of the Printwise™ products. The Heidelberg press was also used to a limited extent for some conventional press runs during this time period. One unsuccessful Printwise™ press run was also conducted on the web press and is described below.

Old Colony supplied data on material consumption for the Heidelberg press and the overall print shop. The technical evaluation of printing performance covered the four months of intermittent use between mid-August and mid-November 1996. The print shop manager filled out an average evaluation form during an interview at the end of the demonstration period for the Heidelberg press. The averaged evaluation form is considered to be a reasonable reflection of product performance. It was modified for Old Colony operations and material tracking methods.

5.2 Technical Printing Performance

Old Colony's print shop manager considered the standard evaluation criteria used at other facilities to be appropriate for the Heidelberg press. Figure 8 in Appendix H summarizes the technical performance rankings for use of Printwise™ products on this press. Additional comments on performance by the shop manager are discussed below.

Printing Performance of Heidelberg Press

The shop manager considered that the Printwise™ system performed acceptably.

- Dot gain, runability, and set characteristics were ranked good for the black ink.

- Drying characteristics and overall ink performance were ranked fair.
- The shop manager felt that the use of shop towels was "excessive" with Printwise™ products.
- The ease of cleaning both blankets and rollers was ranked good.

The shop manager estimated that the Printwise™ inks took longer to dry on the paper and Printwise™ presswash took longer to wash rollers. He indicated that the time required for the total washup on each job was 20-35 minutes, about 25% longer than with conventional presswash.

Test Run on Web Press

Because of the limited use of the Heidelberg press, an attempt was made to add the web press to the demonstration project. A test run on this press was performed in September 1996, using web ink supplied some months earlier by Deluxe. No technical representative from Deluxe or SICPA was present.

This test was not successful. A proper balance of Printwise™ ink and fountain solution could not be maintained, and the production run did not produce any usable impressions. Old Colony's press shop manager terminated the test and switched back to conventional products, which printed acceptably.

SICPA and Deluxe technical representatives and Old Colony's print shop manager all speculate that the problem was probably due to the Quadflo integrated four-roller auto dampening system on the web press. The Printwise™ ink, which is capable of becoming water-soluble, may have partially dissolved into the fountain solution. Deluxe's technical representative noted that Printwise™ inks had previously had similar problems with this type of dampening system. This problem does not occur with other dampening systems in which the ink and fountain solution are not in such close contact. The quality of the Printwise™ ink used may also have contributed to the problem.

No further testing of Printwise™ products on the web press occurred.

5.3 Material Consumption and Emissions

The evaluation was conducted for the Heidelberg press only. Table 5-1 displays the results of the analysis.

The shop manager supplied estimates of the amount of conventional products purchased and used on the Heidelberg press and in the entire shop, for the period before and after Printwise™ use. He also recorded the quantity of Printwise™ ink, presswash, and shop towels used during the demonstration. These estimates were used to determine quarterly product use before and after Printwise™. A quarterly, rather than monthly, basis was used because the infrequent use of the Heidelberg press meant that monthly product usage was too small to accurately quantify. To simplify the comparison with Printwise™ products, the limited use of the Heidelberg for print jobs with conventional products during the time period of the demonstration has not been considered in the analysis.

Table 5-1
Average Monthly Material Consumption Before and After
Printwise™ at Old Colony Correctional Center Print Shop

Material Consumption	Before Printwise™ Use	After Printwise™ Use
Black & Color PMS Ink	12.5 lb	
Printwise™ Black & Color PMS Ink		11.9 lb
Conventional Presswash (primarily Varn - 120)	1.2 gal	
Printwise™ Presswash		2 gal
Shop Towels (number of towels)	45 twl	81 twl
Conventional Presswash disposal	0.6 gal	
VOC Byproduct & Emissions		
Conventional (primarily Varn - 120) Presswash (6.8 lb/gal)	8.2 lb	
Total VOC Byproduct/Emissions	8.2 lb	0 lb
Productivity		
Average Impressions/Quarter	250,000	250,000

Products Consumption

The shop manager estimated that about 50 pounds of conventional soy-based ink were used on the Heidelberg press per year, or 12.5 pounds per quarter. About 200 gallons of conventional presswash were used in the facility each year, of which about 75% was

Varn-120 (6.8 pounds VOC per gallon). The shop manager indicated that conventional presswash was used interchangeably on all presses, at a rate that was proportional to the frequency and length of production runs for each press. About one million impressions per year (1-3% of total production in the facility) are made on the Heidelberg. Estimated by this method, about 0.5 to 1.5 gallons of conventional presswash is used quarterly on the Heidelberg. The shop manager also estimated that a press run in the 200,000 impression range on the Heidelberg could use 0.5 to 0.75 gallons of conventional presswash, or about one gallon per quarter. By using these data, it was conservatively estimated that the amount of conventional presswash (Varn 120) used on the Heidelberg was 1.2 gallons per quarter.

The shop manager estimated that the production rate remained constant before and after Printwise™, and that Printwise™ inks would provide on average about 5% better mileage than conventional ink. Consequently, use of Printwise™ ink on a quarterly basis was represented as 11.9 lb/month, 95% of the 12.5 lb/month used of conventional ink. Approximately one gallon of Printwise™ presswash was used to produce 150,000 impressions. Assuming 250,000 impressions per quarter, it was estimated that one gallon of Printwise™ presswash were used per quarter.

Shop Towel Consumption

The production manager noted that use of shop towels was higher with Printwise™ products. For a press run of 50,000 impressions, 8-10 shop towels were used with conventional products, as compared to 15-18 shop towels with Printwise™. This resulted in an estimate of 45 shop towels per quarter before and 81 after Printwise™.

Hazardous Waste Disposal

The print shop discarded about 110 gallons of used presswash as hazardous waste in 1996. Cleaning the Heidelberg press represents approximately 2% of this total. It was estimated that 0.6 gallons were disposed as hazardous waste from this press before Printwise™ per month. After Printwise™, it was assumed that this amount of hazardous waste disposal would be eliminated and that Printwise™ presswash could be discharged to the sewer.

5.4 Volatile Organic Compound (VOC) Generation

Table 5-1 presents the results of calculations to determine VOC emissions on the Heidelberg press before and after use of Printwise™ presswash. VOC emissions from the inks were not estimated because they represented a very small fraction of the total VOCs emitted compared to the presswash.

Total VOCs from the Heidelberg press is estimated to fall from 8.2 to 0 lb/month after Printwise™. This is a significant reduction.

5.5 Financial Analysis

Table 5-2 presents the average monthly operating cost of printing operations for the Heidelberg press.

Table 5-2
Average Monthly Financial Analysis for Old Colony

Product	Without Printwise™ Use			With Printwise™ Use			Monthly Cost Difference
	Monthly Use	Unit Cost	Cost	Monthly Use	Unit Cost	Cost	
Conventional Purchases							
Black & PMS Color Ink	12.5 lb	\$4.25/lb	\$53				-\$53
Presswash	1.2 gal	\$10.77/gal	\$13		\$10.77/gal		-\$13
Printwise™ Purchases							
Black & PMS Color Ink				11.9 lb	\$4.25/lb	\$51	+\$51
Presswash				2 gal	\$1.00/gal	\$2	+\$2
Shop Towels							
Shop Towels (number)	45	\$0.08/twl	\$4	81	\$0.08/twl	\$6	+\$2
Waste Disposal							
Conventional Presswash Disposal	0.6 gal	\$1.95/gal	\$1				-\$1
Waste Ink Disposal				NA	NA	NA	
Total			\$71			\$59	-\$12

Note: Material use amounts are adjusted to reflect normalized production levels before and after Printwise™.

Ink Consumption and Cost

Ink consumption has been estimated to be reduced by 5%. Printwise™ inks were supplied free of cost during the demonstration. It was assumed that Printwise™ ink cost the same as conventional ink, to be consistent with the financial analysis for other

printers to whom Printwise™ ink was supplied at the same cost as conventional ink during the demonstration. Assuming the lower ink consumption at the same assumed price, the switch to Printwise™ ink would result in only a \$2 per month savings.

Presswash Consumption and Cost

The Printwise™ presswash was assumed to cost \$1 per gallon (with no shipping charge), the standard price offered other printers (except United lithograph) during the demonstration. Old Colony used more Printwise™ than conventional presswash. However, because of the lower assumed cost for Printwise™ presswash, elimination of use conventional presswash results in savings of \$13 per month. There was also a small reduction in the cost of disposing of hazardous waste after Printwise™.

Overall Cost Comparison

As a result, the estimates indicate that use of the Printwise™ system at Old Colony was less expensive overall than use of conventional ink and presswash under the assumed pricing arrangements of the demonstration project. Use of Printwise™ products totaled \$59 per month, a reduction of \$12 per month in the cost of \$71 per month without Printwise™.

Impact of Cost Increases for Printwise™ Products

The likely increase in the cost of Printwise™ presswash from \$1.00 to \$5.79 per gallon (including freight) would increase monthly Printwise™ presswash costs from \$2 to \$12 per month and the total monthly cost with Printwise™ to \$69 per month, still less than the total without Printwise™. If this presswash price increase were to be combined with an increase in the average cost of Printwise™ ink of 5% above current ink prices (from \$4.25 per pound to \$4.46), this would raise the total monthly cost of ink with Printwise™ from \$51 to \$53, or by \$2 per month. This results in the same ink cost as for conventional ink (because of the better ink mileage achieved with Printwise™). The total monthly cost with and without Printwise™ would be \$71.

Quantitative data were not available on any other potential savings or increased costs with Printwise™.

5.6 Conclusions

Overall Performance

The print shop manager at Old Colony considered the overall performance of Printwise™ products on the one-color Heidelberg sheetfed press acceptable. While the rankings for cleaning both press units and rollers were good, the shop manager indicated some concern about the longer time required to clean the Heidelberg press with Printwise™ products. He did not feel that the longer cleaning time would represent a production problem on the Heidelberg press, but it might be on the web press.

The print shop manager has indicated his continuing interest in using Printwise™ products on a regular basis for the Heidelberg press (depending on the product quality). While the shop manager is still interested in testing Printwise™ products on the web press, there is some skepticism because of the technical problems encountered previously by Deluxe with this dampening system and on this press.

VOC Reduction

The analysis indicates that Printwise™ products resulted in significant reduction in VOC emissions, but did not reduce the average volume of presswash used. Total VOC emissions are estimated to decrease from 8.2 to 0 lb/month after Printwise™ use. A significant reduction in VOC emissions in the setting of a state prison is a real environmental benefit.

Product Cost Issues

Printwise™ product use was less expensive than conventional products under the assumed pricing arrangements of the demonstration. There appears to be some flexibility for limited price increases in the Printwise™ products without making Printwise™ use more expensive overall. However, the confidence of this conclusion would be increased by further evaluation, particularly to document if the rate of ink consumption is in fact less with Printwise™ ink.

Appendix A
Technical Information on the Printwise™ System

Toxics Use Reduction Success Story

DELUXE'S SOLVENT-FREE PRINTING SYSTEM

SUMMARY

Deluxe Corporation, one of the largest lithographic printers in the United States, has developed a water-washable ink system that eliminates the use of petroleum-based solvents. These solvents, which generally consist of volatile organic compounds (VOCs), are found in ink and the cleaning solutions used to wash ink from press blankets. The evaporation of these solvents accounts for a significant amount of the emissions from the lithographic printing industry. The development project was initiated in response to increasingly strict U.S. Environmental Protection Agency proposed emission standards under the Clean Air Act that affect the printing industry. VOCs present employee health and safety concerns and contribute to ozone formation in the lower atmosphere.

Deluxe Corporation estimates that nationwide, prior to introduction of its new ink and blanket wash system, the company emitted two million pounds of solvent into the air each year. However, by now using its new solvent- and VOC-free printing system in its more than 55 printing plants, Deluxe's VOC emissions have fallen by at least half. In addition, the company has alleviated employee health and safety concerns related to solvent use and reduced its hazardous waste.

BACKGROUND

Deluxe Corporation is a 79-year-old Fortune 500 company with annual sales of \$1.6 billion. The company, headquartered in St. Paul, Minnesota, employs more than 17,000 people. Deluxe Check Printers is the company's principal business and is the nation's largest check printer, with a 50 percent market share and operations in 30 states. Other Deluxe divisions print computer and business forms, gift wrap and greeting cards. The company uses lithography for 95 percent of its printed products. Historically, to clean lithographic ink from printing press blankets, petroleum-based press wash solvents have proven to be most effective.

TUR PLANNING

In 1990, faced with air permitting challenges in many states and anticipating stricter pollution regulations from EPA, Deluxe set out to develop a water-based or reduced-VOC press wash. After a year, Deluxe expanded its focus to printing as a system—that is, the company began to look at lithographic ink and press wash as interdependent, not independent, elements.

The company studied ink chemistry and soon developed a solubility conversion mechanism by which the solubility of lithographic ink could be selectively controlled.

The charts show monthly usage and VOC emission calculations for Deluxe Corporation's Massachusetts check printing plants in Boston and Springfield. The calculations were made using the mass balance method. Implementation of the new printing system at the Boston plant resulted in a 49 percent reduction (334 pounds) per month in the level of VOC emissions; implementation at the Springfield plant resulted in a 70 percent (881 pounds) per month reduction.

DELUXE BOSTON Product	Before Deluxe Ink and Solvent Free System			After Deluxe System Implemented		
	Lbs/Gal Used	VOC per Lb/Gal	Actual Lbs VOC	Lbs/Gal Used	VOC per Lbs/Gal	Actual Lbs VOC
Blanket wash/numbering machine cleaner	100	6.26	626	50	6.26	313
Common roller wash 1	2	7.10	14	0	7.10	0
Common roller wash 2	1	6.60	7	0	6.60	0
Deluxe roller wash glaze remover	3	6.76	20	3	6.76	20
Common litho ink	75	0.05	4	0	0.05	0
Magnetic ink	105	0.05	5	97	0.05	5
Deluxe ink	0	0.01	0	70	0.01	1
Deluxe roller wash 1	0	3.00	0	1	3.00	3
Deluxe roller wash 2	0	0	0	80	0	0
TOTALS			676			342
DELUXE SPRINGFIELD						
Blanket wash/numbering machine cleaner	170	6.26	1064	50	6.26	313
Common roller wash 1	8	7.10	57	0	7.10	0
Common roller wash 2	11	6.60	73	0	6.60	0
Deluxe roller wash glaze remover	7	6.76	47	7	6.76	47
Common litho ink	132	0.05	7	0	0.05	0
Magnetic ink	154	0.05	8	154	0.05	8
Deluxe ink	0	0.01	0	156	0.01	1
Deluxe roller wash 1	0	3.00	0	2	3.00	6
Deluxe roller wash 2	0	0	0	210	0	0
TOTALS			1256			375

Once Deluxe incorporated the solubility conversion mechanism into the manufacture of traditional lithographic ink formulations, the company found that the ink performed as a conventional insoluble lithographic ink during printing, but could be converted to a soluble state and cleaned from press components afterwards using a simple water solution. The company found that its new printing "system" worked on conventional press equipment and required no new technology. In addition, the solubility conversion is reversible. As a result, used blanket wash can be treated chemically and the solubilized ink will precipitate. This allows easy separation of the ink from the wash and results in easy laundering of shop towels

In April 1993, Deluxe officially announced its development of a solvent-free printing system, including its water-washable ink and VOC-free press wash solution. The company has filed, and has pending, several patents covering the system. Since then, the company has refined its system, and has found that its ink meets or exceeds the performance of conventional lithographic inks. The company is now using its new system in its nationwide network of printing plants. Deluxe began selling the system on a limited basis in the first quarter of 1994.

OTHER BENEFITS

- Deluxe manufactures ink from a 100 percent vegetable oil base.
- The new printing system does not solve one environmental problem only to create another.
- The new printing system offers a cost-effective solution to EPA's Control Technique Guideline stipulating a limit of 30 percent VOC in press wash solutions by May 1995.
- The Deluxe system generates no hazardous waste, reduces chemical storage needs, eliminates solvents flushed into local water systems, and eliminates solvents present in disposable shop towels that are often sent to landfills.

This success story is one of a series of such documents prepared by the Office of Technical Assistance for Toxics Use Reduction (OTA), a branch of the Massachusetts Executive Office of Environmental Affairs whose mission is to assist industry in reducing the use of toxic substances and/or the generation of toxic manufacturing byproducts. OTA's nonregulatory services are available at no charge to Massachusetts businesses and institutions that use toxic chemicals. For further information about this or other success stories, or about OTA's technical services, contact: Office of Technical Assistance, Executive Office of Environmental Affairs, Room 2109, 100 Cambridge Street, Boston, Massachusetts 02202, (617) 727-3260.

PRINTWISE™ INK CLEAN UP PROCEDURES

Printwise™ wash is made up of water, soap and salt. When the water evaporates during the cleaning process, some soap and salt are left behind.

To prevent ink train and water fountain contamination, water should be used to rinse the rollers and a dry rag should be used to remove the wash (while still wet) from the plate and/or blanket.

Care should be taken to prevent spilling wash up solution into the water pan because the ingredients (soap and salt) do not evaporate into the air like solvent.

A breakdown of the water fountain solution could occur after repeated contact with the Printwise™ wash. This contact could happen from the roller wash up and from the plate and blanket cleaning.

Please see clean up procedures.

Printwise™ Ink - Clean Up Procedures

Blanket Cleaning

- ◆ Immerse rag in the Printwise™ wash and squeeze out excess.
- ◆ Use the rag to thoroughly apply wash to blanket without using very much force to remove ink on the first pass around.
- ◆ Use a clean area on the rag to wipe away the ink on the second pass around the blanket, rotating the rag often (you should find that the wash has had a chance to chemically change the ink after the first revolution making it easier to remove from the blanket without using much physical effort).
- ◆ Follow up - while the blanket is still wet - with a dry rag to remove remaining wash (soap and salt).
- ◆ If any haze is noticed on the dry blanket, use a tap water soaked rag to dissolve remaining soap/salt. Follow with a dry rag because the water is slow to evaporate.

Plate Cleaning

- ◆ To remove the ink from the plate, use the same procedure as in the blanket cleaning - that is, soak the rag completely and let the chemistry dissolve the ink.
- ◆ Then remove the wash by buffing the plate with a dry rag.
- ◆ Apply gum or plate preserver for prolonged down time.
- ◆ Remember that the Printwise™ wash is mostly water and if during the roller washing procedure any wash drips on to the plate, the gum or plate preserver will be removed (solvent does not remove gum but water does!). Regumming may be necessary.
- ◆ Printwise™ ink may stick to the aluminum plates and make restarts more difficult after extended down time. Consider washing ink from image area to use less stock while waiting for the water system to clean up plate.

Roller Wash

- ◆ Start tower and apply the wash to the front and the back of the roller train.
- ◆ Engage the wash up blade and continue to apply the wash to both sides of the tower (**Printwise™ wash works differently than a solvent** and it is necessary to apply the wash to the roller train in different areas to help the wash contact all the rollers).
- ◆ The soap in the wash may cause the rollers to slip if too much solution is applied.
- ◆ The Printwise™ wash **will be slower** than a solvent wash (it **will be a deeper cleaning** with the gum and etch from the fountain solution and the paper dust being removed along with the ink). Be patient.
- ◆ As the rollers are being cleaned, some of the water will evaporate which will leave some soap and salt behind. **Apply tap water to finish the wash process** - two applications of water (allowing each application to carry down to the wash up tray) should be sufficient.

Ink Fountain Cleaning

- ◆ The Printwise™ wash works by chemically changing the ink a layer at a time. Because of this, it is **important to scrape as much of the ink from the fountain** which will provide a thinner film to be removed.
- ◆ Immerse the cleaning rag in the Printwise™ wash and squeeze out excess.
- ◆ Apply the wash and allow the chemistry to work for a short time.
- ◆ The wash works in a way that is **very different from a typical solvent** - the ink is not dissolved and pulled through the rag. Use clean areas of the rag continuously to remove the ink. **If clean spots are not used in the rag, the ink will smear and not be removed.**
- ◆ This clean up procedure will take getting used to but it will work.

Impression (Back) Cylinder and Bearer Cleaning

- ◆ Again, immerse rag in wash up solution and squeeze out excess.
- ◆ Apply evenly to surface on the first pass. **Allow the chemical reaction to do the work.**
- ◆ Use a clean area on the rag to remove the ink on the second pass.
- ◆ Remove the soap and salt (while the wash is still wet) with a dry rag.

Appendix B
Criteria for Supplier Participation and Example Invitation Letter

DELUXE INK PROJECT

GEC is providing an opportunity to have participants offer their significantly-reduced VOC printing ink and press wash system to be tested during a demonstration project funded by the Toxics Use Reduction Institute. Currently, the Deluxe ink/press wash system is a participant in this project.

The conditions for project participation are as follows:

- The participant must provide an ink/press wash system which can be or currently is marketed to the lithographic community. The printing ink will be tested in heatset or non-heatset web or sheet fed printing operations.
- The participant can offer a system meeting these criteria even though the ink/press wash system is still undergoing research and development or beta site testing.
- The participant must offer an ink/press wash system that significantly reduces VOC emissions, at least 50%.
- The participant can not offer either a low VOC ink or press wash which can be used indiscriminately with products offered by other suppliers. The ink and press wash must be used in specific combination and has been or can be marketed as a system to significantly reduce VOC emissions. An aqueous-based press wash is preferred. This demonstration project is not for the testing of low-VOC press washes in the market only but ink/press wash systems.
- The ink/press wash system must be compatible with the production of high quality lithographic materials.
- The ink/press wash can have permanent or transient chemical/physical properties which permit high quality lithographic production and press cleanup. Because the ink and press wash are used as a system, they do not have to be chemically similar to products currently on the market as long as the ink/press

wash system is compatible with existing printing presses of participating printers. If the presses must be retrofitted with ancillary equipment to run the ink/press wash system, then the participant must supply the equipment at no cost to the participating printer.

- The participant must agree to supply the ink and press wash at a cost comparable to products currently purchased by the printers solicited to participate in the demonstration project.



*Goldman
Environmental
Consultants, Inc.*

*Great Pond Center
15 Pacella Park Drive
Randolph, MA 02368-1755*

*617-961-1200
Fax 617-961-6546*

Mr. Glen Hanson
Superior Printing Ink Co.
61 Brigham Street
Marlboro, MA 01752

August 17, 1995

Dear Mr. Hanson,

Goldman Environmental Consultants (GEC) is presently working, in collaboration with the Massachusetts Toxics Use Reduction Institute (TURI), on a demonstration project that tests the use of new technologies in the lithographic printing industry that sharply reduce use of volatile organic compounds (VOCs). We are currently searching for ink manufacturers that can provide a "near-zero" VOC printing ink and press wash system to be tested during the demonstration. We plan to test two such systems, one of which will be the Deluxe Printwise™ ink system. We are seeking one additional system for the demonstration. An attachment is included with this letter, providing a brief description of conditions for project participation.

The demonstration project includes voluntary market testing of the ink/press wash systems in printing facilities, and will take place over a six-month period. Eight printing facilities will be chosen to participate (each system will be tested by four printers). Baseline data will be collected on current printing operations and will be compared with data collected during the evaluation period of the demonstration to assess the technical performance and economic and environmental impacts of the "near-zero" VOC ink/press wash systems. The systems would be tested on both sheet-fed and web lithographic presses.

GEC would like to know if your firm manufactures such a system and if you would be interested in having it tested during the project. Please reply by September 1, 1995 if you are interested in participating. Refer to the attached letter for further information on conditions for project participation.

Page 2
Mr. Glen Hanson

If you have any questions or additional information that may be of use to us regarding this project, please call me or Jill Berkey at 617-961-1200.

Sincerely,

A handwritten signature in cursive script that reads "Roy Crystal". The signature is written in black ink and is positioned above the typed name.

Roy Crystal
Manager, Environmental Planning Group
enclosure

DELUXE MATERIAL SAFETY DATA SHEET (MSDS)

ISSUE DATE: November 16, 1994

SUPERCÉDES: June 20, 1994

SECTION I – PRODUCT INFORMATION

TRADE NAME	Printwise Business Forms Ink	EMERGENCY TELEPHONE #	800-228-5635 ext.198
CHEMICAL NAME AND SYNONYMS	Printwise Water–Washable Coldset Business Forms Ink (All Colors) This MSDS covers Series WCP, WCS and WBF.		
MANUFACTURER	DELUXE CORPORATION – INK DIVISION P O BOX 64404 ST PAUL MN 55164-0404	800-262-4074	

SECTION II – HAZARDOUS INGREDIENTS

	%	TLV	PEL	UNITS
This MSDS meets the requirements of both Canada's WHMIS legislation and USA OSHA's Hazard Communication standard. The SECTION II-HAZARDOUS INGREDIENTS information is a Trade Secret per OSHA regulation 29 CFR 1910.1200 (i).				
DELUXE HMIS RATING: Health 0 Flamimability 1 Reactivity 0 Personal Protection X (See SECTION VIII)				
NFPA 704 rating: 0 – 1 – 0				

SECTION III – PHYSICAL DATA

BOILING POINT (°F)	>212	SPECIFIC GRAVITY (Water=1)	1.069
VAPOR PRESSURE (MM Hg)	UN	PERCENT VOLATILE BY VOLUME (by EPA Test Method 24)	0.07 pounds/gallon 0.8% by weight
VAPOR DENSITY (AIR=1)	N/A	EVAPORATION RATE (BuAc=1)	> 1, nil
SOLUBILITY IN WATER	VARIES	APPEARANCE & ODOR	Paste, little odor

SECTION IV – FIRE & EXPLOSION HAZARD DATA

FLASH POINT/Method used	over 260F PMCC	FLAMMABLE LIMITS (%)	LEL	UEL
			N/E	N/E
EXTINGUISHING MEDIA	Foam, water fog, CO2, or dry chemical. See NFPA 325M for comments on substances with flash points over 212F.			
SPECIAL FIREFIGHTING PROCEDURES	Wear SCBA and protective clothing when fighting chemical fires.			
UNUSUAL FIRE & EXPLOSION HAZARDS	None known.			
ADDITIONAL INFORMATION	Dense smoke can be generated while burning. Ink soiled rags (shop towels) are subject to spontaneous combustion under certain conditions similar to other oily rags.			

NA – Not Applicable

NE – Not Established

UN – Unavailable

MSDS046 WK1

SECTION V – HEALTH HAZARD INFORMATION**TOXICOLOGICAL PROPERTIES (SYMPTOMS/EFFECTS OF OVEREXPOSURE)**

Direct eye contact may cause mild, temporary irritation. This material is considered a minimal irritant by InVitro International's EYETEX in vitro ocular irritancy test. Prolonged, repeated skin contact may cause mild irritation in sensitive individuals. This material is considered a minimal or non-primary irritant by InVitro International's SKINTEX in vitro dermal irritancy test. High concentrations of this material in a mist or aerosol may cause mild respiratory irritation. Medical conditions generally aggravated by exposure: None known.

CARCINOGENICITY (YES OR NO) NTP: NO IARC: NO OSHA: NO

OTHER: No carcinogenic, mutagenic or teratogenic effects are known or expected from long term use of this product.

FIRST AID MEASURES

EYES	Immediately flush eyes with large amounts of water while holding eyelids open. Seek medical attention if irritation develops and persists.
SKIN	Wash with soap and water. Seek medical attention if irritation develops and persists.
INHALATION	Inhalation and ingestion are not expected routes of exposure under normal use conditions. Move victim to fresh air. Seek medical attention if symptoms develop.
INGESTION	This material is considered nontoxic by ingestion. Seek medical attention. Do NOT induce vomiting.

SECTION VI – REACTIVITY DATA

STABILITY	Normally stable.
INCOMPATIBILITY	Strong oxidizers, strong alkalis, heat or open flames.
DECOMPOSITION	Dense smoke, Carbon Dioxide, Carbon Monoxide.
POLYMERIZATION	Does not occur.

SECTION VII – SPILL OR LEAK PROCEDURES

PROCEDURES	Observe precautions from other sections. Wipe up small spills with rags. Dispose of rags in containers approved for oily cloth waste (rag can).
WASTE DISPOSAL METHOD	US EPA Hazardous Waste No.: None. Disposal must be in accordance with Local, State or Province and Federal Regulations.

SECTION VIII – PREVENTIVE MEASURES

RESPIRATORY	Not normally required. For symptoms of overexposure, wear NIOSH approved respirator with organic vapor & oil mist protection as specified by Industrial Hygiene personnel.
EYEWEAR	Wear safety glasses or chemical safety goggles if the potential for gross splash/spatter exists.
CLOTHING/ GLOVES	If potential for prolonged, direct skin contact exists, nitrile or other chemical resistant gloves are recommended.
VENTILATION	General ventilation.

SECTION IX – ADDITIONAL INFORMATION

Store in a closed container, in a cool, dry, ventilated area.

Keep container closed when not in use. Handle similar to other oil-based inks.

This product is not considered a hazardous material during transport by US-DOT HMTA or Canada TDGA.

Contact your Deluxe Ink representative for EPA SARA Title III information for colored inks.

MSDS046.WK1

APPROVAL	VINT M. JOHNSON, CIH	USA 612-483-7119
	NAME	TELEPHONE NUMBER

The information contained herein has been developed based upon current available scientific data. New information may be developed from time to time which may render the conclusions of this report obsolete. Therefore, no warranty is extended as to the applicability of this information to the user's intended purpose or for the consequences of its use or misuse.

DELUXE MATERIAL SAFETY DATA SHEET (MSDS)

ISSUE DATE: June 16, 1994

SUPERCEDES: April 1, 1994

SECTION I - PRODUCT INFORMATION

TRADE NAME	Printwise Sheetfed Litho Ink	EMERGENCY TELEPHONE #
		800-228-5635 ext. 198
CHEMICAL NAME AND SYNONYMS	Printwise Water-Washable Commercial Sheetfed Ink (All Colors) This MSDS covers Series HTS, MTS, FDS and HGS.	
MANUFACTURER	DELUXE CORPORATION - INK DIVISION P O BOX 64404 ST PAUL MN 55164-0404	
		800-262-4074

SECTION II - HAZARDOUS INGREDIENTS

%	TLV	PEL	UNITS
This MSDS meets the requirements of both Canada's WHMIS legislation and USA OSHA's Hazard Communication standard. The SECTION II-HAZARDOUS INGREDIENTS information is a Trade Secret per OSHA regulation 29 CFR 1910.1200 (f).			
DELUXE HMIS RATING: Health 0 Flammability 1 Reactivity 0 Personal Protection X			
NFPA 704 rating: 0 - 1 - 0			

SECTION III - PHYSICAL DATA

BOILING POINT (oF)	>212	SPECIFIC GRAVITY (Water=1)	1.069
VAPOR PRESSURE (MM Hg)	UN	PERCENT VOLATILE BY VOLUME (by EPA Test Method 24)	0.07 pounds/gallon 0.8% by weight
VAPOR DENSITY (AIR=1)	N/A	EVAPORATION RATE (BuAc=1)	>1, nil
SOLUBILITY IN WATER	VARIES	APPEARANCE & ODOR	Paste, little odor

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT/Method used	over 260F PMCC	FLAMMABLE LIMITS (%)	LEL	N/E	UEL	N/E
EXTINGUISHING MEDIA	Foam, water fog, CO2, or dry chemical. See NFPA 325M for comments on substances with flash points over 212F.					
SPECIAL FIREFIGHTING PROCEDURES	Wear SCBA and protective clothing when fighting chemical fires.					
UNUSUAL FIRE & EXPLOSION HAZARDS	None known.					
ADDITIONAL INFORMATION	Dense smoke can be generated while burning. Ink soiled rags (shop towels) are subject to spontaneous combustion under certain conditions similar to other oily rags.					

MSDS045.WK1

NA - Not Applicable

NE - Not Established

UN - Unavailable

SECTION V - HEALTH HAZARD INFORMATION**TOXICOLOGICAL PROPERTIES (SYMPTOMS/EFFECTS OF OVEREXPOSURE)**

Direct eye contact may cause mild, temporary irritation. This material is considered a minimal irritant by InVitro International's EYETEX in vitro ocular irritancy test.

Prolonged, repeated skin contact may cause mild irritation in sensitive individuals. This material is considered a minimal or non-primary irritant by InVitro International's SKINTEX in vitro dermal irritancy test.

Medical conditions generally aggravated by exposure: None known.

CARCINOGENICITY (YES OR NO)

NTP: NO

IARC: NO

OSHA: NO

OTHER: No carcinogenic, mutagenic or teratogenic effects are known or expected from long term use of this product.

FIRST AID MEASURES

EYES	Immediately flush eyes with large amounts of water while holding eyelids open. Seek medical attention if irritation develops and persists.
SKIN	Wash with soap and water. Seek medical attention if irritation develops and persists.
INHALATION	Move victim to fresh air. Seek medical attention if symptoms develop.
INGESTION	This material is considered nontoxic by ingestion. Seek medical attention. Do NOT induce vomiting.

SECTION VI - REACTIVITY DATA

STABILITY	Normally stable.
INCOMPATIBILITY	Strong oxidizers, strong alkalis, heat or open flames.
DECOMPOSITION	Dense smoke, Carbon Dioxide, Carbon Monoxide.
POLYMERIZATION	Does not occur.

SECTION VII - SPILL OR LEAK PROCEDURES

PROCEDURES	Observe precautions from other sections. Wipe up small spills with rags. Dispose of rags in containers approved for oily cloth waste (rag can).
WASTE DISPOSAL METHOD	US EPA Hazardous Waste No.: None. Disposal must be in accordance with Local, State or Province and Federal Regulations.

SECTION VIII - PREVENTIVE MEASURES

RESPIRATORY	Not normally required. For symptoms of overexposure, wear NIOSH approved respirator with organic vapor & oil mist protection as specified by Industrial Hygiene personnel.
EYEWEAR	Wear safety glasses or chemical safety goggles if the potential for gross splash/spatter exists.
CLOTHING/GLOVES	If potential for prolonged, direct skin contact exists, nitrile or other chemical resistant gloves are recommended.
VENTILATION	General ventilation.

SECTION IX - ADDITIONAL INFORMATION

Store in a closed container, in a cool, dry, ventilated area.

Keep container closed when not in use. Handle similar to other oil-based inks.

This product is not considered a hazardous material during transport by US-DOT HMTA or Canada TDGA.

Contact your Deluxe Ink representative for EPA SARA Title III information for colored inks.

MSDS04S.WK1

APPROVAL	VINT M. JOHNSON, CIH	USA 612-483-7119
	NAME	TELEPHONE NUMBER

The information contained herein has been developed based upon current available scientific data. New information may be developed from time to time which may render the conclusions of this report obsolete. Therefore, no warranty is extended as to the applicability of this information to the user's intended purpose or for the consequences of its use or misuse.

DELUXE MATERIAL SAFETY DATA SHEET (MSDS)

ISSUE DATE: November 16, 1994

SUPERCEDES: June 16, 1994

SECTION I – PRODUCT INFORMATION

TRADE NAME	Printwise Roller/Blanket Wash	EMERGENCY TELEPHONE #	800-228-5635 ext.198
CHEMICAL NAME AND SYNONYMS	Printwise Water-Washable Ink System Roller/Blanket Wash (B-546)		
MANUFACTURER	DELUXE CORPORATION – INK DIVISION		800-262-4074
TELEPHONE/ADDRESS	P O BOX 64404 ST PAUL MN 55164-0404		

SECTION II – HAZARDOUS INGREDIENTS

%	TLV	REL	UNITS
This MSDS meets the requirements of both Canada's WHMIS legislation and USA OSHA's Hazard Communication standard. The SECTION II-HAZARDOUS INGREDIENTS information is a Trade Secret per OSHA regulation 29 CFR 1910.1200 (i).			
DELUXE HMIS RATING: Health 0 Flammability 0 Reactivity 0 Personal Protection X (See SECTION VIII)			
NFPA 704 Rating: 0 – 0 – 0			

SECTION III – PHYSICAL DATA

BOILING POINT (°F)	212	SPECIFIC GRAVITY (Water=1)	approx. 1
VAPOR PRESSURE (MM Hg)	18mm	PERCENT VOLATILE BY VOLUME	>90%
VAPOR DENSITY (AIR=1)	1	Volatile Organic Compound (VOC) Content	0.0%
SOLUBILITY IN WATER	100%	EVAPORATION RATE (BuAc=1)	>1
		APPEARANCE & ODOR	clear liquid, little odor

SECTION IV – FIRE & EXPLOSION HAZARD DATA

FLASH POINT/Method used	None	FLAMMABLE LIMITS (%)	LEL	N/E	UEL	N/E
EXTINGUISHING MEDIA	Product will not support combustion.					
SPECIAL FIREFIGHTING PROCEDURES	Wear SCBA and protective clothing when fighting chemical fires.					
UNUSUAL FIRE & EXPLOSION HAZARDS	None known.					
ADDITIONAL INFORMATION						

NA – Not Applicable

NE – Not Established

UN – Unavailable

MSDS044 VV1

SECTION V – HEALTH HAZARD INFORMATION**TOXICOLOGICAL PROPERTIES (SYMPTOMS/EFFECTS OF OVEREXPOSURE)**

Direct eye contact may cause mild, temporary irritation. This material is considered a minimal/mild eye irritant by InVitro International's EYETEX in vitro-ocular irritancy test. Prolonged, repeated skin contact may cause irritation in sensitive individuals. This material is considered a minimal or non-primary irritant by InVitro International's SKINTEX in vitro dermal irritancy test. High concentrations of this material in a mist or aerosol may cause mild respiratory irritation.

Medical conditions generally aggravated by exposure: None known.

CARCINOGENICITY (YES OR NO)

NTP: NO

IARC: NO

OSHA: NO

OTHER: No chronic, carcinogenic, mutagenic or teratogenic effects are known or expected from long term use of this product.

FIRST AID MEASURES

EYES	Immediately flush eyes with large amounts of water while holding eyelids open. Seek medical attention if irritation develops and persists.
SKIN	Wash with soap and water. Seek medical attention if irritation develops and persists.
INHALATION	Inhalation and ingestion are not expected routes of exposure under normal use conditions. Move victim to fresh air. Seek medical attention if symptoms develop.
INGESTION	This material is considered nontoxic by ingestion. Seek medical attention if symptoms develop.

SECTION VI – REACTIVITY DATA

STABILITY	Normally stable.
INCOMPATIBILITY	None known.
DECOMPOSITION	None known.
POLYMERIZATION	Does not occur.

SECTION VII – SPILL OR LEAK PROCEDURES

PROCEDURES	Observe precautions from other sections. Wipe up small spills with rags. A mop and water should be used to clean up larger spills.
WASTE DISPOSAL METHOD	This product is not a listed or characteristic hazardous waste according to US-EPA. Disposal must be in accordance with Local, State and Federal Regulations.

SECTION VIII – PREVENTIVE MEASURES

RESPIRATORY	Not normally required. For symptoms of overexposure, wear NIOSH approved respirator for mists or aerosols as specified by Industrial Hygiene personnel.
EYEWEAR	Wear safety glasses with side shields (or goggles) when transferring between containers or whenever the potential exists for splashes.
CLOTHING/ GLOVES	If user has hypersensitive skin and requires protection, wear nitrile or other aqueous chemical resistant gloves.
VENTILATION	General ventilation.

SECTION IX – ADDITIONAL INFORMATION

Store in a closed container, in a cool, dry, ventilated area.

This product is a nonflammable, solvent-free, water-based cleaner. VOC content: 0.0 lbs/gal.

This product is not considered a hazardous material during transport by US-DOT HMTA or Canada TDGA.

This product does not contain any SARA Title III reportable chemicals.

MSDS044.WK1

APPROVAL VINT M. JOHNSON, CIH

USA 612-483-7119

NAME

TELEPHONE NUMBER

The information contained herein has been developed based upon current available scientific data. New information may be developed from time to time which may render the conclusions of this report obsolete. Therefore, no warranty is extended as to the applicability of this information to the user's intended purpose or for the consequences of its use or misuse.

DELUXE MATERIAL SAFETY DATA SHEET (MSDS)

ISSUE DATE: November 16, 1994

SUPERCEDES: July 27, 1994

SECTION I – PRODUCT INFORMATION

TRADE NAME	Printwise Plate Cleaner	EMERGENCY TELEPHONE #	800-228-5635 ext. 198
CHEMICAL NAME AND SYNONYMS	Printwise Water-Washable Ink System Plate Cleaner (B-590)		
MANUFACTURER	DELUXE CORPORATION – INK DIVISION	800-262-4074	
TELEPHONE/ADDRESS	P O BOX 64404 ST PAUL MN 55164-0404		

SECTION II – HAZARDOUS INGREDIENTS

	%	TLV	REL	UNITS
This MSDS meets the requirements of both Canada's WHMIS legislation and USA OSHA's Hazard Communication standard. The SECTION II-HAZARDOUS INGREDIENTS information is a Trade Secret per OSHA regulation 29 CFR 1910.1200 (i).				
DELUXE HMIS RATING: Health . 1 Flammability 0 Reactivity 0 Personal Protection X (See SECTION VIII)				
NFPA 704 Rating: 0 – 0 – 0				

SECTION III – PHYSICAL DATA

BOILING POINT (oF)	212	SPECIFIC GRAVITY (Water=1)	approx. 1
VAPOR PRESSURE (MM Hg)	18mm	PERCENT VOLATILE BY VOLUME	>90%
		Volatile Organic Compound (VOC) Content	0.0%
VAPOR DENSITY (AIR=1)	1	EVAPORATION RATE (BuAc=1)	>1
SOLUBILITY IN WATER	100%	APPEARANCE & ODOR	clear liquid, little odor

SECTION IV – FIRE & EXPLOSION HAZARD DATA

FLASH POINT/Method used	None	FLAMMABLE LIMITS (%)	LEL	UEL
			N/E	N/E
EXTINGUISHING MEDIA	Product will not support combustion.			
SPECIAL FIREFIGHTING PROCEDURES	Wear SCBA and protective clothing when fighting chemical fires.			
UNUSUAL FIRE & EXPLOSION HAZARDS	None known.			
ADDITIONAL INFORMATION				

MSDS047.WK1

NA – Not Applicable

NE – Not Established

UN – Unavailable

2

SECTION V – HEALTH HAZARD INFORMATION**TOXICOLOGICAL PROPERTIES (SYMPTOMS/EFFECTS OF OVEREXPOSURE)**

Direct eye contact may cause mild, temporary irritation. This material is considered a mild eye irritant by InVitro International's EYETEX in vitro ocular irritancy test. Prolonged, repeated skin contact may cause irritation in sensitive individuals. This material is considered a minimal/mild or mild skin irritant by InVitro International's SKINTEX in vitro dermal irritancy test. High concentrations of this material in a mist or aerosol may cause mild respiratory irritation. Medical conditions generally aggravated by exposure: None known.

CARCINOGENICITY (YES OR NO) NTP: NO IARC: NO OSHA: NO

OTHER: No chronic, carcinogenic, mutagenic or teratogenic effects are known or expected from long term use of this product.

FIRST AID MEASURES

EYES	Immediately flush eyes with large amounts of water while holding eyelids open. Seek medical attention if irritation develops and persists.
SKIN	Wash with soap and water. Seek medical attention if irritation develops and persists.
INHALATION	Inhalation and ingestion are not expected routes of exposure under normal use conditions. Move victim to fresh air. Seek medical attention if symptoms develop.
INGESTION	This material is considered nontoxic by ingestion. Seek medical attention if symptoms develop.

SECTION VI – REACTIVITY DATA

STABILITY	Normally stable.
INCOMPATIBILITY	None known.
DECOMPOSITION	None known.
POLYMERIZATION	Does not occur.

SECTION VII – SPILL OR LEAK PROCEDURES

PROCEDURES	Observe precautions from other sections. Wipe up small spills with rags. A mop and water should be used to clean up larger spills.
WASTE DISPOSAL METHOD	This product is not a listed or characteristic hazardous waste according to US-EPA. Disposal must be in accordance with Local, State and Federal Regulations.

SECTION VIII – PREVENTIVE MEASURES

RESPIRATORY	Not normally required. For symptoms of overexposure, wear NIOSH approved respirator for mists or aerosols as specified by Industrial Hygiene personnel.
EYEWEAR	Wear safety glasses with side shields (or goggles) when transferring between containers or whenever the potential exists for splashes.
CLOTHING/ GLOVES	If user has hypersensitive skin and requires protection, wear nitrile or other aqueous chemical resistant gloves.
VENTILATION	General ventilation.

SECTION IX – ADDITIONAL INFORMATION

Store in a closed container, in a cool, dry, ventilated area.
This product is a nonflammable, solvent-free, water-based cleaner. VOC content: 0.0 lbs/gal.
This product is NOT considered a hazardous material during transport by US-DOT HMTA or Canada TDGA.
This product does not contain any SARA Title III reportable chemicals.

MSDS047.WK1

APPROVAL VINT M. JOHNSON, CIH USA 612-483-7119
NAME TELEPHONE NUMBER

The information contained herein has been developed based upon current available scientific data. New information may be developed from time to time which may render the conclusions of this report obsolete. Therefore, no warranty is extended as to the applicability of this information to the user's intended purpose or for the consequences of its use or misuse.

Appendix C
List of Printer Contacts and Participants

Status of Printer Participation & Contacts

Printer / Contact	Initial Contact	Response / Status / Type
Department of Procurement & General Services, Commonwealth of Massachusetts - in house print shop McCormack Building One Ashburton Place, Room P-11 Boston, MA 727-7500 x 344 Joe Braga, Pressroom Supervisor	Contacted 9/27/95; Meeting 6/5/96.	Agreed to participate; started in early August; running on small web for last 2 months; will complete an "averaged" evaluation form; have web & duplicator presses; business forms & offset sheet-fed lithography.
Massachusetts Department of Correction Industries / Print shop Old Colony Correction Center One Administration Road Bridgewater, MA 02324 Mike Kmiecik, Shop Manager 508-697-3360	Contacted Fall 1995; Agreed to participate April, 1996.	Agreed to participate; will start in October 1996; have sheet-fed, web and duplicator presses; business forms & sheet-fed offset lithography; beginning to use on web and/or one-color Heidelberg; must wait for suitable jobs.
United Lithograph 48 Third Avenue Somerville, MA 02143 Jay Meiselman, V.P. of Manufacturing 617-776-6400	Contacted Fall 1995; Conducted trial November, 1995.	Agreed to participate; Started November 27, 1995; Sheet fed lithographic commercial printer; using process color on 6 color Komori.
Standard Register 259 Hartford Turnpike Tolland, CT 06084 203-875-0731 Ken Banks, Supervisor, Maintenance & Engineering Fran Fagan, Pressroom Supervisor	Contacted November, 1995; Requested more information; Meeting June 6, 1996.	Agreed to participate; Already using Printwise on web and other presses; have provided extensive past data on material usage; will complete composite evaluation form; Business forms printer.
S&A Paramount 9 Powder Hill Road Lincoln, RI 02865 401-333-0800 fax 401-334-3512 Bruce Goodwin	Contacted Fall 1995; Unsure, meeting June 6, 1996.	Agreed to participate; Already using Printwise on web & duplicator presses; completed evaluation forms and ran special mileage test & recorded material consumption; Business forms printer.
Bassette Printers 400 Caldwell Street Springfield, MA 01101-0999 Russ Clark, Pressroom Supervisor Dave Gibb, V.P. of Manufacturing	Contacted October, 1995; Requested more information.	Tested extensively once, completed evaluation forms; did not further participate (technical concerns with drying time & hue matching); Sheet-fed lithography, commercial printer.
MacKinnon Printing Co. Inc. 6 Ledge Rock Way Acton, MA 01720 508-263-8435 John MacKinnon	Met at PINE Expo. June, 1996; Interested.	Possibly interested in participating but SICPA may not be able to support (too small); Small sheet-fed lithography; 1-2 person shop.

Status of Printer Participation & Contacts

Printer / Contact	Initial Contact	Response / Status / Type
Red Sun Press, Inc. 94 Green Street Jamaica Plain, MA 02130 Maggie Cohn 617-524-6822	Contacted October 26, 1995; Not optimistic due to small size of operation; Requested further info. on project and Deluxe.	Not presently interested.
Milton-Bradley Safety Department 443 Shaker Road East Longmeadow, MA 01028 Chris Zobel 413-525-1995	Contacted October 31, 1996; Follow-up May, 1996; No recent response	Assume not presently interested.
LaVigne Press, Inc. 10 Coppage Drive Worcester, MA 01603 Kenneth LaFleche 508-799-4467	Contacted October 31, 1995; Attended U.L. Demo.; Agreed to participate but canceled due to delay.	Not presently interested; May want to try in January, 1997.
Nimrod Press, Inc. 75 University Ave Westwood, MA 02090 Robert Olson 617-251-2600	Contacted November 13, 1995.	Not interested.
Pilgrim Plastic Products Co. 278 Babcock St. Boston, MA 02215 Ed Andler 617-782-9300	Contacted November 13, 1995; Wants to be kept informed of demo. and future testing; Attended demo.; Contacted Deluxe.	Not presently interested, process not compatible.
The Finch Engraving 368 Congress St. Boston, MA 02210 David Finch 542-6857	Contacted November 13, 1995; Attended U.L. demo. May, 1995.	Not presently interested.
Champagne Lafayette John Chester 508-651-0400	Contacted November 13, 1995; Several followup contacts were made; Attended U.L. demo.	Not presently interested.
Standard Register PO Box 4450 Middlebury, VT 05703 Warren Smith 802-388-7911	Contacted November 15, 1995; Requested more information.	Status unknown.
Reynolds-Dewalt Printing Industrial Park New Bedford, MA 02745 Paul Bergeron 508-995-5118	Contacted November 16, 1995; Attended U.L. demo.	Not presently interested.
Bay State Press & Printing 2 Watson Place Building 5C P.O. Box 3310 Framingham, MA 01701 Bill Sergi 508-887-0116	Contacted Fall 1995.	Not presently interested.

Status of Printer Participation & Contacts

Printer/Contact	Initial Contact	Response/Status/Type
King Printing Company, Inc. 181 Industrial Ave. E Lowell, MA 01851 Jack Simpson 508-458-2345	Contacted Fall 1995.	Not presently interested.
Daughters of St. Paul 50 St. Paul's Ave Boston, MA 02130 Sister Edward Marie 617-524-8035	Contacted November 16, 1995.	Not interested.
Nines Discriminating Printers 20 Industrial Park Road Hingham, MA 02043 Jerry Green 617-749-9990	Contacted October 20, 1995; No response to demo. invitations.	Assume not presently interested.
Saltus Press 24 Jolma Road Worcester, MA 01604 Butch Dion 508-752-1969	Contacted October 23, 1995; No response to demo. invitations.	Assume not presently interested.
U.S. General Printing Office 28 Court Square Boston, MA 02108 Roger White 617-720-3680	Contacted October 26, 1995; Not interested December, 1995.	Status unknown.
Blue Hill Press 520-A Turnpike Street Canton, MA 02021 Paul Lauenstein, President 617-828-7570	Contacted October 26, 1995; Interested but unable to participate.	Status unknown.
Classic Copy & Printing 678 Massachusetts Ave. Cambridge, MA 02139 Diane Derow 617-864-9025	Contacted October 26, 1995; Attended U.L. demo.	May be interested in demo. in August.
W.E. Andrews 140 South Road Bedford, MA 01730 Steve Wellenback 617-275-0720	Contacted November 16, 1995; Not willing to devote entire press 100% of the time, may do spot testing of a product.	Not presently interested.

Status of Printer Participation & Contacts

Printer / Contact	Initial Contact	Response / Status / Type
Dynograp 147 West 4th Street Boston, MA 02127 John Fuller 617-268-1900	contacted November 21, 1995; Product and project info. sent, including invite to U.L. demo.	Not presently interested
Winthrop Printing 235 Old Colony Road South Boston, MA 02127 Leo Daily 617-268-9660	Contacted Fall 1995.	Not presently interested.
Allied Business Documents 333 Buckland Street Providence, RI 02907 Hank Fontaine, V.P. Technical Services 401-461-1700	Contacted Fall 1995; Invited to U.L. demo.	No Response; Assume not presently interested.

Appendix D
Example Letter of Participation



Goldman
Environmental
Consultants, Inc.

Great Pond Center
15 Pacella Park Drive
Randolph, MA 02368-1755

617-961-1200
Fax 617-961-6546

S&A Paramount Printing
Mr. Peter Rainone
9 Powder Hill Rd.
Lincoln, RI 02865
401-333-0800

October 11, 1995

Dear Mr. Rainone,

Tom Hendrich, of Deluxe Ink, would like us to inform you of a demonstration project that Goldman Environmental Consultants (GEC) is presently conducting, in collaboration with the Massachusetts Toxics Use Reduction Institute (TURI), using funds from the Environmental Protection Agency, that tests the use of new technologies in the lithographic printing industry that sharply reduce use of volatile organic compounds (VOCs). The Deluxe Printwise™ "Near-zero" VOC printing ink and press wash system will be tested during the demonstration by participating printing facilities. We plan to evaluate the technical, environmental, and economical impacts of this system, to test the practical impacts of using "near zero" VOC ink/press wash systems in printing facilities. For a complete description of the demonstration, the project scope of services and Deluxe Printwise™ promotional material is enclosed.

GEC is currently seeking printing facilities to participate in the voluntary market testing of the Deluxe Printwise™ ink/press wash system. Eight printing facilities will be chosen to participate. The demonstration project will take place over a six-month period. The first three months will be used to introduce and integrate the new system to the facility and to record baseline press operations data. The following three months will be the "evaluation period" of the demonstration. We envision that one press would be dedicated to use of the ink/press wash system (which could be one of your less critical presses) for the three-month period. During these three months, performance data will be collected through the ongoing completion of a standardized evaluation form, to be filled out by the print press operator or facility manager. The baseline data and evaluation data will be compared to assess the technical performance and economic and environmental impacts of the "near-zero" VOC ink/press wash system.

The Deluxe Printwise™ printing system works on conventional press equipment and requires no new technology. The Printwise™ system includes a vegetable oil based ink that is made soluble with the use of a water-based press wash solution. This is made possible by a "solubility conversion mechanism" that converts the ink to a soluble state. Deluxe has agreed to provide cost adjustments so that the cost of its ink and press wash system is the same as current printer costs for these items.

There are several potential benefits that may result from the use of the Deluxe Printwise™ and other similar "near zero" VOC ink/press wash systems. The reduction of VOC emissions from print presses is an environmentally friendly action, which will reduce the amount of smog in the atmosphere. Environmental compliance and permit costs that result from VOCs emitted from press operations, may be reduced due to low VOC system use and subsequent lowered emissions. Employee health and safety will be improved with the elimination of solvent handling. Money may be saved on the replacement of rollers and

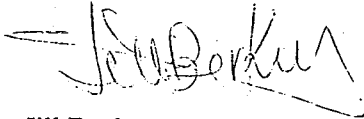
Page 2; Rainone

blankets because they are less likely to dry out and need replacement with the use of water-based press wash than with the use of solvents. Printed products could be environmentally marketed, by calling attention to the fact that you are printing your product with a system that reduces VOC emissions. These are just a few of the potential benefits of using the "near zero" VOC ink/press wash system; more are listed in the enclosures.

The Deluxe Printwise™ system has already been successfully used in various commercial printing facilities. Two examples of printing facilities using the system are West Publishing Company and Target Stores. The extent and success of their use is described in the enclosure entitled "Eco-friendly Offset Ink Scores".

The Deluxe Printwise™ system will be tested at a Massachusetts printer in the near future, as part of our demonstration project. Before committing to participate in our demonstration, you would be able to observe the system in use, or test it on one of your presses. GEC will contact you within the next week to determine if you are interested in seeing the system in use, exploring participation in this demonstration project or have any further questions, or please feel free to contact me or Roy Crystal at 617-961-1200.

Sincerely,

A handwritten signature in black ink, appearing to read "Jill Berkey", with a horizontal line extending to the left.

Jill Berkey
Environmental Scientist
enclosures

cc: Jodie Siegel- Toxics Use Reduction Institute

Appendix E
Deluxe Customer Feedback Form

Customer Name: <u>BASSETTE PRINTERS</u>					Date: <u>7/10/96</u>
Address: <u>400 CADWELL DR. - SPRINGFIELD, MA. 01101</u>					
Contact/Title: <u>RUSS CLARK</u>			Phone: <u>(413) 781-7140</u>		
Press Operator(s): <u>TOM EARLY, DON BATOR</u>					
Press Type & Size: <u>HEIDELBERG SPEEDMASTER 40" 6 COLOR</u>					<input type="checkbox"/> Perfecting
Dampening System: <u>HEIDELBERG</u>					<input checked="" type="checkbox"/> Integrated <input type="checkbox"/> Segregated
Fountain Solution: <u>PRISCO 3451</u>		Ratio: <u>3 OZS/GAL</u>		PH	
Alcohol Substitute: <u>ALKALESS 3000 - PRISCO</u>		Ratio: <u>2 OZS/GAL</u>		Cond.	
Water: <input checked="" type="checkbox"/> Tap <input type="checkbox"/> R.O. <input type="checkbox"/> D.I. <input type="checkbox"/> Dist		Heat-Set: <u>Web Temp.</u>		Oven Temp. <u> </u> Oven Length <u> </u>	
Plate: <u>KODAK</u>			Blanket: <u>DYC SK10</u>		
Ink Series: <u>FDS</u>	1st Down	2nd Down	3rd Down	4th Down	5th Down
Color & Tack	<u>BLACK / 17</u>	<u>CYAN / 16</u>	<u>MAGENTA / 15</u>	<u>YELLOW / 14</u>	
Product Code	<u>FDSSPK005-8P</u>	<u>FDSSPC005-8P</u>	<u>FDSSPM005-8P</u>	<u>FDSSPY005-8P</u>	
Batch Number	<u>MV960508.03</u>	<u>MV960508.02</u>	<u>MV960509.05</u>	<u>MV960507.04</u>	
Density-Target/Result	<u>1.70-1.10 /</u>	<u>1.30-1.40 /</u>	<u>1.30-1.40 /</u>	<u>.95-1.05 /</u>	
Dot Gain-Target/Result					
Stock: <u>ELEGANCE GLOSS</u>				Physical Properties	
Ink / Water Balance: <u> </u>				Packaging	
Set Characteristics Expectation / Result: <u> </u>				Labeling	
Drying Characteristics Expectation / Result: <u> </u>				Body of Ink	
End Use of Printed Product: <u> </u>				Skimming	
Press Speed: <u> </u> Length of Run: <u> </u>					
Make Ready / Role-up: <u>WATER SPEEDS ALL DOWN - ESPECIALLY MAGENTA</u>					
Runability / Printability: <u>INK RAN ON PRESS FINE - MAY BE A HUE DIFFERENCE BETWEEN EXISTING INK AND PRINTWISE - SOME COLOR DIFFICULTY. RUSS CLARK COLLECTED DATA ON DENSITY AND DOT GAIN COMPARISON.</u>					
Clean Up: Plates: <u>WASHED UP FINE</u> (OTHER MANUF.)					
Blankets: <u>DID NOT WASH VERY WELL - MAY HAVE BEEN OLD INK ON BLANKETS</u>					
Fountain: <u>SLIGHTLY MORE TIME CONSUMING</u>					
Rollers: <u>WASHED UP FINE</u>					
Additional Customer Comments: <u>VARNISH HAS AN AMBER TINT - THIS IS NO GOOD</u>					
What Is Required To Convert This Customer:					
Customer Potential Ink Sales:			Current Ink Supplier:		
Sales Representative: <u>GREG K.</u>			<input type="checkbox"/> Ink Sample Enclosed		
Response Desired By:			<input type="checkbox"/> Fountain Solution Sample Enclosed		

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Appendix F
Demonstration Project Evaluation Forms

FORM 1

Prior Month
Productivity & Consumption

Company _____

Contact _____

Address _____

Phone _____

Date _____

Press Configuration

Type _____

Model _____

Year _____ Capacity _____

of Colors _____

Oven Model _____

CONSUMPTION

Black Ink

Supplier _____ % VOC Content (average)

_____ lbs x \$ _____ /lb = \$ _____

Color Ink

Supplier _____ % VOC Content (average)

Cyan _____ lbs x \$ _____ /lb = \$ _____

Magenta _____ lbs x \$ _____ /lb = \$ _____

Yellow _____ lbs x \$ _____ /lb = \$ _____

Press Wash

Supplier _____ % VOC Content (average)

_____ gals x \$ _____ /gal = \$ _____

PRODUCTIVITY

Average number of production runs/shift _____ Total make-ready time (hrs) _____

Number of shifts/month _____ Total cleanup time (hrs) _____

Average number of sheets printed/run _____

WASTE GENERATION

Ink

_____ drums x \$ _____ /drum = \$ _____

_____ drums x 450 lbs/drum = _____ lbs

Press Wash

_____ drums x \$ _____ /drum = \$ _____

_____ drums x 450 lbs/drum = _____ lbs

NOTE: Calculate waste generation for demonstration press only, not for whole plant.

FORM 2
Feedback Form
First Run of the Day

Company _____
 Contact _____
 Date _____

Ink Consumption

Black lbs: _____ Magenta lbs: _____ Color: _____ Color: _____
 Cyan lbs: _____ Yellow lbs: _____ lbs: _____ lbs: _____

Paper Stock

Coated: _____ Uncoated: _____ Cast Coated: _____

Number of Impressions

Waste Sheets

Ink Coverage

Press Speed Range

of impressions: _____ # sheets: _____ Heavy __ Medium __ Light __ _____ sph to _____ sph

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Color Matching & Quality	Black				
	Cyan				
	Magenta				
	Yellow				
Runability					
Set Characteristics					
Drying Characteristics					
Overall Ink Performance					
Blanket Wash - Ease of Cleaning					
Roller Wash - Ease of Cleaning					

Blanket Wash Characteristics

Oz used: _____ Ave. Cleaning Time (min): _____

Oz of water used: _____ Ave. Drying Time (min): _____ Odor: _____

Roller Wash Characteristics

Oz used: _____ Ave. Cleaning Time (min): _____

Oz of water used: _____ Ave. Drying Time (min): _____

Fountain Solution

Oz used: _____ Dilution factor: _____

Shop Towels

towels used _____

General Comments

FORM 3

Monthly Productivity & Consumption

Company _____

Contact _____

Date _____

MATERIAL CONSUMPTION

Black Ink _____ lbs

Color Ink

Cyan _____ lbs Magenta _____ lbs Yellow _____ lbs

Red _____ lbs

Petroleum Press Wash

_____ gals

Deluxe Wash

_____ gals

Shop Towels

_____ # towels

PRODUCTIVITY

Average number of production runs/shift _____

Total make-ready time (hrs) _____

Number of shifts/month _____

Total cleanup time (hrs) _____

Average number of sheets printed/run _____

WASTE GENERATION

Ink

_____ lbs

Petroleum Press Wash

_____ lbs or gals

COMMENTS

**Appendix G
Resource List**

Informational Resources

Environmental Protection Agency New England Environmental Assistance Team	800-906-3328
The Massachusetts Toxics Use Reduction Institute	508-934-3275
Executive Office of Environmental Affairs Office of Technical Assistance	617-727-3260
Massachusetts Department of Environmental Protection Northeast Region 10 Commerce Way, Woburn	617-932-7600
Southeast Region 20 Riverside Drive, Lakeville	508-946-2700
Central Region 75 Grove Street, Worcester	508-792-7650
Western Region 436 Dwight Street, Springfield	413-784-1100
Massachusetts Water Resources Authority (MWRA)	617-242-7310
OSHA Consultation Service (Massachusetts Division of Labor and Industries)	617-969-7177
Printing Industries of New England (PINE)	508-655-8700
Graphic Arts Technical Foundation (GATF)	412-621-6941
SIPCA Ink Systems Corporation	703-455-8050

Appendix H
Summary Technical Printing Performance Evaluation Forms

Figure 1	United Lithograph
Figure 2	S&A Paramount - Web Presses
Figure 3	S&A Paramount - Duplicator Presses
Figure 4	S&A Paramount - Heidelberg Press
Figure 5	Standard Register - Web Presses
Figure 6	Standard Register - Raised Imprint Presses
Figure 7	Central Reprographics - Web Press
Figure 8	Old Colony - Heidelberg Press

Figure 1 - Summary of Technical Printing Performance at United Lithograph

<h2 style="margin: 0;">FORM 2</h2> <p style="margin: 5px 0;">Feedback Form</p>	<p>Company: United Lithograph Contact: Rick Jay Date: February 1996 - April 1996</p>
--------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------

Ink Consumption	Black lbs: <u>2.45</u>	Magenta lbs: <u>2.22</u>	Color: <u>N/A</u>	Color: _____
	Cyan lbs: <u>2.90</u>	Yellow lbs: <u>2.14</u>	lbs: _____	lbs: _____

Paper Stock	60 - 100 #	cover & text	
Coated: <u>X</u>	Uncoated: _____	Cast Coated: _____	

Number of Impressions	Waste Sheets	Ink Coverage	Press Speed Range
# of impressions: <u>16004</u>	# sheets: <u>877</u>	Heavy <u>4</u> Medium <u>13</u> Light <u>3</u>	<u>6500</u> sph to <u>7000</u> sph average

Print/Press Performance Characteristics	Rating			
	Excellent	Good	Fair	Poor
Dot Gain	Black	24		
	Cyan	23	1	
	Magenta	23		1
	Yellow	24		
Runability	23	1		
Set Characteristics	24			
Drying Characteristics	23			
Overall Ink Performance	23			
Blanket Wash - Ease of Cleaning			20	
Roller Wash - Ease of Cleaning			11	10

Note: Numbers represent number of times each box was checked.

Blanket Wash Characteristics	Oz used: <u>87</u>	Ave. Cleaning Time (min): <u>8</u>
Oz of water used: <u>N/A</u> Ave. Drying Time (min): <u>2-3</u> Odor: <u>NO</u>		

Roller Wash Characteristics	Oz used: <u>28</u>	Ave. Cleaning Time (min): <u>15-20</u>
Oz of water used: <u>42</u> Ave. Drying Time (min): _____		

Fountain Solution	Oz used: _____	Dilution factor: _____	Shop Towels	# towels used <u>123</u>
--------------------------	----------------	------------------------	--------------------	--------------------------

General Comments Red scumming a problem at times;

Black ink density was weak; wash. Solutions could be stronger - cut ink better; occasional soap film

(operator experience important; took more operator skill)

Figure 2 - Summary of Technical Performance at S & A Paramount - Web Presses

<p>FORM 2 Feedback Form Job: Long-term average</p>	<p>Company: S & A Paramount Contact: Bruce Goodwin Date:</p>
-------------------------------------------------------------------	--------------------------------------------------------------------------

Paper Stock Coated: _____ Uncoated: _____ Cast Coated: _____

Number of Sheets Printed # of sheets 11,000 - 66,000 **Waste Sheets** # of sheets <1%

Ink Coverage Heavy __ Medium X Light ____

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Dot Gain	Black	X			
	PMS Colors	X			
Runability		Black	PMS Colors		
Set Characteristics			X		
Drying Characteristics			X		
Overall Ink Performance			X		
Blanket Wash - Ease of Cleaning			X		
Roller Wash - Ease of Cleaning				X	

	Petroleum Press Wash	Printwise Press Wash
Number of Press Units Washed	1	1 - 2
Number of Fountain Washings		1
Number of Blanket Washings		3 - 4
Number of Back Cylinder Washings		

Shop Towels # towels used 1-2 / job

General Comments Printwise presswash takes a little more elbow grease to clean blankets; ink roller washups often require 3/4 volume of Printwise presswash and 1/4 petroleum based presswash
(Printwise may take off bulk & leave filmy substance in rollers).

Figure 3 - Summary of Technical Performance at S & A Paramount - Duplicator Presses

FORM 2 Feedback Form Job: Long-term average	Company: S & A Paramount Contact: William Kelly Date:
----------------------------------------------------------	-------------------------------------------------------------

Paper Stock Coated: _____ Uncoated: _____ Cast Coated: _____
Number of Sheets Printed # of sheets 100-48,000
(2,500 ave.) **Waste Sheets** # of sheets 3-4%
Ink Coverage Heavy Medium Light (usually medium)

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Dot Gain	Black	X			
	PMS Colors		X		
Runability			X		
Set Characteristics			X		
Drying Characteristics			X		
Overall Ink Performance			X		
Blanket Wash - Ease of Cleaning				X	
Roller Wash - Ease of Cleaning				X	

	Petroleum Press Wash	Printwise Press Wash
Number of Press Units Washed		1/Job
Number of Fountain Washings		1/Job
Number of Blanket Washings		1/Job
Number of Back Cylinder Washings		1/Job

Shop Towels # towels used 1/half day

General Comments Color stays on the main inking rollers;
Need to be cleaned repeatedly with washup mats (six mats/ press);
Currently, 3 wash up mats with conventional presswash (standard practice)

Figure 4 - Summary of Technical Performance at S & A Paramount
One-Color Heidelberg Sheetfed Press

<p>FORM 2 Feedback Form Job: Long-term average</p>	<p>Company: S & A Paramount Contact: William Kelly Date:</p>
-------------------------------------------------------------------	--------------------------------------------------------------------------

Paper Stock Coated: _____ Uncoated: _____ Cast Coated: _____

Number of Sheets Printed # of sheets _____ **Waste Sheets** # of sheets _____

Ink Coverage Heavy __ Medium _ Light __

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Dot Gain	Black	X			
	PMS Colors		X		
Runability			X		
Set Characteristics			X		
Drying Characteristics			X		
Overall Ink Performance			X		
Blanket Wash - Ease of Cleaning			X		
Roller Wash - Ease of Cleaning			X		

	Petroleum Press Wash	Printwise Press Wash
Number of Press Units Washed		
Number of Fountain Washings		
Number of Blanket Washings		
Number of Back Cylinder Washings		

Shop Towels # towels used _____

General Comments Squeegee system used for cleaning press results in good cleaning performance on blankets and rollers by Printwise presswash; Printwise presswash always used with Printwise inks.

Figure 5 - Summary of Technical Performance at Standard Register - Web Presses

<p>FORM 2 Feedback Form Job: Long-term average</p>	<p>Company: Standard Register Contact: Fran Fagan Date:</p>
-------------------------------------------------------------------	---------------------------------------------------------------------

Paper Stock Coated: Uncoated: Cast Coated:

Number of Sheets Printed # of sheets_ **Waste Sheets** # of sheets_

Ink Coverage Heavy Medium Light

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Color Matching & Quality	Black		X		
	Pantone Colors		X		
Runability			X		
Set Characteristics			X		
Drying Characteristics			X		
Overall Ink Performance			X		
Blanket Wash - Ease of Cleaning				X	
Roller Wash - Ease of Cleaning			X		

	Petroleum Press Wash	Printwise Press Wash
Number of Press Units Washed		1
Number of Fountain Washings		1
Number of Blanket Washings	1	
Number of Back Cylinder Washings		2

Shop Towels # towels used _____

General Comments PrintwiseTM Presswash used for ink fountains and rollers, conventional presswash for blankets (PrintwiseTM presswash took longer to clean blankets); like PrintwiseTM ink performance.

Figure 6 - Summary of Technical Performance at Standard Register - Raised Imprint Presses (Holm Jet Crash Imprint & Innovative - Nail)

<p>FORM 2 Feedback Form Job: Long-term average</p>	<p>Company: S & A Paramount Contact: William Kelly Date:</p>																																																																
<p>Paper Stock Coated: _____ Uncoated: _____ Cast Coated: _____</p>																																																																	
<p>Number of Sheets Printed # of sheets _____ Waste Sheets # of sheets _____</p>																																																																	
<p>Ink Coverage Heavy __ Medium <u>X</u> Light __</p>																																																																	
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<p>General Comments <u>Use Printwise presswash exclusively on Innovative</u> <u>part of Innovative / Nail Press; use mostly conventional presswash on Jet Crash Imprint Press</u> <u>(operator preference) but Printwise presswash performed well in the test.</u></p>																																																																	

Figure 7 - Summary of Technical Performance at Massachusetts Central Reprographics Unit - Web Press

<p style="text-align: center; font-size: 1.2em; margin: 0;">FORM 2</p> <p style="text-align: center; margin: 0;">Feedback Form</p> <p>Job: _____</p>	<p>Company: Mass. Div. of Operational Services</p> <p>Contact: Joseph Braga / Steve Smith</p> <p>Dates: 6 weeks of use between 7/1/96 - 11/19/96</p>
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Paper Stock Coated: _____ Uncoated: _____ Cast Coated: _____

Number of Sheets Printed # of sheets _____ **Waste Sheets** # of sheets _____

Ink Coverage Heavy __ Medium __ Light __

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Dot Gain	Black		X		
	Cyan				
	Magenta				
	Yellow				
Runability			X		
Set Characteristics		X			
Drying Characteristics			X		
Overall Ink Performance			X		
Blanket Wash - Ease of Cleaning			X		
Roller Wash - Ease of Cleaning			X		

	Petroleum Press Wash	Printwise Press Wash
Number of Ink Roller Units Washed	1	1
Number of Fountain Washings		1
Number of Blanket Washings		1
Number of Back Cylinder Washings		1

Shop Towels # towels used _____

General Comments Printwise presswash rejuvenated ink rollers; Printwise takes

 about 15 minutes longer for entire washup, but permits washup less often; currently uses

 mostly Printwise presswash & limited amount of conventional presswash.

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Figure 8 - Summary of Technical Performance at Old Colony - Heidelberg
One - Color Sheetfed Press

FORM 2
Feedback Form

Company: Old Colony Correctional Center
Contact: Michael Kmiecik
Dates of use: 6-7 days total, 8/96 - 10/96

Paper Stock Coated: _____ Carbonless Uncoated: X Cast Coated: _____

Number of Sheets Printed # of sheets 13,000/day **Waste Sheets** # of sheets less than 5%

Ink Coverage Heavy Medium X Light

Print/Press Performance Characteristics		Rating			
		Excellent	Good	Fair	Poor
Dot Gain	Black		X		
	Cyan		N/A		
	Magenta		N/A		
	Yellow		N/A		
Runability			X		
Set Characteristics			X		
Drying Characteristics				X	
Overall Ink Performance				X	
Blanket Wash - Ease of Cleaning			X		
Roller Wash - Ease of Cleaning			X		

	Petroleum Press Wash	Printwise Press Wash
Number of Press Units Washed	N/A	4
Number of Fountain Washings	0	4
Number of Blanket Washings	0	20
Number of Back Cylinder Washings	0	4

BASED ON 4 DAY RUN

Shop Towels # towels used Excessive Amounts

General Comments Roller cleaning time was extended; an excessive amount of rags were needed (4 to 5 with Printwise versus 2-3 with petroleum solvent).

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