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Pollution Prevention Implementation Plan for Printing Industries

Iowa Small Business Development Centers

Iowa Waste Reduction Center

IOWA POLLUTION PREVENTION INITIATIVE

POLLUTION PREVENTION IMPLEMENTATION PLAN

FOR PRINTING INDUSTRIES

SMALL BUSINESS DEVELOPMENT CENTERS - IOWA WASTE REDUCTION CENTER

The Pollution Prevention Implementation Plan for Printers was prepared as part of the Iowa Pollution Prevention Initiative (IPPI) pilot project. IPPI demonstrated the team approach to small business pollution prevention technical assistance through integration of existing Iowa Small Business Development Center and Iowa Waste Reduction Center services. This cooperative effort was designed to help small businesses learn about and implement pollution prevention through recognition of pollution prevention options, comparison of costs and benefits, and evaluation of financing options.

The Pollution Prevention Implementation Plan (PPIP) for Printers provides:

- An overview of pollution prevention options,
- A review of the costs and benefits associated with these options, and
- Steps for pollution prevention implementation and financing

Use of the PPIP will help a small business select pollution prevention practices that have a high probability of being successful from quality/production, environmental and economic standpoints. While this particular PPIP addresses the printing industry, other PPIP's are available for metal manufacturing and vehicle maintenance facilities. Many pollution prevention options recommended for lithographic printing can be adapted to all types of printing shops and printing methods.

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Disclaimer

Mention of any company or product name should not be considered an endorsement by the Iowa Small Business Development Center, Iowa Waste Reduction Center or the funding agencies.

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Introduction

Pollution prevention positively affects both the general public and the participating business. Tangible and intangible benefits include environmental protection, resource conservation, material purchase and waste disposal cost savings, and positive public relations. While pollution prevention options are well documented in the media and case studies, implementation at a specific business involves more than simply good intentions. While it is safe to say every business can benefit from pollution prevention, selecting the correct options involves considerable evaluation.

Pollution prevention techniques that work well at one type or size of business may not work well at all businesses. Despite the inherent overall benefits afforded by pollution prevention, barriers to implementation do exist and must be identified in order to assure success. Barriers to pollution prevention include:

- Limited staff time to properly research and evaluate opportunities
- Quality and availability of necessary data to make accurate evaluations
- Potential influence (positive and negative) on the affected process and/or product quality
- Real or perceived implementation costs
- Opposition to change

Pollution prevention options should be evaluated in concept for general applicability. Individual options of interest should then be evaluated based on three simple premises:

- Will it reduce waste or prevent pollution?
- Will it work in this particular application (i.e. does an alternative solvent provide adequate cleaning, will personnel use it, etc.)?
- Is there an economic benefit associated with the alternative?

While there are numerous intangible benefits that could be included in this evaluation, for the cost conscious business, the three criteria listed above essentially dictate the ‘go/no-go’ decision.

Section 2: Photoprocessing Systems and Printing Inks

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Photoprocessing Systems and Printing Inks

COMMONLY OBSERVED PRACTICES

Photoprocessing Systems

Materials used in graphic arts photography include film that has a paper, plastic or glass base covered with a light-sensitive coating called a photographic emulsion. This emulsion is usually composed of silver halide salts in gelatin. Most photographic films are made of polyester.

Commonly used developing agents contain an accelerator, a preservative and a restrainer. Frequently used chemicals are hydroquinone and metol. Developing action is stopped by immersing film into a fix bath of sodium thiosulfate (hypo), ammonium thiosulfate, or sodium hyposulfite. Hypo is the major ingredient of fixing baths, with potassium alum, acetic acid, and sodium sulfite also present. Alkaline developer is carried over into the fix bath on films and prints immersed in the fixer. An acid stop bath is often used prior to the fixing bath to stop the action of the developing solutions and to prevent contamination of the fix bath.

After the negative or positive is fixed, some of the fix bath chemicals (hypo) remain in the gelatin emulsion layer. If these chemicals are not removed they can react with the silver to form yellow-brown silver sulfide. To prevent sulfide formation, fix chemicals are washed from the emulsion in a water bath until the hypo is dissolved out. Small amounts of processing chemicals and silver rinsed from film can accumulate in the final water bath.

Nonhazardous wastes generated during image processing steps include empty containers, used film packages, film spools, and outdated materials. The primary hazardous waste stream is silver containing materials such as used film, and silver-bearing chemistries, including rinsing water. Prior to discharge of silver-bearing water solutions, local, state and federal wastewater and hazardous waste requirements must be met.

Inks

Both traditional water-based printing processes and waterless printing technologies are used by printers. Ink, fountain solution, water quality, substrate and press adjustment all play a role in achieving the proper image.

Traditionally, lithographic inks have been petroleum-based. Pigments used in these inks are primarily inorganic metals. Ink additives include solvents, varnishes and dryers. Recently, manufacturers have developed many new ink formulations using vegetable and soy-based oil and fewer heavy metal pigments.

Wastes generated include outdated inks, dried ink and ink skins, excess ink from cleaning the ink tray, empty ink containers and volatile organic compound emissions (VOC's) from petroleum-based inks.

GENERAL POLLUTION PREVENTION OPTIONS

- Storage and Handling
- Inventory and Purchasing
- Improved Processes
- Material Substitution
- Electronic Technology

The amount of photoprocessing and ink wastes can be dramatically reduced through simple techniques and the use of specialized equipment. Following is a summary of pollution prevention options.

Storage and Handling - Photoprocessing Material and Ink

- Store photoprocessing chemicals and ink following manufacturers direction
- Storage area should be free of dust and other contaminants
- Inspect material upon receiving a shipment
- Inspect material prior to use

Photoprocessing chemicals and inks sensitive to temperature and light should be stored according to manufacturers directions. Improper raw material storage and handling can result in spoilage and out-dated or expired material. Many photoprocessing and plate developing chemicals are light and temperature sensitive. Chemical containers list recommended storage conditions and shelf life. These recommendations should be followed explicitly. Storage areas should be free of dust or other contaminants that could destroy raw materials.

All materials should be inspected upon arrival; unacceptable or damaged product should be returned to the manufacturer or supplier. Materials should also be inspected prior to use, this eliminates printing an unacceptable product.

Inventory and Purchasing - Photoprocessing Material and Ink

- Implement first-in, first-out material usage to prevent expired shelf life
- Purchase computerized inventory systems
- Purchase special order material in quantities that can be used prior to expiration dates
- Test expired material for effectiveness prior to disposal or recycling
- High volume material should be purchased in bulk
- Recycle product containers or return them in exchange for full containers

Inventory managed using the first-in, first-out practices (product with oldest purchase date and/or closest expiration date is used first) will help reduce expired shelf life. Computerized inventory systems, while effective in reducing wastes, are expensive ($7,500 to $300,000) and may be cost effective for only the largest printers. Systems that only track inventory are less expensive. Specialty or rarely used materials should be purchased in quantities that will allow complete use prior to product expiration whenever possible. Product that is expired should not be disposed until it is tested for effectiveness, expiration dates are estimates and many factors affect their accuracy.

High volume materials can be purchased in bulk, usually at a reduced cost per unit. Arrangements should be made with the vendor to recycle the containers or to return them in exchange for full containers of new product.

Improved Processes - Photoprocessing

- Use an acid stop bath prior to fixing
- Use hand squeegees
- Purchase automated processing equipment
- Closely monitor chemical replenishment
- Purchase automatic replenishing systems
- Reduce wastewater quantities and water usage
- Employ countercurrent rinsing techniques

- Use automatic flow and heat controls
- Use rinse bath agitators
- Recycle rinse water
- Keep containers closed: use floating lids, add glass marbles to prevent evaporation and oxidation of chemicals
- Reuse fixer
- Recycle silver either on site or off site
- Recycle scrap film and paper
- Join printing industry trade and professional associations
- Attend Graphics Arts and Printers Conferences, Seminars and Tradeshows

Immersion of developed film into an acid stop bath prior to fixing will help eliminate chemical carryover to the fixer. Using hand squeegees to wipe excess liquid in a non-automated processing system can reduce chemical contamination in carryover from one process bath to the next bath by 50 percent. Caution must be exercised when using hand squeegees, film may be damaged if the image has not hardened completely. Automated processing equipment that has waste minimization features, such as squeegees, should be considered when purchasing new equipment. Minimizing fix bath contamination increases recyclability, extends the life of chemicals baths, and reduces the quantity of replenisher chemistry required to bring the fix solution back to operating strength.

Closely monitor chemical replenishment. Automatic replenishing systems can improve the accuracy of renewing fix solutions and effectively monitor and reduce quantities of chemistry used.

Cost of automated equipment for photoprocessing systems varies greatly, depending on factors such as type and size of processor, type and quantity of film processed, and degree of automation. Several vendors and manufacturers should be consulted to determine the most effective automated processing equipment for each business.

Counter-current rinsing reduces the amount of contamination in processing solutions as well as conserves water when compared to traditional parallel tank wash systems. Water from prior rinsing is used in the initial film wash; fresh water is introduced only at the final rinse stage, where most of the contamination has been previously removed by earlier stage rinsing.

Automatic rinse water flow and controls can be installed in place of continuous flow systems that start consuming water at the beginning of the work day and run continuously, whether film is being processed or not. It has been suggested that automatic water flow controls should be set to insure complete water changeout in the tray once every 5 minutes. The method by which the water enters and leaves the washing tank also affects the efficiency of the washing process. Best results are obtained when the water enters at the bottom of the tray and leaves through the top of the tray. A moderately warm wash water (80°F.) helps remove the hypo. Automatic and temperature flow controls when used in conjunction with mechanical agitation, can decrease time required for removal of hypo by 30 percent.

Recycle rinse water using one of the many systems on the market. Although the cost of consuming water is not typically an issue of concern, water conservation measures should be followed whenever possible. Water recycling equipment capital cost can be as much as $4,000 + depending on the size and complexity of the system. A 90-95 percent reduction in water usage is common with these systems. In addition to reduced water consumption, the time spent cleaning the processor is reduced, and processor productivity and product quality may be improved. Recycling equipment maintenance includes regular addition of chemical biocides and replacement and disposal of spent filters. Spent filters may contain a high concentration of silver and may be a considered hazardous, therefore a hazardous /nonhazardous waste determination (i.e., TCLP test) is advised prior to disposal.

Keep chemical containers closed. Floating lids can be used to reduce the contamination and evaporative losses in bleach and developer tanks. If appropriate, use glass marbles to raise the liquid level of process chemicals to the lid level. Keeping containers closed and liquid to the top will extend chemical life by reducing the amount of oxygen the liquid is exposed to. Cost of floating lids, marbles and employee training is minimal compared to savings from reduced material loss.

Fixer should be reused when possible. Optimize usage of all chemistries by consulting the product manufacturers to determine which can be reused and the steps required to ensure a quality finished product. Purchase and use fixers that can be recycled.

Developer can be recycled and replenishment chemistry can be reduced by 60 to 75 percent. The current cost of developer recycling technology can range from $4,000 to $9,500.

Silver can be removed and recycled from fixer and bleach-fix. As much as 80 percent of the total silver processed for black and white and almost 100 percent of the silver in process color work will end up in the fixer or bleach-fix solution. Silver is also present in rinse water following the fix step due to carry over. To remove silver to levels below regulatory limits (5ppm or local level) a combination approach using a primary silver recovery unit to remove the bulk of silver in combination with a "tailing" unit to remove residual silver should be used.

The benefit of silver recovery is dependent on the current market prices for silver. Recovered silver flake can be sold as high as 80 percent of the silver market value and desilvered fixer can potentially be reused.

Silver recovery can be conducted using two basic approaches: on-site recovery using commercially available equipment or off-site recovery through a silver recycling service. Recycling companies will provide pick up and recycling services to a print shop. Some recycling services retain a percentage of the recovered silver's value as payment, while others may charge for their services. Recently, photoprocessing chemistry manufacturers have begun recycling programs for printers using their chemistries. Prior to signing on to a new program, a business should accurately determine the current quantities of chemistry being used, stored and disposed of each calendar month and compare this with the projected recycling program quantities. If the quantities of hazardous waste (i.e. spent fixer or caustic developer) stored on site or generated per month exceed their current generator category quantity limits, the business could be in violation of hazardous waste regulations and may be subject to fines and/or the requirements of a more stringently regulated generator category. In addition, silver containing wastes cannot be stored on site for purposes of 'speculative accumulation'.

Three common types of in-house silver recovery methods are used by photoprocessors. The first two, electrolytic (electrowinning) and metallic replacement are used to recover silver from fix solution. The third method, ion exchange is used to remove silver from rinse water. Ozone oxidation, reverse osmosis and chemical precipitation are other less frequently used methods to recover silver.

1. Electrolytic units can be used as a batch recovery system, a continuous recovery system or as a recirculating recovery system.

   In electrolytic batch recovery, overflow fixer is collected in a tank and stored. When sufficient volumes have accumulated, the waste fixer is pumped to an electrolytic cell for silver removal.

Batch system cells are usually designed to desilver spent fix at initial silver concentrations of about 5,000 mg/l. After batch recovery the effluent typically contains 200-500 mg/l of silver.

Continuous electrolytic recovery units must be carefully sized to allow sufficient fixer residence time for optimal plating out of silver. Some units can sense silver concentrations and will automatically adjust current densities.

Recirculating electrolytic silver recovery systems are installed "in-line" and remove silver at approximately the same rate it is added by film processing. A continuous stream of fixer from in-use process tanks is recirculated through the unit, silver is removed and the fix is returned to the process tank for reuse. Processors must be equipped with a circulation pump and a separate electrolytic unit. Fix chemistry that has had silver electrolytically removed can be replenished and reused.

Factors which affect the operation and efficiency of electrolytic silver recovery systems are as follows:

- ✓ **Silver Concentration -** Electrolytic recovery efficiency is directly related to the silver concentration of the fixer. The higher the silver concentration, the higher the plating efficiency; the lower the concentration, the lower the efficiency. When silver concentration is below 1 gram/liter (0.12 troy oz./gal), plating efficiency and plating current fall off rapidly, reducing the recovery rate of the unit.
- ✓ **Type of Fixer -** The type of fixer can greatly affect the electrolytic recovery process and the type of electrolytic cell required. For example, bleach-fix solutions require a specially designed electrolytic system. A sufficient amount of sodium sulfite must be present in the fixer for the electrolytic process to work properly. Special "electro" fixer is available with increased concentrations of sulfite.
- ✓ **Line Voltage -** Another factor that can reduce plating efficiency is line voltage. Too low a voltage will cause reduced plating. If the voltage is too high the equipment will not operate properly.
- ✓ **pH -** The pH of the fixer can influence the plating efficiency of the recovery cell. Too high and silver may indiscriminately plate on all surfaces, including inside the processor itself.
- ✓ **Specially coated paper kits -** These kits are available to estimate the silver concentration, sulfite concentration and pH of the fixer. These inexpensive aids will help maximize silver recovery efficiency.

Typically, fixer solution that has been desilvered by electrolytic recovery methods will still contain higher than allowable levels of silver for discharge to the sanitary sewer. Acceptable levels of silver in wastewater vary widely; the local wastewater treatment plant superintendent can provide information concerning the levels of silver allowable for discharge in your area. Use of a follow-up recovery method or tailing method such as a metallic exchange canister is advised and should remove silver to allowable levels.

Cost of electrolytic units varies from approximately $400 to $5,000, based on site-specific factors. Electrolytic units plate a nearly pure silver flake on the cathode making the recovered silver flake value close to commodity market prices. The desilvered fixer can be replenished and reused.

2. The metallic replacement method for silver recovery is based on the principle that a more active metal (iron, zinc or aluminum) will replace a less active metal (silver) in solution. Spent fixing bath is passed through a canister or bucket containing steel wool or a mesh screen. The silver settles to the bottom of the canister as a sludge. The silver-bearing sludge needs to be refined further, therefore, its resale value is considerably lower than electrolytic recovered silver.

   A simple method for determining the amount of silver that a recovery system should yield is based on multiplying the silver concentration of the solutions entering the recovery cartridge by the volume of solution being treated. Specially designed silver estimating test papers, impregnated with a chemical substance that changes colors according to the amount of silver present in a solution, are used to determine the silver concentration. These test papers should also be used to determine the effluent concentration from the final cartridge. To test for silver levels of less than 1 gram/liter, soak the test papers for 1 hour before comparing to the color indicator.

   If a canister fails to collect silver or the silver yield does not meet expectations, any of the following may be the cause: type of film being processed, exposure level, processing work load, replenishment rate, solution carry-out, obstruction of solution flow, channeling, flow rate, incorrect type of recovery cartridge, incorrect installation, chemical condition of the fixing solution or pH of the fixer. Cartridge manufacturers and vendors are the best resource to diagnosis and solve problems associated with their equipment.

   A series of canisters is recommended for optimal silver recovery. When canisters are used in series, the first canister removes the bulk of the silver, and the second polishes the effluent of the first and also serves as a safety factor if the first unit is overloaded. When the first canister is exhausted, the second becomes the first, and a fresh unit replaces the second. Change out has been recommended when the silver in the effluent of the first cartridge reaches 25 percent of the influent concentration. For most effective operation, the pH of the solutions passing through the metallic replacement canister should be between 5 and 5.5. Below pH 4, the steel wool dis solves too rapidly, above 6.5, the replacement reaction is so slow that silver removal is incomplete. Proper pH control is critical to high silver recovery in metallic replacement canisters.

   A metallic replacement canister can capture approximately 85 percent of the recoverable silver in the form of sludge. Fixer that is desilvered using a metallic replacement bucket can not be reused as fix chemistry because of the excessive iron concentration (~4,000 mg/l) in the effluent. Metallic replacement buckets, used in series, may remove silver to levels acceptable for discharge to the sanitary sewer.

   Cost of metallic replacement canisters range from approximately $50 to $500. Additional expense includes further refining of the silver, disposal cost of desilvered fix chemistry and purchase cost of replacement chemistry.

3. Ion exchange is the reversible exchange of ions between a solid resin and a liquid. The silver-thiosulfate complex has a high affinity for the resin making it difficult to reclaim the silver and regenerate the resin. A common problem is system plugging by suspended matter, such as gelatin. Ion exchange silver recovery is used to polish silver-bearing rinse water. It can produce effluent with silver concentrations as low as 0.1 ppm and recover as much as 98 percent of the silver. Cost of ion exchange systems range from $3,300 to $4,400 and are typically not cost effective for any but the largest printers, unless they are necessary to reduce silver concentration to acceptable levels for sewer discharge.

Scrap film and paper contain silver salts or elemental silver. Silver recovery services may agree to recycle scrap film and paper along with the silver recovered from spent fixer.

Printing industry trade and professional associations are an excellent source for product and process information. Graphics arts and printing conferences throughout the country provide "one-stop" shopping for information on costs and benefits of automation in photoprocessing. New technologies are introduced and demonstrated through trade associations and conferences. Professional association membership dues, benefits, and related cost of attendance at conferences and meetings will vary widely. Cost of membership dues may be tax deductible.

Improved Processes - Ink

- Dedicate presses for specific colors and for "hazardous ink" only
- Use a standard ink sequence for process colors
- Schedule print runs from lighter to darker colors
- Improve accuracy in job estimation
- Counsel customers about environmental impact of hazardous materials
- Use an antiskinning spray
- Train employees to use retrofitted or new equipment properly
- Purchase and use a computer controlled mixing program
- Use a digital scale for accurate measurements

Dedicate presses for specific colors and for "hazardous ink" only to decrease the number of cleanings needed for each press and the quantity of ink wasted. Use a standard ink sequence for process colors. Schedule runs from lighter to darker colors to decrease the amount of cleaning necessary. Improve accuracy in job estimation and "prethink" printing jobs. Counsel customers about the environmental impact associated with particular color, paper or printing method choices. Make sure that print jobs reflect the true cost of doing business and disposing of hazardous waste.

Use a computer controlled mixing program and digital scale for mixing colors. Computer mixing software allows the printer to custom mix any ink color from colors already in inventory, thereby decreasing the purchase of new colors and increasing the use of instock colors. Use a digital scale to accurately measure ink formulations and remove the guesswork of mixing colors. In one case study, a printer's estimated cost to purchase the hardware, software and digital scale for the mixing program was approximately $2,500. The company reduced in-house ink inventory 40 to 50 percent. Problems associated with ink skinning were attributed to operator inexperience using the mixing program and the high number of jobs requiring a quick drying ink. Existing inventory had been purchased with dryers premixed into the ink. In the future, ink dryers will be purchased separately and added only when needed.

Material Substitution - Photoprocessing

- Ask vendors for nonhazardous chemical substitutes that do not contain mercury or cyanide salts for intensifiers and reducers
- Ask vendors for nonhazardous developers and finishers
- Accept only nonhazardous samples of product
- Request and read Material Safety Data Sheets
- Use silverless films such as diazo, vesicular, photopolymer, electrostatic, or selenium-based
- Use pre-sensitized lithographic plates, and discontinue use of etched plates.
- Use water-developed plates.

Vendors are excellent sources of information about substitutes for hazardous chemicals, films and plates. Request that vendors regularly provide literature about new or less toxic materials to staff. Use caution when accepting samples; be sure that the product does not contain other hazardous components that will require costly disposal. Many commonly used photographic intensifiers and reducers contain hazardous compounds, such as mercury or cyanide salts. Nonhazardous developers and finishers are available that are reported to be nontoxic with flash points over 200° F. Read labels and Material Safety Data Sheets (MSDS) before purchasing products.

Presensitized lithographic plates are an excellent alternative to metal etched plates. Some presensitized plates are processed with water only, further eliminating potentially hazardous wastes. Plates can also be produced directly from copy or artwork. Electronic systems are making a strong appearance on the market that totally eliminate the photoprocessing step.

Material Substitution - Ink

- Vegetable/soy inks
- Ultraviolet curable inks (UVC)
- Electron beam curable inks (EBC)
- Water washable ink systems
- Waterless inks

Cost of material substitutions will vary and should be selected accordingly. Benefits include reduced quantity of hazardous waste generated, reduced volatile organic compounds (VOC's), decreased disposal costs and possibly reduced handling, storage and disposal requirements.

Vegetable- or soy-based inks have many benefits. Environmentally, these inks reduce VOC emissions, are easier to recycle and may be nonhazardous. They are also made from a renewable resource. Drying times for vegetable/soy inks has been a problem but has been overcome with the addition of dryers and drying powders. Currently, soy inks are 10 - 15 percent more expensive than petroleum-based inks, but may show a 25 percent increase in print capability. Soy inks generate less waste because maintaining the correct water balance is much easier. The ink is clear which means pigments show through better producing brighter colors and less dot gain. Soy inks are rub resistant and lower quality paper can be used. As formulations improve, many printers have achieved increased coverage and excellent color with most soy ink except black, which remains problematic. Overall, vegetable/soy inks are the most economically feasible substitute for petroleum-based inks.

Ultraviolet and electron beam curable inks will not cure until exposed to either electron beam or ultraviolet energy and, therefore, can be left in the fountain overnight without skinning. This decreases both press cleaning time and waste ink generation. Also UVC and EBC inks do not emit VOC's because they contain no solvents. EBC and UVC inks are not easily recycled and both inks cost up to two times more than traditional inks. The major drawback is the high equipment costs and worker exposure to X-ray radiation. A good EBC system can cost $1 million, while UVC systems cost about $200,000 for equipment and installation. Waterless inks are not necessarily less toxic or hazardous than other ink types, but the waterless printing system as a whole generates considerably less VOC emissions than traditional lithographic processes. Major drawback of this technology is high equipment costs and employee training. Waterless technologies produce a very high quality product but many customers are not willing to pay the extra expense.

Electronic Technology - Photoprocessing

Prepress has undergone tremendous technological change from the expansion of electronic capabilities and the explosion of computer chip technology. The goal of electronic prepress is to create completely digital master copy. This may be accomplished using high-end computer systems that electronically combine type, drawings, and images. Electronic prepress and imaging may involve preparing text using a personal computer to create disk files, to create page layout, typesetting, and to paint and draw graphics. Editing is immediate and easily manipulated by composition software programs.

Lasers can be used to scan images and make plates. Most recently, images can be created electronically by using a digital camera. The camera captures an image, digitizes it and either stores the image for input at a later time or immediately transports the digitized image to a computer for editing or enhancement. The entire procedure results in no film or processing wastes.

The obvious advantages of electronic prepress is speed, reduced prepress costs associated with traditional methods, labor savings, editing time and ease, the ability to integrate a number of files on disk, and unlimited creative options. A major environmental impact of electronic prepress is the opportunity to reduce or prevent pollution (silver-bearing wastes) generated using traditional methods.

Disadvantages include high initial cost of acquiring the necessary computer hardware and software, scanners, and expansion or add-on technologies such as digital cameras. Training will be required for technicians.

Many businesses find that a combination of traditional and desktop publishing works well and is cost-effective.

COST/BENEFITANALYSIS

The following formulas and comparison tables have been created to help printers begin the process of calculating the cost and benefit provided by implementing pollution prevention practices. Each business must enter it's own data into the formulas to obtain accurate cost/benefit information for their situation. Example values for costs and quantities of material used or wasted are estimates and may not accurately reflect true costs and benefits. Comparison tables should be used to weigh the basic difference between options. In-depth research into each option should be conducted before making product, process or equipment changes.

Storage and Handling - Photoprocessing Material and Ink

The cost of improved storage and handling practices includes employee time and costs associated with proper waste disposal of outdated or expired materials. Disposal costs may be a one time only expense if proper storage and handling practices are consistently followed. The benefit (savings) is relative to the quantities of materials that historically have been wasted, the replacement cost of those materials and disposal costs for wasted material. One intangible benefit is the decreased business liability for mismanagement, (improper storage and/or waste characterization) of potentially hazardous wastes. Table A has been created to better illustrate potential savings of improved storing and handling of raw materials.

Table A Storage and Handling Procedures			
ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Quantity disposed per year (gallons)	15	
B	Disposal cost per gallon	$5.45[a]	
C	Quantity purchased as replacement	15	
D	Purchase cost per gallon	$20.00	
E	Current operating costs = (A x B) + (C x D)	$381.75	
F	Initial time spent (hr)	8	
G	Employee wages per hour	$10.00	
H	Implementation cost = F x G	$80.00	
I	Continuing time spent per week (hr)	1/2	
J	Yearly pollution prevention costs = I x G x 52	$260.00	
K	Potential yearly savings = E - J	$121.75	

[a] Based on disposal cost of $300/55 gallon drum

Inventory and Purchasing - Photoprocessing Material and Ink

Costs associated with implementing improved inventory and purchasing practices involve staff time and training for initial inventory analysis and product usage review, inventory tracking, establishment of a proper stocking program (newest product placed behind oldest product). Good inventory management will achieve an estimated 10 to 20 percent savings in product purchase costs. A formula to determine the costs of a manual inventory system is found in Table B.

Table B Manual Inventory System			
ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Quantity disposed per year (gallons)	75[a]	
B	Disposal cost per gallon	$5.45[b]	
C	Quantity purchased as replacement	75	
D	Purchase cost per gallon	$20.00	
E	Current operating costs = (A x B) + (C x D)	$1,908.75	
F	Time spent learning inventory system, initial inventorying (hr)	40	
G	Employee wages per hour	$10.00	
H	Implementation cost = F x G	$400.00	
I	Continuing time spent doing inventory per week (hr)	1	
J	Yearly pollution prevention costs = I x G x 52	$520.00	
K	Potential yearly savings = E - J	$1,388.75	

[a] Assuming 500 gallons/year is purchased and 15% is wasted because of poor inventory controls
[b] Based on disposal cost of $300/55 gallon drum

Computerized inventory system cost and applicability are relative to each business situation. Complete systems that do estimating, manage customer files and history, plan print jobs, conduct production analyses, billing, invoicing, and inventory range from $75,000 to $300,000. Basic systems with estimating and inventory capabilities may cost from $7,500 to $12,500.

Improved Processes - Photoprocessing

The cost and efficiencies of equipment such as automatic film processors, replenishment systems, water flow and heat controls, and rinse bath agitators vary widely. Table C has been created to provide some degree of comparative information when evaluating pollution prevention alternatives.

Table C
Photoprocessing Methods

Method of Application	Capital Cost	Process Complexity	Waste and Emissions	Additional Considerations
Conventional tray processing	Low	Low	High	Variability in processed film quality
Automatic processor	Medium / High	Low	Low / Medium	Consistency in processed film quality
Automatic processor with chemical monitoring/ replenishment	Medium / High	Low	Low	Reduces photoprocessing chemistry consumption

Procedural changes such as countercurrent rinsing, closing chemical containers, to reduce product oxidation are relatively inexpensive and are compared in Table D.

Table D
Procedural Changes for Photoprocessing

Method of Application	Capital Cost	Process Complexity	Waste and Emissions	Additional Considerations
Countercurrent rinsing	Low / Medium	Low	High	Space required for tanks and installation cost
Closing chemical containers	Low	Low	Low / Medium	Easy
Add marbles	Low	Low	Low	Easy

Silver recovery from fixer solutions is an excellent pollution prevention option that many printers have adopted. The economics and efficacy of silver recovery systems vary based on factors specific to each business. Some of the factors are: method of silver recovery and removal, efficiency of the recovery unit, operator experience in processing film, type and quantity of film processed, and type of fixer used. Table E will help to conduct an initial analysis of the cost and benefits of each method of silver recovery.

Table E
Silver Recovery Methods

Method of Application	Capital Cost	Process Complexity	Waste and Emissions	Additional Considerations
Off-site recycling by a silver recycling service	Low	Low	High	Large quantities of hazardous fixer will accumulate on site and may affect hazardous waste generator category, fees charged by service can be high, replacement fixer must be purchased
On-site recycling: Electrolytic	Medium / High	Medium / High	Low	Recovers almost pure silver flake, silver can be sold, desilvered fixer can be reused, disposed fixer may require a "tailing" system to remove silver from fixer to discharge levels
On-site recycling: Metallic Replacement	Low	Low	Low / Medium	Recovers silver in sludge form, fee charged for further refining, fixer typically can not be reused due to high iron content, replacement fixer must be purchased, a series of canisters is needed to remove silver from fixer to discharge levels
On-site recycling: Ion Exchange	Medium / High	Medium / High	Low	Ion exchange is for removal of silver from rinse water, filters will require disposal and replacement and may be hazardous, additives and biocides must be added periodically, effective for high volumes of rinse water

Improved Processes - Ink

Many pollution prevention options involve in-house procedural changes, such as dedicating a press for one color or specialty colors to decrease press and fountain cleaning frequency, sequencing print jobs from light to dark colors, improved accuracy in job estimation, and presenting less hazardous alternatives to customers. These changes will require input and cooperation from press operators and management.

A computer controlled custom ink mixing system and digital scale involve capital expenditure and employee training. Table F lists some pertinent factors to consider.

Table F Computerized Ink Mixing System				
Method of Application	**Capital Cost**	**Process Complexity**	**Waste and Emissions**	**Additional Considerations**
Computer ink mixing system	Medium	Medium	Low	Low capital expenditure if existing PC can be used or upgraded, employees must be trained to used, digital scale required, can reduce ink inventory by 40-50 percent

Material Substitution - Ink

Petroleum-based inks emit high amounts of VOC's and are derived from a nonrenewable resource; therefore finding an adequate substitute is the primary pollution prevention option that will be investigated. There are many factors to consider when selecting an ink substitute such as type and age of press, printing process used, customer demand, and press operator expertise to name only a few. Table G compares major categories of ink substitutes.

Table G Material Substitution - Ink				
Method of Application	**Capital Cost**	**Process Complexity**	**Waste and Emissions**	**Additional Considerations**
Vegetable / Soy Ink	Low	Low	Low	Made from renewable resources, may cost 10 - 13% more, is very easy to recycle, black ink could be a problem
UVC	High	Medium / High	Very low	No VOC's, inks more difficult to recycle
EBC	Very High	Medium / High	Very low	Employee exposure to x-ray, cost up to $1 million for equipment, no VOC's, ink more difficult to recycle
Waterless Ink	High	High	Medium low	Waterless presses are very expensive (over $1 million), employee must be trained, low VOC's ink is not necessarily nonhazardous or less toxic

Electronic Technology - Desktop Publishing

In the past decade some printers had made the changeover to digital prepress technologies. Businesses have spent anywhere from 10's of thousands of dollars for simple front end systems to millions of dollars on complete systems with workstations, servers, imagesetters, and digital proofers.

Perhaps the most informative method to provide an overview of "going digital" is to present one small printers experiences with a changeover to digital technologies. The complete case study can be found in Pollution Prevention Manual for Lithographic Printers available from the Iowa Waste Reduction Center at 319-273-2079.

Case Study: Desktop Publishing

A small printer in Des Moines, Iowa, responding to increases in chemical and disposal costs, moved away from traditional typesetting and printing to desktop publishing.

Initially, the printer purchased a Macintosh computer and a laser printer, and tried to run a hybrid system with one desktop publishing system and four traditional Compugraphic typesetters. Once the boxes were opened, the printer knew he was in over his head, so he contacted a consultant to install the software and train his staff. Once the staff became familiar with desktop publishing, it became the system of choice, which made integrating both systems difficult. The time had come to make a choice: desktop or traditional. Encouraged by input from his employees, he chose desktop.

The printer secured a $23,000 loan to purchase three more computers and a second laser printer. He replaced the older model Macintosh with a newer, large screen model. With this equipment, he had desktop publishing stations capable of matching demand. He expanded his font library and his graphics capability increased dramatically. The consultant he had worked with previously agreed to set up the entire desktop publishing system and to conduct training for his employees.

The transition was difficult but, with help from the consultant, the business was running smoothly within three weeks. The consultant was invaluable in the transition, explaining the process and providing troubleshooting training for employees.

The printer is so pleased with the changeover to desktop publishing that he is seeking capital to expand current capabilities to include four more computers. Future plans include adopting technologies such as direct-to-plate to eliminate traditional photoprocessing.
The small printers advice to those who are contemplating desktop publishing: "Go for it" .... Find a good consultant, shop around, do not overlook universities, colleges, or community colleges...but hire the best consultant you can afford." Vendors of desktop publishing may also be able to provide installation, training and troubleshooting services.

The costs of going digital will vary ($15,000 - $40,000), but many printers are now making the transition successfully after thoroughly investigating several desktop publishing systems. The ultimate payoff will be in dollars gained in increased production and a decrease in toxic photoprocessing chemistry usage rates.

Electronic Technology - Computer to Plate

A new technology is becoming more prevalent at larger businesses, metal computer-to-plate (CTP). The platesetter and other components of a complete CTP system do not necessarily offer any new products as was typical of digital prepress technology. To determine whether new technology such as CTP is worth investing in, a new set of financial benchmarks must be used, i.e., Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI) and Payback Period (PP). This financial jargon can be difficult to understand and even more difficult to use for the typical business person without the input from outside financial experts. Shops that wish to pursue this technology should already have sophisticated electronic prepress capabilities and be equipped for digital color proofing before taking the next step to CTP. One expert estimated that printers and trade shops should be prepared for a minimum $250,000 capital costs to move into CTP technology.

Section 3: Dampening Systems

Small Business Development Centers
Iowa Waste Reduction Center

Dampening Systems

COMMONLY OBSERVED PRACTICES

Many operating variables, including ink, plates and press speed, influence the selection of the proper dampening solution. Because operating variables differ from facility to facility, so do press chemistries.

Most commonly, presses are equipped with automatic dampening systems of some type. Different types of dampening systems are available because there are many different inks and presses. Fountain solutions vary to optimize the effectiveness of each different system. Often, printers use alcohol in the dampening solution to enable easier press control. Dampening system automation can noticeably decrease makeready time and materials.

Alcohol, because it evaporates quickly, is considered a volatile organic compound or VOC. Once volatilized, it will react with nitrogen oxides in sunlight to form atmospheric ozone. Reducing and eliminating alcohol may also provide a healthier work environment for employees. For these reasons, it is regulated. Many state and municipal regulations will not permit alcohol usage exceeding 3 - 8.5 percent, depending on location. Printers in geographic areas that exceed federal ambient air standards are required to operate alcohol free.

POLLUTION PREVENTION OPTIONS

The most practical options for preventing pollution and reducing fugitive emissions from the dampening system are presented in this section.

Extending the Useful Life of the Dampening Solution

When determining how to manipulate press factors, it is imperative to create conductivity and pH curves for the fountain solution to estimate solution concentration. Conductivity will increase as the fountain solution picks up ink, lint, dust and, with nonalcoholic substitutes, as water evaporates during use.

By monitoring pH, printers can observe press chemistry changes which will indicate when the pH has shifted from the best range for printing.

Extending product life is an excellent way to prevent pollution and decrease raw material costs. The most common methods of extending product life are:

1. Using a filtration system on recirculating units to remove contaminants such as paper-dust and lint. Filter systems can be used for just one fountain pan or for a recirculating system serving multiple presses. Filter media can be as simple as a charcoal or polypropylene filter, or may be a mixed media, free flow design. The filter media should remove ink residue as well, eliminating the need to dump fountain solution after color changes.

2. Using a refrigeration unit to reduce evaporative losses. Sources indicate that the optimum fountain solution temperature is 50˚F - 55˚F. Reducing temperature from 80˚F to 60˚F can reduce alcohol consumption by 44 percent. If an alcohol substitute is used, cooling will increase viscosity, or the ability of the fountain solution to flow. Be careful not to overcool the fountain solution because ink will become tacky and cause picking or piling problems. Clean condenser coils regularly.

3. Using an automatic mixing system to accurately mix fountain solution to the proper concentration. Controlling the alcohol substitute concentration in the fountain solution is not easy because water evaporates more readily than the substitute. Automatic mixing systems relieve the burden of monitoring conductivity, though it is impossible to determine the actual concentration of alcohol substitute in fountain solution.

Organic growth in recirculating systems can require stringent cleaning. In some geographic areas, this can be a significant problem. Ultra violet light reduces algae, waterborne fungi, and bacterial growth. The traditional method of preventing organic growth in the recirculating unit is to clean the unit with a 10 percent bleach wash followed by numerous rinses.

Foaming can be a specific concern when using alcohol substitutes or nonalcoholic fountain solutions. Foam-free recirculating systems, if compatible with the press, eliminate foaming and the need for anti-foam agents. For recommendations, contact press equipment manufacturers, fountain solution vendors, or printing society associations.

All these controls extend the useful life of the dampening solution and offer print quality benefits by keeping press operating factors from varying.

Eliminating Alcohol from the Fountain

Studies indicate that an effective dampening system can achieve quality printing using 5 percent or less of alcohol or alcohol substitute. When selecting an alcohol substitute consider the type of ink, press and printing constraints. To achieve the best print quality without relying on alcohol, several factors must be monitored and adjusted to accommodate different fountain solution properties.

Before making any changes to the printing process, review how the affected dampening system works. Consult chemical suppliers regarding available options specific to the press model, dampening system, ink roller wash, blanket wash and papers used. Provide a sample of makeup water to the fountain solution vender to determine which products (fountain solution, alcohol substitutes, anti-foaming agents, etc.) are compatible. Discuss the change in fountain solution with the ink supplier to prevent an incompatible selection and record and recommendations provided.

Adjust the dampening roller pressure setting and plate to blanket pressure to accommodate the alcohol substitute's different surface tension and viscosity. Check durometer readings for the inking and dampening form rollers. The press manufacturer can help in determining proper settings, though it is recommended that the durometer of the metering roller be reduced to 18-22.

When first using an alcohol substitute, follow the manufacturer's mixing instructions. Use the smallest amount of fountain substitute indicated in the instructions and measure the pH and conductivity of the mixture. Record the mixture and measurements in a log. This becomes the reference point. Print with this mixture, recording observations about its performance. Note how the plate rolls up, how the press starts after feed trips, if excess fountain solution is used to keep the plate clean, and if the metering roller is picking up ink. Discuss this information with the vendor for further suggestions and clarification.

Adjust concentration and print again until the optimum mix is achieved. When optimum performance is achieved, note the concentrations of fountain solution, water and alcohol substitute. Use this information as a reference for standard press operation. Start experimenting with alcohol substitutes on one press at a time, phasing in additional presses when the previous one is running smoothly. Keep a press log current, noting maintenance schedules, problems and solutions.

Conductivity and pH can predict fountain solution quality. Conductivity measures the ability to transmit an electrical charge and is proportional to the concentration of ions in solution. Measure conductivity of the water and fountain solution mixture, increasing the fountain solution concentration incrementally and graph the values. The graph provides a visual means to estimate fountain solution concentration based on conductivity.

Conductivity increases during press runs because impurities, such as ink and paper, are picked up by the dampening system. Measure conductivity on a daily basis. When problems with print quality arise, re-measure fountain solution conductivity. This measurement can help predict print problems that result from fountain solution quality.

Alcohol and alcohol substitutes affect conductivity, so when the optimum mix is determined, take conductivity measurements again. If using alcohol, remember that alcohol will evaporate during press runs. Alcohol substitutes evaporate slower than water, so during press runs, water may need to be added.

The pH, acidity (0-7) or alkalinity (7-14), of the fountain solution affects the print quality. As the pH of the fountain solution becomes more alkaline, the ability of the gum to desensitize the non-image areas decreases, causing "scumming" where the ink replaces the gum on the plate. When the pH of the fountain solution drops, the acid reacts with the drier, making it useless as a drying stimulator.

Measure and record the pH of the fountain solution to determine the optimum range for printing.

Although the paper's pH minimally affects the fountain solution's pH, it is beneficial to know if the paper used for each job is alkaline or acid in case of a problem. Alkaline paper is produced using a process that includes calcium carbonate. During printing, the calcium can accumulate in the fountain solution, raising the conductivity without affecting pH. Calcium buildup can create print problems including scumming.

The incoming water's conductivity affects the performance of alcohol substitutes. In areas with hard water (water with high mineral content), water purification systems; such as water softeners, reverse osmosis or deionization systems; are recommended to eliminate problems that alcohol addition formerly masked.

Water softening systems exchange magnesium and calcium carbonate with sodium carbonate. This form of treatment is effective in eliminating calcium or magnesium salt deposits from spray bar dampening systems or nozzle tips.

Deionizing units remove minerals and salts from the water, reducing conductivity to less than 50 micromhos. This type of treatment can change pH depending on the type of deionizing unit used. These units are recommended if the water supply quality is highly variable.

Reverse osmosis units remove salts, minerals and organic matter from the water. The conductivity of the treated water is reduced to 50 micromhos or less and the pH should be neutral. These units are recommended for water supplies of variable quality, as well.

Reverse osmosis units include a water softening unit, carbon filters to remove organic matter, and a micro-membrane to remove sodium carbonate. Reverse osmosis units tend to cost more than deionizing units but have less operating costs.

Low flow may cause the water temperature to increase from one side of the fountain tray to the other. This will affect the fountain solution's viscosity and its ability to cover non-image areas of the plate. Low flow may result from clogged lines or improperly routed lines. Measure the temperature of the fountain solution across the pan. If it varies more than two degrees (+/-), check the flow rate into the water pan.

Overcoming Obstacles of Alcohol Substitutes

The following suggestions may help correct problems that can occur when using an alcohol substitute:

1. **Clean presses thoroughly.** Carefully select cleaners that are effective for inks and fountain solution used. If the system is not cleaned sufficiently between uses of different alcohol substitutes, roller stripping can occur. When this occurs certain areas of the roller become more sensitive to ink than others, and apply an inconsistent ink thickness. For older presses, copperizing the rollers may eliminate the problem. To correct this on newer presses with nylon- or teflon-covered oscillator rollers, flush the ink rollers with warm water after removing the ink with cleaner.

   Brush dampener systems need the brushes cleaned frequently to prevent increasing the water feed rate to compensate for the dirt. Keep brush guards in place and use white rollers to easily identify soiling.

2. **Control the water feed carefully.** Excessive water feed will cause emulsification and poor dampening system performance. On some presses, if the dampening system is left on when the paper feed stops, the inking system will flood. The reduced nip between the chrome roller and form roller necessary to run alcohol substitutes intensifies this problem.

3. **Check the pressure settings of all rollers.** Check both the dampening roller pressure setting and the plate to blanket pressure settings. Include the optimum settings in the press log for reference.

4. **Inspect the chrome roller for pitting or ink sensitivity.** Pitting can cause an uneven water feed rate across the press. Pitted chrome rollers should be replaced.

5. **Check the metering roller for ink sensitivity or salt deposits.** Alcohol substitutes can affect the water receptivity of the chrome and metering rollers. When this happens, it is recommended to etch the chrome roller with a 1:32 etch (1 ounce phosphoric acid to 32 ounces gum) to restore water receptiveness. Water receptivity of the metering roller is maintained by applying gum.

   Some fountain solutions encourage salt deposits on the metering roller. The metering roller needs to be backed away from the chrome roller and cleaned. If the conductivity of the water is above 300 micromhos, a water softening unit could eliminate the deposits.

6. **Check the hardness of the metering rollers.** Banding or grind marks, comblike or corduroy-like marks on the substrate in the direction of paper flow, can occur if the metering rollers are too hard. This can occur even when using rollers of normal hardness, 25-30. These effects may also occur if the fountain solution is not mixed correctly.

   Use softer rollers or rollers with a slightly grained surface. Consult press manufacturer and fountain solution manufacturer regarding optimum hardness for metering rollers. Continue monitoring the hardness of the rollers. When the durometer reading varies by 10 points beyond the recommended range, replace or recondition the roller.

   Rollers harden over time and a combination of age and glazing can render the rollers ineffective. Deglazing rollers should reduce roller hardness by five durometer points.

COSTS AND BENEFITS

When making the move to alcohol-free printing, there are unrecoverable costs. Many printe across the United States are going alcohol free because it is required by law. In addition t areas where the federal government has required air emissions reductions, many state and local agencies have also required air emissions reductions from all industries, including printing. Other printers are reducing their alcohol consumption for other environmental compliance reasons, such as reducing air permit requirements.

Financial pay back can be calculated by comparing true costs to traditionally externalized costs such as the costs of environmental compliance (i.e. permitting fees, staff or consultants that prepare the permit applications) and, if the businessperson opts for noncompliance, the fines associated with regulatory violations.

Once the printer has eliminated alcohol, print quality usually improves and is more consistent. This should have direct pay offs in higher productivity from easier press control and higher customer satisfaction. Another externalized benefit is the public relations of being a good neighbor.

The following charts indicate the appropriate data necessary to estimate the costs and benefits of the pollution prevention opportunities discussed. An example is provided for mathematical purposes. Before preparing the "Actual" column of the chart, it is necessary to discuss substitute products with vendors and obtain the cost of the proper product for the substitution.

Table H below compares the costs of using alcohol and using an alcohol substitute in an area allowing alcohol use.

Future analyses should incorporate price changes and increased productivity from better press control. Makeready wastes should also decrease, reducing operating expenses.

In areas where alcohol use is allowed, it may be the most cost beneficial to reduce alcohol consumption by installing water treatment equipment. By ensuring consistent water quality, press factors will not vary dramatically and alcohol usage can be decreased to 5 percent. Other variables affected by maintaining press chemistry are makeready time and paper use. Makeready time can be decreased by 5 percent and paper saving of 1 percent can be achieved just by keeping press chemistry constant.

Table H
Alcohol and Alcohol Substitutes
Cost Caparison Worksheet

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Cost of alcohol	$2.00/gallon	
B	Volume consumed	2 gallons/mon.	
C	Multiply cost by volume = A x B	$4.00/month	
D	Air permitting fees (if applicable)	$12.50[a]	
E	Permit preparation	$800.00[b]	
F	Total (Cost of alcohol + any permit expenses) = C + D + E	$860.50[c]	
G	Cost of noncompliance	<$10.000/day	
H	Cost of substitute	$2.60/gallon	
I	Volume consumed	1.32 gal/mon.	
J	Substitute cost (Multiply cost by volume) = H x I	$3.43/month	
K	New rollers	$600.00/roller	
L	Water treatment equipment	$2100.00 total	
M	Other equipment necessary	None	
N	Total equipment costs = K + L + M	$2700.00	
O	Operating cost (Cost incurred from downtime for change over, lost time, etc.) = O x C	$460.00[d]	
P	First year expenses = J + N	$3201.18	

[a] Assuming $25/ton emissions fee and actual emission of 0.5 tons.
[b] Assuming application is prepared by a consultant charging $50/hour in 16 hours. This is conservative. Training a staff member to prepare the permit is recommended.
[c] Annual alcohol cost = $4/month x 12 months/year = $48/year
Total cost of alcohol = $48/year for alcohol + $12.50 air emission fee + $800 permit application preparation = $860.50
[d] Assuming 18 hours @ $20/hour and $100 in supplies = $460

The following chart compares the costs and complexity of press accessories.

Table I
Press Accessories Comparison

Equipment	Capital Cost	Process Complexity	Additional Considerations
Filtration system on recirculating units	Low	Low	Requires recirculating unit. Organic growth may be a problem
Foam-free recirculating systems	Low	Low	Must be compatible with press and fountain solution.
Refrigerated unit	Low	Low	Take care not to overcool alcohol substitutes.
Automatic mixing system	Medium	High	Controls conductivity but makes it difficult to determine the concentration of alcohol substitute used. Requires operator training.

Low = Approximately $2,500 or less.
Medium = $2,500 - $5,000
High = Over $5,000

Filtration systems, foam-free recirculating systems and refrigerated units are most effective when operating as a system. Systems should be in the medium price range.

Table J
Water Treatment Unit Comparison

Equipment	Capital Cost	Process Complexity	Additional Considerations
Water softening	Low	Low	Will only reduce salt deposits from spray bar dampening systems or nozzle tips.
Deionizing units	Medium	Medium	Will reduce the conductivity of the water. This is the best choice for high volume water consumption.
Reverse osmosis	Medium	Low	Remove salts, minerals and organic matter.

Low = Approximately $2,500 or less.
Medium = $2,500 - $5,000
High = Over $5,000

For best results, use a combination of the above treatment methods. Water treatment equipment should be sized for pressroom needs and can be sized for fountain solution needs only. When fountain solution requires small quantities of water, a less expensive option may be to purchase distilled water.

Section 4: Press Cleaning

Small Business Development Centers
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Press Cleaning

COMMONLY OBSERVED PRACTICES

Currently many printers are still using highly volatile traditional solvents for press cleaning. Another common cleaning practice is pouring the cleaner over the parts to be cleaned and not reusing this solvent. This unnecessarily consumes large quantities of cleaner. Some facilities are using disposable wipes; although, launderable towels are becoming more common.

POLLUTION PREVENTION OPTIONS

Many options for pollution prevention are available for press cleaning. They can be as simple as behavioral changes and product substitutions, to as complex as adding equipment.

Procedural Behavior Changes to Reduce Cleaning Wastes

The obvious area to begin identifying pollution prevention opportunities is with procedure. Changing habits, nevertheless, is difficult. When identifying areas of behavioral change, always evaluate why the procedure is performed in its current manner. In terms of cleaning, it is important to know why the cleaning is necessary and how clean is clean enough. EPA studies estimate that almost 50 percent (by volume) of high VOC cleaners evaporates before cleaning. Over cleaning adds expense and possibly more stringent environmental compliance issues.

Identified below are three easy procedural changes to reduce waste and optimize resources.

1. Clean presses as needed, not on a schedule. Immediate cleaning and using automatic systems will minimize cleaner consumption and prevent buildup of ink, paper dust or lint that will affect print quality. When ink does build up, stronger cleaners become necessary.
2. Use the least amount of cleaner possible. Apply the cleaner to the rag instead of pouring it over the part. Much cleaner is wasted when it is poured onto the press.
3. If cleaners must be poured over rollers or press parts, use a catch pan beneath the part (like roller trays) and empty the used cleaner into a closed container as soon as the rollers are wiped. Store used cleaner by color for future blanket and roller cleaning.

Reduce Air Emissions

The waste stream of most concern in printing facilities is often air emissions. To help reduce air emissions from storage:

1. Store all volatile cleaners in closed containers. Make low VOC cleaners readily available at each press. Store high VOC cleaners in another area, reinforcing that the press operator is to use it only for specific purposes such as color change.
2. Do not leave an open funnel in the waste drum. Open funnels allow the container to continually emit VOCs. This is also considered an open container under hazardous waste regulations. Closable funnels are available, but most regulators expect the bung to be kept in the drum when waste is not being added.
3. Collect used rags in a self-sealing, flame-resistant can.

Reducing Solid Waste

Many printers are currently using disposable towels for cleaning. These towels can only be used once and then must be discarded. Because they contain residual ink and cleaners, they are potentially hazardous and require laboratory testing to characterize whether they are hazardous or non-hazardous. This characterization will determine the proper disposal method.

As an alternative, laundry service towels can be used. Most laundry services will accept towels dirtied with industrial and commercial wastes as long as they are not saturated. Using a laundry service will decrease the volume of solid waste going to the landfill as well as eliminate the need for laboratory testing. Launderable towels are not considered a waste because they are laundered and reused. However, the liabilities associated with waste ink and cleaners is not eliminated, it is transferred to the laundry.

Pressroom P2

Other means of procedural changes can prevent pollution on the press. The following practices require only planning and can save time and money by decreasing cleaning costs associated with products, ink, cleaner, and down time.

- Schedule jobs by color. Clean the ink tray only when changing colors.
- Sequence colors from lightest to darkest: yellow, magenta, cyan, black. Sequencing reduces cleaning and prevents a darker color from bleeding through the lighter color. Sequencing also reduces fountain solution changes if the press doesn't have a filtration unit.

Product Substitution

Many control technologies include equipment to capture and destroy emissions. If a company can reduce emissions using product substitution or process change, the expense of the air pollution control equipment may be eliminated. Substitute cleaners, containing no more than 30 percent VOCs by weight, have lower vapor pressures and higher flash points than traditional cleaners, but may not effectively clean all areas of the press.

Chemical manufacturers that supply cleaners are developing low VOC cleaners. Just as there are many different presses, there are many different cleaners. Most low VOC cleaners continue to contain naphtha, average 3.5 pounds per gallon of VOCs and have a flashpoint greater than 200°F. "Quick drying" cleaners may have slightly higher VOC contents and usually have a flashpoint below 140°F, making them hazardous. Some substitutes present a two step approach by first using a cleaning solution with a high VOC content followed by a low VOC rinse as the second step. Refer to proposed and enacted regulations regarding low VOC cleaners to ensure compliance.

The effectiveness of low VOC cleaners continues to improve, but, because the first cleaners performed poorly, the industry is not readily accepting them. EPA research has demonstrated successful substitution of low VOC cleaners using an integrated approach. Cleaning equipment, targeted product substitution, and changing operator practices can reduce VOC emissions from cleaning.

Low VOC blanket and roller washes generally contain naphtha, inorganic phosphates and proprietary compounds. Some contain a fine abrasive to enhance ink removal. Many formulations are totally proprietary and ingredients are not listed. When selecting a low VOC cleaner, contact manufacturers to discuss your cleaning needs. Be sure to consider ink, paper, fountain solution and the type of press the cleaner is to be used on.

Do not judge low VOC cleaners by the performance of one product. Try a variety of different formulations and target cleaners for a specific purpose. A low VOC cleaner effective on ink trays and metal parts of the press may not be effective as a blanket wash.

When selecting a new product, determine the specific pollution prevention goal to be attained. Review the product's material safety data sheet for hazardous constituents (i.e. naphtha, 1,2,4, trimethylbenzene), the flashpoint (if less than 140ºF the material becomes an ignitable hazardous waste when discarded) and the VOC content, either expressed as a percent (preferably less than 30) or in pounds of VOC per gallon of solution.

Measure the amount of new product necessary to clean the press and compare it to the amount of traditional cleaner used. If it takes twice as much low VOC cleaner (3.5 pounds VOC per gallon) to effectively clean the press, the actual VOC emissions may be equal or slightly more with the low VOC cleaner. Properly using traditional cleaner with attention to operational changes could better reduce VOC emissions.

It is important to follow manufacturers' cleaning directions for new products. If the products are not used as intended, more will be necessary to clean the press. Low VOC cleaners tend to be water-soluble or water-miscible, and often have a water rinse following cleaner application. Though this may take more time than traditional cleaner, this rinse is also removing paper dust and lint.

Take care when cleaning directions indicate "immediately rinse" or "let product work into ink." Rinsing immediately may be necessary to prevent a blanket wash from leaving a film on the blanket. For effective cleaning, low VOC roller cleaners may need time to loosen excess ink to effectively clean.

Warm water generally is more effective for rinsing cleaners than cold water. If minerals build up, look at rinse water quality before blaming the cleaner.

And finally, remember that allocating time for employees to experiment with substitute cleaners and create press procedures that use low VOC cleaners is an investment in decreasing control technology costs to meet air emission standards. Feedback from employees and constructive suggestions will create a pollution prevention program that produces less waste and is responsive to the company's needs.

Equipment to Reduce Cleaning Needs

Automatic cleaning systems remove excess ink that would otherwise saturate the cleaning solution and require more cleaner to perform adequately. These systems also prevent ink buildup, decreasing the need for stronger cleaning solutions.

Additionally, automatic blanket cleaners reduce the amount of solvent used and waste generated. When used properly, automatic blanket cleaners can also reduce wasted time and lost impressions. One report cites that lost impressions were reduced from 1,200-3,000 to 250-350 when using an automatic blanket wash.

Elements of an automatic blanket cleaner include a control box, a solvent metering box for each press unit, and a cloth handling or brush unit. Many larger presses are equipped with automatic blanket cleaners and older presses can be retrofitted. The automatic blanket cleaner uses less solvent to clean the blanket (because of its metering system) and is faster than manual cleaning.

One company manufactures a unit that employs a rotary oscillating spray and brush device with solvent recovery to collect and reuse the cleaner. The unit is an enclosed system designed to reduce overspray and eliminate wipe-up towels.

Roller wash-up blades and ink blades remove residual ink from specific rollers, reducing the amount of cleaner needed. The roller and wash-up blades' condition influence how well both stay clean. The blade's angle against the roller should be adjusted to apply sufficient pressure without being grabbed or pulled under the roller. Press speeds should be just slow enough to allow for thorough cleaning. The slower the press speed, the more cleaner is used.

Presses can be equipped with specialized form rollers in place of standard form rollers, such as oscillating or hickey-picking, to respond to special needs of the lithographer. Using specialized rollers reduces press operator dependency on cleaners.

Automated press control systems, usually purchased to improve productivity and reduce makeready, also reduce cleaning needs. Systems that adjust ink/water ratio, ink density and image density on the plate, eliminate the iterative cleaning between press operator adjustments.

High quality optics and computer control systems allow for automatic plate scanners to determine the relative density of the printing image across the plate's surface. This information can be transferred to an automatic ink key setting system, adjusting the ink profile for each ink slide position. Automatic registration uses optical scanners to locate the registration marks and set this position for the duration of the press run.

One manufacturer has developed an optical system that monitors the ink/water ratio. Because both the water feed and ink keys are part of the system, any deviation of the ratio detected can be corrected. The system correlates the refraction of light from the ink form roller with the amount of water emulsified in the ink. This system could also encourage the transition to successful alcohol-free printing.

Regulatory reminder...

- Manage petroleum-based solvents and inks as hazardous waste. Some inks may not be hazardous when discarded but are unacceptable for landfill disposal because they are liquid and contain hydrocarbons. Most states require that a waste be solid for acceptance at a landfill, or be tested to verify that it is nonhazardous.
- Disposable rags may be landfilled if laboratory testing demonstrates that they are nonhazardous. Launderable rags are not subject to a hazardous waste determination by the user because they are reused after cleaning.
- Press cleaning releases VOCs. Intentionally evaporating used solvent is illegal disposal of a hazardous waste and subject to penalty. Additionally, it exposes workers to poor working conditions.

COSTS AND BENEFITS

Procedural changes can decrease operating costs by decreasing the amount of cleaner that is consumed and disposed of. Additionally, using less cleaner will reduce the amount of VOC emissions from cleaning.

This example is using costs associated with traditional high VOC cleaners. Cost savings using low-VOC cleaners will be higher.

Table K Decreasing Cleaner Consumption			
ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Amount of cleaner previously used	10 gal/month	
B	Amount used by cleaning only as necessary	9 gallons	
C	Amount saved = A - B	1 gallon	
D	Amount of solvent decreased by using only as much as necessary for cleaning job[a]	1.5 gallons	
E	Total amount solvent saved = C + D	2.5 gal. saved	
F	Cost of solvent	$2.50/gallon	
G	Multiply volume saved by cost = E x F	$6.25 saved	
H	Decreased disposal costs	$22.75 (2.5 gal x $9.10[b])	

[a] This amount can only be determined by evaluating cleaning needs and quantifying the amount of cleaner necessary to adequately clean and subtracting that from the quantity of cleaner currently used.

[b] Disposal cost calculated based on $500/55 gallons = approximately $9.10/gallon. Consult manifests for actual hazardous waste disposal costs. Decreasing hazardous waste generation may also reduce hazardous waste generator requirements. Air emissions will also be decreased by decreasing consumption. This may have permitting advantages. Both are indirect costs.

Cost Benefit Analysis for wiping parts instead of pouring solvent over them.

Table L Cost Benefit Analysis - Wiping Parts Instead of Pouring Solvent Over Them			
ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Amount of cleaner used pouring	1 gal/month	
B	Amount of cleaner used wiping	.5 gal/month	
C	Subtract difference = A - B	.5 gal.month	
D	Cost of cleaner	$2.50/gallon	
E	Amount hazardous waste averted	$1.25/month	
F	Multiply volume saved by cost = C x D	.5 gal/month	
G	Cost of off-site disposal	$500/55 gal. (approx $9.10)	
H	Multiply volume by cost = F x G	$4.55 saved	

Adding direct and indirect savings will give the gross savings. Wiping parts instead of pouring solvent over them for cleaning may have other indirect costs, such as increased laundry fees for using more launderable rags. To calculate the net savings, subtract the increase in laundry fees.

Because many cleaners are highly volatile, wiping may also reduce air emissions and find cost benefit in reduced compliance requirements.

If pouring is necessary, collecting cleaner and storing it by color for reuse will also decrease the need for new cleaner. Cost benefits include decreased cleaner and disposal costs.

Launderable Towels

Table M
Laundry Service Towels vs. Disposable Towels

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
	DISPOSABLE TOWELS		
A	Cost of towels	$0.08/each	
B	Volume consumed	$100/month	
C	Multiple cost by volume = A x B	$8/month	
D	TCLP[a]	$400.00	
E	Disposal fees (hazardous) Nonhazardous	Assuming TCLP indicates nonhaz - Negligible	
F	Violation for no TCLP	<$10,000/day	
	LAUNDERABLE TOWELS		
G	Cost of laundry towels	$0.10/towel	
H	Volume consumed	80 towels	
I	Multiply cost by volume = G x I	$8.00/month	

[a] Prior to the disposal of any commercial or industrial by-product, the generator is required to determine if the waste is hazardous or nonhazardous. In the instance of disposable towels, if ink and/or solvent are considered hazardous, the towels are considered potentially hazardous and require proper laboratory testing to determine proper disposal methods. The $400 is an average cost of the laboratory test.

Low VOC Cleaners

Equipment and product changes also reduce the amount of VOCs emitted. This not only can have environmental compliance advantages, it will increase the quality of the working environment.

Table N
Cost Comparison - Low VOC Cleaners vs. Traditional Cleaners

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
	TRADITIONAL CLEANER		
A	Cost of current cleaner	$2.50/gallon	
B	Volume consumed	10 gal./month	
C	Multiply cost by volume = A x B	$25.00/mon.	
D	Disposal fees (if applicable)	None[a]	
E	Total (Cost + Disposal) = C + D	$25.00/mon.	
	Low VOC		
F	Cost of appropriate alternative (3.5 #VOC/gallon)	$18.00/gallon	
G	Volume consumed	2 gal./month	
H	Multiply cost by volume = F x G	$36.00	
I	Disposal fees (if applicable)	None[a]	
J	Total (Cost + Disposal) = H + I	$36.00/mon.	
K	Fines for noncompliance in areas where printers may not use cleaners containing more than 3.5 #VOC/gallon	<10,000/day/ violation	

[a] Example assumes that cleaner is poured onto a launderable rag and parts are wiped instead of pouring cleaner directly onto the part. If pouring cleaner directly onto the part, include the cost of solvent disposal. For either practice, include all costs of the towels, including disposal of disposables.

When determining a cost benefit for using a low VOC cleaner also incorporate the costs of disposal (hazardous vs. nonhazardous) and possible air permitting costs. Compliance costs can be reduced tremendously by simply decreasing VOC emission rates. Low VOC cleaners offer an excellent opportunity to decrease VOC emissions. If a source is considered a Major Source under Title V permitting requirements, simply reducing emissions to under the Title V thresholds can eliminate Title V emissions fees as well as the fees associated with preparing the permit application. Many businesses have hired consultants to prepare permit applications and have paid tens of thousands of dollars for these services.

Table O
Cost Benefit Worksheet
Automatic Blanket Cleaners

ITEM	VARIABLE	EXAMPLE	YOUR FACILITY
A	Automatic blanket cleaner	$800 (for duplicator press)	
B	Amount of solvent used without automatic blanket cleaner	10 gallons	
C	Amount of solvent used with automatic blanket cleaner	9 gallons	
D	Amount of solvent saved = B - C	1 gallon saved	
E	Cost of solvent	$2.50/gallon	
F	Multiply cost by volume = D x E	$2.50	
G	Time spent cleaning prior to equipment installation	20 minutes	
H	Cleaning time with equipment	15 minutes	
I	Time saved = G - H	5 minutes	
J	Value of 1 hour operating time	$20.00/hr	
K	$ saved per cleaning = I x J	$1.67	
L	Raw materials savings[a]	$1.00/cleaning	
M	Savings per cleaning = K + L	$2.67/cleaning	
N	Number of times press is cleaned	10/week	
O	Savings x number of cleanings = N x O	$26.70/week	

[a] i.e. solvent, launderable towels, etc.

Automatic blanket cleaners are most effective on small presses and short press runs. This equipment tends to be restrictive to larger presses printing high quality images.

Automated press equipment designed as add-on equipment may not be available for all presses and is often not cost effective. Automated equipment is most cost effective when purchased pre-installed on a new press.

Section 5: Financing Options

Small Business Development Centers
Iowa Waste Reduction Center

Pollution Prevention Implementation Plan for Printing Companies

Photoprocessing Systems

Several of the improved processes for photoprocessing do not involve additional financing. However, the purchase of automated processing equipment, automatic replenishing systems and recycling costs may have significant capital costs.

In-house silver recovery methods can vary in cost and therefore require different financing alternatives. An electrolytic unit that can be used as a batch recovery system may cost from $400 to $5,000; the metallic replacement method has lower initial costs (less than $500) but additional expenses can increase operating costs. Ion exchange silver recovery is generally not cost effective for smaller printers and the cost ($4,000) should generally be financed internally by a larger printer.

Dampening Systems

Alcohol is frequently used in the dampening solution to enable easier press control. However, alcohol is considered a volatile organic compound (VOC) and is regulated. The movement away from alcohol to alcohol substitutes will cause the printer to incur unrecoverable costs. The financial costs for noncompliance can be very significant, so when preparing a cost analysis for a lending institution, it is important to treat the additional costs as liability insurance.

Press Cleaning

Most pollution prevention options in press cleaning do not involve financing costs, but some more dramatic changes may involve purchasing additional equipment. Automatic cleaning systems may require outside financing.

Pollution prevention initiatives that require external financing may range from a few thousand dollars to significant capital outlays. Even if the working relationship with the financial institution is excellent, the institution may be hesitant to finance some of these projects without some type of guarantee.

FINANCING NEEDS

The first step is to review the firm's monthly cash flow from operations statements. The least expensive way to finance less expensive pollution prevention technologies is to internally finance the capital outlays. However, this may not always be possible in the printing industry because of tight cash flow cycles. Therefore, many firms will turn to their financial institutions for financing needs. Pollution prevention initiatives that do not show quick paybacks may meet with some resistance from the lender. That is where the Small Business Administration's (SBA) financial assistance program can be very useful to the business.

The largest financial assistance program is the SBA. The SBA has several programs that may help finance pollution prevention and/or reduction capital projects. The most common and largest program is the 7(a) loan guaranty program. The 7(a) program allows the SBA to reduce risk to lenders by guaranteeing the major portion of loans made to small businesses.

The eligibility requirements and credit criteria of this program are very broad in order to accommodate a wide range of financing needs. When you have put together the list of equipment that you need to purchase you will fill out an application for a loan with a lending institution. The lender will review the application and decide if it merits a loan on its own or if it requires additional support. Many firms will have little difficulty in obtaining the needed financing for smaller projects; however, a firm with a significant level of debt already on its balance sheet may need the SBA loan guarantee before the financial institution will extend further credit.

The SBA can guarantee up to 80 percent on loans of up to $100,000, which will be sufficient for most pollution prevention projects. If the loan is more than $100,000, the guarantee drops to 75 percent up to a maximum guaranty of $750,000 (75 percent of a $1 million loan).

There are no balloon payments, prepayment penalties, application fees or points permitted with 7(a) loans. Repayment plans may be tailored to each individual business.

Most pollution prevention purchases could be financed over a period of 5 to 7 years. Both fixed and variable interest rates are available. Rates are pegged at no more than 2.25 percent over the lowest prime rate as published in the Wall Street Journal on the day the application is received by the SBA. (Loans under $50,000 may have slightly higher rates.)

The SBA charges the lender a nominal fee to provide a guaranty and the lender usually passes this charge on to the borrower. The fee is based on the maturity of the loan and the dollar amount that the SBA guarantees. On any loan with a maturity of one year or less, the fee is 0.25 percent of the guaranteed portion of the loan. On loans with maturities of more than one year where the portion that the SBA is $80,000 or less, the guaranty fee is 2 percent of the guaranteed portion. The SBA will require that you pledge sufficient assets to adequately secure the loan.

Most pollution prevention projects will typically be less than $100,000 so the Low Documentation Loan (LowDoc) program may be the best alternative to obtain reasonable financing with a minimal amount of paperwork. For firms with established relationships with lenders and those meeting the lender's requirements for credit, LowDoc is a simple one page SBA application form with a rapid turnaround time. Like the 7(a) program, the SBA will guarantee up to 80 percent of the loan amount.

Most lending institution will require a projected cash flow statement, projected income statement and projected balance sheet. Examples are available from your local SBDC office.