Do You Operate a Printing Shop?

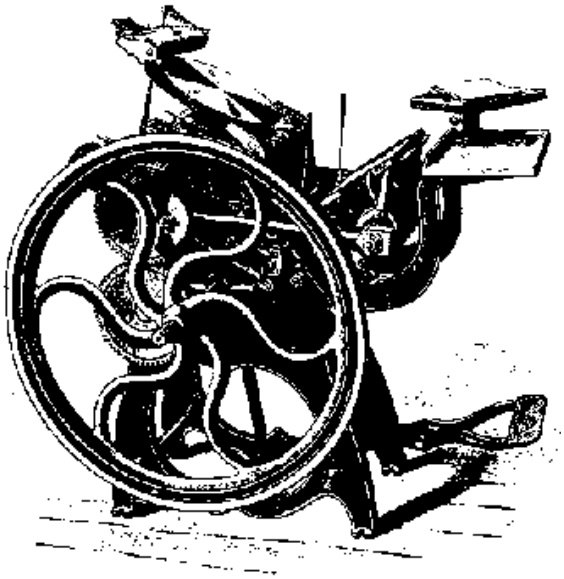
Would you like to:

- **Improve your profits?**
- **Avoid regulatory headaches?**
- **Do your part in protecting the environment?**

If you answered yes to any of these question, read this Code.
It is one of your finest resources!

PRINTING
CODE OF PRACTICE
INTRODUCTION & CHECKLISTS

Best Management Practices For Pollution Prevention and
Pollution Prevention Award Certification



by:
The Joint Task Force of the City of Albuquerque
Public Works Department/Pollution Prevention Program and
the Albuquerque Printers Task Force

1998

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Acknowledgements

Acknowledgments:

This document has been completed with the assistance of the Craftsmans Club, a XXX. And the New Mexico Silver Users Association (NMSUA), a non-profit trade association working to educate industry and the public on business and environmental issues.

Disclaimer:

The City of Albuquerque does not endorse any of the techniques, businesses, equipment, or methods mentioned in the following document. This document is intended only as advisory guidance for the Printing industry in developing approaches for pollution prevention/source reduction. Compliance with environmental and occupational safety and health laws is the responsibility of each individual business and is not the focus of this document.

Introduction

This Code of Practice is intended to promote a baseline of voluntary compliance practices by businesses. Businesses participating will be certified by the City and awarded annual recognition certificates, which will be published in local media. The Code identifies options and alternatives to achieve pollution prevention goals according to the processes used in the printing industry.

The Pollution Prevention Program is non-regulatory and is an educational and research tool that can provide you with information concerning methods of source reduction and pollution prevention for your business. If requested, Pollution Prevention personnel are available for on-site consultations to review your printing processes and discuss methods of pollution prevention and waste minimization as needed. The Program can also put you in contact with other non-regulatory services concerning hazardous waste, air quality and storm water, if requested.

The Albuquerque Printers Task Force (see appendix A) worked with the Albuquerque Public Works Department/Pollution Prevention Program staff to identify opportunities to reduce all types of discharges from printing facilities. Of particular interest is the reduction of solvents, silver and other heavy metal discharges.

The City of Albuquerque is also part of the National Environmental Advisory Task Force (NEAT), which is a national group of trade associations, technical societies, municipalities, and government agencies whose members are vitally affected by the environmental regulation of silver. NEAT's purpose is to encourage communications between the regulatory and regulated communities, support scientific research, and share current scientific, technical and economic information so that the common goals of pollution prevention, recycling, water conservation, and regulatory compliance can be met.

❑ Understanding the Printing Code of Practice

The following material is the Albuquerque Printing Industry Code of Practice Introduction & Checklists. A companion document, the Reference Materials, is available on request. The Code of Practice is not a regulatory document. Methods and processes mentioned herein are not required, but are included as examples of pollution prevention common to the industry. The Checklists refer to page numbers where specific information can be found. If you find that the information you are seeking is not in the Code, please contact the Pollution Prevention Program at (505)873-7059 to either request additional information, or to provide information on pollution prevention or waste management practices common to other businesses with similar processes and equipment.

A great amount of information is provided in this Code including references to hazardous waste issues. The hazardous waste information is meant to inform you as to the potential liabilities your business could face. Much of the information provided is an attempt to prevent your company from the need of dealing with hazardous waste regulations by removing your wastes from the classification of being a hazardous waste, or reducing the amount of wastes your company generates. Your knowledge of hazardous waste issues is your best method to avoiding potential liabilities and reducing or removing your wastes from the hazardous waste classification. (see Appendix F. Hazardous Waste Information).

This segment of the Code includes:

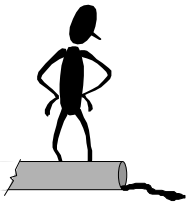
1. Introduction
2. Section 1: Pollution Prevention Checklists
3. Section 3: Printing Checklists
4. Appendices: A, B, C, D, and Bibliography

❑ What the Code Will Not Answer

This Code will not answer specific questions concerning health and safety. Due to the variety and number of chemicals and processes used in printing, the Code would be unable to maintain a focus on pollution prevention while attempting to address all health and safety issues.

If you are concerned about facility health and safety, you should consult OSHA or the PMA (See Appendix B).

❑ The Need for the Code of Practice



Wastewater discharged from printing facilities to Publicly Owned Treatment Works (POTWs), is of interest to many municipal, state and federal agencies. POTWs must oversee discharges and require the removal of pollutants including metals such as silver and copper, and various chemicals, to maintain compliance with their EPA permit discharge requirements. Although significant loading can come from other industrial sources, the large number of printing facilities in Albuquerque is of special interest to the Albuquerque POTW.

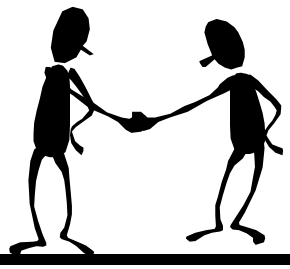
The major areas of opportunity identified by the Albuquerque Printers Task Force for reducing metals and chemical discharges from photoprocessing facilities include the following:

Major Areas of Opportunity include:

1. Better understanding of the technologies and the capabilities of on-site metal recovery equipment and procedures.
2. Written, standardized procedures for operation and maintenance of the processing and metal recovery equipment, and collection and storage of materials for recovery.
3. Better analytical tools for measuring metals concentration.
4. Training programs for operators and maintenance personnel.
5. Improved record keeping. Know what you use and throw away.
6. Equipment and process inspection and spill control plans.
7. Process modifications to minimize metal and chemical discharges.
8. Translation of training materials and procedures into languages other than English.

This Code of Practice identifies Best Management Practices (BMPs) for printers. This Code could be implemented by any POTW to assist businesses and to assure compliance with EPA and State discharge limits. The Code can also be implemented as part of a pretreatment program to include a pollution prevention program component. The guidelines can then be implemented by businesses who will then be certified and given annual recognition certificates under the Program.

Participation is voluntary, but the alternative is to face potentially more direct regulation through permitting, discharge reporting, etc. Avoiding this regulatory alternative is in everyone's interest. The goal of the Code of Practice concept is to achieve results through voluntary compliance which will ensure that the City's wastewater discharge to the Rio Grande is environmentally acceptable.



Avoiding this regulatory alternative is in everyone's interest.

POLLUTION PREVENTION PROGRAM

A non-regulatory, technical assistance program for businesses on the latest waste reduction methods and technologies

WHAT IS POLLUTION PREVENTION?

Pollution prevention is the use of materials, processes or practices that reduce or eliminate the creation of pollutants at their source. This includes: equipment modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control that results in reduced waste generation. Even though recycling, energy recovery, treatment, and disposal are not included in this definition, some forms of "in-process" recycling may qualify as pollution prevention.

HOW THE POLLUTION PREVENTION PROGRAM WAS CREATED:

In September of 1992, the City of Albuquerque received a 2 year Pilot Program grant from the United States Environmental Protection Agency and the New Mexico Environment Department to initiate a technical assistance Pollution Prevention (P2) Program for industries within the City. The Pilot Program encouraged a permanent program within the Wastewater Utilities Division of the Public Works Department. The goal of the Program is to assist the industrial community in eliminating pollution through the use of source reduction techniques and technologies. If pollution is reduced, industries and the City spend less time and money on waste treatment, disposal and regulatory compliance.

WHAT THE PROGRAM DOES:

The City of Albuquerque owns and operates New Mexico's largest municipal wastewater treatment plant: the Southside Water Reclamation Plant. This facility is capable of receiving and treating 76 million gallons of domestic wastewater on a daily basis. The Plant services more than 400,000 people, 100 permitted industries and over 10,000 commercial accounts. Reduction of wastewater pollutants at their source eliminates the need for treatment and disposal, and results in smoother operations, helping to maintain compliance with the City's discharge to the Rio Grande, and provides a cleaner environment.

THE PROGRAM:

Pollution prevention assistance can range from supplying information on vendors of a particular chemical or piece of equipment, to conducting a detailed on-site waste reduction assessment of an industrial facility. During a waste reduction assessment the pollution prevention team look to source reduction and pollutant elimination as the primary methods of reducing waste generation and the need for waste disposal. Techniques like water recycling can sometimes achieve significant cost savings over a short period of time. In many assessments it is determined that hazardous materials can often be replaced by less or non-hazardous substitutes.

THE POLLUTION PREVENTION STAFF:

The Pollution Prevention Program staff consists of one environmental engineer, two full-time waste minimization specialists, two technicians, and one intern all with experience in industrial processes and waste reduction methods. Pollution Prevention Program staff are available to assist industries in implementing pollution prevention activities within their facilities.

OPPORTUNITIES TO SAVE MONEY:

Since the Program's inception in September of 1992, the Pollution Prevention Program has assisted more than 100 businesses in understanding and making use of the latest developments in pollution prevention and waste reduction. These businesses have saved money by eliminating costly waste treatment and disposal problems and stringent regulatory requirements associated with waste management.

VOLUNTARY COMPLIANCE GOAL:

Participants are encouraged to consider the Best Management Practices mentioned in Codes of Practice as developed for different types of businesses. Codes of Practice will be developed with the help of businesses and be in line with national and local regulations and guidances where available. This is intended to be a voluntary compliance program insofar as legally permissible. Formal wastewater discharge regulation through discharge permits issued by City's Wastewater Pretreatment Unit will be needed only where legally required or for those parameters found to be in violation of the City's discharge to the Rio Grande.

RECOGNITION AWARDS:

The Pollution Prevention Program has recognized more than 100 industries for their commitment to reduce silver discharges. These businesses were awarded with the 5PPM Silver Program certificate. A Pollution Prevention certificate has also been developed to recognize business' which have implemented facility wide pollution prevention plans.

5 PPM SILVER PROGRAM

A non-regulatory recognition program awarding businesses for their efforts to voluntarily meet the City's 5 parts per million discharge requirement

GOAL: To reduce facility total silver discharge to 5 parts per million (mg/L) or lower

The 5 PPM Silver Program is a joint effort of the City of Albuquerque and the New Mexico Silver Users Association (NMSUA). The program relies on voluntary compliance to reduce the amount of silver being discharged into the City's sewer system.

How the Program Functions:

1. The City of Albuquerque's Waste Minimization Program and NMSUA will provide information and assistance on how to reduce silver discharges.

2. To be considered for the program:
   A. The facility (e.g. jewelers, photoprocessors, printers, etc.) must, in some manner, utilize silver that results in a potential waste (suppliers are welcome).
   B. The facility should have or be prepared to implement and maintain an appropriate silver reduction plan necessary to maintain a silver discharge at or below 5 ppm.
   C. Records must be kept showing that the silver recovery/reduction equipment/program is being maintained properly and that the recovered/spent material is being reclaimed or disposed of properly.

The facility should obtain and file the manifests or receipts and EPA ID numbers (where necessary) of the reclaimer, recycler or disposal service.

   D. Businesses must fill out the 5 PPM Silver Program Application (one page, see next page)
   E. Site visits will be conducted by the City to determine facility compliance. Sampling will determine silver discharge levels.

3. Those facilities meeting the above criteria and complying with the 5 ppm discharge requirement will receive a certificate of recognition. Any facility not maintaining the 5 ppm standard will loose this certificate, but the City will work with the business to find an appropriate method to reduce silver discharge.

All businesses participating in the program will be sampled annually and recertified, as necessary. The Program has over 100 participants and is growing. Many businesses advertise their commitment to Pollution Prevention in their Yellow Pages and other advertisements.

The New Mexico Silver Users Association encourages public patronage of 5 PPM Silver Program members.

Businesses can apply through the NMSUA by writing to:
NMSUA, PO. Box 25801, Albuquerque, NM 87125-0801, or contact the Waste Minimization Program at (505)873-7004 for additional information.

Or you can fill out and mail the following, attached application.

PRINTING/PHOTOPROCESSING
5 PPM SILVER PROGRAM APPLICATION

Jointly sponsored by New Mexico Silver Users Association
and the
City of Albuquerque -Public Works Department/Wastewater Utility Division
Pollution Prevention Program

Business Name: _____

Business Address: _____

City: _____ State: _____ Zip: _____

Telephone: _____ Fax: _____

How many years at present location: _____

Business Contact: _____

Title: _____ Phone: _____

Business Type:
(check all
that apply)

- ❍ Commercial Printing
- ❍ Graphic Arts
- ❍ Medical Practice
- ❍ Commercial/Photo Lab
- ❍ Printing
- ❍ Professional Photo Studio
- ❍ Dental Practice
- ❍ Other _____

Processing Type:
(Check all
that apply)

- ❍ Color Film &/or Paper
- ❍ Dental X-Ray
- ❍ Movie Film
- ❍ Slide Film
- ❍ Microfilm
- ❍ Medical X-Ray
- ❍ B&W Film &/or Paper
- ❍ Non-Destructive Testing X-Ray
- ❍ Research Radiography
- ❍ Other _____

WASTE MINIMIZATION PRACTICES

1. Does your business use any of the following silver recovery equipment (i.e. metallic replacement cartridge(s), electrolytic unit(s), or other methods)? If so please list:

   _____

   _____

2. If your business does not use any silver recovery equipment, is any silver bearing waste delivered or picked up for silver recovery? Please list who accepts the silver bearing waste and what is done with the waste:

   _____

   _____

3. Please estimate how much fix/bleach fix your business uses monthly or annually (on average), and which are your peak production month(s):

   _____

   _____

AGREEMENT

I understand that membership in the 5PPM Silver Program requires this business to adhere to the following code of practice:

A. The business should have or be prepared to install and maintain appropriate equipment or business practices in order to maintain a silver discharge under 5PPM.

B. Records should be kept showing that silver recovery equipment is being maintained properly and that materials are being reclaimed or disposed of properly.

C. Businesses that do not use any silver recovery equipment should keep records of where material is sent for reclamation or disposal.

D. Inspections will be conducted by the City to determine facility performance. Free wastewater samples may be taken on an annual basis to determine silver discharge levels.

I believe that the information herein is true, accurate, and complete.

Print Name	Title
Signature	Date

Mail this plan to:

Waste Minimization Program
5 PPM Silver Program
COA - PWD/WWUD - Pretreatment Unit
4201 Second ST SW
Albuquerque, NM 87105
(505)873-7004

P2 Information

Printing can generate a variety of byproducts and recoverable materials. Some common types may include:

- Solvents
- Solvent/ink saturated rags and wipes
- Spent photographic fixers/rinsewater
- Acid, alkaline, high VOC cleaning solutions
- Recoverable metals (e.g. aluminum plates)
- Chlorofluorocarbons (CFCs)
- Waste Film and Papers
- Inks
- Obsolete/outdated stock
- Fountain Solutions

❑ Introduction to Pollution Prevention

Although it has become a catch phrase, pollution prevention is an integral facility process. Many printers have been practicing pollution prevention for years. Good housekeeping and inventory management, production optimization, recycling, recovery and reuse are all methods of pollution prevention. What pollution prevention does is take these ideas and place them under a single heading, but this does not diminish the practices already in use by many printers.

Pollution prevention involves questioning and reviewing every facility process, the chemicals and the associated procedures. The ultimate questions that should be asked are:

'Am I doing this process this way simply because I've always done it this way?'
and;
'Is there a better, less polluting and potentially less expensive, way of doing this process?'
The answers will often be yes.

Pollution prevention consists of waste management approaches that reduce the amount of waste materials generated or requiring disposal. Pollution prevention can reduce the amount of hazardous and non-hazardous wastes generated in your business.

This benefits businesses by minimizing:

- disposal costs
- cost of future liabilities
- transportation costs
- off-site treatment costs
- worker safety costs
- fees and taxes
- insurance costs
- current operating costs (e.g., raw material costs)
- regulatory compliance costs (record keeping, reporting, tracking, lab costs, etc.)

❑ The Hazardous Waste Generator Fee

The New Mexico State Environment Department, Radioactive and Hazardous Waste Bureau, has implemented a hazardous waste generator fee. A fee is charged on all small quantity (SQG) and large quantity generators (LQG), but conditionally exempt small quantity generators (CESQG) are not required to pay the fee. This is one reason why it is important to determine and document your generator category. By becoming and maintaining a CESQG status you are exempt from much of the hazardous waste regulations and the State's fees (see Reference Materials, Appx. ??).

Additionally, pollution prevention can increase business productivity and employee safety, improve environmental protection, and enhance community relations. These benefits may be realized by a business by implementing the following pollution prevention methods:

Source Reduction: is an activity that prevents or reduces the generation of waste materials that may otherwise be released to air, land or water. Examples include: substituting input material or changing production processes to reduce the amount of waste generated. A good example is the substitution of a solvent with a water based cleaner. This not only reduces the VOC content in the facility but also increases employee safety and can often reduce material cost.

Recycling: is the use, reuse, or reclamation of materials. Examples include: employing on-site or off-site techniques to remove contaminants from a waste stream so that the regenerated material can be reused. A good example is silver recovery from spent fixers. Silver recovery should be a common practice in printing and instead of disposing or discharging the spent fixers, which removes the silver from future use, the silver can be recovered, reclaimed and reused.

NOTE:

Silver scrap and flake recovered from electrolytic units and all recovery cartridges should be triple rinsed to remove any residual fixer. This is the photoprocessing industry's standard procedure and will reduce the possibility of the material being considered a hazardous waste. Fixers are considered hazardous when they contain more than 5 mg/L (ppm) of silver.

To be successful, a pollution prevention program must be organized. It is not hard to organize a pollution prevention program, but you will need to spend some time to get started. While conducting your self-assessment keep in mind the following principles:

❑ Principles of Pollution Prevention

A Facility owners/managers must be committed to pollution prevention for it to work.

B A pollution prevention program should include specific written goals and objectives.

C Identify your wastes. Are they hazardous or non-hazardous?

D You should know how your materials and wastes are managed and the associated costs.

E Train all employees in waste handling and pollution prevention methods.

F Be aware of the waste regulations that apply to your business.

G Make pollution prevention an integral part of all facility processes, not just a folder on your desk.

The following chart shows the basic steps you can use in implementing a pollution prevention program in your business.

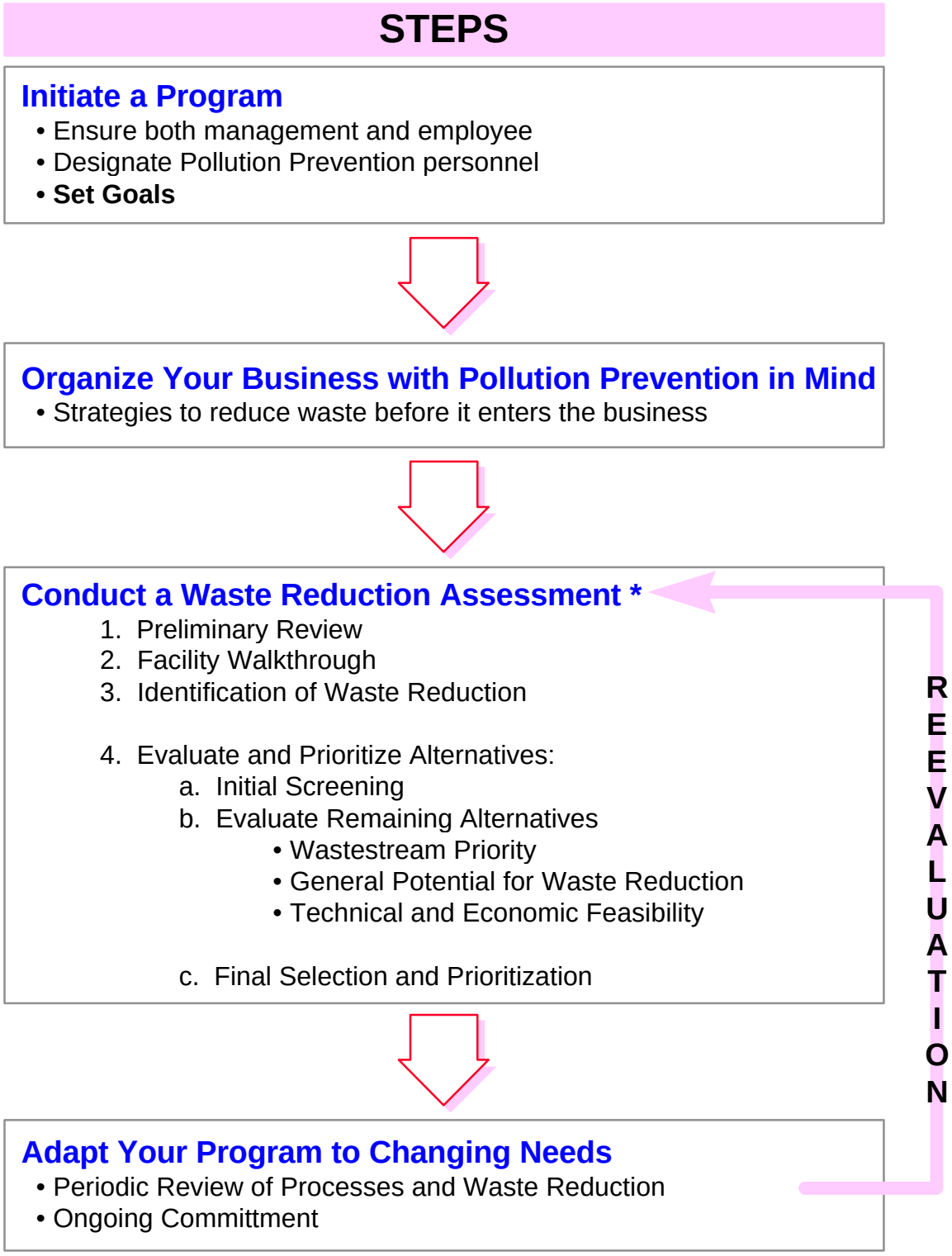


Figure 1. Pollution Prevention Program Steps

- Contact the Pollution Prevention Program (P2) at 873-7059 or 7058 for assistance in conducting a waste reduction assessment. P2 assistance is non-regulatory and free.

❑ Liability

Pollution prevention can be conducted in several areas of a business. These areas pose differing levels of liability. The more a business does to reduce the amount of wastes generated the less liability for the business. On the other hand, the more wastes a business sends to disposal the greater the business liability. The different areas are:

A Inventory Management - buy only what you need to reduce out dated stock chemicals. Rotate stock to use chemicals in date sequence. Check delivered stock for damage to reduce spills and to return damaged stock.

B Production-Process Modification - Modify the manufacturing process to reduce waste. Simple quality and process checks can reduce the amount of wastes generated.

C In-Process Recovery and Reuse - Increase the amount of materials recovered and reused within the facility process.

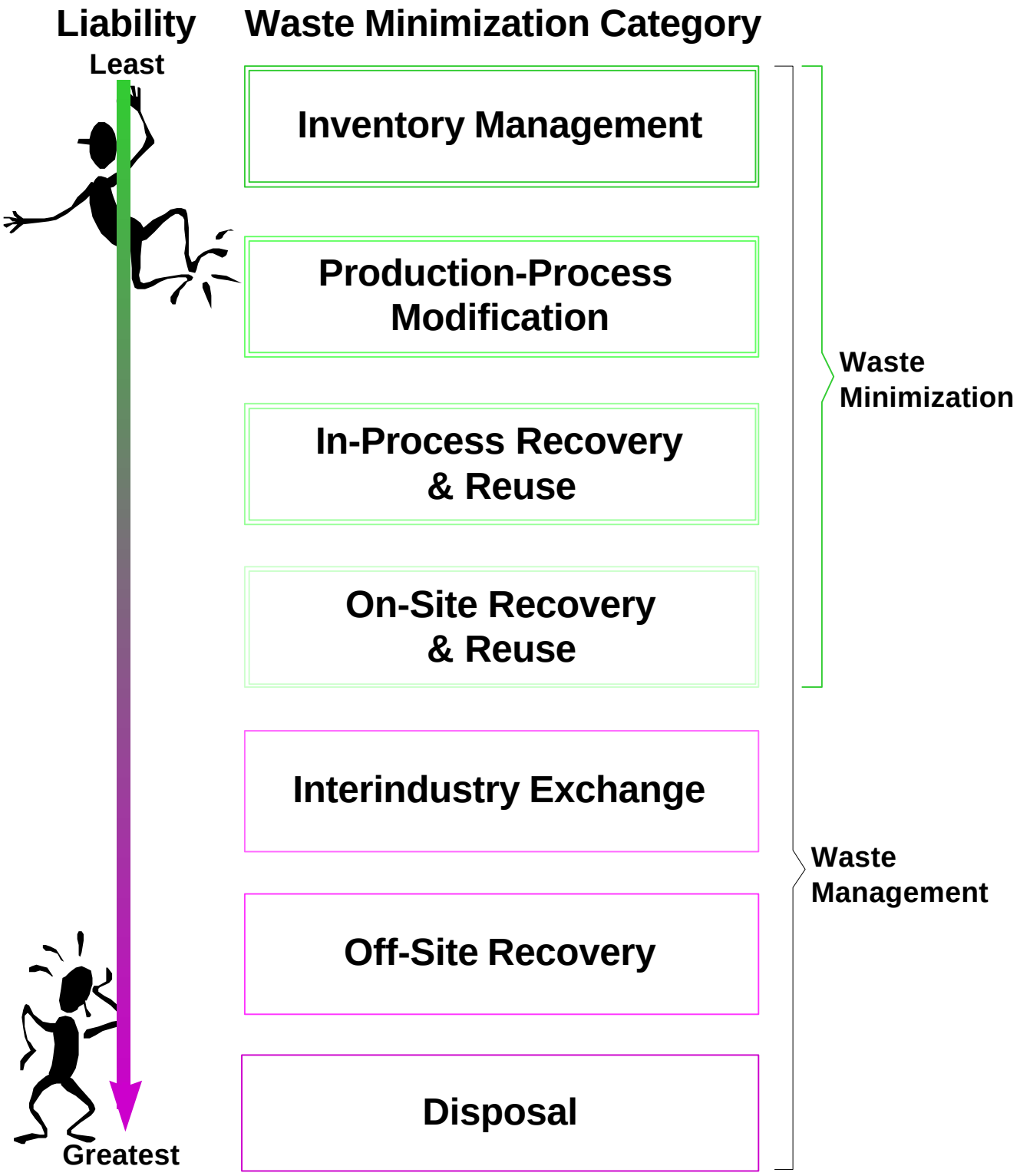
D On-Site Recovery and Reuse - Increase the amount of materials recovered and reused within the facility.

E Interindustry Exchange - Waste materials can be exchanged between businesses. One business' waste material may be another's raw material. Materials traded are usually in very large quantities such as tons or railroad car volumes.

F Off-Site Recovery - Sending materials for off site smelting, refining and recovery, etc.

G Disposal -Sending materials off-site for disposal as hazardous waste. Due to strict regulations hazardous waste disposal carries the greatest level of liability. Disposal is not considered a waste reduction method, but can be an associated process when materials are disposed of properly after waste reduction or recovery techniques have been used.

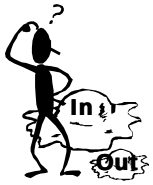
The following chart shows the differing levels of liability by pollution prevention procedure.



(Adapted from 'Standard Handbook of Hazardous Waste Treatment and Disposal', McGraw Hill, Harry Freeman, Editor in Chief, 1989)

Figure 1. Liability Issues in Waste Management

❑ Assessing Your Pollution Prevention Opportunities



These checklists will help you perform a pollution prevention assessment. The objective of this assessment is to identify ways to reduce or eliminate waste, or recover materials, through a careful review of your facility operations and waste streams. After selecting a specific area, or areas, to focus on in your pollution prevention efforts, a number of options should be developed and evaluated. Then, evaluate the technical and economic feasibility of the selected options. Finally, select the most promising pollution prevention options for implementation.

Useful Questions:

1. What are the recoverable materials and/or hazardous and non-hazardous wastes, and from what processes are the materials/wastes, generated? What are the volumes generated?
2. Which wastes are hazardous and which are not? What makes these wastes hazardous?

NOTE: Silver scrap and flake recovered from electrolytic units and all recovery cartridges should be triple rinsed to remove any residual fixer. This is the industry standard procedure and will reduce the possibility of the material being considered a hazardous waste. Fixers are considered hazardous when they contain more than 5 mg/L (ppm) of silver.

3. What are the input and the processed materials used which generate the wastes of a particular process?
4. How much of a particular input material is used in the process?
5. What are the raw material process losses?
6. How efficient is the process?
7. Are unnecessary wastes generated by mixing recyclable wastes with other process wastes, especially with hazardous wastes?
8. What housekeeping practices are used to reduce the amount of waste generated?
9. What process controls are used to improve process efficiency?
10. What are the facility's current hazardous and non-hazardous waste disposal costs (including disposal fees, permit fees, raw material purchases, etc.)
11. Are you mixing hazardous wastes with non-hazardous wastes? This is extremely important. If you mix hazardous wastes with non-hazardous wastes you are increasing the amount of hazardous waste you pay to have disposed. You should be segregating your hazardous and non-hazardous wastes to reduce your disposal costs. This means that you should also be familiar with your wastes and understand what constitutes a hazardous waste.

Keep it Non-Hazardous **Keep it Non-Hazardous** **Keep it Non-Hazardous** **Keep it Non-Hazardous**

See Appendix E. Consistent Compliance is Essential, and Appendix F. Hazardous Waste Information, for additional material.

Contact the Pollution Prevention Program (P2) at 873-7059 or 7058 for additional assistance or information.

❑ Checklists

Complete the following pollution prevention checklists to see if your business is maximizing pollution prevention techniques.

❑ Management Practices

1. Does your facility have an established pollution prevention program in place? ❍ **Yes** ❍ **No** Is a specific person or committee assigned to oversee the success of the program? ❍ **Yes** ❍ **No** Does the program have set pollution prevention goals? ❍ **Yes** ❍ **No**	If there is enough staff available, a committee may be more successful than a single person. One person is not always available when necessary, could leave the company or otherwise be absent, and may not have the expertise in all necessary areas. Pollution prevention programs are more successful if they contain written pollution prevention elements, especially written goals.
2. How frequently are overall material balances for the facility performed?	In order to accurately assess your pollution prevention efforts, you must keep track of the raw materials entering and the products and wastes leaving your processes.
3. Are there employee education programs on how to avoid excessive waste generation? ❍ **Yes** ❍ **No** How often are the training programs offered?	You can reduce the amount of waste generated by spills if you train employees to properly handle and store hazardous and other wastes. Some trade associations and local environmental health agencies sponsor employee training seminars and some consulting firms offer employee training as part of their package of services.
4. Are you fully aware of the current local, state, and federal regulations related to hazardous material storage, treatment, disposal, and recycling? ❍ **Yes** ❍ **No**	Compliance with existing laws and regulations is helpful to a good pollution prevention program. See Reference Manual, Appendix E. PMA Information and Appendix F. Hazardous Waste Information when reviewing waste generation.

5. Has your facility conducted an environmental assessment to determine regulatory compliance? ❍ **Yes** ❍ **No**	Assistance is available for any concern. See City and State references in Appendix B, or call the City of Albuquerque's Pollution Prevention Program at 873-7004.

❑ Material Management Practices

Are all materials tested for quality before being accepted from suppliers? ❍ **Yes** ❍ **No**	Materials should be inspected before being accepted, and unacceptable or damaged materials should be returned to the manufacturer or supplier. This avoids both disposal of a nearly full container of unusable material and printing an unacceptable product.
Are expired age-dated materials tested for effectiveness before being disposed of? ❍ **Yes** ❍ **No**	Materials having expired shelf-life should not automatically be thrown out. Instead, this material should be tested for effectiveness. The material may be usable, rather than becoming a waste. A recycling outlet should be found for left over raw material that is no longer wanted.
Is obsolete raw material returned to the supplier? ❍ **Yes** ❍ **No**	When & where possible
Is paper stored in a humidity and temperature-controlled area? ❍ **Yes** ❍ **No**	Sheetfed paper should be conditioned to the temperature and humidity of the press room for one day before printing; this requires additional space in the press room.
Is inventory used in first-in, first-out order? ❍ **Yes** ❍ **No**	Inventories should be kept using the "first-in, first-out" practice. This will reduce the possibility of expired shelf life. This practice may not work for specialty materials that are seldom used. For large inventories computerized systems can track the amounts and ages of the raw materials.
Does the current inventory control system adequately prevent waste generation? ❍ **Yes** ❍ **No**	To prevent raw material contamination, the storage area should be kept clean. Also, the storage area should not be open to through traffic. Through traffic will increase dust and din in the storage area, increasing possible contamination. In addition, spills in the storage area will be easier to contain if traffic is restricted.

Is there a formal personnel training program on raw material handling, spill prevention, proper storage techniques, and waste handling procedures? ❍ **Yes** ❍ **No** Does the program include information on the safe handling of the types of drums, containers and packages received? ❍ **Yes** ❍ **No** How often is training given and by whom?	Formal training aids in reducing spills and properly prepares employees for spill control.
Are stored items protected from damage, contamination, or exposure to rain, snow, sun and heat? ❍ **Yes** ❍ **No**	Protecting stored items can decrease contamination and improve material life and usability.
Does the layout of the facility result in heavy traffic through the raw material storage area? ❍ **Yes** ❍ **No** If no, Can traffic through the storage area be reduced? ❍ **Yes** ❍ **No**	Heavy traffic increases the potential for contaminating raw materials with dirt or dust and for causing spilled materials to become dispersed throughout the facility. To prevent raw material contamination, the storage area should be kept clean. Also, the storage area should not be open to through traffic. Through traffic will increase dust and din in the storage area, increasing possible contamination. In addition, spills in the storage area will be easier to contain if traffic is restricted.
What measures are employed to prevent the spillage of liquids being dispersed? When a spill of liquid occurs in the facility, what cleanup methods are employed (e.g., wet or dry)?	Proper handling process materials can reduce contamination, spillage and waste. Use dry methods whenever possible and where safety allows.
Do you try to order smaller containers of infrequently used materials to avoid disposing of large quantities of unused obsolete materials? ❍ **Yes** ❍ **No** Have you tried to order larger containers of frequently used materials to reduce the number of small containers that must be cleaned and disposed of? ❍ **Yes** ❍ **No**	Raw material order quantities should be matched to usage. Small printers should order ink in smaller containers according to use. This avoids having a large, partly used container of ink going bad in storage because it wasn't properly sealed. Residual ink in sheetfed ink cans should be smoothed and covered in order to prevent loss by skinning. Large printers should order materials in large containers, which may be returnable, thereby eliminating or reducing the need to clean them. It takes less time to scrape out the large single container than several small ones. Ordering materials in returnable tote bins may maximize these advantages. However, the size of container chosen by the printer is

	determined by economics of volume as well as consideration of waste minimization.
Are all empty bags, packages, and containers that contained hazardous materials segregated from those that contained non-hazardous wastes? ❍ **Yes** ❍ **No**	REMEMBER: Do not mix hazardous with non-hazardous wastes. See Appendix F. Hazardous Waste Information

❑ Production Management

Production management involves proper scheduling to reduce the need for equipment cleaning, and dealing with management practices, such as employer/employee relationships, that may have an influence on the amount of waste generated.

1. Are sequential operations adjacent to each other? ❍ **Yes** ❍ **No**	Sequential operations should be adjacent to avoid excess material handling. This reduces the potential for material and precious metal losses and reduces accidental spills.
2. Are process solutions prepared by trained personnel? ❍ **Yes** ❍ **No**	You can often minimize waste and improve the consistency of process solutions by assigning a limited number of properly trained personnel to mix chemicals/materials.
3. Does your facility maintain dust collectors and fans in proper working condition? ❍ **Yes** ❍ **No**	Dust collectors and ventilation fans should be maintained in top working condition. Good maintenance practices will reduce health risks and allow better collection of airborne particles.
4. Does your facility have a formal facility inspection plan? ❍ **Yes** ❍ **No**	Regular inspections of your facility's storage, waste treatment, and production areas will help maintain optimal production and identify equipment and process malfunctions early. This will help you identify equipment and process problems early and provide time to correct problems before a small problem becomes a major issue.

❑ Spill Control

Spill control is especially important for printers because of the value of the silver used and the concentration of silver in their process solutions.

1. Does your facility conduct equipment inspections on a routine basis to identify leaks or equipment malfunctions? ❍ **Yes** ❍ **No**	Routine inspections of your shop's production, storage, and waste treatment areas should be conducted on a daily basis to identify leaks and malfunctioning equipment. Identifying problems at an early stage helps reduce spills and other uncontrolled releases.
2. Do you have procedures in place to handle leaks or spills? ❍ **Yes** ❍ **No**	Fire departments require spill containment, and material segregation of reactive materials, around storage areas to minimize the spread of any spilled material. Ensuring a quick and proper response to leaks and spills can help you reduce waste generated by the cleanup of spills. Keep an emergency spill plan available and educate employees in its use. Training your employees also satisfies legal requirements. See Reference Manual, Appendix H. Hazardous Materials Emergency Response Plan.

❑ Guidelines for a Spill Control Plan

It is a good idea for any business handling materials which are or may be considered hazardous to have a spill control plan. If a business is unable to contain a spill and it is discharged into the sanitary sewer or storm drain, released into the air, or spilled on the ground it is very important to notify the proper authorities. By preparing and filing your Spill Prevention Plan (with the Fire Department, see Appendix H) you will be fulfilling part of the requirements under RCRA (Resource Recovery and Conservation Act) Hazardous Waste Reporting (see Appendix F) and under the Superfund Amendments and Reauthorization Act (SARA) community right to know. Following are some general spill control procedures:

A **Be prepared** with onsite equipment/material to handle spill and have a written plan.

B **Isolate** the spill area and limit entry.

C **Notify** the proper authorities: During the work week (Mon-Fri, 8AM to 5PM) call the Industrial Waste Engineer at 873-7004. On weekends, holidays, and after hours telephone notification can be made at 873-6217.

D **Equip** trained personnel with PROPER personal protective equipment

E **Identify** the material and quantity spilled and select an appropriate approach (see MSDS or 1994 Emergency Response Guidebook for guidance).

F If the spill is treated on site, dispose of the spill in accordance with federal, state, and local regulations.

Accidental spills happen fast and without warning so it is also important to have spill control equipment available. Businesses have to determine what spill control method is best for them. The following are some methods/treatments a business can use for spill control including sorbents, treatment agents, or hazardous material vacuums for spills.

Sorbents. Materials that soak up liquids through absorption or adsorption. Sorbents come in particulate, sock, or pillow form. Depending on the spilled material the sorbents may be considered hazardous after the spill has been cleaned up.

Treatment Agents. Usually available for acid, caustic, or solvent spills. They come in dry powder form and are shaken, poured, or sprayed onto a spill. When used properly these agents will neutralize and solidify spills.

Hazardous Material Vacuums. Vacuums can be used to clean up dry chemical spills or to collect and contain virtually any dry pollutants.

Remember: Every time you clean up spilled hazardous material the cleanup material becomes hazardous as well. The best method to reduce the amount of hazardous waste you generate is to eliminate the hazardous material or at least work towards eliminating accidental spills.

Example:

Mr. Spillalot was thinking about the double decker chocolate cake he had waiting for him at home as he pushed a 55 gallon drum of nitric acid around the shop he worked in, Axidentsrus Inc. Suddenly Mr. Spillalot tripped! The acid spilled, and slowly began creeping towards a drain in the floor. Fortunately Mr. Spillalot's boss a had written spill control plan. Mr. Spillalot remembered his training and looking around he spotted hanging on the wall a piece of paper that said Spill Control Plan.

'Boy, thought Mr. Spillalot, I am sure glad my boss is efficient!!!' After he finished following the instructions on the paper, and properly containing and cleaning up the spill, he began thinking about the macaroni casserole his wife was making him for dinner.

(see Appendix F. Hazardous Waste Information, Preparing for and Preventing Accidents).

Spill Control Plan

Equipment Required

- ❑ Gloves
- ❑ Apron
- ❑ Goggles
- ❑ Bucket
- ❑ Mop
- ❑ Sponges
- ❑ Absorbent Material
- ❑ Neutralizing Material

Spill Response Procedures

1. Put on Gloves, Goggles and an Apron
2. Contain the spill with a mop or absorbent materials available. Do not allow material to reach floor drains.
3. Check the appropriate material safety data sheet (MSDS) for special handling, ventilation, personal protection, or other pertinent data.
4. Clean up the spill as directed
5. Use the mop and sponge to clean the area thoroughly.
6. Package and label all contaminated absorbent materials for off-site disposal.
7. Notify the manager/owner that a spill has occured (see below).
8. Notify the appropriate government agency (see below).

Spill Response Personnel

name	pager/phone
Mr. Doright, Manager	555-5765/555-5655
Mr. Knowenough, Owner	555-5235/555-5755
Ms. Authorizer, City Waste	555-5895

(Form adapted from: "Code of Management Practice: Guide for Commercial Imaging", The Silver Council, 1997, National Association of Photographic Manufacturers, Inc., page 32.

Section 1

PRINTING INFORMATION

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- ❑ Wastestreams Typical of the Commercial Printing Industry 1:1
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- ❑ Photoprocessing Materials Which are of Concern 1:2
- ❑ Printing and Finishing Inks 1:4
- ❑ Printing Process Checklists 1:5

❑ Wastestreams Typical of the Commercial Printing Industry

- Waste photochemical solutions and films (for example, some negative developers for lithography are classified as hazardous as products and may also be hazardous as wastes under state regulations)
- Waste inks containing hazardous components (often metallic pigments and solvents)
- Ink and solvent contaminated rags used for cleaning
- Lubricating oils from machinery

❑ The Photographic Process

Silver-based photographic materials consist of solid crystals of silver chloride or silver bromide suspended in gelatin and coated on a film or paper support. The processing of photographic films and papers consists of three steps:

1. development of the image;
2. removal of some or all of the silver; and,
3. stabilizing the image by rinsing residual thiosulfate and silver-thiosulfate complexes out of the emulsion layers with water. In the case of washless processing, a stabilizer solution replaces the water.

Black and White Film Processing

Black-and-white photographic materials include X-ray films, graphic arts films and papers, and microfilms, as well as black-and-white motion picture films and professional films and papers. After processing, the image in these materials is metallic silver. In the non-image areas, the remaining solid silver chloride or silver bromide crystals are removed as a soluble silver-thiosulfate complex in a solution called fix. In black-and-white products, about 40% of the silver will remain in the film or paper as the metallic silver image.

Color Film Processing

Color photographic materials include the majority of amateur and professional films and papers and motion picture films, along with some graphic arts products. During development, metallic silver is coupled to the dye. This metallic silver is then converted to crystals of silver bromide or silver chloride by a solution called a bleach. After the bleach step, the silver chloride or bromide is removed as a soluble thiosulfate complex in a fix solution. In some paper processes, the bleach and fix baths are combined into a single solution called a bleach-fix. In color products, virtually no silver remains in the film or paper after processing.

❑ Silver Recovery

Prior to using a silver recovery method, the combined silver-rich solutions resulting from the development of photographic materials will contain between 2,000 and 8,000 mg/L (2 to 8 grams per liter) of silver. This concentration will vary even within the same facility and process. While being considered a precious metal, silver is also a regulated pollutant. The City of Albuquerque requires that wastewater discharge not contain more than 5 mg/L silver and the predominant method of meeting this requirement is to use silver recovery equipment or a reclamation company.

By removing silver rich solutions from your waste stream you:

- Reduce your liability in meeting wastewater discharge requirements
- Reduce your liability by reducing your hazardous waste handling costs and meeting hazardous waste requirements (silver bearing wastes are considered hazardous wastes.
- Possibly increase your business revenues by returning money to your business

City of Albuquerque studies have found that a consistent discharge of less than 5 mg/L can be achieved at the process discharge point, and can typically be done cost effectively (see Appendix D. Case Studies). While existing City regulations require the facility discharge meet Sewer Use Ordinance limits, it is feasible that future discharges may be required to meet these limits from the process discharge point (i.e., from where the equipment discharges to the sewer system).

NOTE: Dilution is not a valid method of reducing the silver concentration of your photographic solutions. Dilution only increases the volume of the waste and does nothing to reduce the amount of silver being disposed or discharged.

❑ Photoprocessing Materials which are of Concern

Heavy Metals

Heavy metals include cadmium, chromium, cobalt, copper, gold, iron, lead, manganese, mercury, molybdenum, nickel, silver, and zinc. Many of these heavy metals are regulated due to their potential toxicity (see Reference Materials, Appendix F Hazardous Waste Information). In addition to silver, some photosensitive materials and cleaners may contain small amounts of certain heavy metals. The following is a description of certain regulated heavy metals and other materials that may be found in photographic materials and/or cleaners:

Silver	Silver compounds are the basic light-sensitive material used in most photographic films and papers. Processing solutions will contain silver because the silver will be dissolved by fix and bleach-fix solutions, or it leaches from the film during processing. No silver is used as a component of the solutions themselves. After silver is removed from the photographic films, the silver is carried out in the fix/bleach-fix solution and in smaller amounts from wash water, usually in the form of a silver thiosulfate complex. Much of the silver in the silver thiosulfate complex can and should be recovered.

Chromium	Some bleaches used in black-and-white reversal processes, and some system cleaners, contain chromium compounds. Hexavalent chromium is harmful and should not be discharged to the sewer system.
Zinc	Zinc is present in the effluent of a few color photographic processes.
Cadmium	Cadmium is present in only a few black-and-white films. Cadmium is potentially toxic and should not be discharged to the sewer system.
Selenium	Selenium based toners should not be discharged to the sewer system. If selenium is at 1 ppm (mg/L) concentration then the material is considered a hazardous waste, must be handled as a hazardous waste, and cannot be discharged to the sewer.
Other Materials	
Cyano Complexes	Unlike free cyanide, ferro- and ferricyanide ions (also known as hexacyanoferrates) have a low level of toxicity. Bleaches that contain hexacyanoferrates are used in only a few photographic processes. Since cyanide is present, although it is complexed, it is important to reduce the use or cyanide concentration of these bleaches. The City's industrial wastewater analysis does not differentiate between complexed cyanide compounds (such as hexacyanoferrates) and free cyanide, but rather combines the two and analyzes for 'total cyanide.' Cyanide compounds should not be discharge to the sewer system.
Hydroquinone	Hydroquinone is commonly used in photographic developers as a reducing agent for silver. Tests have shown that hydroquinone can be toxic to some organisms at relatively low concentrations. Fortunately, hydroquinone is used in very low concentrations, and small concentrations are readily degraded to innocuous products.
Ammonium	Ammonium fixers are a source of high concentrations of ammonium ions. When discharged to a treatment plant some ammonium will be carried through the plant and will be discharged to the receiving river. In the river the ammonium can be oxidized to nitrates and possibly free ammonia. Due to strict regulations the City's treatment plant must remove nitrates prior to discharging to the river and must regulate industrial discharges of ammonium, ammonia, and nitrates.
Phosphates and Nitrates	Metaphosphates are used as sequestering agents in some processing solutions to minimize sludging. A few processing solutions contain trisodium phosphate or other phosphates as buffers. Only a few processing solutions contain nitrates and are often in very small concentrations.
Solvents [See Section 6, Solvents]	Solvents, including xylene, 1-1-1 trichloroethane, alcohols, acetone, etc. should not be discharged to the sewer system. Many solvents are explosive, can react with other materials in a sewer system, and can damage the biological processes used in waste treatment systems. You should review your solvents and their use. Less/non-hazardous alternatives are typically available and you should consult your supplier for a list of alternative solvents or contact the Pollution Prevention Program to research alternatives. Often, the solution is as simple as replacing alcohol with deionized/demineralized water. Since the DI water does not have salts the water will dry without spotting.

(This table detailing photoprocessing materials was adapted from Disposal and Treatment of Photographic Effluent, Publication No. J-55, Eastman Kodak Company, 1989.)

❑ Printing Checklists

Silver recovery is the predominant method printers have to reduce the amount of silver being discharged from their business. This section begins with the printing checklists which refer to additional information following the checklists. The checklists are designed to assist you in detailing your process(es) and will direct you to information concerning your process types and waste volumes.

If you are a printer, it is recommended that:

A You begin by completing the checklist.
B From the checklist you will begin to see the options developed for, and the concerns that exist about, your process type.
C After completing the checklist you can then reference additional material for more detailed information concerning silver recovery, etc.

The following checklists and information sets out to:

A Explain the options that you, as a printer, have available to reduce your silver discharge.
B Meet or exceed and maintain discharge requirements, thus reducing your interaction with government regulators.
C Reduce or eliminate the need to dispose of silver bearing wastes. Doing so reduces or eliminates the liability your business faces by handling your wastes as hazardous materials.
D Help you recover silver which can then be sold and the money returned to your business.

Checklist	Comments	Refer to
1. Do you process film? ❍ **Yes** ❍ **No** Is silver removed and recovered from photoprocessing waste streams? ❍ **Yes** ❍ **No** Is silver recovery done onsite? ❍ **Yes** ❍ **No**	Silver can be reclaimed and recycled from all photoprocessing fixer solutions. Fixers typically have a large amount of dissolved silver which makes the waste fix a hazardous material and a material that should not be poured down the drain. If you do process photographic films you should consider installing recovery equipment or collecting the waste fix and take it to a local recycler, or contract with a local company to collect and haul your waste fix. On-site silver recovery is dependent on fixer volume. For small volumes it may be easier and more cost effective to have a reclamation company take the waste fixer.	Section 3 Section 3, pg. 3.3
2. Do you replace fixer and developer at the same time? ❍ **Yes** ❍ **No**	Fixers can outlive developer 2 to 6 times. Using a fixer or silver test kit can reduce chemistry costs. Kits can be test strips or drops. Air and heat are the main enemies of developers. Use floating lids and monitor developer temp. to extend developer life.	 Section 3, pg. 3.15

3. Do you know how much fixer you use? ❍ **Yes** ❍ **No**	Knowing how much fixer you use will help you determine whether you should consider recovery equipment or off-site recovery. There are specific volumes where recovery equipment is economically viable.	Section 3, pg. 3.3
4. Are any of the following techniques used to increase the life of the fixing bath? ❍ **Yes** ❍ **No** Is countercurrent rinsing used to reduce wastewater volume? ❍ **Yes** ❍ **No** Can processing equipment be modified to incorporate these features? ❍ **Yes** ❍ **No**	❍ Add ammonium thiosulfate ❍ Add acetic acid ❍ Use an acid stop bath ❍ Monitor temperature and pH ❍ Other Increasing fixer life will increase the amount of silver in solution. Silver recovery should be implemented. Automated processing equipment can be modified and hand processing fixers can be captured for future silver recovery. Captured fixers can be processed through silver recovery equipment or sent to a reclaimer. Some automated processors can be modified to include additional wash tanks. If you are purchasing a new processor one should be chosen that has at least two or more wash tanks. Typically the first one or two wash tanks can be plumbed to the silver recovery equipment. Stagnant rinses can be used for hand processing to reduce total water use.	Section 3, pg. 3.13

Automated Processing	Comments	Refer to
1. Is your film processor plumbed to a recovery system? ❍ **Yes** ❍ **No**	Silver rich solutions from processors should be plumbed to silver recovery equipment or captured. Fixer should not be combined with developer, doing so will impair silver recovery. Distinctly different fixers should be segregated and treated separately. Combining very different fixer chemistries can make it difficult to recover silver.	Appendix D. Case Studies
2. Do you use continuous silver recovery? ❍ **Yes** ❍ **No**	Using a continuous system can reduce your fixer replenishment by up to 75%. This type of system also recovers much of the silver and reduces your process discharge.	Used on large volumes

3. When you process film, Do you attempt to reduce your water use? ❍ **Yes** ❍ **No**	Using rinse tanks and not running water continuously will greatly reduce the amount of water you use. This includes dilution. Dilution is not a method of waste reduction. With dilution you are simply reducing the concentration of the waste material, not reducing or eliminating the waste you generate. Are your washes on automatic timers? If so, are the timers properly set and are solenoid valves and switches working properly.	Section 3, pg. 3.13 Remember: **Dilution is not the Solution to Pollution**

Inks	Comments	Refer to
1. Do any of the inks or thinners used contain hazardous materials (i.e., chlorinated solvents, lead or chrome pigments, mercury, etc.)? ❍ **Yes** ❍ **No** If yes, has material substitution been tried? ❍ **Yes** ❍ **No**	Any raw inks containing hazardous materials will typically be considered hazardous when the ink becomes a waste. These inks should be segregated from other inks as much as possible. Mixing a non-hazardous ink with a hazardous ink generates a larger amount of hazardous material. Substitute any hazardous inks with non-hazardous inks wherever possible.	Appendix F. Section 7. Inks
2. Do you scrape ink containers as much as possible to remove as much ink as possible? ❍ **Yes** ❍ **No**	Rubber spatulas can be used to remove ink from the corners of most containers. Removing as much ink as possible reduces the amount of waste ink being thrown away. Since the degree of cleanliness is a function of operator effort, the amount of ink discarded can vary widely. By purchasing ink in recyclable bulk containers, the bulk container can be returned to the ink supplier for refilling instead of being thrown away. In addition, the use of bulk containers also cuts down on the amount of cleaning required since the surface area of the container per unit volume of ink stored is reduced.	
3. Have you considered the use of soy-based inks?	Some soy-based inks may decrease your overall solvent use and VOC emissions.	Section 7. pg. 7.6, Soy-based Ink at Sheet-fed Offset Printer Study

Etching/Plating	Comments	Refer to
1. Are metal etching/plating operations performed at your plant? ❍ **Yes** ❍ **No**	Because of increasing environmental regulations and higher costs of hazardous waste treatment and disposal, the printer should replace metal etching or plating processes wherever possible. Alternative processes include presensitized lithographic, plastic or photopolymer, and hot metal which do not present the hazardous material problems associated with metal etching and plating operations.	
2. Are metals recovered from solution bath dumps or waste streams? ❍ **Yes** ❍ **No**	Due to the hazardous nature of many of the metals and etching solutions metals should be recovered and the etching solutions handled properly.	

Plate Processing	Comments	Refer to
1. Do you use presensitized plates? ❍ **Yes** ❍ **No**		
2. Does the plate processor have an automatic replenishment system for developer/finisher? ❍ **Yes** ❍ **No**		
3. Are plate processor conditions frequently monitored? ❍ **Yes** ❍ **No**		
4. Are spent plates recycled? ❍ **Yes** ❍ **No**		
5. Have water-based plate development systems been used or tested? ❍ **Yes** ❍ **No**		

Printing and Finishing	Comments	Refer to
1. Are ink containers properly resealed after use? ❍ **Yes** ❍ **No**	Ink wastes can be reduced by preventing inks from drying out. If ink wastes are greater than expected check daily operations to determine if inks are being properly handled and immediately resealed after use. Open containers are subject to contamination with paper dust and dirt, as well as forming a "skin" on the surface, loss of solvent, or eventual hardening. Sheetfed offset lithographic inks should be leveled in the can before placing a liner over the ink. Other offset lithographic inks may have low enough viscosity to level themselves.	Section 7, pg. 7.1
2. Do any of the inks contain hazardous materials such as solvents or heavy metals? ❍ **Yes** ❍ **No** Has the use of less hazardous inks been attempted? ❍ **Yes** ❍ **No**	Some solvents and heavy metal pigments can make inks hazardous. A hazardous raw material will typically result in a hazardous waste. replace hazardous inks with non-hazardous inks wherever possible. If hazardous inks must be used segregate these inks from non-hazardous inks. If possible do not combine hazardous with non-hazardous.	Section 7, pg. 7.2 & 7.13
3. Are ink fountains filled according to expected need as opposed to routine filling? ❍ **Yes** ❍ **No** Are automatic ink levelers employed? ❍ **Yes** ❍ **No** Are ink fountains cleaned between runs? ❍ **Yes** ❍ **No**	Waste can be avoided by only filling the ink fountains for expected need. Ink waste and spoilage is reduced by maintaining the desired ink level in the fountain for optimum inking conditions. Automatic ink levelers are commercially available.	Section 7, pg. 7.1

4. Is a standard ink sequence used to reduce cleaning? ❍ **Yes** ❍ **No**	By going from lighter to darker inks you may not need to clean a thoroughly, this reduces press downtime and solvent use. Adopting a standard ink sequence can reduce the amounts of waste ink and waste cleaning solution: if a standard ink sequence is employed, the ink rotation is not changed with the job and you do not have to clean out the fountains in order to change the ink rotation. Using a separate solvent for each separate color can reduce the amount of solvent being used. Used solvent that has been used for a specific color can be reused to clean the press when that color is used again. Clean solvent will be used for final press cleanup, but not as much clean solvent will be needed.	
5. Are measures employed to prevent drying ink or formation of skins inside the fountain & cans? ❍ **Yes** ❍ **No**	This can reduce your ink waste volume.	
6. Are waste inks recycled or returned to the manufacturer? ❍ **Yes** ❍ **No**	Where possible	
7. Have alternative fountain solutions been tried? ❍ **Yes** ❍ **No**	IPA should be replaced where possible. IPA adds greatly to a facility's VOC emissions. Reducing IPA use will reduce VOC emissions.	
8. Has the use of automatic blanket cleaner been attempted? ❍ **Yes** ❍ **No**		

9. Has the use of less hazardous cleaning solvent been attempted? ❍ **Yes** ❍ **No** Can the waste solvent be collected and used as thinner? ❍ **Yes** ❍ **No** Can the cleaning solvent be recycled? ❍ **Yes** ❍ **No** Can soaps and detergents be used for cleaning? ❍ **Yes** ❍ **No**	Reducing the amount of hazardous solvents will reduce the amount of hazardous waste you generate. It may also reduce the amount of VOC emissions your shop generates. Used solvent may be reused as a thinner for black inks. Used solvents can also be used as the first cleaning wash, following the first wash with clean solvent. If using a standard color sequence separate solvents can be used for each separate color. This allows the re-use of the solvent continuously for each color with minimal addition of clean solvent.	Section 6, pg. 6.6
10. Is the roller blade kept in good condition and its angle checked for most effective cleaning? ❍ **Yes** ❍ **No**		
11. Is waste lube-oil sent to a recycler? ❍ **Yes** ❍ **No**		
12. Is paper use minimized by proper pre-production planning and lay-out? ❍ **Yes** ❍ **No** Is waste paper and trash sent to a recycler? ❍ **Yes** ❍ **No**	Paper is the major wastestream encountered in the lithographic industry. Almost 98 percent of the total waste generated by this segment of the industry is spoiled paper and paper wrap. Waste paper comes from rejected print runs, scraps from the start and end of runs, paper at the end of the web, and overruns. Do not forget to include office paper.	
13. Are plant material balances routinely performed? ❍ **Yes** ❍ **No** Are they performed for each material of concern (e.g. solvent) separately? ❍ **Yes** ❍ **No**	Running a plant material mass balance can help determine where a large amount of waste is being generated. Once identified, problem areas can be addressed to determine if the waste generation can be reduced or eliminated.	

14. Are all operator job functions well defined? ❍ **Yes** ❍ **No** Are regularly scheduled training programs offered to operators? ❍ **Yes** ❍ **No** Do you discuss goals of the pollution prevention and review results? ❍ **Yes** ❍ **No**	Well defined job functions and regular training will help employees function efficiently in their areas. Training also allows you to reinforce the concepts of pollution prevention and to discuss solutions to identified problems.	
15. Are there employee incentive programs related to waste minimization? ❍ **Yes** ❍ **No**	Giving employees incentives to reduce facility waste is a great method of reducing facility wide waste generation. Do not forget to reward areas where certain wastes are unavoidable.	
16. Has a waste minimization assessment been performed at the facility in the past? ❍ **Yes** ❍ **No**	If yes, then you may want to review the assessment. If no, then you may want to conduct one now. If your business is large enough go around with press operators and supervisors to assess each area. If you are a small press operator you can conduct the assessment yourself.	

Material Segregation	Segregation of wastes reduces the amount of unknown material in waste and improves prospects for reuse and recovery.	**Refer to**
1. Are spent photoprocessing fixers segregated from wastewater streams? ❍ **Yes** ❍ **No**	Fixers can contain well over 2,000 mg/L silver. This concentrated silver solution should not be discharged to the sewer or poured into a storm drain. This waste material should be segregated and captured for silver recovery.	Section 3
2. Are different solvent wastes segregated? ❍ **Yes** ❍ **No**	If you use many solvents you may be generating a hazardous soup. If possible reduce the number of solvents used in your facility. If unable to reduce the number of solvents used segregate the different solvents wastes. Do not use different solvents on the same shop towel and keep used shop towels segregated since the solvents may chemically react.	Section 6 Section 7, pg. 7.3

3. Are aqueous wastes from equipment clean-up segregated from solvent wastes? ❍ **Yes** ❍ **No**	Keep aqueous and solvent cleanup materials segregated.	
4. Are different types of paper (colored paper vs. white) segregated to increase their resale value? ❍ **Yes** ❍ **No**	Paper is the major wastestream encountered in the lithographic printing industry. Almost 98 percent of the total waste generated by this segment of the industry is spoiled paper and paper wrap. Waste paper comes from rejected print runs, scraps from the start and end of runs, paper at the end of the web, and overruns.	
5. Are different grades of paper (inked vs. clean, high quality vs. Paper wrap) kept segregated for more effective recycling? ❍ **Yes** ❍ **No**		
6. Is general trash segregated to maximize the amount of recyclable paper, film, aluminum, pallets, etc.? ❍ **Yes** ❍ **No**		

Material Consolidation, Reuse and/or Recovery	Comments	Refer to
1. Are many different solvents used for cleaning? ❍ **Yes** ❍ **No** If many solvents are used can the solvent used for the major equipment cleaning be standardized to replace the other solvents used? ❍ **Yes** ❍ **No** Is spent cleaning solvent reused as thinner or initial wash? ❍ **Yes** ❍ **No**	Dangerous chemicals such as benzene, carbon tetrachloride, trichloroethylene, and methanol have been used as components of cleaning solutions. Specially made blanket washes are now available that are less toxic and less flammable. These blanket washes typically contain mixtures of glycol ethers and other heavier hydrocarbons that have a high flash point and low toxicity. Many printers feel that these solvents do not work as well as the solvents mentioned above. However, because of the less hazardous nature of the material, they are gaining in popularity. These blanket washes are typically used for all cleaning operations in the printing step. General cleanup should be done with detergents or soap solutions wherever possible. Solvent cleanup should be used only for cleaning up inks and oils.	Section 6

Appendix A

JOINT TASK FORCE MEMBERS

The City of Albuquerque would like to thank the Albuquerque Printers Task Force and the following for their participation and assistance in developing this Code of Practice.

Appendix B

ENVIRONMENTAL RESOURCES

City - Albuquerque:

Pollution Prevention Program - Non-Regulatory 873-7004
Hazardous Waste Program - Non-Regulatory 768-2600
Storm Water/Hydrology - Non-Regulatory 768-2650
Air Quality Assistance Program - Non-Regulatory 768-1964
Solid Waste Management 761-8180/8182
Fire Marshal's Office (HazMat information) 888-8124
HazMat Emergency Response: 911
(Describe spill and material to dispatcher)
LEPC - Local Emergency Planning Committee 764-6353/6322
P.O. Box 2086, Albuquerque, NM 87103
Fire Department Dispatch (for LEPC after hours and on weekends) 243-6601
Southside Water Reclamation Plant
Pretreatment Unit - Weekdays 873-7004
Emergency - Weekends 873-6217
Silver Users Trade Association
Ron Taylor - President 294-5053
For info on memberships, etc. write to: New Mexico Silver Users Association
PO Box 25801, Albuquerque, NM 87125
Poison Control 843-2551

State - New Mexico:

OSHA - On-Site Consultation - Non-Regulatory 1-800-222-6742
Technical Services Section 1-505-827-4231/4232
1190 St. Francis Dr., P.O. Box 26110, Santa Fe, NM 87502-6110
Local Albuquerque Office (non-consultation) 766-3411
Environment Department Region 1 1-505-841-9450
Emergency Response Commission 1-505-827-9300
Hazardous Waste Management Agency 1-505-827-4308
Hazardous Waste Assistance (6 month amnesty) 505-827-1558
New Mexico Industry Network Corporation (NM-INC) - Albuquerque 843-4250
Small Business Development Center (STARS system) - Albuquerque 224-4246

Federal - Regional & National:

National Association Photo Manufacturers (PMA) ..... 1-517-788-8100 or 1-800-762-9287
EPA Region 6 - Air & Hazardous Materials Division 1-214-767-2600
201 Elm St., Dallas, TX 75270
RCRA Superfund Hotline 1-800-424-9346
Nation Response Center - Emergency number ..... 1-800-424-8802 or 1-202-267-2675
Non-Emergency calls 1-202-887-1255
CHEMTREC - Non-emergency number 1-800-262-8200
EPA Small Business Ombudsman 1-800-368-5888
National Institute for Occupational Safety and Health (NIOSH) 1-800-35-NIOSH
EPCRA Hotline (TRI information) 1-800-535-0202
EPA Office of Water (EPA OW) - P2 Coordinator 1-202-260-6790
EPA Office of Solid Waste - Waste Minimization 1-703-308-8439/8402
NTIS - Public Searches 1-703-487-4642
NTIS - Sales 1-703-487-4650

EPIC

*E*nvironmental *P*rograms *I*ntegration *C*ommittee

Members & Contact Numbers

- **Pollution Prevention Program.....(505) 873-7059 / 7004 (E-Mail: dgates@cabq.gov)**
  - **Dan Gates** - Providing pollution prevention information, waste reduction assessments, and free
    wastewater analysis to businesses discharging into the City of Albuquerque's sewer system or area septic tanks. The free non-regulatory Program offers economical, appropriate and real world pollution prevention/source reduction information and examples. The Program Recognizes local business efforts by awarding the 5PPM Silver Certificate and the Pollution Prevention Award. Assistance and information is provided county and state wide.
- **Storm Water / Hydrology ..... (505) 768-2650**
  - **Valerie Hanson** - EPA NPDES storm water discharge permit applications for storm water runoff
    control. Includes regulated industries and construction activity over 5 acres. Technical assistance available to verify whether your industry is regulated, to evaluate facility drainage and help prepare EPA mandated Storm Water Pollution Prevention Plan (SWPPP). FREE Industrial and Construction Guidance Manuals and educational materials for teachers, youth or adult groups, neighborhood associations, and so forth.
- **Air Quality Assistance Program .....(505) 768-1964**
  - **John Liberatore** - FREE and NON-REGULATORY industry assistance for air quality. Provides technical assistance and site assessments to all industry on regulatory concerns, air quality requirements, and site requirements. TTY at (505)768-2482.
- **Small Quantity Generator Technical Assistance Program (SQGTA). (505) 768-2636**
  - **Therese Martinez-Loner** - The SQGTA program provides on-site assistance, educational training, and written guidance for proper hazardous material and waste management. Services are FREE, NON-REGULATORY and CONFIDENTIAL. The program's mission is to provide an educational resource for Albuquerque's business community, enabling voluntary compliance with local, state and federal hazardous material and waste regulations. The goal is pollution prevention and a sustainable business community.
- **Recycling & Solid Waste Management .....(505) 761-8100**
  - **Jenny V. Chavez** - Educational services and information on waste disposal, recycling outlets, and the City's municipal solid waste landfill. To set up an account, dumpster or bin setup, waste and recycling pick-up, call (505) 761-8100.
- **Sludge Quality Management..... (505) 873-6255**
  - **Steve Glass** - Information on City sludge quality and Rio Grande composted materials. For composted material availability call: Rowland Nurseries, or Western Organic at (505)877-8670.

The City of Albuquerque Small Business Services Guide, provided through EPIC's efforts, is available by contacting Therese Martinez-Loner.

EPIC is staffed by several City employees working together to address all aspects of environmental protection including: air, water and land resources. The programs are geared toward pro-active pollution prevention through free, non-regulatory business assistance. EPIC grew out of a common need to work cooperatively in providing quality technical assistance.

Appendix C

EQUIPMENT SUPPLIERS/RECYCLERS

The following lists are not complete lists of all companies available. The City of Albuquerque does not endorse any of the listed companies or the services they provide. For additional information on pollution prevention contact Dan Gates or Brynda Gutierrez at (505) 873-7058 or 873-7059.

BUSINESS NAME	ADDRESS	CITY/STATE	ZIP	PHONE #	FAX #	SRCS	SRE	SF	MEN
Academy Corporation	6905-A Washington NE	Albuquerque, NM	87109	505-345-1805	505-344-4638	yes	yes	yes	
Arizona Resource Exchange (AzRE)	c/o UofA Recycling Ofc.,Facilities Mgmt. Bldg.#49	Tucson, AZ	85721	520-626-1266	no				yes
Berg Color Tone, Inc.	72 Ward Road	Lancaster, NY	14086	716-681-2696	716-684-0511		yes		
Century	21630 Hanover Ave.	Lakeville, MN	55044	612-985-9995	612-985-9998			yes	
Commodity Refining	116 East Prospect Ave.	Burbank, CA	91502	818-843-2811	no	yes	yes		
DMS Refining	45 East Knoxville	Danridge, TN	37725	423-397-9447	423-397-3963			yes	
Eastern Smelting	37-39 Bubier Street	Lynn, MA	01901	617-599-9000	617-598-4880	yes			
Enviroment-CPC	501 W. Algonquin	Mt. Prospect, IL	60056	847-981-0310	847-981-0315	yes			
Envirosolve Waste Services, Inc.	5338 Williams SE	Albuquerque, NM	87105	505-873-0964	505-873-0964	yes			
FR Chemicals	650 Halstead Ave.	Mamaronick, NY	10543	914-698-7050	914-698-7076		yes		
Hallmark Refining	1743 Cedardale Road	Mt. Vernon, WA	98273	800-255-1895	203-289-6494	yes			
Handy & Harmon	300 Rye Street	South Windsor, CT	06074	203-289-4327	203-289-6494	yes			
Litho-Supply, Inc.	1430 Girard NE	Albuquerque, NM	87106	505-265-3556	no		yes		
McGuire & Strickland Refining Co.	1290 81st. Ave. NE	Minneapolis, MN	55432	612-786-2858	no	yes	yes	yes	
Profit Recovery Systems	2364 Leicester Road	Leicester, NY	14481	800-477-1417	no	yes			
RENEW	MC 112; PO Box 13087	Austin, TX	78711	512-239-3171	512-239-3165				yes
RFE Industries	19 Crows Mill Road	Keasbey, NJ	08832	800-327-7938	908-738-5319	yes			
Rotex Silver Recovery Co.	2000 Larch	Springfield, OH	45503	513-322-0198	513-322-3722		yes		
Safety-Kleen Corporation	2720 Girard NE	Albuquerque, NM	87107	505-884-2277	505-883-4890	yes		yes	
Safetyloid Reclamation	225 Broadway	Methven, MA	01844	800-942-5337	no	yes			
Southwest Radiographics	4610-A McLeod NE	Albuquerque, NM	87109	505-883-9605	505-884-6628	yes		yes	
Springfield Silver	PO Box 89	Mechanicsburg, OH	43044	513-834-2293	513-834-2164	yes	yes	yes	
USI Environmental Reclamation Co.	825 Schoenharr Drive	West Ben, WI	53095	414-334-3000	414-334-6222	yes	yes	yes	

SRCS: Silver Refining & Collection Services
SRE: Silver Recovery Equipment
SF: Scrap Film
MEN: Materials Exchange Network

The above lists are not complete lists of all companies available. The City of Albuquerque does not endorse any of the listed companies or the services they provide.
Provided by the City of Albuquerque's Public Works Department/ Waste Water Utility Division/ Pollution Prevention Program.
For additional information on pollution prevention, or companies interested in being added to this list, please contact the Pollution Prevention Program at 873-7004. (Last update 10-08-96)

Appendix D

CASE STUDIES

❑ Background Information:

Company: Brooks Photo, Inc.
Operation: Commercial Photo Processing
Date of visit: June 24, 1993

❑ Wastewater Stream Delineation:

1. Fix and bleach fix which flows from five developing machines operated at Brooks. These machines are listed below:

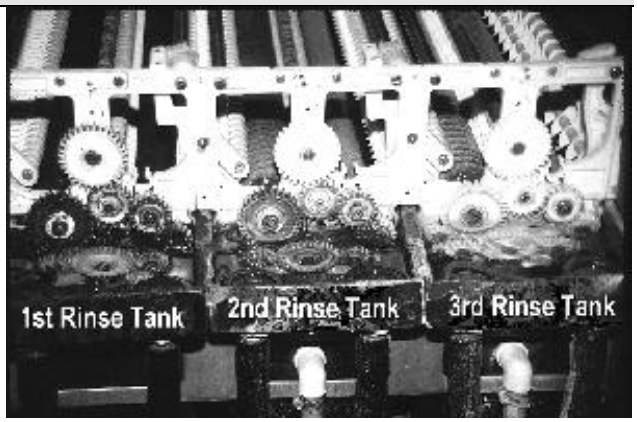
   1. slide processor (E-6)
   2. black & white film processor
   3. black & white paper processor
   4. color negative processor (C-41)
   5. color paper processor (RA-4)

The combined wastestream contains used fix/bleach-fix and any silver removed from the developed film and paper.

2. Processor using a replenished wash system in which the overflow and drain from the first wash tank is routed and plumbed to the silver recovery system.

❑ Waste Minimization Practices

1. Brooks Photo utilizes a silver recovery system to remove the silver from waste stream number 1. The system has two components - an electrolytic recovery unit and two silver recovery cartridges. Fix and bleach fix from all five machines flows into the electrolytic unit and then through two Silver Sur 1000 Cartridges. The cost for this system was approximately $4,000.00



Picture D1. Triple Rinse Processor

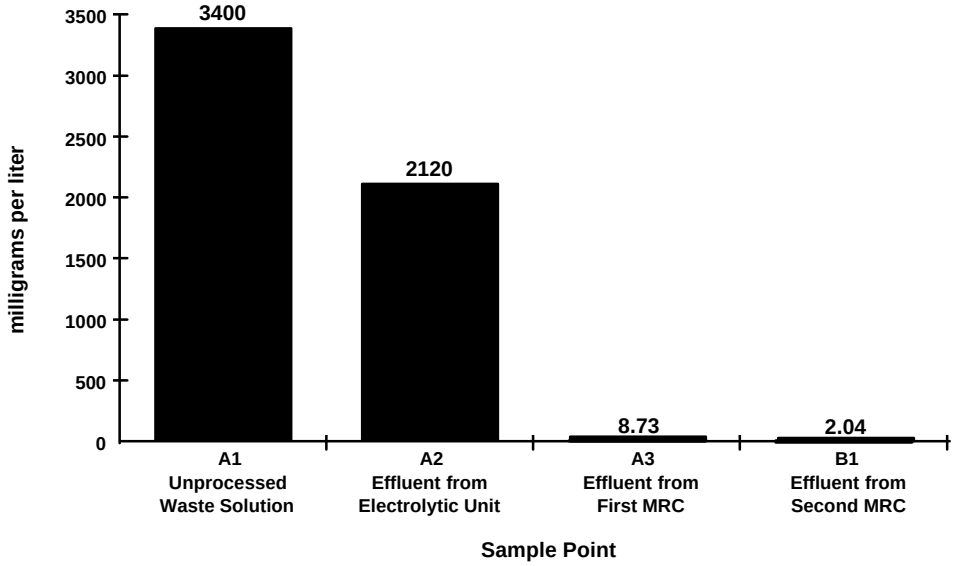
2. Silver is recovered from the color paper processor first wash tank water. This machine has three rinse tanks instead of only one, resulting in a greatly reduced outflow of silver bearing waste. Due to silver concentration in some of the rinse waters (see Picture D1 - note that equipment changes from dark to light as silver concentration is reduced from the first rinse tank to the third rinse tank) rinse water from the first two tanks is routed through the silver recovery equipment. All other rinse water is discharged to the sewer. In the current RA-4 configuration there is only two wash tanks.

❑ Effluent Testing/Results

Wastewater stream number 1 was sampled on June 25, 1993. At the point of discharge to the sewer the silver concentration was below 2 ppm.

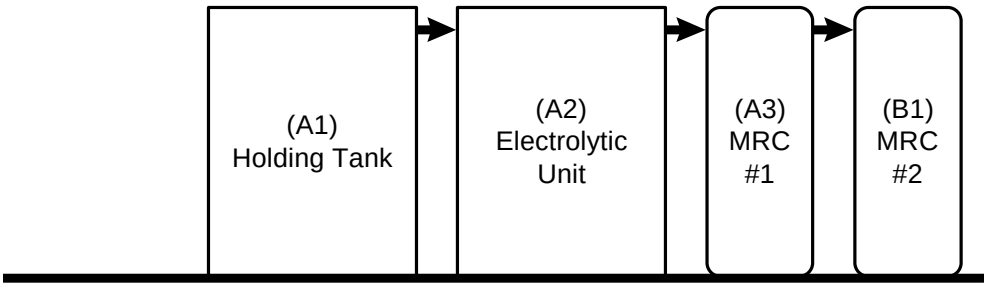
Sample collection began at 9:40 am, June 25, 1993. Four 250 ml samples were collected at the primary holding/pumping station (A1), the secondary reservoir of the electrolytic unit (A2), the effluent from the primary metallic replacement cartridge (A3), and from the tailing cartridge prior to sewer discharge (B1). Samples were also checked for field pH.

Estimated waste fix processed by the silver recovery equipment averages approximately 35 gallons per week (140 gal/month).



When the electrolytic recovery unit was removed for sample collection silver was present on the recovery plates in silver plumes. The recovered silver was recognizable as fine (pure) silver.

Final discharge meets and exceeds the 5 parts per million discharge requirement of the 5PPM Silver Program. From this data it can be seen that the metal replacement cartridges are effective in reducing the silver content in waste photographic fixer solutions and that the 5ppm level can be accomplished at the discharge location of the equipment.



Silver Concentration	3400.00	2120.00	8.73	2.04
Silver Reduction (%)	NA	37.6	99.6	76.6
pH	7.3	7.6	7.8	7.9

❑ 5 ppm Silver Program

Brooks Photo is a certified member of the 5 ppm Silver Program.

❑ Background Information:

Company: Carl's Darkroom
Operation: Film (negative and slide film) processing (C-41 & E-6)
Date of visit: June 25, 1993

❑ Wastewater Stream Delineation

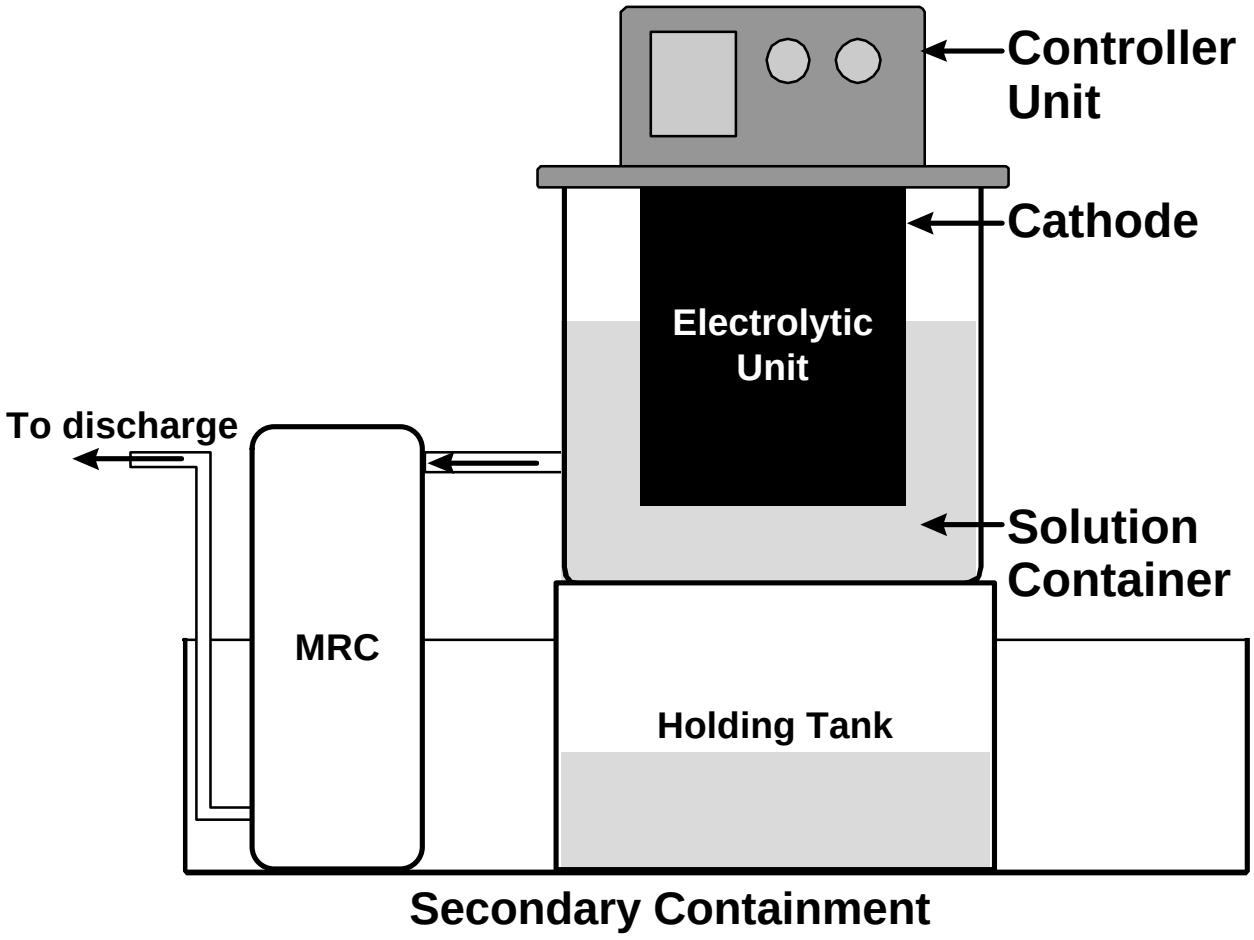
The only wastewater stream at Carl's Darkroom is the silver containing fix discharged from the color film and color slide processing machines.

❑ Waste Minimization Practices

Carl's Darkroom utilizes an electrolytic unit to recover silver from the fix prior to discharge. Fix from both machines is pumped into a small holding tank, from there it is slowly metered into the electrolytic unit. The electrolytic unit's 1988 cost was $2,500.00 and was paid for within one year of operation. Since 1988 more than 1,300 troy ounces (appx. 90 pounds) of silver has been recovered.

❑ Other Potential Waste Minimization Activities

Electrolytic units typically cannot reduce silver concentration below 100 or 200 ppm. The unit at Carl's Darkroom, however, has been tested, in the past, at 3 ppm. For consistency, though, Carl's Darkroom has added one trailing metal replacement cartridge.



❑ Background Information:

Company: Ron's Hour Photo
Operation: Commercial Photoprocessing Lab
Date of visit: July 2, 1993

❑ Wastewater Stream Delineation

1. Fixer/bleach-fix flowing from the film and paper processing machines. It consists of used fixer and silver ions in solution.

2. Rinse water flowing from the film and paper processing machines. It contains a small quantity of silver.

❑ Waste Minimization Practices

Ron's Hour Photo has installed a Silver Recovery System to remove silver from the fixer prior to discharge. The system consists of two Silver Sur 500 cartridges. As the silver bearing fix is metered slowly through these cartridges the silver ions are removed from the solution. This system cost was approximately $1,500.00

❑ Other Potential Waste Minimization Activities

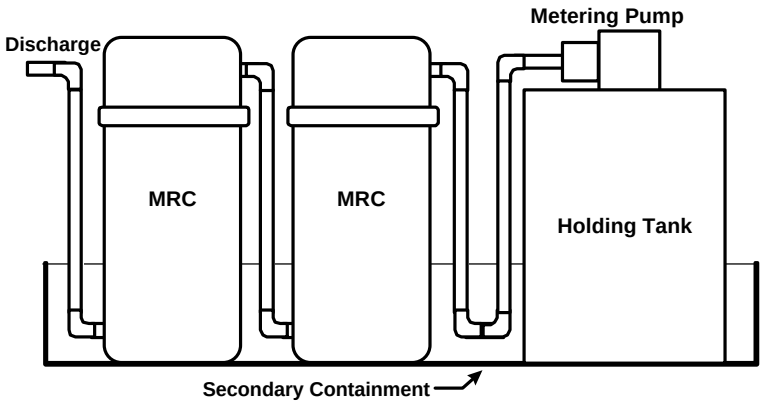
1. Fixer solutions:
   a. Backup cartridge unit in case of a malfunction in one of the existing cartridges.

2. Rinse water:
   a. Rinse water from the processing machines at Ron's Hour Photo is currently discharged to the sewer. A small quantity of silver, brought into the rinse tanks on the film and paper, is discharged. This silver cannot be economically recovered in cartridge system because of the high flow rate and low silver concentration.

   b. Silver in rinse water can be recovered from replenishing or low-flow washes from stabilizers used in washless' processors. These machines have multiple wash/rinse tanks instead of one. This results in a reduced rinse water flow and an increased silver concentration in the first wash/rinse tank which could then be processed by silver recovery cartridges.

❑ Effluent Testing/Results

Ron's rotates the cartridges every 4 to 5 months. Testing is performed by the cartridge supplier, Academy Corporation. Maintenance, supplier sampling and MRC rotation insures a discharge of less than 5 ppm.



❑ Background Information:

Company: Signal Graphics, Westminster, CO
Operation: Printing
Employees: 4

❑ Wastewater Stream Target

Waste Ink

❑ Original System

Disposal of Leftover Ink

Spent/loftover inks from two AB Dick 9800 series offset presses are placed in designated waste containers and picked up by a waste hauler for off-site treatment/disposal. Little recycle/reuse of leftover inks.

❑ New System

Recycle/Reuse of Leftover Inks

Ink trays are filled with only enough ink for each run or shift, and unemulsified inks are returned to their containers. Leftover inks are segregated according to color and type of ink and are combined into containers for reuse. Crisco (shortening) is used to thin the ink as needed for reuse. Fibers and debris can be found in recycled/reused ink; therefore, the ink is reused on print jobs such as bond runs where high quality is not as important.

❑ Cost Savings

Initial Equipment Costs

None

Material Cost Savings

Signal Graphics purchases ~60 lbs. of inks (colored, black, and white) every 3 months at a cost $500.00 or ~$2,000.00/year. They save >5% (~$100.00/yr) on the purchase of new ink since they are able to reuse ~3 lbs. of spent inks per month.

Waste Disposal Costs

Reduces waste disposal by ~3 lb./month. At $300.00/55 gallon drum, this is a cost savings of ~$200.00/yr.

Total Cost Savings

~$300.00/yr.

(from: Colorado Pollution Prevention Case Studies for the Printing Industry, CO P2 Program)

❑ Background Information:

Company: Jefferson County Public School Printing Department
Operation: Printing (90-95% black ink)
Employees: 7

❑ Wastewater Stream Target

Ink, solvent emissions and waste

❑ Original System

Conventional Small Offset Presses are used: an Itek 975 PFA Press and a Multi-Graphics 1250 (one color). These presses run 5,000 impressions per hour one-sided (Multi-Graphics) to 8,000 impressions per hour double-sided (Itek), and require the use of oil or rubber-based inks.

❑ New System

Duplicators are used in place of the offset presses. Two new duplicators were purchased: a Risograph GR 3750 Duplicator and a Gestetner Duplicator 5380. These are uned for low to medium-range one-sided, primarily one-color printing. These units take as original document, digitally scan the image, and transfer it to a master via a thermal imaging process. The master is biodegradable. Water-based ink is microprocessor-controlled and vacuum drawn from a cartridge, eliminating ink waste. The print drum can be quickly changed for color printing. Prints 8,000 impressions/hr. Can run 5,000 - 10,000 impressions/plate.

❑ Cost Savings

Initial Equipment Costs

Risograph GR 3750 Duplicator - ~$16,000.00 (manuf. Suggested retail). Gestetner Duplicator 5380 - ~$15,000.00.

Material Cost

Total material costs for both duplicators: ~$10,000.00/yr, vs. ~$24,000.00/yr for offset presses, a material cost savings of ~$14,000.00/yr.

Waste Disposal Costs Savings

Waste disposal savings have not been quantified. However, JeffCo predicts a 90-95% reduction in generation of ink and solvent wastes.

(from: Colorado Pollution Prevention Case Studies for the Printing Industry, CO P2 Program)

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Silver Coalition, Code of Management Practice for Silver Dischargers, Silver Coalition/Association of Metropolitan Sewerage Agencies (AMSA), 1995. Available by contacting Tom Dufficy (NAPM) at: 1-914-698-7603, or Sam Hadeed (AMSA) at: 1-202-833-2672. $10.00

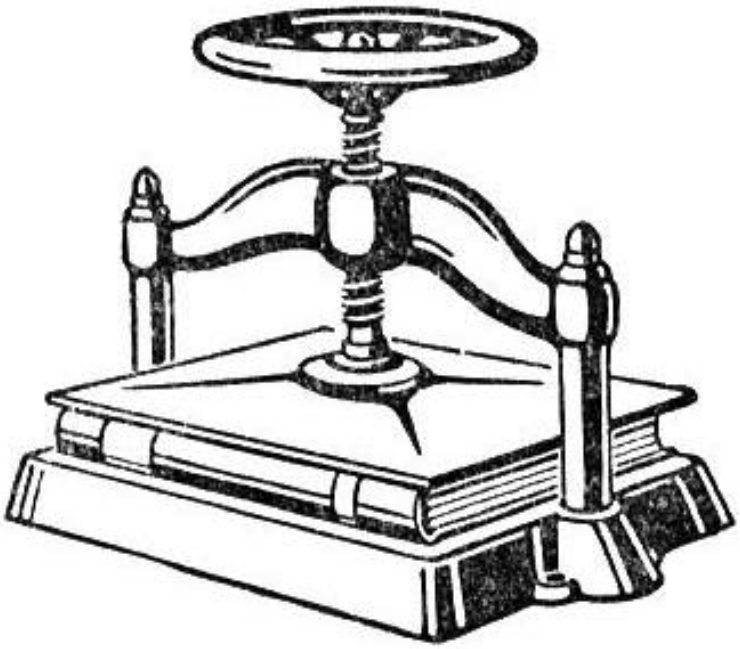
The Silver Council, Code of Management Practice: Guide for Commercial Imaging, National Association of Photographic Manufacturers, Inc., 1997.

PRINTING

CODE OF PRACTICE

Reference Materials

Best Management Practices For Pollution Prevention and Pollution Prevention Award Certification



by:
The Joint Task Force of the City of Albuquerque Public Works Department/Pollution Prevention Program and the Albuquerque Printers Task Force

1998

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Acknowledgements

Acknowledgments:

This document has been completed with the assistance of the New Mexico Silver Users Association (NMSUA), a non-profit trade association working to educate industry and the public on business and environmental issues.

Disclaimer:

The City of Albuquerque does not endorse any of the techniques, businesses, equipment, or methods mentioned in the following document. This document is intended only as advisory guidance for the Photoprocessing industry in developing approaches for pollution prevention/source reduction. Compliance with environmental and occupational safety and health laws is the responsibility of each individual business and is not the focus of this document.

Section 2

INPUTS & OUTPUTS BY PRINTING TYPE

Lithography Process: Inputs, and Outputs		
Process	**Inputs**	**Outputs**
Imaging	Film	Used film and out-of-date film
	Paper	Scrap paper (recyclable)
	Developer	May be volatile and contribute to air emissions. Spent developer (sent to POTW). Do not mix developer with fixer.
	Fixer	May be volatile and contribute to air emissions. Silver is often electrolytically recovered from the fixer prior to discharge of spent fixer to POTW. Silver above 5 mg/L (ppm) is considered a hazardous waste and should not be discharged to the POTW.
	Wash Water	Used rinse water. Concentrated rinse waters can be combined with waste fixers and sent through silver recovery equipment. Check with off-site recovery companies before combining fixers and rinse waters.
	Cleaning Solutions	Rags containing solvents (sent to laundry service or disposed of as hazardous waste)
	Chemical Storage Containers	Empty containers (disposed of or returned to suppliers)
Platemaking	Plates	Used plates (recyclable)
	Water	Used rinse water (discharged to POTW)
	Developer	Spent developer (may contain alcohol; contributes to air emissions)
Printing	Fountain Solution	May contain VOCs and contribute to air emissions
	Ink	Waste oil based ink disposed of as hazardous waste. Solvent-based inks contribute to air emissions
	Paper	Waste paper from bringing press up to required print quality and from rejected prints
	Cleaning Solutions	Solvents used to clean press and remove excess ink contribute to air emissions
	Rags	Ink and solvent-laden rags (sent to laundry service, disposed of as hazardous waste, or treated to recover solvents)
Finishing	Paper	Reject prints and edges from trimming
	Adhesives	Possible losses to the air
	Shipping boxes	Waste issue (recyclable)

Gravure Process: Inputs, and Outputs		
Process	**Inputs**	**Outputs**
Imaging	Digital Data	Film or engraved image carrier (cylinder)
	Film	Used film and out-of-date film
	Paper	Scrap paper
	Photographic processing solution	May be volatile and contribute to air emissions. Silver is often electrolytically recovered from the fixer prior to discharge of spent fixer to POTW. Silver above 5 mg/L (ppm) is considered a hazardous waste and should not be discharged to the POTW.
	Wash Water	Used rinse water. Concentrated rinse waters can be combined with waste fixers and sent through silver recovery equipment. Check with off-site recovery companies before combining fixers and rinse waters.
	Cleaning Solutions	Rags containing solvents (sent to laundry service, disposed of as hazardous waste, or treated to recover solvents)
	Chemical Storage Containers	Empty containers (disposed of or returned to suppliers)
Cylinder Making	Copper-clad Cylinder	Used cylinders
	Acid etching solution	Waste solution
Printing	Ink	Solvent-based inks (toluene-based for mass-circulation printing and alcohol-based for packaging) maintain the required low viscosity and contribute to air emissions. Waste ink disposed of as hazardous waste
	Heat	Ovens are used to drive off the solvents to dry the ink. Ink solvents are recaptured through chillers and other equipment
	Paper	Waste paper from bringing press up to required print quality and from rejected prints
	Cleaning Solutions	Solvents used to remove excess ink contribute to air emissions
Finishing	Paper	Reject prints and edges from trimming
	Adhesives	Possible losses to the air
	Shipping boxes	Waste issue (recyclable)

Flexography Process: Inputs, and Outputs		
Process	**Inputs**	**Outputs**
Imaging	Film	Used film and out-of-date film
	Paper	Scrap paper
	Developer	May be volatile and contribute to air emissions. Spent developer (to POTW). Do not mix developer with fixer.
	Fixer	May be volatile and contribute to air emissions. Silver is often electrolytically recovered from the fixer prior to discharge of spent fixer to POTW. Silver above 5 mg/L (ppm) is considered a hazardous waste and should not be discharged to the POTW.
	Wash Water	Used rinse water. Concentrated rinse waters can be combined with waste fixers and sent through silver recovery equipment. Check with off-site recovery companies before combining fixers and rinse waters.
	Cleaning Solutions	Rags containing solvents (sent to laundry service, disposed of as hazardous waste, or treated to recover solvents)
	Chemical Storage Containers	Empty containers (disposed of or returned to suppliers)
Platemaking	Plate mold	Used molds, engravings and washes
	Rubber plate	Used plates, defective plates and photopolymer
	Etching and wash-out solutions	Waste solution and spent solvents
Printing	Ink	Waste ink disposed of as hazardous waste. Solvent-based inks contribute to air emissions.
	Paper/film	Waste paper and film from bringing press up to required print quality and from rejected prints
	Heat	Exhaust heat and odor. High alcohol content of some inks contribute to air emissions as ink dries. Water-based inks are used for paper and some films
	Cleaning Solutions	Solvents used to remove excess ink contribute to air emissions and hazardous wastes
Finishing	Paper/film	Reject prints, edges from trimming, box and bag-making wastes
	Adhesives	Possible losses to the air

Letterpress Process: Inputs, and Outputs		
Process	**Inputs**	**Outputs**
Imaging	Film	Used film and out-of-date film
	Paper	Scrap paper (recyclable)
	Developer	May be volatile and contribute to air emissions. Do not mix developer with fixer.
	Fixer	May be volatile and contribute to air emissions. Silver is often electrolytically recovered from the fixer prior to discharge of spent fixer to POTW. Silver above 5 mg/L (ppm) is considered a hazardous waste and should not be discharged to the POTW.
	Wash Water	Used rinse water. Concentrated rinse waters can be combined with waste fixers and sent through silver recovery equipment. Check with off-site recovery companies before combining fixers and rinse waters.
	Cleaning Solutions	Rags containing cleaning solvents (sent to laundry service, disposed of as hazardous waste, or treated to recover solvents)
	Chemical Storage Containers	Empty containers (disposed of or returned to suppliers)
Platemaking	Plate mold	Used molds
	Plate	Used plates (recyclable)
	Plate developer solution	Waste solution
Printing	Ink	Waste ink disposed of as hazardous wastewater. Solvent-based inks contribute to air emissions
	Paper	Waste paper from bringing press up to required print quality and from rejected prints
	Cleaning Solutions	Solvents used to remove excess ink contribute to air emissions
Finishing	Paper	Reject prints and edges from trimming
	Adhesives	Possible losses to the air
	Shipping boxes	Waste issue (recyclable)

Screen Printing Process: Inputs, and Outputs		
Process	**Inputs**	**Outputs**
Imaging and Screen Making	Emulsion	Waste emulsion and out-of-date product
	Photosensitization solution (needed for unsensitized films only)	Waste solution
	Screen (polyester, nylon or wire mesh)	Excess screen trimmings; used screens
	Frame	Reused
	Developer	Spent developer (sent to POTW). Do not mix developer with fixer.
	Fixer	Spent fixer (silver reclaimed and recycled). Silver is often electrolytically recovered from the fixer prior to discharge of spent fixer to POTW. Silver above 5 mg/L (ppm) is considered a hazardous waste and should not be discharged to the POTW.
	Chemical Storage Containers	Empty containers (recycle where possible)
Printing	Ink	Waste ink usually disposed of as hazardous waste. Solvent-based inks contribute to air emissions
	Paper or other printing substrate	Waste paper from bringing press up to required print quality and from rejected prints
	Blockout	Removed during screen reclamation and disposed with screen reclaim chemicals
	Screen Reclamation Chemicals	Screen reclamation chemicals and ink are disposed of in rags and in clean-up wastewater
	Water	Water used for screen reclamation is discharged to POTW; sometimes it is filtered prior to discharge
Finishing	Paper or other printing substrate	Reject prints and edges from trimming
	Adhesives	Possible losses to the air
	Shipping boxes	Waste issue (recyclable)

Section 3

IMAGE PROCESSING (PRE PRESS)

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This section contains the information on equipment and processes currently used in photoprocessing and printing facilities to reduce their waste generation and disposal costs. Most of the equipment is readily available and in-house techniques and process changes are easily implemented. If you completed the separate checklists portion of the Photoprocessing Code the following information is referenced. The following information will help you better understand what techniques and equipment are available in accomplishing photoprocessing/printing pollution prevention.

The printing industry's photographic process uses input materials similar to those used in other fields of photography. The purpose of this step is to produce a photographic negative (for lithography and letterpress) or a positive (for gravure, screen printing, and other lithographic processes). Input materials for the process include paper, plastic film, or a glass base covered with a light-sensitive coating called a photographic emulsion. This emulsion is usually composed of silver halide salts and gelatin. The desired image is projected onto the film to produce a film negative or a film positive. When the exposed photographic emulsion is developed, the silver halide in the emulsion is converted

to metallic silver, in proportion to the amount of exposure it has received. The developing action is stopped by immersing the film in a fixing bath, which is mainly composed of sodium thiosulfate ("hypo"). The fixed photographic emulsion is then rinsed. If an image is to be printed as a color reproduction, transparencies are made for each of the colors to be used on the press. Multi-color printing is done by passing the same substrate through several single-color printing operations. Three or four basic colors are combined on the final product to yield any color desired.

Image processing can generate a great amount of silver bearing wastes. Typically these wastes are considered a hazardous waste. Due to this the material should be properly handled and, where possible, the silver should be recovered and recycled.

Image making most frequently involves typesetting and photodeveloping. Typical wastestreams include: photographic chemicals, paper and films, silver, and solid wastes. Pollution prevention opportunities include:

- Implementing operational and work practice changes that can extend the life of chemical baths, reduce the amount of chemicals used and reduce wastewater generation;
- Using chemical substitutes, such as non-silver photographic films (under development);
- Replacing the repetitive steps of photographing, editing, re-shooting, and the photodeveloping process with electronic imaging (including the capability to edit images on a computer);
- Developing inventory control programs that offer the advantage of reducing spoilage of photodeveloping chemicals and supplies such as paper and film.

❑ Fixer Solution Volume and Recovery Equipment

To address the issues facing silver recovery, there are a few questions you should be able answer.

1. What volume of waste fix solutions do I generate in gallons or liters per month?
2. Why do I want to use silver recovery?
   - ❍ A. Payback from recovered silver?
   - ❍ B. Environmental protection?
   - ❍ C. Reduction of my Hazardous Waste Generator status?
   - ❍ D. All the above?

1. What Volume of Waste Fix Solutions do I Generate?

Determining how much waste fix you generate may influence your decision on what type of silver recovery you may use and how much you may pay for a recovery system. You can use your purchasing records and/or personal knowledge of your process to determine fixer volume and use. Volumes can be broken into three distinct areas:

- ❍ Less than 20 gallons per month
- ❍ 20 to 40 gallons per month
- ❍ Greater than 40 gallons per month

❑ Less than 20 gallons per month

If you generate less than 20 gallons per month of waste fix you may want to take it to a local photographic silver recovery company. For volumes under 20 gallons per month the amount of silver recovered may not pay for the recovery equipment capital and operating & maintenance costs. It may be a more cost effective alternative to contract with the silver recovery company to either pick up the waste fix or have you deliver the waste fix to the company (many companies provide appropriate containers for storing and shipping). Taking your waste fix to a recovery company removes the silver from the waste stream and reduces your liability, especially when the other option is disposal.

Picture 4.1 - Recovered Silver on a flat plate cathode

❑ Between 20 to 40 gallons per month

If you generate more than 20 but less than 40 gallons per month of waste fix, you may want to consider installing metallic replacement cartridges (MRC). These cartridges, when used in pairs, can often recover enough silver to cover the operating and maintenance costs and may pay for the equipment capital cost. Payback relies on the amount of waste fix generated and the silver concentration in the fix.

Recovery equipment suppliers will typically sample your waste fix to determine average silver content and expected silver recovery efficiency. By determining the silver content the equipment supplier should also size the equipment to the amount of waste fix being generated. MRC's are capable of reaching and maintaining a silver discharge level of 5 PPM (5 milligrams per liter) or lower.

❑ More than 40 gallons per month

For large volumes of waste fix, electrolytic recovery combined with MRC's or large MRC's alone can be cost effective. Due to the cost of electrolytic units, large volumes of waste fix need to be processed to recover enough silver to cover the capital and operating/maintenance cost of an electrolytic system. Typically, electrolytic units alone can remove silver to around 200 PPM, MRC's are necessary as polishing units to remove silver to 5 PPM or lower. One silver recovery system, using an electrolytic unit and a single MRC, processing appx. 80 gallons per month of waste fix, recovered enough silver that the system was paid for within the first year of operation. Silver discharge concentrations are under 5 PPM using this system. Cost of the system was approximately $2,500.00 (see Appendix D. Case Studies, in the Introduction & Checklists document).

Picture 4.2 - Recovered Silver on rotating round cathodes

2. Why do I want to use silver recovery?

A. Payback on recovered silver?

At lower volumes and/or lower silver concentrations payback may not occur. Typically, the larger the volume of waste fix, the greater the possibility that payback will begin to happen after a year or more. If you generate less than 20 gallons per month, it may be easier and more cost effective to take your waste fix to a reclaimer.

B. Environmental protection?

You can help protect the environment by removing waste fix from landfills and the sewer system. Doing so puts back into use a precious metal that would otherwise be tossed into the trash or discharged to the treatment plant.

If silver, other heavy metals, or other pollutants reach the treatment plant, they can disrupt the biological processes used to treat the city's domestic wastes. These pollutants will either accumulate in the sludge generated from waste treatment or be discharged to the river. Either of these could create a regulatory compliance problem between the City and the EPA. If a compliance problem occurs, the City may be required to use regulatory pressure on businesses and the public to reduce the discharge of certain pollutants.

C. Reduction of Hazardous Waste Generator Status?

You can reduce your hazardous waste generator status by recovering materials on-site and sending the recovered material to a recycler. This removes a waste that would otherwise be considered a hazardous waste and turns it into a reusable and a potentially profitable material.

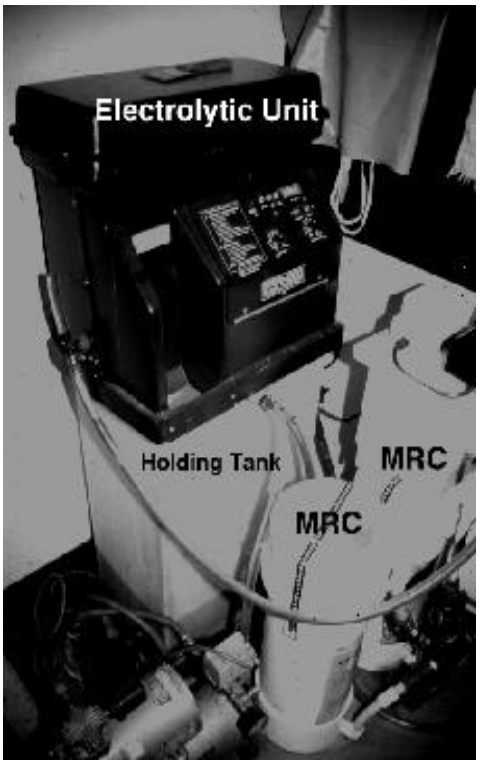
Recovery Process Matrix			
Fixer Volume (gallons per month)	**Reclaimer**	**MRC's**	**Electrolytic**
less than 20	+	+ -	-
20 to 40	+ -	+	+ -
more than 40	-	+	+

+ = Cost effective
- = Cost may exceed capital and/or operation and maintenance costs
+ - = may be cost effective, depending on fixer volume and silver concentration - check with you equipment supplier

❑ Electrolytic Recovery

For large volumes of waste fixer, electrolytic recovery (also know as electrolysis) is an efficient and cost-effective method of silver recovery. In electrolytic silver recovery, electric current reduces the silver-thiosulfate complex and plates almost pure silver metal onto the negatively charged electrode. This electrode is called the cathode and is made of a piece of stainless steel or other metal/material. There are two basic types of electrolytic equipment: one in which the cathode rotates in the solution; and, the other in which the solution flows around a stationary cathode. **Either type of equipment is capable of recovering more than 90% of the silver from the silver-rich solutions.** Electrolytic units are typically unable to meet discharge levels of under 200-300 PPM.

The use of in-line electrolytic silver recovery and closed loop fix solutions can significantly reduce the amount of silver carried over into the final wash water and discharged to the POTW. Where the use of such closed loop fixers and in-line silver recovery is possible, mixing and chemical usage can be reduced by up to 50%, further increasing the cost effectiveness of this technology. This approach may not be feasible in all circumstances and is dependent on the imaging media and application solution volume and silver concentration.



Picture 4.3 - Example of an Electrolytic/MRC Recovery System

Fix solutions from black and white processes are easy to desilver electrolytically and require little, if any, pH adjustment. Recovery efficiencies of more than 90% can be achieved. Yet, typically all electrolytic units will require one or more MRC tailing cartridges to reduce silver discharge below 5 PPM.

Bleach-fix and fix solutions from color processes that contain iron-complex oxidizing agents are not as easy to desilver electrolytically. Higher current densities and longer times are required, with occasional pH adjustments. The optimum pH range for silver-rich solutions containing iron is 7.8 - 8.5. Under acidic pH conditions (pH < 7.0), the iron-EDTA complex used in bleaches and bleach-fixes will oxidize the silver plated on the

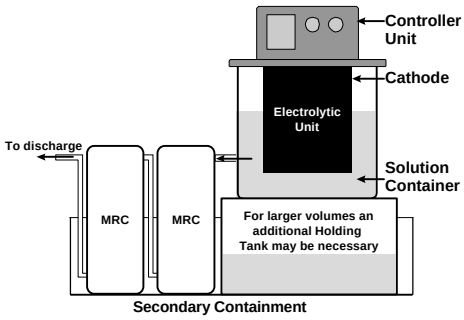


Figure 4.1 - Example of an Electrolytic/MRC Recovery System

electrode and move it back into solution. As the pH becomes more basic, (pH > 7.5), the oxidizing power of this iron-EDTA complex is reduced and the plating of silver onto the electrode becomes more efficient. With proper equipment and pH adjustments, silver recovery efficiencies approaching 90% can be achieved from these solutions.

Attempts to achieve higher efficiencies than those recommended by the manufacturer can actually lead to lower silver recovery. By overextending the electrolysis time or significantly raising the current density, sulfiding can occur. This results in coating the cathode with a black, yellow or other color sulfide precipitate (you will smell rotten eggs), rendering it unsuitable for continued silver recovery.

❑ Metallic Replacement

Metallic replacement is a process where elemental iron undergoes an oxidation-reduction reaction with silver thiosulfate to produce ferrous ions and metallic silver. The exchange reaction is very rapid, but is dependent on the contact of the silver-thiosulfate complex with the iron surface. Flow rate, iron surface area, contact time, and the solution pH are the major variables influencing the recovery efficiencies.

To ensure good and controlled contact, metallic replacement is accomplished by metering the silver-rich solutions through a container of steel wool, iron particles or an iron-impregnated resin.

These containers are generally referred to as metallic replacement cartridges (MRCs), chemical recovery cartridges (CRCs) or silver recovery cartridges (SRCs).

As the recovery cartridge is used, the active surface area is reduced and small channels will begin to develop in the iron substrate. The efficiency of recovery will gradually diminish until breakthrough occurs, at which time the cartridge or core material is replaced.

Picture 4.4 - Example of a MRC Recovery System

A properly designed and maintained MRC system is capable of recovering more than 95% of the silver from silver-rich solutions (includes waste fixers and wash waters) when used in accordance with manufacturer specified flow rates. Two MRCs connected in series, with a valve in-between to allow testing, will prevent the discharge of silver-rich solutions to the drain. A properly designed and maintained two-cartridge system with manufacturer specified flow rates is capable of recovering 99% of the silver from silver-rich solutions.

One of the most effective MRC systems is to use two recovery cartridges. There are two reasons to use two recovery cartridges. There are two reasons to use two cartridges in series: 1) the second cartridge removes additional silver, typically below 5ppm; 2) if the first cartridge fails or becomes spent the second cartridge acts as a back-up system by continuing to remove silver from the waste silver-rich solutions. When the first cartridge is spent, the second cartridge becomes the first cartridge in the series and a new/recored second cartridge is installed (see figure 4.3). A two cartridge system removes silver more consistently and thoroughly than a single cartridge system and protects against releasing large amounts of silver due to system failure.

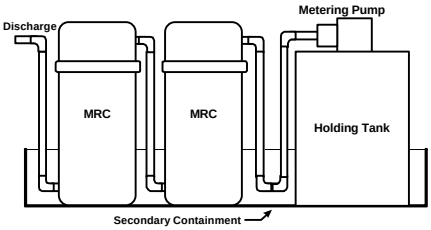


Figure 4.2 - Example of a MRC Recovery System

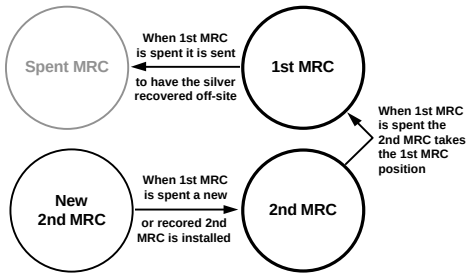


Figure 4.3 - MRC Recovery System Cartridge Rotation

Levels Reachable Using Silver Recovery Systems		
Equipment	**PPM**	**Comments**
Electrolytic alone	100-200 (optimal)	single chemistry systems can go below 100 PPM
Electrolytic with tailing MRC(s)	less than 5	meets regulatory requirements
MRC(s) alone	less than 5	meets regulatory requirements
*Meets City of Albuquerque, “Sewer Use Ordinance” discharge requirement of 5 PPM		

See Appendix E. PMA Information Testing Data

Solutions being discharged from any system should be tested and monitored to assist in determining the efficiency of the recovery equipment. Many equipment supplier/recovery companies will provide free testing to determine equipment efficiency by calculating the percentage of silver being recovered. When the system has been installed, you may wish to test on a weekly basis to estimate your recovery system capability and to assist in determining proper settings. Afterwards, and depending on your solution volume and recovery system capabilities, you can test your system on a monthly, bi-monthly, or quarterly basis.

❑ Precipitation

Silver can be precipitated using a wide variety of compounds (precipitants) that form insoluble complexes when added to silver rich waste streams. Older precipitants such as sulfide, borohydride and amineboranes are somewhat difficult and potentially hazardous to use. Consequently these precipitants are not generally recommended for use at facilities processing photographic materials unless personnel are available with adequate chemical training in the use and handling of these chemicals. These older precipitants, however, are gradually being replaced with more reliable and

less hazardous organic precipitants and equipment combinations, potentially making this technology more favorable.

The silver precipitation process is accomplished by metering silver-rich solutions or wash water into a reaction vessel. A prescribed amount of precipitant is added according to the manufacturer's direction. The resulting insoluble silver complex is allowed to settle or be filtered out as a sludge. The desilvered supernatant can then be discharged, while the sludge containing silver is collected and sent to a silver refiner. A properly designed and maintained system is capable of recovering 99.9% or more of the silver from silver-rich solutions.

❑ Other Technology

Evaporation /Distillation	This method concentrates the silver-rich solutions and can be used with wash water. Silver-rich solutions can be concentrated to between 8% and 30% of their original volume. In general, the residue that remains is still a liquid sludge, although some companies offer a distillation device for small volumes that produces a solid. The distillate will contain small amounts of ammonia and some organics making it unusable for mixing fresh developer solutions. Distillates can be used to make new secondary replenishers such as bleach, fixer and stabilizers.
Ion Exchange	Ion exchange technology, while still relatively expensive, can be used to recover silver from dilute processing solutions and wash waters. Two types of ion exchange technology exist. Conventional ion exchange relies on attracting the negatively-charged silver thiosulfate complex to positively-charged sites on an ion exchange resin. When the positively-charged sites are filled, breakthrough occurs. The resin is either regenerated by removing the silver-thiosulfate complex with a concentrated negatively-charged ion solution, or replaced. Ion exchange relies on converting the silver thiosulfate complex to a silver sulfide precipitate in or on the resin beads. These resin beads are typically sent to a silver refiner or reclaimer where the beads are smelted to recover the silver. **Ion exchange cannot be used for recovering silver directly from silver-rich fix and bleach-fix solutions.** These concentrated thiosulfate solutions will strip silver from the resin, and can actually result in more silver being discharged from the resin column than is present in the feed solution. Thus, ion exchange lends itself only to the recovery of silver from wash waters and dilute processing solutions. Typically, more than 90% of the silver from wash waters can be removed. In certain circumstances, where image permanence is not critical (such as pre-press facilities), equipment that utilizes ion exchange technology is an effective and economic means of managing silver in the wash water and reducing the volume of process water required. It is most effective when used in conjunction with an in-line silver recovery unit for the preceding fixer solution. The spent cartridges may be sent to a refiner for the recovery of silver. However, in other photographic processing operations such as photofinishing, the cost, space and technical requirements of a properly sized system may preclude its

use. Other considerations include the environmental impact of back flush systems versus the small amount of silver recovered. Acidification of silver-rich solutions for in situ precipitation can release sulfur dioxide presenting a potentially dangerous health hazard. The acidic solution produced must also be neutralized before disposal to the POTW.

Ion exchange is not recommended as a primary silver recovery operation for silver-rich solutions. It could, however, be a valuable technology for removing silver thiosulfate and thiosulfate ions from wash waters in circumstances where reuse of wash water is important from a conservation perspective.

Reverse Osmosis

Reverse osmosis (RO) is a type of membrane filtration technology and can be used with wash water. In RO the waste water stream flows under pressure over the surface of a selectively permeable membrane. Under pressure, water molecules pass through the membrane and the other constituents including silver are left behind. The extent of the separation is determined by the pore size, the dynamic pressure and the surface chemistry of the membrane. The result is two streams. One is a permeate of relatively clean water (water that may be able to be reused in photographic processes). The other is concentrated waste stream containing silver, which can be sent to a silver refiner (U.S. Environmental Protection Agency, 1991).

Reverse osmosis has been successfully used to remove up to 90% of the silver from process wash waters and very dilute photoprocessing solutions. Recent developments in this technology have allowed its use for in-line recovery and reuse of silver-rich solutions in limited circumstances. This technology is not, however, appropriate for removing silver from most spent silver-rich solutions in photographic processing operations. The high chemical content of these solutions tends to quickly clog the membranes. The maintenance requirements and application limitations of this technology can be significant and may discourage its use in facilities processing photographic materials.

Recovery Equipment Matrix

Equipment	Fixer[1]	Bleach Fix[1]	Dilute Solutions	Wash Water
Metallic Replacement Cartridges[2]	+	+	+ -	-
Electrolytic Recovery[3]	+	+	-	-
Ion Exchange	-	-	+	+
Reverse Osmosis	-	-	+	+

\+ = Effective for silver recovery
\- = Typically not effective for silver recovery
\+ - = may be effective, depending on silver concentration and/or volume

1. Mixtures of fix and bleach fix may complicate the ability of certain systems to recover silver. Single chemistry systems are more efficient, but silver can still be recovered from combined chemistries. Do not mix developer and fixers.
2. Dilute solutions can be processed using MRC's. Careful monitoring is required and the cartridges will typically degrade before a great amount of silver has accumulated. Payback should not be expected.
3. The greater the silver concentration the greater the silver recovery using electrolytic systems

❑ Equipment Operation and Maintenance

All recovery methods and equipment require some level of operation and maintenance. If waste fix is taken to a reclaimer time must be allotted to collect and deliver the fix or prepare the waste fix to be picked up. The method of capturing spent fix must be properly maintained and monitored so that accidental spills do not occur from overfilling containers or from leaks in containers, hoses, etc. Most companies provide proper containers for storage and transport. These containers should be kept sealed and properly labeled (see Appendix F. Hazardous Waste Information, pg. 14). Receipts detailing the materials picked up or delivered to the reclamation company should be maintained and kept on file for at least three years.

Equipment should be operated and maintained along manufacturers or suppliers specifications. Hoses, pumps and all other equipment should be regularly inspected for leaks, cracks, etc. Improper operation and poor maintenance will result in inefficient silver recovery and will increase the cost of the equipment; less recovered silver means less of the equipment is paid off. Wastewater discharged from the system should be tested to determine silver concentration. This will determine if the system is operating efficiently and effectively and if the system is removing silver to 5 PPM or lower. Many system suppliers or recovery companies provide testing to determine equipment efficiency. Some systems require operator knowledge and many equipment suppliers will provide training or will provide appropriate materials to assist employees in the operation of the recovery equipment.

❑ Secondary Containment

Any system located near a floor drain should have secondary containment. The purpose of secondary containment is to control an accidental spill or tank/cartridge failure and to keep waste silver-rich solutions from entering the floor drain and the sanitary sewer system. Secondary containment can be either a container in which the recovery equipment sits, a dike around the recovery equipment, a dike around the floor drain, or the floor drain can be capped either permanently or with a removable plug.

❑ Now that I've installed recovery equipment what do I do with the recovered metal?

The standard procedure is to triple rinse any silver bearing materials. This means that if you are using an electrolytic unit and you have accumulated silver scrap and flake, prior to sending this to a recycler, you need to triple rinse the scrap and flake. If you use recovery cartridges you need to triple rinse these before you send them for recoring/recycling.

Why triple rinse?

You need to remove any dissolved silver salts before you send the material to a recycler. Silver is considered a hazardous material and by not removing the dissolved silver salts prior to transportation the material could still be considered a hazardous waste. If you are caught transporting such a material (for Small and Large Quantity Generators) to a recycler the fines could be large. Triple rinsing removes the majority of the dissolved salts and removes the possibility that the material could be considered a hazardous waste.

See Appendix E. PMA Information for additional clarification

❑ Disposal

Disposal of silver-rich solutions can often be a difficult and expensive endeavor. Disposal of any liquid waste that contains more than 5 mg/L of silver is considered a hazardous waste. If you generate and dispose of such liquid wastes you are required to follow the hazardous waste regulations as determined by the Resource Conservation and Recovery Act (RCRA). These regulations detail the proper and safe methods for disposal of hazardous wastes. If you throw silver-rich solutions into the dumpster or discharge these solutions to the sewer system you could also be fined for violating hazardous waste disposal regulations.

Disposal also requires that any waste you generate be tracked from cradle to grave. This means that you are responsible for the generation and proper disposal of your wastes. If it is found that the disposal company you hired was not properly disposing of the material, you could be held financially responsible for clean-up of the contaminated site. Even when the hazardous waste has left your business you are responsible for any inappropriate and illegal action involving your wastes. It is your responsibility to verify that your wastes are properly handled and disposed.

Disposal is not a method of pollution prevention and is not a dominant method of managing wastes. Disposal does nothing to reuse materials, reduce the amount of pollutants being generated and does not have the potential to return money to your business. Disposal will cost your business money in the short term and possibly in the long term. Costs associated with disposal may be seen well after you have retired from your business.

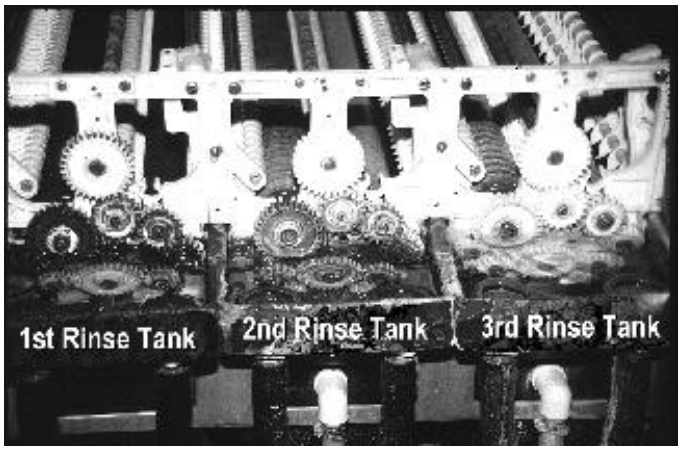
Disposal	
Do you keep track of all the materials you send to disposal? ❑ **Yes** ❑ **No**	You should maintain and keep on file all manifests, receipts and tracking materials for wastes you have disposed. To reduce the amount of paperwork and business liability you should review your processes and material use to reduce the amount and number of wastes you currently generate. By not generating the waste you will not have to have it disposed.
Do you commingle like wastes prior to disposal? ❑ **Yes** ❑ **No**	Commingling is the process of combining similar wastes into a larger container. For commingling, wastes should not be reactive and should be of the same hazard classification. Compared to lab packs, commingling can be much cheaper (up to 1/4 the cost) than using lab packs. Due to absorbent materials and waste container space Lab packs typically can only accommodate 14 gallons of wastes in a 55 gallon lab pack. Commingling can accommodate the full 55 gallon drum space. (from: "Laboratory Waste Management: A Guidebook," ACS Taskforce on Laboratory Waste Management, ACS, Washington, D.C., 1994) Commingling should be done carefully and employees should be trained in the procedures. Simple errors such as combining incompatible wastes can endanger your business and/or generate a mixed hazardous waste. this can make your wastes difficult to handle and expensive to have disposed. One example is the segregation of non-chlorinated solvents from chlorinated solvents. Mixing a small amount of chlorinated solvent in with the nonchlorinated solvents will cause the entire container to become a hazardous waste and will be expensive to have handled and disposed.
Do you segregate wastes prior to disposal? ❑ **Yes** ❑ **No**	Segregating wastes can greatly reduce the amount of hazardous wastes you generate, thus reducing your disposal costs. If you mix 1 pound of hazardous waste with 9 pounds of nonhazardous waste you will have 10 pounds of a hazardous waste. Your best option is to make sure that the 1 pound of hazardous waste does not get mixed with the nonhazardous wastes.

For more information concerning Hazardous Waste Regulations see
Appendix E. PMA Information, and Appendix F. Hazardous Waste Information

❑ Automatic Processors - The Importance of Wash Tanks

Different film processors can affect the amount of silver being discharged to the sewer system. Any film processor with a series of rinse tanks will reduce the amount of silver being discharged. Typically, processors with at least three rinse tanks are best in that they greatly reduce the amount of silver in the wastewater discharge. Rinse water from the first and even second rinse tank can often be combined with the waste fixer solutions to be processed by silver recovery equipment.

Accumulation of silver will differ from the first rinse tank to the last rinse tank. See picture 4.5 - the black residue on the first rinse tank and the gray residue on the second rinse tank is silver. Rinse tanks play an important role in reducing silver discharges. A rule of thumb for rinse tanks is that each successive rinse tank will reduce the concentration of silver by a factor of ten. Therefore, if the initial drag-out concentration is 1,000 mg/L the first rinse tank will reduce this to 100 mg/l, the second rinse tank reduces it to 10 mg/L, and the third rinse tank reduces this to 1 mg/L.



Picture 4.5 - Example of silver concentrating at the different wash stages

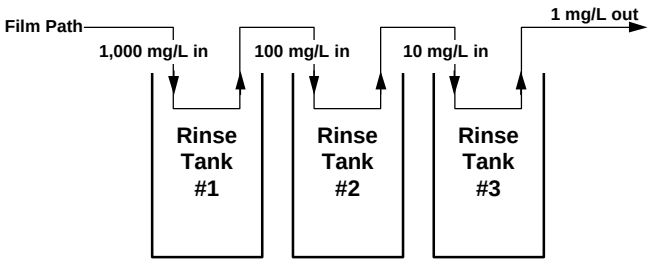


Figure 4.4 - Example of silver concentration reduction at different wash stages

All processors should be plumbed to either a collection point to capture all waste fix or to silver recovery equipment.

When using electrolytic recovery washes should be plumbed into the recovery system after the electrolytic unit but before the MRC's. This allows the washes to be processed by the MRC's but does not dilute the fixer solution in the electrolytic unit. Electrolytic systems work more efficiently with high concentrations of silver.

❑ Equipment Listing

To better understand your equipment you may want to list:

1. your different processors,
2. the number of rinse tanks in each processor, and whether some are plumbed to silver recovery,
3. whether the processor discharge is plumbed to silver recovery or is captured.

Processor		Rinse Tanks		Fixer		Silver Recovery		
Make	**Model**	**#**	**Recovery**	**Plumbed**	**Captured**	**Electrolytic**	**MRC**	**None**
Example A	A-1 processor	3	1&2 plumbed and combined with fixer	X			X	

❑ Other In-House Methods of Pollution Prevention

Photoprocessing uses many different chemicals, many of which are affected and degraded by the environment. You should attempt to limit your chemicals exposure to air, high temperatures and other potential contaminants. The following list can reduce the amount and cost of the chemicals you currently purchase.

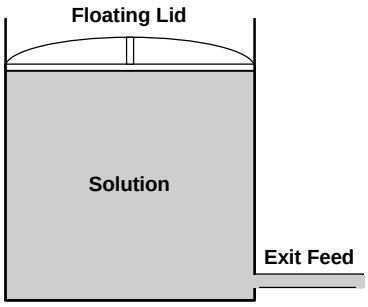


Figure 4.6 - Floating Lid

- **Floating Lids and Covers** - All chemicals baths should be covered with a floating lid or cover. This prevents air from contacting and degrading the solutions which shortens the solutions life span and increases the need for replenishment or for a new solution bath (Figure 4.6).
- **Squeeze out the air** - For partially empty bottles squeeze out as much air as possible before recapping to reduce air degradation.
- **Temperature** - For temperature sensitive chemicals store them properly and monitor the temperature when the solution is being used in a process.
- **Storage** - Store materials and chemicals according to package directions and protect from extreme heat and cold.
- **Rotate Stock** - The basic rule is "FIRST IN, FIRST OUT." Rotate chemical stock making sure older mixes are used first. Order mixes in sizes that best fit your usage. Unmixed chemistry should not be stored for long periods. You should also follow the manufacturers directions to determine shelf life for mixed solutions.
- **Container Disposal** - Rinse all containers with water and puncture or cut the containers before disposal. This makes it so the containers cannot be reused.

❑ Plate Making & Screen Making Operations

Typical wastestreams include: outdated material and chemicals, damaged or used plates and screens, wastewaters containing acids, alkalis, solvents, plate coatings, developers, screen emulsions, and rinse water.

Pollution prevention opportunities include:

- Changing operational and work practices to reduce chemical use including recovery and recycling of spent chemicals and heavy metals, which require steps to reduce contamination of chemical baths; counter-current washing; and filtration of screen making wastewaters to remove particulates;
- Recycling plates and plate materials to the manufacturer or a metal recoverer;
- Researching and commercializing of other major changes in printing plate development, primarily related to alternative chemistries. For example, using water-developed lithographic plates and film instead of solvent processing may eliminate the need for pretreatment of wastewaters if they are being discharged to the sewer;
- Replacing ferrocyanide bleaches with iron-EDTA bleaches which eliminate certain treatment and disposal requirements;
- Reducing environmental releases related to plate-making and screen-making through new techniques. For example, laser plate making using non-silver plates is under commercial development and could replace chemical development of plates;
- Reducing wastewater through new technologies such as "washless" processing systems. While still expensive to install, these systems can reduce wastewater by as much as 97 percent.

THE "ECONOMY SIZE" MYTH

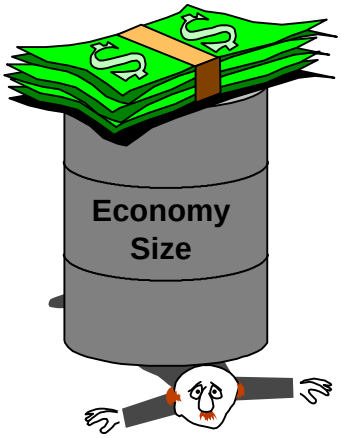
AND WHY LESS IS BEST

Do you purchase chemicals in large volumes? ❑ **Yes** ❑ **No**	When a large container is purchased, often a small quantity is used and the excess is stored. Large volumes increase the possibility of having excess chemicals in the lab that are past their expiration dates. This results in large amounts of potentially hazardous waste.
Do you use all the material in a container? ❑ **Yes** ❑ **No**	Do not begin new procedures with new chemicals, bypassing previously opened containers. Partially filled containers begin to collect around the shop. Unused chemicals can greatly increase the amount of hazardous wastes a shop generates.
Do you properly label chemical containers? ❑ **Yes** ❑ **No**	The cost of having even a small quantity of unknown chemical analyzed prior to disposal can exceed $1,000.00. Proper labeling: • Should be legible and permanent. • Decreases the risk of accidents and injuries resulting from improper labeling or storing. • Allows surplus chemicals to be reused rather than requiring disposal due to being unknown chemicals. • Reduces analysis and associated costs prior to disposal. • Assists in regulatory compliance, such as the hazard communication plan.
Do you keep on file all records of hazardous waste disposal? ❑ **Yes** ❑ **No**	Records of all materials sent to disposal must be on file for at least three years, although the general recommendation is to maintain these records for the life of the business.
Recommendation:	To avoid costly surplus, purchase chemicals in small prepackaged containers. Purchases should be done to fulfill immediate lab needs, this reduces the possibility of excess chemicals and containers.

LESS IS BEST

There are many reasons for smaller volume purchases

- Material taken from large "Economy Size" containers can be twice as costly as material taken from smaller packages.
- Disposal costs per package can be up to 25% less for smaller containers than large containers.
- Smaller containers are emptied faster and there is less chance of chemical decomposition when using smaller containers.
- Accident risk and exposure to hazardous materials is reduced when handling small containers.
- Business liability and paperwork is reduced due to the reduction of materials being disposed.
- Records of all materials sent to disposal must be on file for at least three years, although the general recommendation is to maintain these records for the life of the business.
- Higher costs are associated with the handling and storage of larger containers. Additional stockroom planning and design is needed to prevent and control fires, increase ventilation, and reduce accidental spills and chemical reactions.
- Larger containers often require additional equipment such as smaller transfer containers, funnels,
- pumps, and labels.
- Additional labor is needed to subdivide larger containers into smaller containers.
- Additional personal protective equipment may also be necessary.



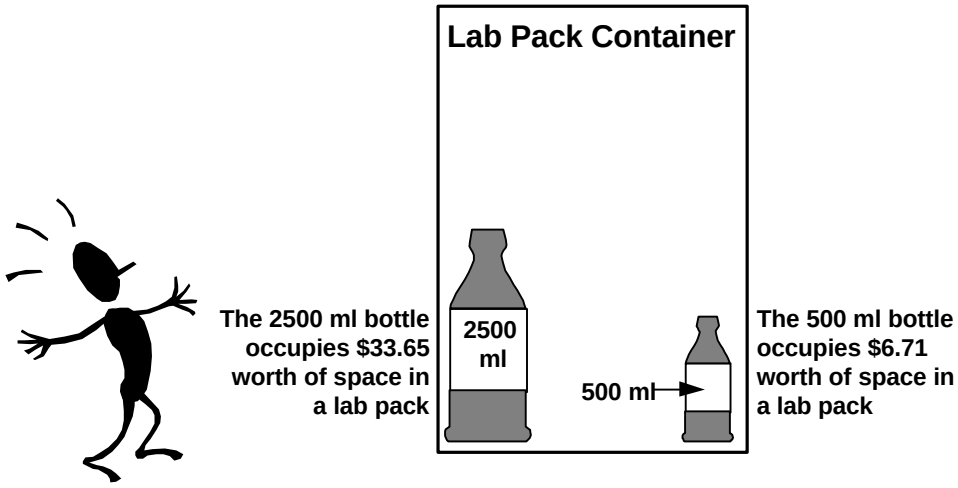
Purchasing-Disposal Economics

(in 1993 dollars)

(Example is for Phenol)	**Size of package**	
	500 ml	**2500 ml**
Purchase Price	$25.00	$65.00
Unit Purchase Price per milliliter	0.05	0.03
When 1000 ml are used (the rest is disposed)		
Price per milliliter (purchase price ÷ 1000 ml)	0.05	0.07
Estimated Bottle Disposal Cost	0.00 (no bottles)	33.65 (1 bottle)
Total Cost (purchase + disposal)	50.00	98.65
Total Cost per milliliter (Total Cost ÷ 1000 ml)	0.05	0.10
When 1300 ml are used (the rest is disposed)		
Price per milliliter (purchase price ÷ 1300 ml)	0.05	0.05
Estimated Bottle Disposal Cost	6.73 (1 bottle)	33.65 (1 bottle)
Total Cost (purchase + disposal)	81.73	98.65
Total Cost per milliliter (Total Cost ÷ 1300 ml)	0.06	0.08

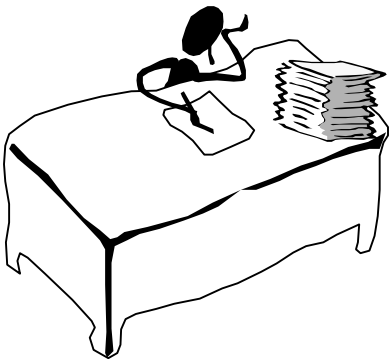
(from: "Less is Better: Laboratory Chemical Management for Waste Reduction," 2nd Ed., American Chemical Society Task Force on Laboratory Waste Management, ACS, 1993)

A 2500 ml bottle occupies approximately $33.65 worth of space in a lab pack, a 500 ml bottle occupies approximately $6.71 of space in a lab pack (a typical 55 gallon lab pack can hold appx. fifty-two 500 ml bottles). No matter how much chemical is used (unless the bottle is emptied) the container will always cost this amount since a bottle will take up the physical space in the lab pack container.



Unless your lab uses all the chemical in an "Economy Size" container disposal costs will often outweigh bulk material savings.

Inventory Management	
Do you track your purchases from the time of purchase to final use or disposal? ❍ **Yes** ❍ **No**	Tracking what the material was used for and how it was disposed of can lead to significant advances in your business' pollution prevention efforts. Tracking a chemical from purchase to disposal can reduce duplicate purchases. Allowing for redistribution of surplus materials can reduce waste generated from partially filled containers or out-of-date stock. Whatever method you use to track purchases (i.e., computer program, ledger books, note cards, etc.) accuracy relies on the cooperation of all lab employees and should be incorporated in your employee training.
Do you keep all records of all hazardous wastes set off-site for disposal? ❍ **Yes** ❍ **No**	Records of all materials you send to disposal must be on file for at least three years. The general recommendation is to maintain these records for the life of the business. Maintaining records of disposal methods, costs and materials disposed of can assist in your pollution prevention activities. If you consistently dispose of large containers with small amounts of unused chemicals you may want to review your purchasing habits and tracking methods.

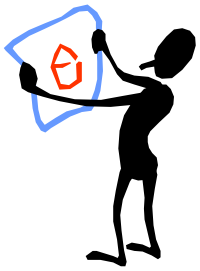


Section 4

PRESS OPERATIONS

During printing, the image is transferred to a substrate of paper or some other material. Typical wastestreams include: inks, substrate, cleaning solutions, and in the case of lithography, fountain solutions. Pollution prevention opportunities include:

- Improving housekeeping and implement better operating practices, such as covering reservoirs and containers, scheduling jobs according to increasing darkness of ink color, using wipes as long as possible, and controlling inventory, can all minimize solvent losses from inks and cleaning solutions.
- Reduce ink vaporization by using diaphragm pumps which do not heat ink as much as mechanical vane pumps.
- Recycle waste solvents on-site or off-site. Segregating solvents may allow a second use (e.g., for equipment cleaning or ink thinning).



- Recycling of certain waste inks where possible.
- Recycling of product rejects where possible.
- Using alternative ink and cleaning products with reduced VOC emissions. Lowering the VOC emissions from printing and press cleanup may be accomplished using vegetable oil-based inks or water-based inks (rather than solvent-based inks) where possible and using low-VOC or VOC-free cleaning solutions. A new printing system that features an oil-based lithographic ink that can be converted to a water-soluble state is currently available, allowing a water-based blanket wash to be used.
- Eliminating the use of chromium-containing fountain solutions to reduce the toxicity of spent fountain solutions.
- Installing automatic ink levelers help to keep ink conditions optimal.
- Using automatic cleaning equipment which can often be retrofitted to existing presses and operations. Typically, lower volumes of cleaning formulations are applied with such cleaning equipment, air contact, and thus volatilization, is reduced, and most are designed to include recycling and reuse of cleaning solutions.
- Minimizing finished product rejects by automating (noncontact) monitoring technologies which detect tears in web and press performance.
- Using fountain coolers to reduce evaporation from the dampening fountain.

Section 5

POST-PRESS OPERATIONS

The final steps in making a printed product may involve folding, trimming, binding, laminating and embossing. Typical wastestreams include: scrap substrate from trimming, rejects from finishing operations, and VOCs released from adhesives. Pollution prevention opportunities include:

- Collecting and reclaiming recyclable materials is often done.
- Replacing VOC-based adhesives with water-soluble adhesives (binding adhesives that are not water-soluble may interfere with later recycling), hot-melt adhesives, or mechanical methods in binding operations.

<Enter data on the paper recycler out of Belen - McKinnley Paper>

Section 6

SOLVENTS

Cleaning solvents are used to clean the presses. The rubber blankets are cleaned once or twice per eight-hour shift to reduce or eliminate imperfections resulting from dust, particles, or dried ink. When lower quality paper is used, cleaning is required more frequently. A variety of solvents and cleaning solutions is used in the industry. Solvents include methanol, toluene, naphtha, trichloroethane, methylene chloride, and specially formulated blanket washes.

❑ Common Solvents and Their Hazards

How to use this chart: The solvents are grouped according to chemical class so that relative toxicity and flammability can be compared within the class. Chemicals in the same class often have similar solvent properties, so that safer substitutes may be found using this chart. The chart is meant as a guide to common solvents and their hazards. For more complete information, other sources should be consulted.

Abbreviations

abdom	abdominal
ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
asp	aspiration
C	Ceiling, level not to be exceeded
chem	chemical
pneum	pneumonia
CNS	Central Nervous System
derm	dermatitis
diarr	diarrhea
disturb	disturbances
dizz	dizziness
drow	drowsiness
FP	Flash Point in degrees Fahrenheit
GI	gastro-intestinal system
head	headache
ing	ingestion
irr	irritating
mm Hg	millimeters of mercury
musc	muscular system
narc	narcosis
NIOSH	National Institute for Occupational Safety and Health
NIOSH**	NIOSH recommends reducing exposure to lowest feasible concentration
OSHA	Occupational Safety and Health Administration
PEL	OSHA Permissible Exposure Limit
PEL*	PEL listed below in chart
perm	permanent
PNS	peripheral nervous system
PPM	parts per million
REL	NIOSH Recommended Exposure Limit
repro	reproductive system
resp sys	respiratory system
TLV	ACGIH Threshold Limit Value
URT	upper respiratory system
UV	ultraviolet radiation
vis	visual system
vom	vomiting
VP	vapor pressure in mm Hg at 68ºF

Example:

Solvent Class	TLV PEL PPM	FP ºF	VP mm Hg	Organs Affected	Symptoms	Comments
Alcohols						**One of the safer classes**
ethanol (denatured, ethyl or grain alcohol)	1000	55	43	CNS, eye irr, nose, skin, liver, repro	drow, fatigue, headache, irr, tremors; repro	least toxic alcohol; identify denatured

Ethanol has a flash point of 55ºF (meaning it will readily ignite), has a vapor pressure of 43 meaning it will readily evaporate (<1.0). It will affect the central nrevous system, nose, skin, liver, reproductive system, and is an eye irritant. It will cause drowsiness, fatigue, headache, irritation, tremors, and will affect reporduction.

Solvent Class	TLV PEL PPM	FP ºF	VP mm Hg	Organs Affected	Symptoms	Comments
Alcohols						**One of the safer classes**
ethanol (denatured, ethyl or grain alcohol)	1000	55	43	CNS, eye irr, nose, skin, liver, repro	drow, fatigue, headache, irr, tremors; repro	least toxic alcohol; identify denatured
isopropyl alcohol (rubbing alcohol)	400	53	33	eyes, skin, resp	mild eye, nose, throat irr; drow, dizz, head; dry skin	One of the least toxic alcohol
Methanol (wood or methyl alcohol)	200	52	92	eyes, skin, CNS, GI	eye irr; head, drow, nausea, vom; vis disturb; blindness	Use ethanol when possible; absorbed through skin
n-propyl alcohol	200	72	21 (77ºF)	skin, eyes, resp, GI	mild eye, nose, throat irr; dry skin; drow, head; ataxia	absorbed through skin
isoamyl alcohol (fusel oil)	100	109	2	eyes, skin, resp	eye, nose, throat irr; narc, head, dizz; short breath; nausea, vom, diarr; skin irr	absorbed through skin
isobutyl alcohol	50	82	9	eyes, skin, resp	eye, throat irr; head, drow; skin irr	absorbed through skin
diacetone alcohol	50	125	1	eyes, skin, resp, liver, kidney, blood	eye, nose, throat irr; corneal damage; narc, head, dizz	Most toxic alcohol
Aliphatic Hydrocarbons						
pentane(s)	600	-57	400 (65ºF)	skin, eyes, resp	eye, nose irr, drow; derm; chemical pneumonia (asp)	Extremely flammable, REL 120 PPM
heptane	400	25	40 (72ºF)	skin, eyes, resp	head, dizz, nausea; derm; chemical pneumonia (asp)	Substitute for n-hexane, Extremely flammable, REL 85 PPM
petroleum distillates (naptha, aliphatic petroleum naptha, benzine, petroleum ether)	400*	-40 to -86	appx. 40	skin, eyes, resp, CNS	dizz, drow, head, nausea; eye, nose, throat irr; dry, cracked skin; chemical pneumonia (asp)	Mixture aliphatic hydrocarbons; may contain n-hexane if boil pt. <156ºF
VM&P naptha (benzine)	300	>22	2 to 20	skin, eyes, resp, CNS	dizz, drow, head, nausea; eye, nose, throat irr; dry, cracked skin; chemical pneumonia (asp)	One of the least toxic, but flammable
gasoline	300	-45	-	skin, eyes, resp, CNS	dizz, drow, head, nausea; eye, nose, throat irr; dry, cracked skin; chemical pneumonia (asp)	Do not use; may contain benzene and/or lead

mineral spirits (Stoddard solvent, paint thinner)	100	>100	appx. 4 (77ºF)	skin, eyes, resp, CNS	dizz, drow, head, nausea; eye, nose, throat irr; dry, cracked skin; chemical pneumonia (asp)	Odorless paint thinner, turpenoid or mineral spirits with reduced aromatics preferred. Combustible
kerosene (Fuel oil #1)	none	110 to 162	-	skin, eyes, resp, CNS	dizz, drow, head, nausea; eye, nose, throat irr; dry, cracked skin; chemical pneumonia (asp)	No TLV or PEL established. Use TLV for mineral spirits
n-hexane	50	-7	150 (77ºF)	skin, eyes, resp, PNS, CNS	head; nausea; numbness of extremities; musc weakness; eye, nose irr; chemical pneumonia (asp)	Do not use; extremely flammable; other hexane isomers similar to heptane
Aromatic Hydrocarbons						**Try to avoid aromatic hydrocarbons**
toluene (toluol)	100	40	20 (65ºF)	CNS, liver, kidneys, skin, repro, eyes	fatigue, weak; confusion, euphoria, head, dizz; dilated pupils; insomnia; derm; chemical pneum (asp)	Absorbed through skin
xylene (xylol)	100	81	9	CNS, eyes, GI, blood, liver, kidneys, skin, repro	dizz, drow, incoherence, staggering gait; eye, nose, throat irr; anorexia, nausea, abdom pain; derm; chemical pneum (asp)	
coal-tar naptha	100	100	<5	resp, skin, eyes	lightheadedness, drow; skin, eye, nose irr; derm; chemical pneum (asp)	Do not use; mixture of aromatics; can contain benzene; Absorbed through skin
styrene (vinyl benzene)	50	88	5	CNS, resp, eyes, skin, PNS	eye, nose irr; drow, weakness, unsteady gait; narcosis; derm; numbness; chemical pneum (asp)	Absorbed through skin
benzene (benzol)	1	12	75	blood, CNS, skin, bone marrow, eyes, resp	eye, nose, resp irr; dizz, head, nausea; chemical pneum (asp); bone marrow depression, cancer	Do not use; causes leukemia; Absorbed through skin; extremely flammable
Chlorinated Hydrocarbons					**Try to avoid chlorinated hydrocarbons. NIOSH ** May produce phosgene gas and other toxics when heated or exposed to UV.**	
methyl chloroform (1,1,1-trichloroethane, chlorothene)	350	none	100	CNS, skin, eyes, heart	head, lassitude, CNS, poor, equilibrium; eye irr; derm; heart arrhythmias	One of the least toxic; can be fatal in enclosed spaces or "sniffing"; REL 350 PPM
trichloroethylene (ethylene trichloride, trichloroethene, triclene)	50	90	58	resp, heart, kidneys, liver, CNS skin	head, vertigo; vis dis, tremors, drow, nausea, vom; eye irr; derm; heart arrhythmias, abnormal skin sensations	Do not use; suspect carcinogen; absorbed through skin; REL 25 PPM; NIOSH**
methylene chloride (methylene dichloride, dichloromethane)	50	none	350	CNS, skin, eyes, heart	fatigue, weak, sleepiness; limbs numb, tingle; nausea; flushed face' neck (esp w/alcohol); liver damage; cancer; derm	Do not use; suspect carcinogen; forms carbon monoxide in blood; NIOSH**
perchloroethylene (tetrachloroethylene)	25	none	14	liver, kidneys, eyes, upper resp, CNS	nose, eye irr; CNS depression; liver, kidney damage	Do not use; suspect carcinogen; absorbed through skin; NIOSH**
1,1,2-trichloroethane (beta--trichloroethane, vinyl trichloride)	10	none	19	CNS, eyes, nose, liver, kidneys	CNS depression; nose, eye irr; liver, kidney damage	Do not use; suspect carcinogen; absorbed through skin; NIOSH**

carbon tetrachloride (carbon tet)	2*	none	91	CNS, eyes, lungs, liver, kidneys, skin	CNS depression; nausea, vom; liver, kidney damage; skin irr	Do not use; suspect carcinogen; absorbed through skin; many fatalities with alcohol; NIOSH**
chloroform (methane trichloride, trichloromethane)	2*	none	160	liver, kidneys, heart, eyes, skin	dizz, mental dullness, nausea, disorientation; head, fatigue; anesthetic; skin, eye irr	Do not use; suspect carcinogen; absorbed through skin; NIOSH**
ethylene dichloride (1,2-dichloroethane, ethylene dichloride)	1*	56	64	liver, kidneys, CNS, eyes, skin	CNS depression; nausea, vom; derm; eye irr, corneal opacity	Do not use; suspect carcinogen; absorbed through skin; NIOSH**
1,1,2,2,-tetrachloroethane (acetylene tetrachloride)	1	none	9 (86ºF)	liver, kidneys, CNS, blood	nausea, vom, abdom pain; tremor fingers; jaundice, enlarged liver; derm; increased monocytes in blood	Do not use; suspect carcinogen; absorbed through skin; NIOSH**
Esters						
ethyl acetate	400	24	746	eyes, skin, resp	eye, nose, throat irr; head, drow; derm	Least toxic ester
isopropyl acetate	250	36	42	eyes, skin, resp	eye, nose, skin irr; derm; head, drow	
methyl acetate	200	14	173	eyes, skin, resp	nose, throat irr; head, drow; optic atrophy	Extremely flammable
sec-amyl acetate	125	89	7	eyes, skin, resp	eye, nose, skin irr; derm; head, drow	
isoamyl acetate (banned)	100	77	4	eyes, skin, resp	eye, nose, throat irr; derm; head, drow	
n-amyl acetate	100	77	5 (77ºF)	eyes, skin, resp	eye, nose irr; derm; head, drow	
Ethers						**Forms explosive peroxides**
ethyl ether (ether, diethyl ether)	400	-49	440	CNS, skin, resp, eyes	dizz, drow, head, nausea, vom; skin, eye, URT irr	Do not use; extremely flammable
tetrahydrofuran (THF)	200	6	132	CNS, skin, resp, eyes	eye, URT irr; nausea, dizz, head	Do not use; extremely flammable
dioxane	25	55	29	liver, eyes, kidneys, skin	drow, head, nausea, vom; eye, nose, throat irr; liver damage; kidney failure; derm	Do not use; suspect carcinogen; REL 1 PPM C; NIOSH**
Glycols						
propylene glycol (1,2-propanediol)	-	210	0.07	skin. eyes	slight skin, eye irr; practically non-toxic by ing	Least toxic glycol
triethylene glycol (triglycol)	-	350	<0.01	skin. eyes	slight skin, eye irr; slightly toxic by ing	
ethylene glycol (glycol, 1,2-ethanediol)	50 C	241	0.06	liver, eyes kidneys, resp, skin	eye, nose, throat irr; head, nausea, vom, kidney, liver damage; skin sensitizer	Absorbed through skin; lethal oral dose adult 100 ml
diethylene glycol (carbitol)	50 AIHA	255	0.01	liver, eyes kidneys, resp, skin	nausea, dizz, kidney & liver damage (ing); mild skin, eye, resp irr	Absorbed through skin; lethal oral dose adult 70 ml
Glycol Ethers and their acetates						**Try to avoid ethers**
2-butoxyethanol (butyl cellosolve, ethylene glycol monobutyl ether)	25	143	0.8	liver, eyes, kidneys, lymphoid system, skin, blood, resp	eye, nose, throat irr; blood, liver, kidney damage; head, dizz, nausea	skin absorption more serious than inhalation; not shown to have adverse reproductive effects like others

2-ethoxyethanol (cellosolve, ethylene glycol monoethyl ether)	5	110	4	lungs, eyes, blood, kidneys, liver, repro	eye, resp irr; anemia (bone marrow); liver, kidney damage; lowered sperm count, miscarriages in humans	Do not use; absorbed through skin; serious reproductive effects in humans and animals; NIOSH**
2-methoxyethanol (methyl cellosolve, ethylene glycol monomethyl ether)	5	102	6	CNS, blood, skin, eyes, kidneys, repro	head, drow, weakness; anemia, bone marrow damage; ataxia, tremors, lethargy; eye irr	Do not use; absorption more serious than inhalation; serious reproductive effects in humans and animals; NIOSH**
2-ethoxyethanol acetate (cellosolve acetate, ethylene glycol monoethyl ether acetate)	5	124	2	resp, eyes, GI, repro	eye, nose irr; head, nausea, vom; liver and kidney damage	absorbed through skin; similar to but more irritating than 2-ethoxyethanol; NIOSH***
2-methoxyethanol acetate (methyl cellosolve acetate, ethylene glycol monomethyl ether acetate)	5	120	2	kidneys, brain, CNS, PNS	kidney damage; brain damage; eye irr	absorbed through skin; similar to but more irritating than 2-methoxyethanol; NIOSH***
Ketones						
acetone (dimethyl ketone)	750	0	180	resp, skin CNS	eye, nose, throat irr; derm; head, dizz	Least toxic ketone; extremely flammable; REL 250 PPM
methyl ethyl ketone (MEK, 2-butanone)	200	16	71	CNS, resp	eye, nose, throat irr; head, dizz, vom	Extremely flammable; synergistic with hexane and methyl butyl ketone
methyl isobutyl ketone (MIBK, hexone)	50	64	16	resp, eyes, skin CNS	eye, nose, throat irr; derm; head, dizz, nausea	Very objectionable odor; absorbed through the skin
methyl isoamyl ketone (MIAK)	50	96		resp, eyes, skin CNS, liver, kidneys	eye, nose, throat irr; derm; head, dizz, nausea	
cyclohexanone (pimelic ketone)	25	146	5 (77ºF)	resp, eyes, skin CNS, liver, kidneys	eye, nose, throat irr; derm; head, dizz, nausea	absorbed through the skin
methyl butyl ketone (MBK, 2-hexanone)	5	77	4 (77ºF)	CNS, PNS, skin, resp	eye, nose irr; numbness of extremities, musc weakness; derm; head, dizz, drow	Do not use; absorbed through the skin; REL 1 PPM
isophorone	4*	184	0.4 (77ºF)	resp, skin, CNS	eye, nose, throat irr; derm; fatigue, head, dizz, nausea	Do not use; severe depression
Others						
tetrachlorotrifluorethane (Freon 113)	1000	none	284	CNS, heart, resp	cardiac arrhythmias	Emits phosgene gas when heated; other freons act similarly
turpentine (gum spirits)	100	95	5 (77ºF)	skin, eyes, kidneys, resp	skin, eye, nose, throat irr; head, vertigo, dizz; sensitizer	Absorbed through skin; replace with turpenoid or odorless mineral spirits
morpholine	20	98	6	eyes, resp sys, skin	visual disturbances; eye, nose, throat irr; cough; liver, kidney damage	Absorbed through skin

dimethylformadine (DMF)	10	136	4 (77ºF)	heart, kidneys, liver, skin, testes	head, dizz, nausea, vom; liver damage; high blood press; facial blush; derm; testicular cancer; kidney, heart damage (animals)	Avoid if possible; absorbed through skin; suspect carcinogen; NIOSH**
carbon sulfide (carbon bisulfide)	4*	-22	297	CNS, PNS, heart, eyes, kidneys, liver, skin, repro	head, dizz; poor sleep, nervousness, psychosis; liver, kidney, PNS and CNS damage; skin, eye burns and irr; heart disease	Do not use; absorbed through skin; highly toxic; extremely flammable

(From: Art Hazards Newsletter)

❑ Alternative Cleaning Solvents

(From: Guides to Pollution Prevention: The Commercial Printing Industry, EPA/625/7-90/008, August, 1990)

Dangerous chemicals such as benzene, carbon tetrachloride, trichloroethylene, and methanol have been used as components of cleaning solutions. Specially made blanket washes are now available that are less toxic and less flammable. These blanket washes typically contain mixtures of glycol ethers and other heavier hydrocarbons that have a high flash point and low toxicity. Many printers feel that these solvents do not work as well as the solvents mentioned above. However, because of the less hazardous nature of the material, they are gaining in popularity. These blanket washes are typically used for all cleaning operations in the printing step. General cleanup should be done with detergents or soap solutions wherever possible. Solvent cleanup should be used only for cleaning up inks and oils.

❑ Reducing the Need to Clean

(From: Guides to Pollution Prevention: The Commercial Printing Industry, EPA/625/7-90/008, August, 1990)

Most presses are cleaned by hand with a rag wetted with cleaning solvent. The dirty solvent remains on the rag. A separate waste solvent is not produced. To reduce the amount of solvent and the number of rags used, ink fountains should be cleaned only when a different color ink is used or when the ink might dry out between runs. Aerosol spray materials are available to spray onto ink fountains to prevent overnight drying, so that the ink can be left in the fountain without cleaning at the end of the day. This reduces the amount of waste ink produced and the amount of cleaning solvent and rags used.

For example, a protective film was sprayed over each of four ink fountains on a small offset printing press at the end of each work day. The waste ink was reduced by 5 pounds per day. Based on a disposal cost of 70 cents per pound and 250 operating days per year, the savings in disposal costs are $875 per year. The need for new ink was reduced by 5 pounds per day. At a cost of $2.00 per pound, the savings in raw material costs are $2,500 per year. The total operating cost savings are $3,375 per year. The cost of the spray is relatively low. Also, less labor is needed to spray the fountains than is needed to drain and clean out the fountains and dispose of the waste ink. This labor savings would improve the source reduction economics.

❑ Increasing Cleaning Efficiency

(From: Guides to Pollution Prevention: The Commercial Printing Industry, EPA/625/7-90/008, August, 1990)

Where cleaning of rollers is accomplished with solvent and roller wash-up blade, several factors affect cleaning efficiency: condition of the rollers; condition of the blade; the blade's angle of attack against the roller; and press speed during wash-up. Both rollers and blade should be in good condition. The blade's angle of attack should be adjusted so that sufficient pressure is exerted on the roller, but the angle should not be so coarse that the blade can be "grabbed" and "pulled under" the roller. Too slow a press speed means long wash up times, and generally increased solvent use.

❑ Collect and Reuse Solvent

(From: Guides to Pollution Prevention: The Commercial Printing Industry, EPA/625/7-90/008, August, 1990)

In this practice, solvent is poured over the equipment and then wiped clean with a rag. The solvent is collected in drip pans under the equipment and becomes waste solvent which can be reused. If one container of solvent is used for each color printing unit, the solvents can be reused without cross-contaminating the inks. Used solvent can be reused in cleaning most of the ink from the rollers and blankets, with only a small amount of fresh solvent needed for the final cleanup. Small solvents stills can be used to reclaim the solvent.

In some cases, used solvents having one particular ink color can be used to make up the solvent content of new inks of the same color. This has been done at a company in North Carolina using alcohol/acetate formulations in its flexographic printing process. At Rexham Corporation in Mattews, N.C., toluene is used to clean the ink from the press, and runoff toluene is collected as waste. Rexham has nearly eliminated its toluene waste by segregating used clean-up toluene according to the color and type of ink contaminant and then reusing the collected wastes to thin future batches of the same ink. The procedure has no effect on product quality and has resulted in almost 100% reuse of the toluene solvent. However, solubility characteristics are critical to some types of flexographic printing plates and this approach should be investigated carefully.

❑ New Cleaning Solvents for Industrial Cleaning

A pollution prevention fact sheet on new cleaning solvents for industrial cleaning

Why Change Solvents?

Solvents are indispensable in many manufacturing operations, such as cleaning and painting. Unfortunately, some that have been used successfully for many years now require expensive controls or will become unavailable because they are harmful to humans and/or the environment. To protect health and the environment, Congress passed a series of laws, implemented by EPA and OSHA regulations, to control solvents which are:

Ozone-depleting (CFCs, TCA, Halons)
Smog-producing (VOCs-Volatile Organic Compounds)
Toxic (Toxic Release Inventory, 33-50 list)
Hazardous (flammable, corrosive, narcotic, etc.)

Some examples of undesirable solvents are included in the EPA's 33-50 list of 17 toxic materials. Industry has been asked by EPA to voluntarily cut the use of these materials. The solvents on the list are:

1,1,1-trichloroethane (TCA)
benzene
carbon tetrachloride
chloroform
dichloromethane (methylene dichloride)
methyl ethyl ketone (MEK)
methyl isobutyl ketone
tetrachloroethylene (perchlorethylene)
toluene
trichloroethylene (TCE)
xylene

In addition, the RCRA law and regulations drastically increased the cost of hazardous waste disposal, and the Superfund law made the generator responsible for any problem resulting from his waste. For example, if a transporter dumps waste rather than delivering it to the proper destination, the generators are legally responsible for cleanup even if they were unaware of the transporter's action. These new laws and regulations are forcing manufacturers to change processes or find solvent substitutes. Before making any change, a manufacturer should review plant operations and test the proposed change carefully. For example, if an undesirable cleaning solvent is now being used, consider the following before deciding on a replacement solvent:

Why is cleaning necessary?
What is the soil?
How much soil can be tolerated?
Can prior processes be changed to prevent soiling?
Can subsequent processes be changed to tolerate soil?

If cleaning is necessary, select potential substitutes and then test to find the best substitute. Environmentally undesirable solvents often have excellent physical properties. Most will dissolve a variety of soils, displace particles or water, are quick drying and recyclable. Some are nonflammable and self-rinsing in vapor degreasers. There are no "drop-in" environmentally-friendly substitutes; use of an acceptable substitute probably will require changes in processes and equipment.

❑ More Alternative Solvents

The following are unusual solvents which are potential substitutes for undesirable solvents. These chemicals are usually considered only after more common cleaners - aqueous, terpene or hydrocarbon - are determined to be inadequate. Unlike the more common cleaners, most of these chemicals have only recently been used as solvents in manufacturing. Information about specific applications may not be available, therefore testing and evaluation should be completed before switching from the current solvent.

Dimethyl Sulfoxide

Solvent for epoxy, urethane and other polymers and resins
Useful in paint strippers
Water-soluble, hygroscopic (absorbs water)
Miscible with most solvents except hydrocarbons
Recyclable by distillation (Boils at 189°C)
Low toxicity, but penetrates skin; protective gear needed
High flash point (203°F)
Evaporates slowly; may require water rinsing and drying

Propylene Carbonate

Solvent for epoxy, urethane and other polymers and resins
Useful in paint strippers
Not hygroscopic but decomposes in acid or alkali
Slight skin, moderate eye irritant; use protective gear
High flash point (270°F)
Evaporates slowly; may require rinsing and drying

N-Methyl Pyrrolidone

Hot NMP dissolves most oils; cooling releases oils
Helps remove burnt-on carbon deposits
Useful in paint strippers
Miscible with water and solvents except hydrocarbons
Protective gear required
High flash point (199°F)
Evaporates slowly; may require rinsing and drying

Dibasic Esters

Mixture of methyl esters of short chain aliphatic acids
Replaces acetone for rubber and resin cleanup
Solvent for inks, hand cleaners, textile lubricants

Mix with NMP to dissolve resistant resins
Useful in paint strippers
Recyclable by vacuum distillation
Stable at normal temperatures, humidity and pH
Personal protection required
High flash point (212°F)
Evaporates slowly; may require rinsing and drying

Lactate Esters

Produced by sugar fermentation
Ethyl and butyl esters good solvents for polymers, resins
Warm ethyl lactate removes both salts and flux from circuit boards
Used in paint strippers
Biodegradable, recyclable
Ethyl, butyl esters are approved food additives
Low toxicity; eye and skin protection, ventilation needed
High flash point for butyl ester (174°F)
Low flash points for methyl and ethyl esters; hazardous

Diacetone Alcohol

Dissolves fats, oils, waxes, and resins
Replaces acetone in fiberglass product manufacture
Miscible with water, alcohol, acetone, other solvents
Recyclable by distillation
Requires good ventilation
Flash point 133°F.; less hazardous than acetone (0°F)
Evaporates more slowly than acetone
Supercritical Carbon Dioxide
Heated pressure chamber (35°C, 2,000 psig) required
Carbon dioxide becomes supercritical at these conditions
Dissolves oils, fats, waxes, greases, plasticizers, etc.
Penetrates smallest openings
Release of pressure releases dissolved soils
Repressurization regenerates SCD
Nonflammable
No rinsing or drying required
Used to remove caffeine from coffee (50 million pounds/yr.)

For more information about any of the above solvents, contact the manufacturer. Request the Manufacturers Safety Data Sheet (MSDS) which provides detailed information about physical properties, toxicity, personnel protection, other safety precautions and waste disposal. Be aware that health and safety concerns and environmental regulations are constantly changing. Choose a cleaner that will still be desirable years from now.

Success

Wellcraft Marine (Sarasota) has used two alternatives to replace acetone in fiberglass resin cleanup. According to Bill McDonald of Wellcraft, "We used to use a lot of acetone. We'd have a 6000 gallon tanker of acetone delivered and 10 days later we'd have to order another tanker... and we were recycling!! All of that was lost to evaporation."

In 1991, Wellcraft tested a number of acetone substitutes and decided to begin using diacetone alcohol (DAA). "With diacetone alcohol, we had estimated that it would last 16 times as long as acetone. But when we ordered our first 6000 gallons, 6 months later we were still using it. You can see how a low vapor pressure cleaner can save a company like us money. We paid $20,000 for a piece of (recycling) equipment and in 2 months it was paid for."

But Wellcraft didn't stop there. According to Bill, "DAA was OK. We proved for 2-1/2 years that it could be used. But it was a stepping stone. As with any product, you need to be looking for something better."

Wellcraft has now started using propylene carbonate (PC) for resin clean-up. Says Bill, "PC is a great solvent - the departments love it. PC has better solvency than DAA, and it keeps resins in solution. With DAA the resins would sink to the bottom of the tanks. If a guy left a tool in a container of DAA overnight, when he came in his tool would be all gummy. Also, DAA was regulated as a hazardous waste because of the low flash point (133°F); PC has a flash point of 270°F, so it's not regulated as a hazardous waste.

"The reason we didn't go with PC originally is that we didn't have the equipment to recycle it. I'm responsible for this stuff from cradle to grave, at Wellcraft and beyond, and recyclability plays a very important role. Propylene carbonate is a tough animal to recycle. We did finally find a way to recycle it, but the flow rates are very slow. We are in the process of purchasing new recycling equipment to improve the flow rate."

The only down-side according to Bill: "We have a hard time getting PC. There aren't many suppliers in Florida; we have to have it trucked in from Texas. As far as I know, we're the first boat manufacturer to start using propylene carbonate full scale. We figure everybody should be doing this. It's just so cost effective, I can't believe there is anyone out there still using acetone. Even a small business should take out a loan, if they have to, to buy recycling equipment.

Section 7

INKS

❑ Printing and Finishing Inks

Many printers would use less hazardous products if given the choice, provide that product quality is not compromised. Suppliers should advise printers of specific inks that are recyclable or non-hazardous and provide samples that illustrate finished products. Printers should encourage their suppliers that they are interested in such inks.

Ink composition varies widely. Some inks contain chemicals that would be classified as hazardous; others do not. Inks frequently get their color from metals or hazardous pigments they contain. Inks containing metals and/or those inks using a solvent carrier are often classified as hazardous. It is the responsibility of shop owners to determine whether the inks used in their operations are hazardous. For assistance in making this determination, review the container label and the MSDS or ask your ink distributor.

Most inks may be recycled: spent inks of different colors are often blended to make black ink. For smaller print shops, consider coordinating with larger plants or newspapers (ones that use rubber or oil based inks) to recycle ink. These businesses usually recycle their inks on-site or ship them off-site in bulk shipments. Also consider purchasing inks from a distributor who will take or buy back unused or spent inks.

Waste Reduction Alternatives

- Fill ink fountains only enough for a particular run or shift. Return all unemulsified inks to their containers. Install automatic ink levelers in large web presses to keep ink fountains at their optimal level for good print quality.
- Run similar jobs simultaneously to reduce waste generation between cleanup and start of the next run.
- Use water based inks whenever possible to decrease the use of solvent based inks that cause employee and environmental hazards.
- Dedicate one press for inks containing hazardous pigments or solvents.
- Save old inks and market them as ‘house colors.’
- Donate unemulsified inks to trade schools, colleges, etc.

❑ Some Inks and their Hazardous Properties

CAS No.	Ink Description	Alt. Description	Metal	Substitute Description	Comments
147148	Pigment Blue 15	Cu Phthalocyanine	Copper	Blue 16	Will be noticeably off shade
84583777	Pigment Blue 62	Victoria Blue CFA	Copper	Blue 1	
1328536	Pigment Green 7	Phthalo Green	Copper	Green 2 or Green 1	Poor strength, loss of other properties too.
14302137	Pigment Green 36	Phthalo Green	Copper	Green 2 or Green 1	Poor strength, loss of other properties too.
67801018	Pigment Orange 46	Ba Ethyl RLC	Barium	Orange 16 & Red 22	Other oranges are available but significantly higher costs
7585413	Pigment Red 48:1	Ba Permanent Red 2B	Barium	Red 22	
5280660	Pigment Red 48:4	Mn Permanent Red 2B	Magnesium	Red 48:2	
1103384	Pigment Red 49:1	Ba Lithol	Barium	Red 2	
5160021	Pigment Red 53:1	Ba Red Lake C	Barium	Red 22	
68929135	Pigment Red 66	Anthosine Red 3B	Barium	Not Available	Discontinued routine use in the industry
12237637	Pigment Red 169	Rhodamine 6G CFA	Copper	Red 81:1	
12237626	Pigment Violet 27	Crystal Violet	Copper	Not Available	Discontinued production in the United States
1344372	Pigment Yellow 34	Chromium & Lead	Chromium	Yellow 14 or Yellow 12	Does not have strong opacity of Yellow 34
8007189	Pigment Yellow 53	Tin & Nickel	Nickel	Yellow 14 or Yellow 12	Does not have strong opacity of Yellow 34
68511626	Pigment Yellow 150		Nickel	Yellow 14 or Yellow 12	Does not have strong opacity of Yellow 34

❑ Removing Solvent and Ink from Printer Shop Towels and Disposable Wipes

By: Minnesota Technical Assistance Program

Background Information

Shop towels and disposable wipes that are contaminated with excess solvent and ink pose significant risks to the environment if they are sent to a landfill or commercial laundry facility. This is because:

- If the solvent and ink-contaminated towels are sent to a commercial laundry facility, the excess solvents and inks are washed out into the wastewater. This can create dangerous conditions in sewer lines as well as pass through municipal wastewater treatment plants. These contaminants can then end up in our lakes, streams and rivers.
- If contaminated disposable wipes are put in the dumpster, they pose a hazard due to the flammability or toxicity of many solvents. In addition, the contaminated wipes could end up in a landfill where the solvents may leach into the groundwater. Cleaning up the resulting groundwater contamination is costly and complicated. Your company may be held liable for the contamination and may be required to pay for clean-up costs.

Management of Shop Towels Sent to Commercial Laundry Facilities

If you do not remove excess solvents from shop towels, they must be managed as a hazardous waste and must not be laundered. However, management techniques can be used to remove excess levels of solvents and inks from shop towels so they can be sent to an authorized commercial laundry facility. Three options used to accomplish this are listed below.

NOTE: The following options will not be effective without the involvement of employees in suggesting how to make changes, and a successful and repeated employee training program.

Option 1: Change Clean-up Procedures

- Eliminate the practice of using solvent-soaked towels to clean rollers.
- Use equipment that limits the ability of workers to soak towels in solvent before they are used to clean ink from roller blankets. This includes plunger cans that moisten but do not soak towels, and squeeze bottles that moisten towels by limiting the amount of solvent that can be easily soaked into a towel. Squeeze bottles also can be used to apply solvent directly to the roller blanket.
- Limit access to solvent.
- For each press, distribute a limited amount of solvent for clean-up each workday. Provide equipment like squeegee bottles or plunger cans to employees to help them limit the amount of solvent used for each clean-up. To make this work effectively, employees need to understand why limiting the use of solvent will yield potential benefits for everyone.

NOTE: One Minnesota company that recently limited solvent usage for each press has realized $100 savings per day in solvent purchases.

- Establish procedures to prevent dumping liquid solvent and ink waste in used towel containers.
- Make it easy for employees to collect solvent and ink waste.
- Explain to employees that liquid waste cannot be added to towel containers, and that towels must not be used to soak up solvents and inks that collect in trays after roller blankets are cleaned.
- Place a drum or container for solvent and ink waste close to the containers used for towels. This drum or container should be clearly identified and labeled and have a large enough opening to allow solvent and ink waste to be easily poured from long collection trays. When not being filled, liquid storage drums must remain closed.
- Fabricate a special chute that allows easy transfer of solvent or ink that is collected in trays on raised platforms to a drum on the floor below.
- On one end of each solvent collection tray, drill a hole, install a drain fitting, and attach a hose through which the solvent or ink can be drained into a container. It is easier to transfer the solvent or ink to a storage drum from the container than from the collection tray.

Option 2: Set-up Equipment or Procedures to Separate a Majority of the Solvent and Ink from Soaked Towels.

- A hand-operated wringer (or a mop wringer) can be used to remove excess solvent and ink. (Note: Make certain that the rollers are made of solvent-resistant material.) Place the separated solvent and ink in a closed container and handle as hazardous waste. Label the container clearly so that employees don't mistake solvent and ink waste for water.
- An explosion-proof centrifuge can be routinely used to separate most of the solvent and ink from the towels. The centrifuge must be explosion proof. Note: The cost is in excess of $10,000.
- If you do not have separation equipment, require that towels be hand-squeezed (using protective gloves, eye protection and adequate ventilation) to remove solvent and ink before they are placed in the used towel container.

Option 3: Implement a System Using a Solvent Wash to Clean Ink from Trays.

- A parts washing unit with recirculating solvent can be used instead of towels to clean trays. Trays are removed from the press and placed in the washer unit where the solvent is used to remove the ink waste. A list of companies selling or leasing parts-washer units is provided at the end of this fact sheet.

Caution: Make certain that the unit used has a large enough base support to prevent it from tipping over.

- A stream of solvent (for example, from a squeeze bottle) can be used to wash ink waste to one end of the tray equipped with a drain hole, a drain fitting, and a hose to drain the waste into a container. The solvent is then easily transferred from the container to a storage drum.

Management of Disposable Wipes

- Collect the soaked wipes in a drum and manage as hazardous waste. However, if wipes are contaminated with a solvent that is hazardous only for ignitability (D001 or F003), remove the solvent as described in procedures for towels that are laundered. Once the solvent is removed, the wipes can be managed as industrial solid waste (if approved by your local regulatory agency).
- Change to reusable cloth towels, and set up a procedure to remove excess solvent and ink waste as outlined above. Then the towels can be sent to an authorized commercial laundry facility.
- Limit access to disposable wipes and solvent for press clean-up. This will automatically result in a reduction in waste.

Other Considerations

The success of your company's program to reduce solvent and ink levels in towels or disposable wipes will depend on:

- Management's commitment to a workable solution.
- Employees' attitudes as well as their level of cooperation and commitment.
- The effect of changes in procedure or equipment on each employee's ability and ease to perform their work.
- Designation of an employee(s) with authority and responsibility for towels and solvent management.
- Repeat training provided with reasons for following procedures.
- Opportunities for employee input to improve procedures.

NOTE: To be successful in reducing your costs, your company must take steps to ensure that no wipes end up in the waste solvent storage drum. Towels or wipes can jam up a pump used at the recycling or disposal facility. Your company may be charged for losses to equipment and time, should this occur.

❑ Waste Reduction Evaluation of Soy-based Ink at Sheet-fed Offset Printer

United States Environmental Protection Agency, Risk Reduction Engineering Laboratory
Cincinnati, OH 45268
Research and Development
EPA/600/SR-94/144
September 1994
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Project Summary

This Waste Reduction and Innovative Technology Evaluation project focused on the use of soy-based inks as a substitute for petroleum-based inks in sheet-fed offset printing. The goal of the study was to evaluate the waste reduction and economic effects of using soy-based inks in place of the petroleum-based inks traditionally used in sheet-fed offset printing. The main potential environmental benefits claimed for soy-based inks are that they are a renewable resource and emit less amounts of volatile hydrocarbons during the printing process. No published studies verify the claim of reduced air emissions or quantify other environmental aspects of suing soy-based inks such as the amount of liquid wastes generated and cleaners required. Other reported benefits of soy-based inks are that they are biodegradable in landfills and are more conducive to cleanup with degradable and less toxic cleaners than are petroleum-based inks.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the program demonstration that is fully documented in a separate report (see ordering information at back).

Introduction

The impetus for developing soy-based inks initially came from the oil shortages of the 1970's that threatened the supply of petroleum-based chemicals. Now, increased emphasis on improving worker safety and reducing environmental emissions is motivating the printing industry to seek cleaner technologies. In the 1980s, soy-based inks were first used in offset web presses for printing newspapers, mainly for presumed environmental benefits. In the late 1980s, soy-ink formulations were marketed for sheet-fed offset presses.

Sheet-fed soy inks are defined as those that have a minimum of 20% soy oil by volume. The soy oil replaces petroleum oils in the ink vehicle and varnish components. Use of the soy oil affects color, drying, and other operating characteristics of the inks. Soy-based inks used in sheet-fed presses still contain at least 10% petroleum oils. Research is continuing to increase the proportion of soy and other vegetable-based oils in these ink formulations while maintaining satisfactory printing characteristics.

The Office of Printing Services (OPS) at the University of Illinois is the operating partner in this study. They are considered a medium size, in-plant printer and gross about $4.5 million annually. They agreed to enter into this cooperative project because of their commitment to active research participation and out of a desire to be a model environmentally aware print shop. They were one of the first sheet-fed offset presses in the United States to use soy-based inks.

Approach

Data for this study was collected during a full-scale print run on a Miller TP104 Plus six-color press in July 1992 at the OPS. The print job evaluated was a 4400 sheet, six-color, work-and-turn. Only four of the six colors were included in the study because the type of ink used for two colors was not changed between the runs. All inks included in the study were manufactured by the same company, Handschy, Inc. of Bellwood, IL.[1] In-plant measurements consisted of:

- Weighing the containers of inks, blanket cleaners, and roller cleaners used during makeready and printing at each press unit before and after each print run.
- Cleanup rags were weighed before and after each print run.
- Wastes in the wash-up trays were weighed at each press unit at the end of each run.
- Samples of each type and color of ink and each cleaner used were analyzed at the same temperature as the press for total solids and volatile content at the Hazardous Waste Research and Information Center's (HWRIC) Hazardous Materials Laboratory.

The operators at OPS use the same cleaners for both petroleum-based and soy-based inks. They had previously tried aqueous and less volatile organic cleaners and had not found any satisfactory substitutes. Problems identified with some of the cleaners they tested were that they required more labor, dried much slower, and sometimes left a film on the presses that had to be removed in an additional step.

Results

Ink Use

During the two print runs studied, makeready for the petroleum-based ink run was considerably more involved than that for the soy-based run. This was caused by excess moisture in the original batch of paper and not by differences in the inks. This difference in the two runs affected ink and blanket cleaner usage and waste paper generated. The excess moisture in the paper caused it to curl and wrinkle during feeding into the press. This problem was not a result of the type of ink being used for that run but because the paper had been stored in high humidity conditions before the first run. Because of this, about 25% more pages were printed using petroleum-based inks, which makes a comparison of inks and cleaners used and waste generated between the two runs difficult. These differences were compensated for to the extent possible in evaluating results of in-plant measurements.

The study results showed that the petroleum-based ink run required larger quantities of three of the four colors of ink than did the soy-based ink print run. The amount shown in the g/100 sheets printed column compensate for the difference in the number of sheets printed during makeready. The % difference column compares the amount of petroleum-based ink used with the amount of soy-based ink used. For these specific print jobs, in total, approximately 17% more petroleum-based inks were used on a per sheet printed basis.

Cleaner Use

Almost 46% more blanket cleaners were used during the petroleum ink run (3,455.4g compared with 2,368.0g). Some of this difference can be attributed to the larger amount of blanket cleaners used

during the longer makeready that occurred during this run. The amount of blanket cleaner used during makeready was not recorded separately from that used during press cleaning at the end of the print run. The amount of additional cleaners used for that purpose during the printing run could not be directly measured; it would not necessarily be directly proportional to the amount of paper printed. Therefore, an equivalent comparison can not be made between the amount of blanket cleaners used for each print run.

At the end of each printing run, roller cleaners were used to clean up the presses. Their use was not affected by differences in makeready, but there was a difference in the way the presses were cleaned at the end of the two runs. At the end of the petroleum ink run, the ink in two of the stations was not changed. Also, since the same colors were used in the next run, each ink station was not cleaned as thoroughly as it was at the end of the second run with soy inks. Overall, about 30% more roller cleaners were used for the soy inks. This was expected since the stations were cleaned more thoroughly at the end of the soy-based ink run. Both inks appeared to require approximately the same amount of cleaners and effort to remove from the presses. On average in typical practice, the amount of cleaner used for the two inks would be expected to be about the same.

Volatile Components

All inks had less than 6% volatile components, and there were significantly less volatile components in the soy-based inks than in the petroleum-based inks. The petroleum-based inks had an average of about 4.6% volatile components compared with an average of about 0.8% for the soy-based inks. Thus, on average, the soy-based inks only had about 17% of the amount of volatiles as the petroleum-based inks. The cleaners contained more than 97% volatile components except for one roller cleaner that contained about 88%.

Based on these laboratory results and on the amount of inks and cleaners used, the amounts of solids and volatiles in the inks and cleaners were calculated. The amounts of volatiles were used to estimate the total mass of air emissions. Over 90% of the liquid wastes originated from the inks. As for the volatiles, over 99% originated from the cleaners in both cases.

Because of the difficulty of directly measuring the amount of emissions from the many sources on the press, the printed papers, and the waste containers, a worst case assumption was made that air emissions were equal to the volatile content of the materials used. Thus, for the petroleum-based ink run, 3,930.15 g were calculated to be evaporated compared with 3,004.30 g for the soy-based ink run. This was about 31% more emissions. As described above, even after adjusting for differences in makeready, about 17% more petroleum-based ink was used. In addition, the petroleum-based inks had a higher volatile content (4.6% compared with 0.77%). Just in terms of ink used, there were 0.39 g/sheets of volatile emissions from the petroleum inks compared to 0.23 g/100 sheets for the soy inks. This is about 70% more emissions to the air for an equivalent amount of printing with petroleum inks.

The mass of volatiles estimated to be emitted from the inks is less than 1.0% of the total mass estimated to be emitted from the inks and cleaners. Since most of the air emissions were from the cleaners, less than 1% overall reduction in air emissions resulted from using the soy-based inks. The longer the print run the greater the reduction in volatile emissions from using soy inks.

Liquid Components

The two main liquid wastes from the printing press were from washup trays and inks and cleaners on used rags. None of these materials were spilled during the two runs. To clean the various rollers and blankets, several rags were saturated with each cleaner and were used to wipe down the press. As a result, the rags contained some highly volatile inks and cleaners. An undeterminable portion of these cleaners and inks ended up in the washup trays. Rather than determining the rapidly changing amount of liquids on the rags immediately at the end of the print run, the rags were dried and the amount of dried solids on the rags was weighed. About 60% more solids were on the rags used to clean the presses after the petroleum ink run. Since more inks and cleaners were used in that run, apparently much of these materials ended up on the cleanup rags.

The amount of liquids in the washup trays from this study was measured directly at the end of the print runs. Almost 10% more liquids were generated in the washup trays after the petroleum ink run. This liquid was a mixture of inks and various cleaners. The amount of each ink and each cleaner that ended up in these trays and the rags (less the amount evaporated and on printed product) could not be directly measured.

The amount of each cleaner used to saturate the rags was not metered out precisely by the press operators so that differences between the two runs in the amounts used were mostly the result of operator variability when they poured cleaners on the rags and not the results of the type of ink being cleaned. We observed no reason for there to be a consistent difference in the amount of liquid wastes generated by the two types of inks studied. Differences resulted from operator variability, extended makeready during the petroleum ink run, and more thorough cleaning conducted at the end of the soy ink run. It can not be concluded that one ink generated more liquid wastes than the other.

Solid Waste

During makeready for the petroleum-based ink run, 1375 waste sheets were generated. The reverse side of 100 waste sheets were reused during makeready for the soy-based ink print run. This is the amount of solid waste generated directly during these print runs. No other containers of solid wastes were observed. Additional solid waste that may be generated in printing include trimmings and excess number of pages printed to compensate for losses that may occur during folding, binding and any other final preparation steps. Because the soy inks generally spread further (by an average of about 17%), less used ink containers may be generated with those inks. The amount of the other solid wastes would be unaffected by the type of ink used. In this case, the difference in makeready waste resulted from moisture in the paper at the beginning of the print run and not from difficulty with using the inks.

Press alignment and ink metering was automated for the press used in this study. Based on observations of manually operated presses at this and other facilities, automation or efficient press set-up, rather than the choice of ink, results in less solid waste being generated during printing. Once operators are familiar with the use of either the petroleum or soy inks, then the amount of solid waste generated during makeready will not be noticeably different. In both cases, more waste paper might be generated on some jobs because of difficulties in obtaining acceptable colors or other print quality factors. In this regard, neither ink appears to have a clear advantage over the other.

Costs

The main cost factor considered was that of raw materials. No equipment expenditures were required by OPS to switch from using petroleum to soy inks. There was a difference in the amount of labor involved in the two print runs but that was due to the problems with paper at the beginning of the first run and that fact that cleanup was more rigorous at the end of the second run. Neither of these differences was due to the type of ink being used. The operating conditions of the press, such as temperature and speed, were the same for each ink so there was no difference in overall rate of production or utilities used because of the type of ink used. Insurance, monitoring requirements, reporting and recordkeeping, and permit requirements are the same for each type of ink. Any differences in future costs for remediation or property damage would be minimal. Employee health costs would slightly favor the use of soy-based inks because of reduced employee exposure to breathing released chemicals. All the quantified cost factors are for the Miller TP 104 press only and not for the entire facility at OPS.

The purchase prices of raw materials (inks, cleaners, and paper) for this print job are approximately the same for both types of ink. Generally soy inks cost about 10% more. The average purchase price for both the soy inks and petroleum inks is about $8.00/lb (or $0.18g). Actual costs, depending on the color, range from about $4.00 to $12.00/lb. Costs do vary, however, when the amount of materials used for petroleum inks is compared with the amount of materials for soy inks. On an equivalent basis of ink used during printing and typical makeready, the overall cost savings in ink used for the soy-based ink print run was estimated to be $1.17. This cost difference is not a major factor in ink selection. Higher costs are involved in printing including labor, materials such as paper, equipment amortization, and utilities. The portion of total printing costs allocated to inks is usually very small.

When adjusted to the amount of acceptable product printed, the difference between cleaner costs for the petroleum and soy-based ink runs for this print job was only 5 cents. This difference would be greater if the cleaning after the petroleum-based ink run had been more thorough. Because the same cleaners were used for both inks and on average there would be no difference between the two inks in the amount of cleaner needed, costs for cleaning would not be expected to differ.

Discussion

Overall, about 17% less soy ink compared with petroleum ink was used for the print job studied. Because less amounts of volatile hydrocarbons are emitted from the soy-based inks, air emissions were less. Since the inks and cleaners continuously evaporate during use and the waste inks and cleaners end up mixed together in washup trays and on the cleanup rags, it was difficult to determine the proportion that evaporated during the actual printing process. Ultimately, most if not all of the volatiles in the inks and cleaners will either evaporate, be discharged to the water (such as from a commercial laundry) or be containerized and sent to a landfill. Some of these emissions will occur at the print shop, some perhaps after shipment of the printed product, and some at waste management facilities. The proportion of volatilization that will occur in any one place will vary depending on how the waste materials are managed. For comparison purposes, it was assumed in this study that all the air emissions occurred at the print shop.

An important factor that influences the amount of waste generated per unit of production is the length

of the print run. Some uses of ink (and resulting wastes generated) in the printing process are fairly consistent among print jobs. For instance, the amount of ink required to coat the rollers and plates for each revolution is relatively consistent. A certain amount of waste is expected for every print job, but a higher proportion of waste is produced per raw material input on shorter print jobs, such as the one monitored here. With longer print jobs, a greater percentage of the ink used would be applied to acceptable product.

To most printers, there are little or no perceived differences in the cost of using soy-based inks because the raw material cost is slightly higher or equivalent to petroleum-based inks. The cost difference is more than offset by the fact that the soy inks spread almost 20% further and do not release as much volatile organic chemicals. Less tangible benefits of using soy inks (company image as being environmentally friendly, improved employee relations due to a perceived healthier working environment, and customer preference for products) are major factors considered by printers. If customer response to product quality is negative, printers will not adopt a new ink. At OPS, their experience has been that customers find the quality of the product to be acceptable, and many prefer to have their job printed with soy-based inks.

A company also must consider the willingness of its workers to switch to and use soy inks and the time it takes for operators to become skilled in using these inks. Understandably there may be some excess waste generated during such a change. At OPS, there was some initial resistance to the new inks. Formulations of soy inks in sheet-fed offset presses were new. In the past few years, these formulations have improved and the press operators at OPS have gained the experience necessary to produce high quality images. Presently, the employees prefer to use soy-based inks on this particular press. A major reason for this is that the soy inks are very similar to petroleum-based inks to work with and clean from presses. If an alternative cleaner was used that took the operators longer or required more effort for the soy inks then there would be considerable resistance and cost.

In addition to using soy-based inks, there are other strategies printers can use to reduce wastes from the sheet-fed offset printing. Since most emissions were from use of the cleaners, these emissions could be reduced if aqueous or less volatile cleaners were used. The press operators at OPS have not found any of the alternative products they tried to be acceptable. It should be kept in mind that the use of less volatile cleaners may increase liquid wastes.

Another strategy to reduce waste would be to reduce the use of cleaners and inks. This can be done in two ways; both may involve additional capital for equipment.

- One way is to recover or reuse waste inks and cleaners. Installing a solvent still to recover chemicals from the washup tray wastes and possibly reusing those chemicals in formulating cleaners might be feasible. Some large printers have reportedly adopted this approach.
- A second way to reduce cleaner and ink usage would be to purchase automatic blanket washers and ink roller train systems. Literature from one manufacturer of this equipment claims that as little as 220 to 275 mL of cleaning solvent can be used during a print run when the automated systems are in use. Although this would not eliminate the need for hand cleaning, it could greatly reduce the amount of cleaner used and, thus, the emissions from the cleaners. It could also reduce employee exposure to potentially harmful substances.

An automatic blanket washer would reduce cleaner use by up to 90%. It should be noted that on some presses where these systems have been installed the operators actually increased use of the cleaners because, even during a print run, the blankets can be cleaned without stopping the press. Automatic ink handling systems allow this type of press to be operated with about 80% less ink in the fountain.

The automatic blanket washer and ink handling systems also reduce makeready and cleanup times, saving the press crew time and exposure to volatile compounds. At OPS, it was estimated that such a system would have a payback of about 3 yr. Most cost savings would be expected in the cost of cleaners and in reduced cleanup time.

Overall, soy inks have some environmental and other advantages for sheet-fed offset printers. The main environmental advantage with soy inks is that they release less than 20% of the mass of volatile organic chemicals compared to petroleum inks. The soy inks also spread about 15% further, which offsets the small difference in cost that currently exists. Reportedly, recycling of soy ink printed paper also has some advantages. In this study all other factors including makeready time, appearance of printed product, and cleanup effort were essentially equivalent between the two types of inks.

The full report was submitted in fulfillment of Contract No. CR-815829 by the Hazardous Waste Research and Information Center, University of Illinois at Urbana-Champaign under the sponsorship of the U.S. Environmental Protection Agency.

Beth Simpson, Pamela Tazik and Gary Miller are with the Hazardous Waste Research and Information Center, Champaign, IL 61820.

Paul Randall is the EPA Project Officer (see below).

The company report, entitled "Waste Reduction Evaluation of Soy-Based Inks at a Sheet-Fed Offset Printer," (Order No. PB95-100046/AS; Cost: $17.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Risk Reduction Engineering Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

Footnotes

[1] Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

From: Massachusetts Toxics Use Reduction Institute

University of Massachusetts Lowell
One University Ave.
Lowell, Massachusetts 01854-2881
Telephone: (508) 934-3275
FAX: (508) 934-3050

Substitute inks available for lithographic, flexographic, and gravure printing can reduce concerns associated with the use of conventional petroleum-based lithographic inks and solvent-based flexographic and gravure inks. This fact sheet summarizes these substitution alternatives. It describes the composition of substitute inks and some use considerations and includes an alternatives matrix that provides comparative information on each alternative, including operational, cost, and quality considerations. Articles, guides, and industry case studies are also listed.

Although inks are not always considered the major source of VOCs and solvents in the printing industry, the decision to use substitute inks can be a beneficial part of an overall toxics use reduction program and can help reduce the use of hazardous or toxic substances in other materials such as cleaning solutions.

The substitution alternatives presented in this fact sheet are not all-inclusive, nor is one ink substitute recommended over another. Examination of substitute inks should involve thorough consideration of environmental and health and safety tradeoffs at all stages of printing, including raw materials acquisition, processing, and recycling or disposal, and any new or unknown hazards in the alternative materials.

Ink substitutions include:

- Vegetable oil inks
- Radiation-curable inks
- Water-based inks

Alternative Ink Materials

Vegetable oil inks contain vegetable oils as are placement for some or all of the petroleum oil in lithographic inks. They are available for heatset and non-heatset web presses and for sheetfed presses and generally require no equipment changes. While various compositions of oils such as linseed, soy, and tuna may be used, many vegetable inks today are soy-based. Because vegetable inks penetrate paper more slowly and set primarily by oxidation, they generally have longer drying times. Most vegetable inks contain some petroleum oil to hasten drying or setting time ' to acceptable standards. The amount of vegetable oil replacing the petroleum oil varies with the manufacturer and also depends on:

Press type: for example, heatset inks require more petroleum oil than non-heatset inks.

Paper type: with more absorbent paper a higher percentage of vegetable oil may be used.

Ink color: black soy-based inks dry more slowly than color soy-based inks.

Because soy oil is clearer than petroleum or linseed oils, soy ink may provide better print quality and brighter colors. The American Soybean Association (ASA) has set standards for the percentage of soy oil in inks and permits use of its "SoySeal" for those that meet minimum requirements for soy oil content, depending on ink type. Although some new color soy inks contain non-toxic pigments and other additives, soy or other vegetable inks may contain hazardous or toxic materials in the pigments, drying compounds, and additives.

Radiation-curable inks include ultraviolet ink and electron beam ink. They consist of one or more monomers and oligomers that polymerize on exposure to radiation. They generally contain no solvent and are particularly recommended for some applications in lithography and letterpress.

Water-based inks are usually composed of pigmented suspensions in water and film formers. Their best application is in flexographic printing on paper, but they are also recommended for some types of gravure printing. Both low-solvent and 100% water-based inks are available.

Substitute Inks by Type

Heatset Inks

Use of vegetable-based heatset inks provides some reduction in VOCs compared with conventional heatset inks. Because heatset printing relies on evaporation and vegetable inks dry primarily by oxidation, substitute heatset inks usually contain a higher level of VOCs than do substitute inks for non-heatset or sheetfed presses. Vegetable oil heatset inks commonly contain 30-35% petroleum oils by weight. Increasing the vegetable oil content increases dryer temperature requirements and can cause scorching of paper and dulling of finished ink film. The dryer heat also volatilizes the ink oils, generating VOC emissions. Ink cost can be 5-8% higher. Soy heatset inks receiving the ASA SoySeal must contain a minimum of 7% soy oil by weight.

Non-Heatset Inks

Vegetable oil inks can be used for both non-heatset web and sheetfed presses and can contain a higher vegetable oil content than heatset inks. They can provide better print quality and brighter colors. Soy-based color inks have a lower overall oil content than soy-based black inks, and therefore dry faster. A higher percentage of the oil in color inks can be soy-derived. Printing on uncoated paper also permits higher vegetable oil content than printing on coated paper. Ink cost is often higher than that of conventional inks, but is expected to decrease. Non-heatset inks receiving the ASA SoySeal must contain a minimum of 30% soy oil (web inks) or 20% soy oil (sheetfed inks).

Newsprint Inks

Newsprint inks can contain a high vegetable oil content due to the absorbency of newspaper. Because the ink dries solely by absorption, it is possible to substitute all of the petroleum oil with vegetable oil, and 100% soy formulations are available. For color newsprinting, soy inks provide brighter colors, better color control, and less rub-off. Soy inks are less likely to build up on the plate, have less tendency to skin over, and greater stability. They permit greater latitude in inkwater balance, allowing more flexibility in press settings, and provide greater coverage per pound of ink. Although black soy-based ink can cost up to 30% more than conventional ink, the higher cost may be offset by greater coverage and reduced newsprint spoilage due to its smoother flow. NewSprint inks must have a minimum soy content of 40% (black ink) and 30% (color ink) to receive the ASA SoySeal.

Form Inks

The absorbency of forms paper permits a fairly high vegetable oil content in form ink. Vegetable oil form inks provide brighter colors than conventional inks. To receive the ASA SoySeal, form inks must contain at least 20% soy oil by weight.

Radiation-Curable Inks

Ultraviolet (UV) and electron beam (EB) inks cure by polymerization on exposure to UV or EB energy. Because they contain no solvents, they release no VOCs. They can be used on both web and sheetfed presses. Because the inks do not dry on the press, they can remain in ink fountains for long periods and reduce press cleaning frequency. Main disadvantages are the high cost of capital equipment are the potential for worker exposure to UV or EB light, which necessitates shielding and other safety devices built into the equipment. Radiation-curable inks may contain toxic chemicals, and prolonged contact can cause dermatitis and skin sensitivity. The cost of UV ink can be twice that of conventional solvent-based inks; EB ink cost is also higher, although less than UV ink. Paper printed with radiation- curable inks cannot be deinked by conventional means.

Flexographic and Gravure Inks

The use of water-based inks in flexographic and gravure printing can reduce worker health and safety risks, air pollution control requirements, and liability and waste disposal costs associated with the use of alcohol solvents. Water-based inks permit replacement of solvent-based cleaners with non-VOC-containing- substitutes. They hold their color and viscosity for longer periods during print runs and may provide better print quality. Because these inks cannot be cleaned with water when dried, equipment must be cleaned more frequently. Water-based inks are less forgiving of imperfections in equipment and may require closer monitoring of operations. Equipment and process modifications maybe necessary. Currently, even inks labeled 100% water-based may contain low levels of solvent, usually alcohol, to enhance adhesion and increase wetting. In some cases, pretreatment may be required before discharging water-based inks to POTWs. Some water-based inks may still contain heavy metal pigments that must be disposed of as hazardous waste. De-inking of material printed with water-based inks may be difficult.

A new water-washable ink with a "solubility conversion mechanism" has been formulated for lithographic printing. This vegetable- oil-based ink acts as a conventional insoluble lithographic ink during printing but can be converted to a soluble state and removed from press equipment with a simple water solution. The ink can be used with conventional equipment.

Summary of Product Substitution Alternatives to Petroleum- and Solvent-Based Inks

Alternative	Applications	Reduction Benefits	Operational Advantages	Operational Disadvantages	Cost	Product Quality	Limitations
Vegetable Oil Heatset Inks	Lithographic Web Presses	Reduced VOC emissions and worker exposure to petroleum oils		Slower drying time; poor drying cot result in setoff, marking, and poor rub resistance	No capital cost; ink cost can be 5-8% higher	Similar quality	Heatset requirements limit replacement of petroleum oils; Ink dryer contributes VOC emissions; Ink waste may still be hazardous
Vegetable Oil Non-Heatset Inks	Lithographic non-heatset web and sheet-fed presses	Reduced VOC emissions and worker exposure to petroleum oils	Can provide better print quality, brighter colors, better pickup and transfer	Slower drying time	No capital cost; ink can be slightly higher	Similar quality, brighter colors and improved clarity	Usually contain some petroleum oils; ink waste may still be hazardous
Vegetable Oil Newsprint Inks	Lithographic Web Presses	Reduced VOC emissions and worker exposure to petroleum oils; 100% replacement of petroleum oils is possible	Better color reproduction; better color control; less rub-off; less tendency to build up or skin over; greater stability; smoother flow; better coverage; greater ink-water balance parameters permit more latitude in press settings	Usually slower drying time	No capital cost; higher ink cost may be offset by reduced newsprint spoilage	Higher quality color printing; similar quality black printing	May contain some petroleum oils; ink waste may still be hazardous
Vegetable Oil Form Inks	Lithographic non-heatset web	Reduced VOC emissions and worker exposure to petroleum oils	Smoother flow, better coverage	slower drying time	Slightly higher Ink cost	Higher quality color printing	May contain some petroleum oils; ink waste may still be hazardous
UV Curable Inks	Lithographic Web and sheet-fed presses	No ink derived VOC emissions or worker exposure to petroleum oil; reduced process waste	No ink drying on press reduces frequency of press cleaning; rapid curing; no set-off; no need for ventilation of printed sheets		Capital equipment cost; higher ink cost; lower energy use than thermal drying; increased productivity	Good gloss and durability; print quality may be less clear; possible adhesion problems on some materials (aluminum, steel, some plastic)	Workers must be protected from UV light; some toxic chemicals in inks; may cause skin sensitivity; ventilation needed to reduce ozone buildup; paper difficult to recycle
EB Curable Inks	Lithographic Web and sheet-fed presses	No ink derived VOC emissions or worker exposure to petroleum oil	No ink drying on press reduces frequency of press cleaning; rapid curing; no set-off; no need for ventilation of printed sheets		Capital equipment cost; considerably higher ink cost;	Print quality less clear	Workers must be protected from EB light; some toxic chemicals in inks; may cause skin sensitivity; often degrade paper; paper difficult to recycle
Water-based Inks	Flexographic and gravure presses	Little or no ink derived VOC emissions or worker exposure to alcohol; allow replacement of solvent-based cleaners and fountain solutions with safer substitutes	Hold color and viscosity longer during press runs; more coverage per pound of ink; reduce need for make-up solvent during printing	Require more frequent equipment cleaning; less forgiving of equipment imperfections; may cause paper curl	May require new capital equipment, greater energy use; reduced hazardous waste disposal and liability costs	Similar quality with new equipment; low gloss on porous substrates	May contain low level of solvent; ink waste may be hazardous; greater energy use for drying

from: Massachusetts Toxics Use Reduction Institute, Fact Sheet 6

Section 8

SCREEN PRINTING INFORMATION

Page

Design for the Environment documents:

- ❑ Screen Printing Work Place Alternatives for Screen Reclamation
- ❑ Screen Printing Smarter, Safer Screen Reclamation
- ❑ Screen Printing Changing Equipment & Reducing Solvent Use in Screen Reclamation

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

July 1996

EPA 742-F-95-010

design FOR THE ENVIRONMENT

SCREEN PRINTING PROJECT BULLETIN 3

SCREEN PRINTING

Work Practice Alternatives for Screen Reclamation

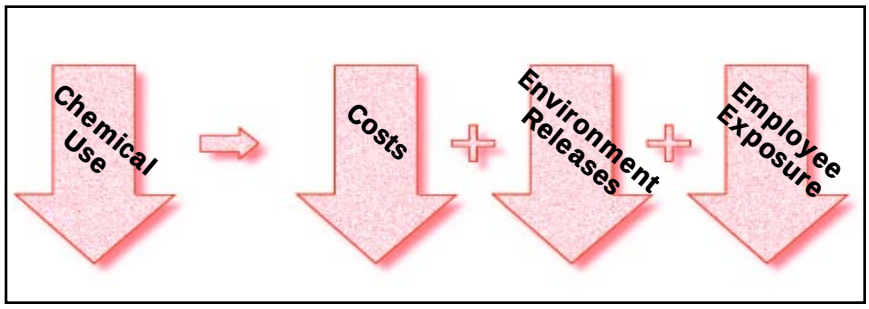
The Design for the Environment (DfE) Screen Printing Project is a voluntary cooperative effort between the screen printing industry and the U.S. Environmental Protection Agency (EPA) dedicated to helping screen printers improve their efforts to reduce risk to their workers and the environment in cost effective ways.

Printers, EPA, product manufacturers, and the screen printing trade association are all concerned with minimizing the environmental and health hazards of screen reclamation. Through the DfE Screen Printing Project, these groups are working together to identify and share information on alternative screen reclamation work practices and to evaluate alternative screen reclamation products. Using information from a survey of screen printers, DfE identified many alternative workplace practices that participants found helped them prevent pollution while reducing chemical exposures and screen cleaning costs.

This bulletin describes simple changes in screen reclamation work practices that have resulted in significant reductions in costs, environmental impact and worker exposures. Although this bulletin concentrates on preventing pollution in the screen reclamation process, it highlights a basic framework for pollution prevention through improved work practices that can be applied to any process in your shop.

Background

A survey of screen printers (conducted by the screen printing trade association) determined that almost 36 percent of the respondents had implemented changes in workplace practices to reduce their use of ink removal or screen cleaning/reclamation products. With little or no capital expenditures, pollution prevention through improved workplace practices can result in cost savings through the reduced use of materials, lower waste disposal costs, less worker exposure and other benefits. Improving work practices to prevent pollution is simply a common-sense approach to running a print shop.



Increase the Benefits by Reducing Your Chemical Use

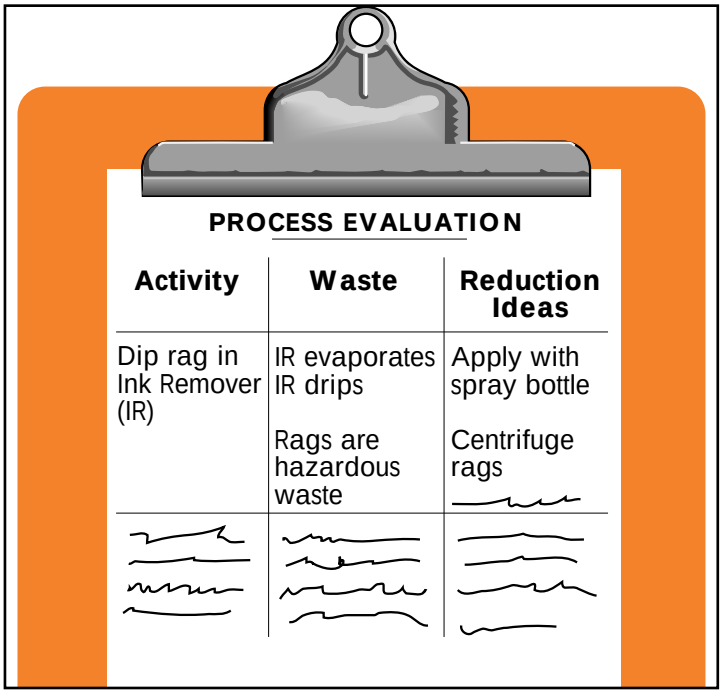
Getting Started

The first step in a pollution prevention program is to examine your process and identify the waste generated by each process step, any inefficient use of resources, and areas where improvements can be made. This examination can be accomplished through an in-house process evaluation. Undertaking a process evaluation involves observing, measuring, and recording data on the materials used and waste generated in your shop. This information will then allow you to take a comprehensive look at your facility and to focus your attention on areas where waste reduction and cost savings are most easily accomplished. After your initial evaluation, periodic in-house evaluations will help you determine the effectiveness of alternative products and practices being implemented. The process evaluation results should be shared with all employees to raise employee awareness about the benefits of the pollution prevention program, to provide them with feedback on pollution prevention progress, and to get their input on improvements. In-house evaluations can give both operators and managers the incentive to strive for continuous improvement.

How Everyone Can Help

Process Improvements

After obtaining a good understanding of your material flows and waste streams through a process evaluation, you should identify your opportunities for pollution prevention. While the materials use and waste generation are different in every shop, and solutions particular to your operation may need to be developed, many of the printers contacted through the survey found similar pollution prevention solutions to be effective, including:



PROCESS EVALUATION

Activity	Waste	Reduction Ideas
Dip rag in Ink Remover (IR)	IR evaporates IR drips Rags are hazardous waste	Apply with spray bottle Centrifuge rags

Evaluate Your Process

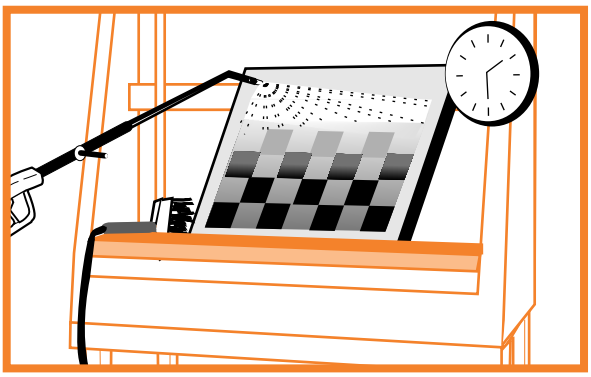
Keep chemicals in safety cans or covered containers.
This minimizes chemical losses from evaporation and spills.

Use plunger cans, squeeze bottles, or specialized spraying equipment to apply chemicals.
The use of such equipment can reduce materials and accidental spills.

Use manual spot application of screen reclamation chemicals and alternative rinses.
One printer reduced chemicals use for screen cleaning 15% by using spot application of ink degradant, and a low pressure rinse, followed by a high pressure water blast.

Reuse shop towels to reduce ink remover use.
If using towels for ink removal, reuse the towel from the last pass of one screen for the first pass on the next screen. This will reduce the number of towels disposed of or sent to the laundry service.

Try increasing your water dilution.
Some printers have been able to dilute their screen reclamation products without reducing performance.



Avoid delays in reclaiming screens

Avoid delays in cleaning and reclaiming screens.
If screens are cleaned promptly, the chemicals needed to remove ink, emulsion, and haze can be reduced.

Recover solvent from rags for reuse.
Some printers realized significant savings in their chemical costs by recovering solvent from used rags either by gravity draining, wringing the solvent into a covered container, or using an explosion-proof centrifuge.

Recover used cleaning product and chemical overspray for reuse.
One printer found that used cleaning chemicals could be captured, treated in a small still to remove pigments, and then used again. Another printer found that installing a simple “catching frame” around each screen to capture overspray during chemical application steps allowed significant amount of chemical to be reused.

Materials Management and Inventory Control

Many printers have found that proper materials management and inventory control cut both the amount of chemicals used and their screen cleaning costs. Keeping track of chemical usage clarifies materials flow, how it relates to waste generation rates, and where pollution prevention opportunities can be implemented. Materials management and inventory control techniques used by many printers to help reduce material use and disposal include:

Manage inventories on a first-in, first-out basis.
This will minimize the disposal of expired materials.

Maintain accurate logs of your chemical and materials stock, use and waste generation rates.
This will help you evaluate your shop's materials flow and identify where wastes are being generated.

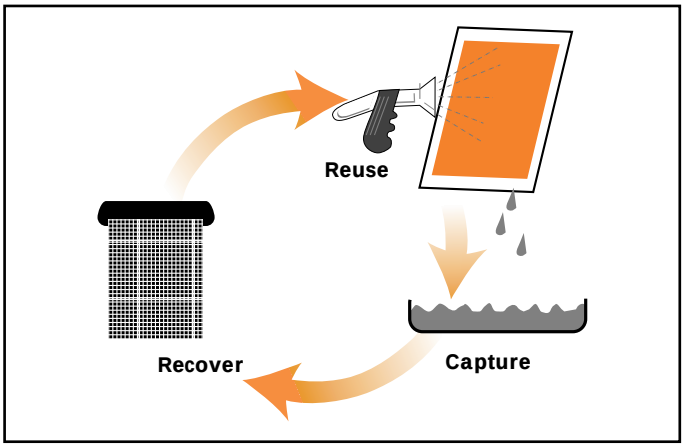
Minimize the amount of chemicals in the production area.
This will encourage materials conservation.

Keep all wastes separate and in clearly marked containers.
This allows wastes to be reused or recycled, and prevents hazardous wastes from contaminating non-hazardous wastes.

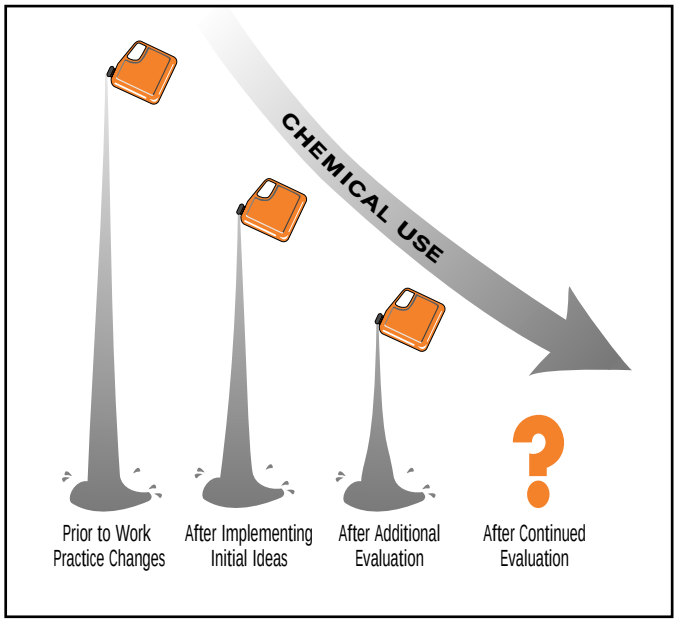
Keeping it Going

According to many printers, a reluctance to change to alternative screen cleaning products or work practices is one of the largest obstacles to pollution prevention in their shops. Much of this unwillingness to try new products, technologies, and procedures arises from employees' lack of awareness of the benefits and a belief that the alternatives will not work. Training on health and safety issues and on materials handling and disposal procedures will help employees understand both the benefits of proper materials handling and disposal and the potential consequences of improper workplace practices to their health and safety, the environment, and company profitability.

Seek your employees' input on pollution prevention activities to encourage their participation; the people closest to the process often come up with the most creative approaches to pollution prevention. Awareness of materials use and waste generation can be fostered by centralizing the responsibility for storing and distributing chemicals, by making employees accountable for the waste they generate, and by providing incentives for waste reductions.



Reuse Your Reclamation Chemicals



Reduce Your Chemical Use
Through Continuous Improvements

It is important that employees are aware of your company's commitment to environmental goals and pollution prevention. Depending on the company size, it may be helpful to prepare a written environmental policy and written procedures on proper equipment operation, maintenance, and materials handling and disposal. Providing feedback to employees on materials handling, disposal and pollution prevention performance re-emphasizes your commitment to pollution prevention and encourages your employees to continue to improve their workplace practices.

Finally, pollution prevention should be an ongoing process where work practices are monitored regularly to ensure that improved practices already identified are actually being implemented on the shop floor, and that new opportunities for pollution prevention are being identified continuously.

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What is the Design for the Environment Screen Printing Project?

U.S. Environmental Protection Agency's (EPA) Design for the Environment (DfE) Screen Printing Project is a voluntary project that encourages printers to consider environmental concerns along with cost and performance when purchasing materials. Replacing hazardous chemicals with environmentally-safer substitutes is one way to reduce the impact of printing on the environment while maintaining product quality. Many printers, however, may not have the time to identify and test environmentally-safer substitutes.

That's where DfE fills the gap. EPA has teamed up with screen printing industry representatives (including trade associations, printers, and suppliers) in the DfE Screen Printing Project. The Project's goal is to evaluate and publicize pollution prevention opportunities in screen printing, particularly in the screen reclamation process.

For More Information...

For more detailed information on technological and chemical alternatives for screen reclamation, see the DfE Screen Printing Project summary booklet, *Designing Solutions for Screen Printers — An Evaluation of Screen Reclamation Systems*. Additional case studies and other bulletins summarizing the evaluation of screen reclamation alternatives are also available.

For copies of this bulletin, other DfE Screen Printing Project materials, or for more information about the project, please contact:

Pollution Prevention Information Clearinghouse (PPIC)
U.S. Environmental Protection Agency
401 M Street, SW (7409)
Washington, DC 20460
Telephone: 202-260-1023
Fax: 202-260-4659

or

Screenprinting and Graphic Imaging Association International (SGIA)
10015 Main Street
Fairfax, VA 22031
Telephone: 703-385-1335
Fax: 703-273-2870

You may also contact the DfE Home Page at: http://www.epa.gov/dfe or the SGIA Home Page at http://www.sgia.org/

Recycled/Recyclable

Printed with Soy/Canola Ink on paper containing at least 50% recycled fiber.

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

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SCREEN PRINTING PROJECT BULLETIN 4

SCREEN PRINTING

SMARTER, SAFER SCREEN RECLAMATION
Alternative System Chi

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

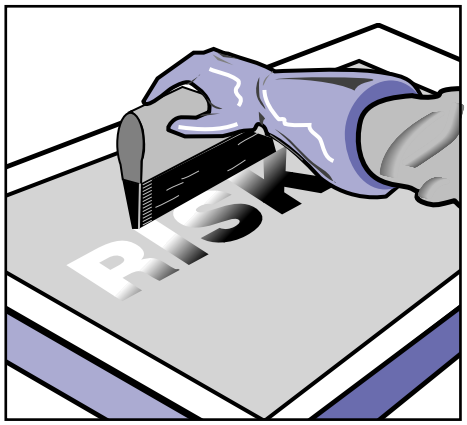
To reduce the hazards of screen reclamation to workers and to the environment, screen printers using solvents for screen reclamation should consider switching to one of the safer substitute products currently on the market. These substitutes often contain less harmful chemicals and have a lower volatile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

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

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

Background

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



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

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

To compare the cost and risk of Alternative System Chi to a known system, a baseline was established using a traditional solvent-based screen reclamation system consisting of: lacquer thinner as the ink remover, a sodium periodate solution as the emulsion remover, and a xylene/acetone/mineral spirits/cyclohexanone blend as the haze remover. These chemicals were selected because screen printers indicated they were commonly used in screen reclamation.

It should be noted the alternative reclamation systems were evaluated using a case study approach; rigorous scientific testing was not conducted. Instead, much of the information presented here is based on printers' experiences with these products as used at their facilities.

Promising Performance

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

Laboratory Testing

During laboratory testing, three imaged screens were reclaimed using Alternative System Chi: one where a solvent-based ink was applied, the second with an ultraviolet-curable (UV) ink, and the third with a water-based ink. In the lab, two applications of the Chi ink remover were required to remove the solvent-based ink. The UV-curable ink and water-

	Chemical Composition		
	Ink Remover	**Emulsion Remover**	**Haze Remover**
Alternative System Chi	Diethylene glycol series ethers Propylene glycol series ethers N-methyl pyrrolidone Ethoxylated nonylphenol	Sodium periodate Water	Diethylene glycol series ethers Propylene glycol series ethers N-methyl pyrrolidone Ethoxylated nonylphenol
Traditional System	Lacquer thinner, consisting of: 30% Methyl ethyl ketone 20% Naphtha light aliphatic 20% Toluene 15% n-butyl acetate 10% Isobutyl isobutyrate 5% Methanol	1% Sodium periodate 99% Water	10% Xylene 30% Acetone 30% Mineral spirits 30% Cyclohexanone

[1] Clear concerns>Marginal concerns>Negligible concerns. Concerns were identified because exact risks were not calculated. The information in this table is based on the September 1994 draft *Cleaner Technologies Substitutes Assessment: Screen Printing Technical Report.*

based inks dissolved more easily, however an ink residue or haze remained on all of the screens after applying the ink remover. The emulsion remover easily dissolved the stencil with only light scrubbing, leaving no emulsion residue behind. When additional ink remover was applied (used instead of a haze remover), it removed the ink residue and lightened the stain on all three screens.

On-site Demonstrations

Two different facilities (referred to as Facility C and Facility D) used System Chi for a month to evaluate how well it performed in an actual production situation. The participating facilities recorded the amount of product used, the length of time needed, and their opinion of how well the product reclaimed the screen.

Ink Remover Performance: At Facility C, the Chi ink remover worked well, although in some cases, it acted more slowly than their standard solvent blend. Facility D found the ink remover worked well, especially on metallic inks.

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

Haze Remover Performance: Alternative System Chi did not include a separate haze remover; instead the manufacturer recommended applying the ink remover again to remove any remaining haze. Facility D found their screens were completely clean after using just the ink and emulsion removers; a haze remover was not needed. At Facility C, the haze remover lightened the haze; however, when the haze was heavy, a ghost image remained on the screen.

Overall Evaluation: At both facilities, the performance of Alternative System Chi was as good as the performance of the facilities' standard screen reclamation products. The consistent performance of the product at SPTF and in the two facilities demonstrates that System Chi can work under different operating conditions.

Health Risks[1]	Performance			Cost
	Ink Remover	Emulsion Remover	Haze Remover	
• Inhalation risks of the ink and haze removers are negligible. • If you use the ink or haze remover on a daily basis without wearing gloves, there is a clear concern for harmful effects from diethylene glycol series ethers absorbed through your skin. If gloves are worn, the risk is negligible. • If your skin regularly contacts the ink or haze removers, there is a concern for reproductive toxicity risk from absorbing N-methyl pyrrolidone. If gloves and safety goggles are worn, the risk is negligible. • There is a clear concern that regular, unprotected contact with the emulsion remover will cause skin and eye irritation and tissue damage. If gloves and safety goggles are worn, the risk is negligible.	In on-site demonstrations, removed the ink well. One of the facilities found it worked very well on metallic inks. In lab testing, dissolved UV-curable and water-based ink well. Two applications were needed to remove the solvent-based ink.	Quickly and easily removed the stencil during facility demonstratio ns and lab tests.	At Facility C, the haze remove lightened moderate stains, but was not effective on heavy stains. At Facility D, haze remover was not needed. In lab testing, the haze remover lightened the ink stain.	Facility C: $3.89/screen or $5,829/year Facility D: $3.25/screen or $4,879/year
• If you use the ink or haze remover on a regular basis, there is a clear concern for harmful health effects from inhaling the chemicals (specifically toluene, methyl ethyl ketone, and acetone). • There is also a clear concern for adverse health effects if your skin contacts the ink or haze remover on a daily basis (from toluene, methyl ethyl ketone, and acetone). The concern is marginal for contact with cyclohexanone in the haze remover. If gloves and safety goggles are worn, these risks are negligible. • There is a clear concern that regular, unprotected contact with the emulsion remover will cause skin and eye irritation and tissue damage. If gloves and safety goggles are worn, the risk is negligible.	Removed solvent and UV inks with moderate scrubbing effort. A gray haze remained on the entire screen. With water-based ink, the ink solidified.	Not demonstrated[2]	Not demonstrated[2]	$6.27/screen or $9,399/year

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

Reduced Risk

Occupational risks and environmental releases associated with using Alternative System Chi and the traditional system for screen reclamation are summarized in the table.

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

Applying either the Alternative System Chi or the traditional system products regularly without wearing gloves can be harmful to your health. In the traditional system, these effects are from the toluene and methyl ethyl ketone in the ink remover, the sodium perio-

date in the emulsion remover, and the acetone in the haze remover. In the alternative system, potential for these harmful effects through skin contact are attributed to diethylene glycol series ethers in the ink/haze remover, and sodium periodate in the emulsion remover. If gloves and safety goggles are worn regularly, however, the dermal risks from either system are negligible.

Minimal Environmental Releases

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

Cost Savings

The performance demonstrations showed that both of the participating facilities could reduce their costs for screen reclamation by switching from the traditional system to Alternative System Chi. As with the risk comparisons, costs of Alternative System Chi were compared to the costs of using the traditional system. It was assumed 6 screens were reclaimed daily and that all screens were 2,127 in^2 (approximately 15 ft^2) in size for both the traditional and the alternative systems. The cost estimate for each reclamation system included labor time spent to reclaim the screen, the cost of an average quantity of reclamation products, and the cost of hazardous waste disposal for RCRA-listed waste or RCRA-characteristic waste (ignitable based on flashpoint). For the alternative system and the traditional system, RCRA issues apply only to the traditional system ink remover.

For Facility C, their reclamation cost per screen would drop by 38% from $6.27/screen to $3.89/screen for annual savings of $3,560. At Facility D, the reclamation cost of $6.27/screen using the traditional system would decrease 48% to $3.25/screen at Facility D for the alternative system. Over a year, the savings would amount to $4,520. The difference in costs between the facilities is due to differences in the quantity of product used and the labor time required per screen as recorded by each facility's employees.

For More Information...

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

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

Pollution Prevention Information Clearinghouse (PPIC)
U.S. Environmental Protection Agency
401 M Street, SW (7409)
Washington, DC 20460
Telephone: 202-260-1023
Fax: 202-260-4659

or

Screenprinting and Graphic Imaging Association International (SGIA)
10015 Main Street
Fairfax, VA 22031
Telephone: 703-385-1335
Fax: 703-273-2870

You may also contact the DfE Home Page at: http://www.epa.gov/dfe or the SGIA Home Page at http://www.sgia.org/

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

design FOR THE ENVIRONMENT

September 1996

EPA744-F-96-011

SCREEN PRINTING PROJECT CASE STUDY 2

SCREEN PRINTING

Changing Equipment and Reducing Solvent Use In Screen Reclamation

The Design for the Environment (DfE) Screen Printing Project is a unique, cooperative effort between the screen printing industry and the U.S. Environmental Protection Agency (EPA). The voluntary project helps screen printers improve their efforts to reduce risks to their workers and the environment in cost-effective ways.

EPA and the screen printing industry are developing a series of case studies to illustrate how screen printers can improve their environmental performance. This case study describes a successful pollution prevention program at Action Graphics, a commercial printer in Louisville, Kentucky, that took the initiative to minimize risks to workers and the environment. In doing so, the company purchased equipment that re-duced solvent use and chose safer alternatives for the solvents it could not eliminate.

Specifically, this case study shows:

- How the need for ink remover can be eliminated by:
  - Reclaiming screens immediately after a print run.
  - Using a high-pressure water system.
  - Switching to more effective, safer emulsion and haze remover products.
- How the quantity of solvent used during the printing process can be greatly reduced by finding more efficient solvents and reusing rags.

Background

Action Graphics produces point-of-purchase display products, such as shelving signs, banners, and window signs used in retail stores and fast-food restaurants. Traditional solvent-based inks are used in about 60 percent of the company's printing, and ultraviolet (UV) curable inks are used in 40 percent. Action Graphics opened for business in 1979 and currently has 30 employees, half of which are directly involved in printing processes.

Over the past five years, Action Graphics has developed a creative and comprehensive approach to pollution prevention. Although a small shop with limited resources, it has greatly reduced solvent use through many innovative changes. **The primary change was the introduction of a high-pressure water system, which eliminated the need for ink remover solvent. In addition, the company substituted safer screen reclamation chemicals, purchased a distiller, switched to a slower-evaporating solvent for screen cleaning during press runs, changed to a safer ink thinner, and developed a rag reuse policy.** These changes lowered the company's level of volatile organic compounds (VOCs) and decreased its generation of hazardous waste.

A Change in Screen Reclamation Equipment and Chemicals

Action Graphics' owner, Joe Miller, began thinking about the unintended effects of the solvents the company used when representatives from the Occupational Safety and Health Administration (OSHA) visited the shop in 1991. While the company was not exceeding OSHA levels for contaminants in the air, the visit made Miller more aware of the possible respiratory health issues associated with solvents used in the screen reclamation process.

At that time, Action Graphics was using a traditional three-step screen reclamation process: first, workers applied an ink remover; second, they applied an emulsion remover; and third, they applied a haze remover to eliminate any remaining ink and emulsion. Each chemical product was washed off the screen with a low-pressure water sprayer at 400 to 500 pounds per square inch (psi). When needed, a degreaser also was used.

The ink remover consisted of diacetonealcohol (75 percent), methylchloroform (10 percent), and 2-butoxyethanol (15 percent). Exposure to these ingredients can cause adverse health effects. Methylchloroform exposure, for example, can cause dizziness, lightheadedness, and mild eye and skin irritation, and may have more serious effects with long-term exposure. The emulsion remover's ingredients included phosphoric acid, which can cause burns after prolonged exposure. The haze remover contained sodium hydroxide, which can also cause burns, and cyclohexanol, which can irritate the eyes, nose, and throat and possibly cause more serious effects at high concentrations. The degreaser did not present health concerns.

Indeed, some workers found vapors from the solvents to be overpowering at times, making breathing difficult in certain areas of the plant and causing eye irritation. In addition, operators occasionally received burns when they used some of the cleaning chemicals improperly.

To reduce these health risks, Action Graphics completely overhauled its screen reclamation process at the end of 1991. The key component of the new process was a high-pressure water system that met Miller's need to improve worker health and the environment by reducing solvent use. The system also promised to pay for itself in a reasonable amount of time. Miller also considered but ruled out enclosed booths in which solvents are reused. These were economically infeasible for the relatively low volume of screens reclaimed at Action Graphics.

Screen reclamation with a high-pressure water system

With the new high-pressure water system, workers transfer screens to the reclamation area immediately after a press run. Speed is essential because it prevents the ink from drying on the screens. Operators apply the emulsion remover with a brush, then rinse the screens by shooting water through them at a pressure of 3,000 psi. The combination of not allowing the ink to dry and using the high-pressure water stream allows workers to flush out both ink and emulsion without the use of ink remover. Eliminating the need for ink remover decreased the company's annual solvent use by approximately 770 gallons, reduced worker exposure to potentially harmful chemicals, and saved over $13,000 per year in purchasing costs.

Action Graphics also changed its emulsion remover to sodium metaperiodate, which, unlike the company's original emulsion remover, does not cause burns. Although the new emulsion remover is slightly more expensive, it is also more highly concentrated, so Action Graphics uses less (see chart for cost savings). Workers complete the process by applying a new, less corrosive haze remover and rinsing it out with water at 3,000 psi.

Another advantage to the new high-pressure water system is that it includes filtration equipment that reduces the amount of waste from the reclamation process discharged into the sewer system. The filtration system removes all particles 5 microns or larger and keeps the wastewater in compliance with local sewer district requirements.

Besides the environmental and health benefits, the new equipment and chemicals actually do a better job of keeping the screens clean. In addition, the old caustic chemicals tended to slowly eat away at the screens. The new system causes less wear and tear on the screens, so they need to be replaced less often.

One of the benefits of solvent reduction is that it almost always saves money. All told, Action Graphics' new system saves $9,400 a year in operating costs. Since the one-time capital cost for the system was only $13,300, it paid for itself in less than 16 months.

Comparison of Yearly Operating Costs*

	Old System	New System
Ink Remover	$13,100	$0
Emulsion Remover	$5,000	$2,600
Haze Remover	$7,800	$10,900
Filter Media	$0	$3,000
Total	$25,900	$16,500
Yearly Operating Cost Savings:		**$9,400**

*Although Action Graphics believes labor costs also were reduced under the new system, specific data are not available.

A Change in Solvents Used During Press Operation

About a year after Action Graphics overhauled its screen reclamation system, another one of its solvents surfaced as a problem. Like many printers, Action Graphics used a solvent during the printing process to remove dried ink left on screens overnight or during lunch breaks. The quickly evaporating solvent, called a press wash, consisted of n-butyl acetate, toluene, n-butanol, and isopropanol.

In 1989, Action Graphics purchased a distiller to reclaim its press wash solvent and consequently reduce its hazardous waste disposal and solvent costs. As a result, the company was able to reuse roughly 100 gallons of solvent over the course of a year, for a savings of about $500 annually. Although this early change was a step in the right direction, when Action Graphics' management applied for a permit with the local Air Pollution Control Board in 1992, they realized that more had to be done. During the application process, the shop discovered that much of its VOC emissions were coming from the quickly evaporating press solvent. The board found that the level of VOCs on the application triggered ordinances that required Action Graphics to perform a best achievable control technology test to find ways to decrease its VOC emissions. These ordinances help protect both the environment and worker health, since VOCs can contribute to air pollution and exposure to VOCs can lead to adverse health effects.

Some of the changes Action Graphics explored to reduce these environmental and health effects included using thermal incineration, catalytic incineration, or carbon absorption. Thermal and catalytic incineration involve burning VOCs that are captured in a dryer. Carbon absorption removes VOCs through activated carbon, which periodically must be sent out for reactivation. Through a cost-benefit analysis, Action Graphics found that these processes required a large capital investment. Since Action Graphics is a small shop, a large financial investment was out of the question. The company decided that chemical reformulation of its press wash was a more affordable alternative. In addition, chemical reformulation promised to stop VOCs from being generated in the first place, a true pollution prevention alternative, instead of trying to capture the VOCs after generation.

Finding a new solvent was no easy task, however. The company spoke with other screen printers, distributors of national brands that are marketed as environmentally friendly, and local chemical suppliers. Action Graphics found that formulations from local chemical suppliers were much less expensive than national brands and through trial and error found one that met its needs. Action Graphics switched to a solvent that contains aromatic solvent naphtha (60 percent), 1-methoxy-2-propanol (30 percent), and oxybispropanolmethylether (10 percent). This mixture evaporates much more slowly than the company's traditional solvent, thereby decreasing Action Graphics' total VOC emissions.

Workers did not like switching to this new solvent, however. Since it evaporates more slowly, press operators were concerned that they would have to check more carefully to see if it was completely evaporated before continuing a press run. To address this issue, company management wrote a letter to the press operators. The letter explained that the new solvent really did not require any additional effort and that the switch was not only necessary to comply with regulations, but also helped create a healthier work environment. Employees gradually adjusted to the new procedure.

The company not only reduced its VOCs by using the new solvent, but also reduced the total quantity of solvent used, since press operators needed less of the slower-evaporating solvent to do the same job. **This switch cut solvent usage from approximately 1,200 gallons per year to 300 gallons. Although the new solvent costs a little more per gallon, the company saves about $2,300 a year in purchasing costs because it uses so much less of the new product.**

At the same time that the Air Pollution Control Board suggested that Action Graphics reduce its VOC emissions from its press wash solvent, the board also noted that the company was close to the emissions limit for ethylene-based glycol ether compounds. If the company exceeded the limit, it would move to a higher emissions category under Title V

of the Clean Air Act and be subjected to a costly permit application process. Many of the company's inks and thinners contained these compounds. Action Graphics followed the same steps it took to locate a new press wash and found a new ink thinner that consisted of safer chemicals, 1-methoxy-2 propanol (85 percent) and oxybispropanolmethylether (15 percent), which are not listed as hazardous air pollutants. Although the company saw no reduction in solvent usage, these safer chemicals cost less than the glycol ether ink thinner, saving the company approximately $900 a year.

Rag Reuse

Another proposed solution for reducing solvents from Action Graphics' best achievable control technology test was to purchase a centrifuge to reclaim solvent from used rags. The company found in its cost-benefit analysis, however, that for its low volume of rags, a centrifuge was not the best option. Instead, the company instituted a policy to reuse the rags as many times as possible before disposal. Now, instead of press operators always reaching for a new rag each time they clean a screen, they are asked to reuse a rag as long as they are running the same color ink. When they change inks, they also change their rags.

Eventually the heavily soiled rags are sent to an industrial laundry. Action Graphics does not reuse rags from the laundry, however, because the laundry washes rags that are used for many purposes, including rags from metal shops. These rags often retain minute metal pieces, which would destroy Action Graphics' screens. Instead, the laundry provides the rags to other companies that do not need to use them on fragile equipment.

The participation rate for rag reuse has not been as high as the company's management would like, because clean rags do a better job cleaning screens. Action Graphics hopes increased education will help employees understand the benefit of generating fewer solvent-soaked rags.

Continued Improvements

While your print shop may use different inks or create different products than Action Graphics, you may still be able to learn from Action Graphics' decisions. When problems were identified, the company actively sought out creative solutions.

Company management weighed all their options carefully, spoke to other printers, and when appropriate conducted cost-benefit analyses before making changes.

Purchasing the high-pressure water system, switching press wash solvents and ink thinner, and instituting a rag reuse policy resulted in win-win situations. These changes enhanced screen reclamation performance, benefitted worker health and the environment, and saved the company money. If you are interested in these improvements, you can learn from Action Graphics' success.

Action Graphics' progress probably will not stop there, however. One of the key factors behind Action Graphics' success has been the company's continued self-evaluation and openness to new ideas. Action Graphics' management is always on the lookout for new ways to improve working conditions and minimize the company's impact on the environment. One future improvement the company is considering is switching over completely to UV curable inks, eliminating its use of solvent-based inks.

For More Information

For more information on the technologies in this case study, contact your equipment suppliers. For more information on other technological and chemical alternatives, refer to the summary booklet *Designing Solutions for Screen Printers—An Evaluation of Screen Reclamation Systems*. For more information on EPA's DfE Program or to obtain additional case studies, bulletins, and other related materials, contact:

Pollution Prevention Information Clearinghouse (PPIC)
U.S. EPA
401 M Street, SW. (7409)
Washington, DC 20460
Phone: 202-260-1023
Fax: 202-260-4659

For more information on this case study and trade association information, contact:

Screenprinting and Graphic Imaging Association International (SGIA)
10015 Main Street
Fairfax, VA 22031
Phone: 703-385-1335

Alternatively, you can visit the DfE home page on the World Wide Web at http://www.epa.gov/dfe or the SGIA home page at http://www.sgia.org

Also be sure to investigate your local health and environmental regulations. Local agencies are familiar with priority issues in your area and can help you find the best ways to prevent pollution in your community.

What Is the Design for the Environment Screen Printing Project?

The U.S. Environmental Protection Agency's (EPA) Design for the Environment (DfE) Screen Printing Project is a voluntary project that encourages printers to consider environmental concerns along with cost and performance when purchasing products to use in their facilities. Replacing hazardous chemicals with environmentally safer substitutes is one way to reduce the impact of printing on the environment while maintaining product quality. Many printers, however, have limited time and resources and therefore need help identifying and testing environmentally safer substitutes.

DfE fills this information gap. EPA has teamed up with screen printing industry representatives (including trade associations, printers, and suppliers) in the DfE Screen Printing Project. The project's goal is to evaluate and publicize pollution prevention opportunities in screen printing, particularly in the screen reclamation process.

Appendix E

CONSISTENT COMPLIANCE IS ESSENTIAL

The toxicity of silver in photographic wastes is a much-debated issue for our industry *[the photoprocessing industry]*. It has always been to our advantage that photographic facilities recovered silver decades before it was required by law. During the past 20 years, chemical and sensitized goods manufacturers have made outstanding progress in decreasing the hazardous nature of photographic products. And now industry representatives are breaking new ground with EPA and state and local agencies based on these exemplary efforts.

The photographic industry consistently provides consultation, scientific and technical data and research, and continuing educational programs for industry members and regulators alike. The environmental and health and safety issues facing photographic businesses are being confronted and we are making headway. But the full cooperation of individuals in the industry is necessary to achieve our goal.

While we continue to work toward fair treatment of silver-bearing wastes under the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA), we must also strive to comply with all regulations now in place.

For example, one of the most important environmental issues is that of handling and shipping silver flake and resins from silver recovery systems. In 1987, following a series of communications with the Environmental Protection Agency, the National Association of Photographic Manufacturers (PMA) obtained a written determination that silver flake and resins from silver recovery are not hazardous under RCRA when properly washed. Thus, triple-rinsed silver flake and resins can be shipped by a commercial carrier without being manifested and hauled by a licensed hazardous waste hauler.

This consideration was gained based on the assumption of industry-wide use of triple-rinsing procedures and toxicity testing. No one is exempt from this requirement if they intend to ship silver flake or resin through the mail or other non-permitted carrier.

Generators of silver flake or resin who do not adhere to proper rinsing procedures, but continue to ship via common carrier, may be in violation of several regulations. Among these are shipping hazardous waste without a manifest, shipping hazardous waste via an unlicensed hauler, misrepresenting a hazardous waste as non-hazardous, hazardous waste labeling, marking and placarding requirements, hazardous waste storage requirements, reporting and record keeping

requirements, and possibly many more EPA, OSHA, Department of Transportation and state hazardous waste laws.

Moreover, because this requirement is recognized throughout the photographic industry, the violations may well be deemed "willful," making them considerably more serious in the eyes of the court.

Even more important, however, is the negative impression given when individual members of an industry do not follow the guidelines established for them by their representatives. The industry as a whole loses credibility with regulatory agencies, and efforts toward positive are forestalled. Without credibility, we cannot hope to change regulations that are unfair to our industry.

The most significant contribution individual industry members can make to the cause of the industry as a whole, is to abide by the regulations as they now stand. In the case of triple rinsing silver flake and resins, the generators of the wastes should adhere to procedures detailed by PMA and manufacturers of silver recovery equipment, as well as requirements of local, state and federal agencies.

Different silver-recovery system configurations and units will require accommodations to ensure that the procedure produces an end product that can be safely and legally shipped. It is also important to note that at least one state, California, considers rinsed silver wastes to be "non-RCRA hazardous waste," and requires it to be manifested and hauled by a licensed hazardous waste hauler.

For equipment-specific instructions on triple-rinsing procedures, contact your silver-recovery equipment supplier or NAPM.

(from: PMA Environs newsletter, February, 1993)

Note you may see in the future:

Refining Customers

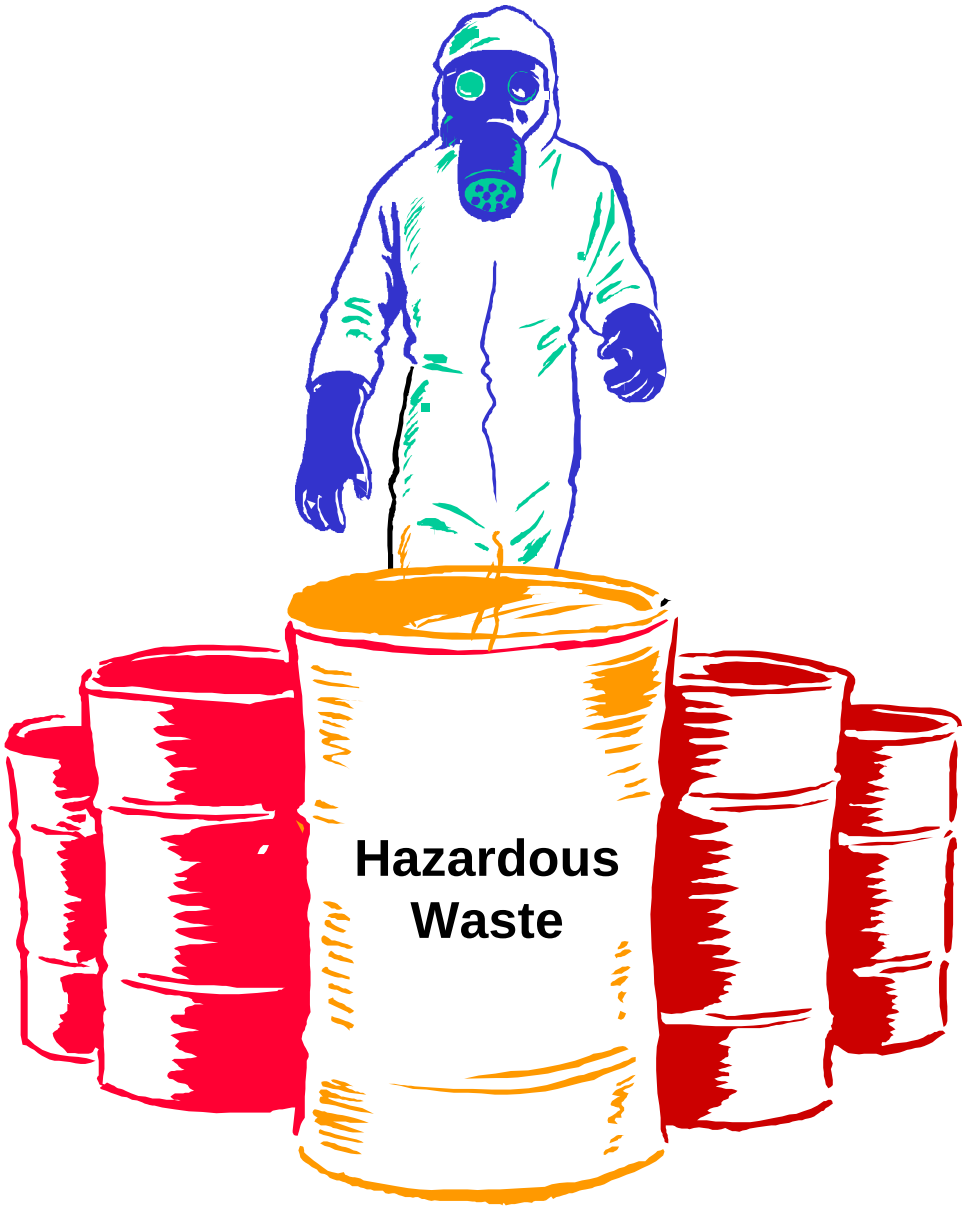
PLEASE follow the enclosed rinsing procedures.

We reserve the option of rejecting silver for recycling that we consider to contain

Hazardous Material!

Appendix F

Hazardous Waste Information



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❑ Hazardous Waste

Mentioning the words "HAZARDOUS WASTE" tends to scare businesses into denial and inaction. Yet, determining and documenting what hazardous and non-hazardous wastes you generate is important to your business. You may be generating a hazardous waste without knowing what you are generating. By not determining what wastes you generate, you are putting your business at risk of stringent fines and additional regulatory action. By determining and documenting what wastes you generate, non-hazardous and hazardous, you are complying with the basic requirements of hazardous waste identification, under the Resource Conservation and Recovery Act (RCRA - often pronounced Rickrah).

Many businesses generate some hazardous wastes. Yet, most shops typically generate so little that they are categorized as Conditionally Exempt Small Quantity Generators (CESQG's) or at most a Small Quantity Generators (SQG's). If you find that you generate more than the small quantity allowed small generators you need additional information not provided in this manual. You should call the P2 Program for additional direction.

Due to the limited regulations it is in your interest to become and maintain a CESQG status. However, even CESQG facilities have guidelines they must follow. One thing you must do is determine the amount of hazardous wastes you generate. This can be based on your knowledge of the process and materials used or by the application of the Toxicity Characteristic Leaching Procedure (TCLP) or other lab data, i.e., total metals sampling for liquid wastes.

How To Determine and Document Your Wastes
Your waste determination should:

A Begin with a facility self-assessment to determine all wastes you generate.
B List all wastes generated. This includes office paper to developers, soap bottles to bleach fix, cardboard boxes to metal scrap, etc. **Anything your business generates as a waste product, whether it goes to recycling, to the garbage, etc., should be listed.**
C From this list begin to determine what wastes are hazardous and non-hazardous. This is reliant upon your knowledge of the processes and materials used (e.g., silver in fixer wastes), by TCLP or total metals sampling for liquids.

The determination of hazardous wastes may require additional steps:

- Look at the process and review what materials and chemicals are used in the process. If the raw chemicals and materials contain hazardous substances they will generally generate hazardous wastes (e.g., silver, lead, cadmium, acids, other heavy metals, cyanide, solvents, etc.)
- Sampling of material according to the TCLP sampling process or suspected metals sampling. The TCLP will determine if the waste material exceeds required leaching levels (i.e., if a waste is put into a landfill it is required to leach no more that a specific level of certain hazardous materials). If the waste exceeds the TCLP it is hazardous and will need to be handled as a hazardous waste.
- If the material is hazardous, determine how much your facility generates monthly. This will determine your generator size.
- **Do not mix hazardous with non-hazardous wastes, doing so makes all the waste material hazardous and may move you into a higher generator category.**
- If waste is non-hazardous list it as such and continue with the determination of other wastes.

NOTE: If the dry material (not a sludge or slurry) is being sent for recycling or reclamation, it may not be considered a hazardous waste (some states require it to be shipped as a hazardous waste even to recyclers), but it should still be on your list (e.g. triple rinsed recovered silver from an electrolytic unit and properly rinsed MRC canisters are not considered hazardous if sent to a recycler/reclaimer). Most liquids, are considered hazardous even if being sent for recycling.

Laboratory analysis by an approved analytical lab may need to be conducted to determine some wastes category, and sampling should be run only for the suspected hazardous waste, such as silver because silver is used in your process. While this will involve spending money it can protect your business.

Typical Hazardous Wastes in Printing

Although all wastes should be listed and a determination made, printing generates certain wastes that should be reviewed. These wastes include:

Ignitable Wastes

Hazardous Waste Code: D001

Any liquid waste that has a flash point below 140ºF & 176ºF (60&#176C). Any non-liquid capable of spontaneous combustion under normal conditions. An ignitable compressed gas or oxidizer (as defined by DOT).

- blanket and roller washes
- isopropyl alcohol
- solvent-based coatings

Corrosive Wastes

Hazardous Waste Code: D002

An aqueous material with pH less than 2.0 or greater than 12.5.

- acids
- waste battery acid
- highly alkaline cleaners
- film/plate processing chemicals

Reactive Wastes

Hazardous Waste Code: D003

Unstable materials that react violently without detonating. React violently with water or form an explosive gas, vapor or fume when mixed with water. Contain cyanide or sulfide and generate toxic gas vapors/fumes at a pH between 2 and 12.5.

- waste bleaches and oxidizers

Toxic Wastes

Haz. Waste Code: D004 through D043

Contains specific contaminants above threshold levels. Typically determined using a test called the Toxicity Characteristic Leaching Procedure (TCLP). Principal candidate contaminants for printers' wastes include:

- See page 8 for list of other toxic materials
- waste fixer
- cleanup solvents
- plate processing chemicals

Whenever you change or add processes, chemicals or process materials, you will need determine the nature of the wastes generated.

Uncontaminated, lithographic inks from excess ink inventory or fountain pulls are typically not hazardous wastes. Discarded inks would only be hazardous wastes if they are ignitable, contain a solvent that is a listed hazardous waste, or if they contain high concentrations of heavy metals. (See the discussion of toxicity in Table 2 above.)

Lithographic inks alone are not usually hazardous, but when inks are mixed with solvents, the ink waste (solvent and ink) mixture is often hazardous if hazardous solvents are used for cleanup. You can reduce your costs of managing ink wastes by separately collecting used cleanup solvents and inks contaminated with those solvents from non-contaminated inks and ink skins. Also, collect hazardous waste solvents separately from non-hazardous solvent wastes. These steps will reduce the amount of hazardous waste that you generate, and the cost to manage those wastes.

Listing Your Hazardous Wastes

Listing all your wastes will help you determine which are hazardous and can be substituted. When you list your wastes you need to list whether the material is hazardous (and if so, determine the how much you generate per month) or non-hazardous and how the determination was made. For example:

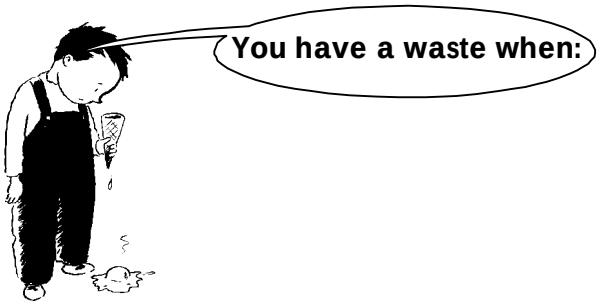
Raw Material	MSDS Available?		Waste Generated		Lab Process	Is Waste Hazardous?		Quantity Generated	Method
	YES	NO	YES	NO		YES	NO		
Fixer	X		X		Silver Test	X		5 gal/month liquid	exceeds 5ppm for silver

Of course, the best waste management alternative is not generating hazardous wastes in the first place. Not generating, or reducing the amount of wastes that you generate, is called source reduction. Source reduction gives the best long-term strategy, but before the benefits of source reduction can be fully appreciated, you have to understand the management requirements for each of these wastes.

Keep on file the process by which you treat any wastes.

REMEMBER:
Keep all records and information on file and accessible.

❑ What is a Waste?



- The material can no longer be used for its intended purpose. This includes old raw materials (expired or off-specification).
- The material will be thrown away.
- The material will be transported away from your facility to be recycled, incinerated, smeltered, or disposed.

❑ What is Hazardous Waste?

As a result of doing business, a company may generate wastes that can cause serious problems if not handled and disposed of carefully. Such wastes could:

- **cause injury or death; or**
- **damage or pollute land, air, or water**

These types of wastes are considered hazardous, and they are currently regulated by federal and state public health and environmental safety laws.

There are two ways a waste may be brought into the hazardous waste regulatory system: **listing**, and identification through **characteristics**.

A Listed Wastes: Your waste is considered hazardous if it appears on any one of the 4 lists contained in RCRA regulations. These wastes have been listed because they either exhibit one of the characteristics described below or contain any number of toxic constituents that have been shown to be harmful to health and the environment.

Some Solvents Used by Printers That Become F-Listed Wastes

F001 - Degreasers	trichloroethylene methylene chloride	1,1,1-trichloroethane carbon tetrachloride
F002 - Spent Solvents not used as degreasers	trichloroethylene methylene chloride 1,1,1-trichloroethane	1,2,2- trichloroethane 1,2,2- trichloroethane chlorobenzene
F003	Xylene Acetone	methanol methyl ethyl ketone (MEK)
F005	toluene methyl ethyl ketone (MEK)	carbon disulfide benzene

B Characteristic Wastes: Even if a waste does not appear on an EPA list, it is considered hazardous if it has one or more of these characteristics:

Ignitable: Any liquid waste that has a flash point below 140ºF & 176ºF (60&#176C). Any non-liquid capable of spontaneous combustion under normal conditions. An ignitable compressed gas or oxidizer (as defined by DOT). Includes blanket and roller washes, isopropyl alcohol, and solvent-based coatings.

Corrosive: Causes damage to skin and dissolves metals and other materials. A liquid with a pH of 2.0 or less, or 12.5 or greater. Examples are waste acids, alkaline cleaners and waste battery acid.

Reactive: Unstable materials that react violently without detonating. React violently with water or form an explosive gas, vapor or fume when mixed with water. Contain cyanide or sulfide and generate toxic gas vapors/fumes at a pH between 2 and 12.5. Includes waste bleaches and oxidizers.

Toxic Substances: (metals and pesticides) Materials that are considered toxic to humans. A waste is TC hazardous if the TCLP (Toxicity Characteristic Leaching Procedure) exceeds the regulatory levels for any of the established 8 metals and 6 pesticides, and 25 new organic compounds.

The following substances are categorized as toxic:

	Substance	Regulated Level (mg/L)	EPA #	Substance	Regulated Level (mg/L)
D004	**Arsenic**	**5.0**	**D011**	**Silver**	**5.0**
D005	**Barium**	**100.0**	D012	Endrin	0.02
D006	**Cadmium**	**1.0**	D013	Lindane	0.4
D007	**Chromium**	**5.0**	D014	Methoxychlor	10.0
D008	**Lead**	**5.0**	D015	Toxaphene	0.5
D009	**Mercury**	**0.2**	D016	2,4-D	10.0
D010	**Selenium**	**1.0**	D017	2,4,5-TPSilvex	1.0

For example: a waste with a TCLP (tested) leachable silver content above 5 PPM is assigned a hazardous waste code D011. (Note: ppm ≅ mg/l)

Other regulated toxic organic compounds:

- Benzene
- Chlordane
- Chloroform
- Carbon Tetrachloride
- Chlorobenzene
- m-Cresol
- o-Cresol
- p-Cresol
- 1,4-Dichlorobenzene
- 1,2-Dichloroethane
- 1,1-Dichloroethylene
- 2,4-Dinitrotoluene
- Heptachlor (& hydroxide)
- Hexachlor-1,3-Butadiene
- Hexachlorobenzene
- Hexachloroethane
- Methyl Ethyl Ketone
- Nitrobenzene
- Pentachlorophenol
- Pyridine
- Tetrachloroethylene
- 2,4,5-Trichlorophenol
- Trichloroethylene
- 2,4,6-Trichlorophenol
- Vinyl Chloride

From this list you will see that silver is categorized as a toxic hazardous waste. Therefore, any materials that come into contact with silver, such as fixers, can be a hazardous waste. There are also selenium substitutes for silver based photoprocessing. With selenium being at 1 mg/L you may want to carefully research the use of selenium based processes as replacements to silver. Waste generators must determine the levels of the above substances (where suspected) in their wastes. This is based on the generators knowledge of the process and materials used or by the application of the Toxicity Characteristic Leaching Procedure (TCLP).

Your facility and industry may generate other hazardous wastes beyond the examples mentioned above. **It is your responsibility to determine whether your wastes are hazardous.**

NOTE: If a hazardous waste inspector shows up at your shop and you have not determined the nature of your wastes, you could face fines. You are protecting yourself and business by spending the time and possibly some money to determine the nature of your wastes.

Acutely Hazardous Waste: These are wastes the EPA has determined to be dangerous in small amounts and are regulated in small amounts similar to large amounts of hazardous wastes. For example, acutely hazardous wastes may be generated using pesticides or a metal plating process. The key to acutely hazardous wastes is that the material must have been used in a facility process or the material must be declared off-specification (a material no longer provided to industry by the supplier). If your facility generates more than 1 kg (2.2 pounds) or stores more than this amount in one calendar month you are subject to the regulations applying to a Large Quantity Generator.

❑ The Mixture Rule

If you mix 100 gallons of a known hazardous waste with 100 gallons of a nonhazardous waste what do you end up with?

A. 200 gallons nonhazardous waste, or
B. 200 gallons listed hazardous waste

The correct answer is B. **Mixing even a small quantity of hazardous waste with non-hazardous waste causes the entire volume of waste to be classified as hazardous.** You will increase your disposal cost and will pay for the disposal of what was once a non-hazardous waste. Also, dilution of characteristic hazardous waste to make it non-hazardous is considered treatment and is subject to regulatory requirements.

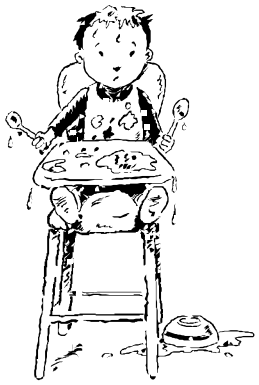
Other Issues Affecting Hazardous Waste Generation

- If you use a sorbent or other spill containment material to clean-up a hazardous waste spill, the containment and spill clean-up material are considered a hazardous waste.
- If you use rags, Q-tips, or other applicators to apply hazardous materials, all these applicators are considered hazardous wastes.
- If you rinse containers that held hazardous waste, the rinse water is considered hazardous.
- If you use a degreaser containing a solvent classified as hazardous, the sludge and associated materials are considered hazardous.
- If you spill hazardous waste on soil, the soil is considered a hazardous waste.

❑ Determine Your Monthly Waste Generation & Accumulation Rates

Good record keeping will make the calculations easier. Remember that the generation and accumulation rates must be calculated for each facility location (site) - do not combine wastes from several separate sites.

A Every calendar month, total all hazardous wastes that you:



- Accumulate on-site for any period of time prior to subsequent management;
- Package and transport off-site;
- Place directly in a regulated on-site treatment or disposal unit;
- Generate as byproducts and remove from the product storage tanks.

Don't Count wastes that

- Are specifically exempted from counting. For example, triple rinsed silver scrap/flake that will be sent off-site for reclamation, or used compressor oil that has not been mixed with hazardous waste (solvents, cleaners, etc.)
- May be left in the bottom of containers that have been completely emptied through conventional means (pouring or pumping). Containers that held acutely hazardous wastes must be thoroughly cleaned.
- Are left as residue in the bottom of product storage tanks, if the residue is not removed from the product tank.
- You reclaim continuously on-site without storing the waste prior to reclamation, such as batch or continuous flow silver recovery equipment. You do have to count any liquid residue removed from the equipment.

- You use an elementary neutralization unit, a totally enclosed treatment unit, or a wastewater treatment unit. An elementary neutralization unit is a regulated tank, container, or transport vehicle (including ships) which is designed to contain and neutralize corrosive wastes.
- Are discharged directly to a publicly owned treatment works (POTW) without being stored or accumulated first. This discharge to a POTW must comply with the requirements of the Clean Water Act and local regulations. The City of Albuquerque's POTW is a domestic sewage treatment plant and is not designed to treat a large amount of industrial waste.
- You have already counted once during the calendar month, and treated on-site or reclaimed in some manner and used again.

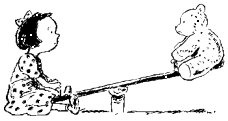
For on-site recycling, calculate the amount of waste generated once per month. For example, you generate 5 gallons of waste solvents in week one, out of which you recover and reuse 4-1/2 gallons as recycled product and have ½ gallon as waste. Your waste generation for week one is 5 gallons. In week two, you add ½ gallon of virgin solvent to the 4-1/2 gallons of recycled solvent and then use and recycle the refreshed 5 gallons. Waste generation for week two is ½ gallon - the ½ gallon of virgin solvent added to the recycled solvent. If instead you dispose the entire five gallons every week, your waste generation per week is 5 gallons of solvent per week. The waste generated is the raw material that has been used in a process. Since the original amount that was used in-process was 5 gallons of raw material, waste generated for week one is 5 gallons. For week 2 only ½ gallon of raw material was used in-process. If you repeat the process for week three and four your monthly waste solvent generation will be 6½ gallons instead of 20 gallons. If the solvent cost $1.00 per gallon you have just saved $13.50 and reduced your disposal costs.

B Convert all measurements to pounds

To make accurate calculations use the following steps:

Gallons to Pounds - One way to accurately convert gallons to pounds is to weigh the waste material.

a. Weigh an empty one gallon container and note the weight.
b. Fill the container with 1 gallon of the waste material (e.g. waste fixer).
c. Weigh the filled container.
d. Subtract the weight of the container from the filled container weight, and you'll know the weight of one gallon of the material in question.



This must be done for each separate type of hazardous waste. You could also have a lab determine the density of your wastes.

C Subtract all the excluded wastes in pounds.

D Calculate total weight of hazardous waste generated for the month.

You should now be able to determine your waste generator category.

C onditionally
E xempt
S mall
Q uantity
G enerators

If your facility generates no more than 100 kilograms (220 lbs, appx. ½ a 55 gallon drum) of hazardous waste or no more than 1 kg (2.2 lbs) of acutely hazardous waste in any calendar month, you are a conditionally exempt small quantity generator and the federal hazardous waste laws require you to:

- Identify all hazardous wastes you generate.
- Send your waste (via an approved waste hauler) to a hazardous waste facility, authorized landfill, or other facility approved by the state. If the material is for reclamation or recycling, you may transport the material to the reclaimer/recycler in the proper containers yourself. Although CESQG's are exempt from the manifest procedure most companies will manifest your hazardous wastes.
- Never accumulate more than 1,000 kg (2,200 lbs) of hazardous waste on your property. If you do, you become subject to all the requirements applicable to the 100-1,000 kg/month generators.

S mall
Q uantity
G enerators

If your facility generates more than 100 but less than 1,000 kg (220 to 2,200 lbs) of hazardous waste and no more than 1 kg (2.2 lbs) of acutely hazardous waste in one calendar month, you are considered a Small Quantity Generator (SQG), and are subject to the federal waste laws that require you to:

- Determine your hazardous wastes and which are subject to regulation.
- Obtain an EPA Identification Number.
- Store wastes in accordance with the proper management of containers.
- Package, mark and label wastes in accordance with the US Department of Transportation's (DOT) hazardous materials transport requirements.
- Use a licensed hazardous waste transporter and fill out a hazardous waste manifest (important for your business records).
- Properly recycle, treat, store, and dispose of your waste at a hazardous waste facility approved to accept hazardous wastes.
- Establish emergency procedures for responding to environmental emergencies such as leaks, spills and fires involving hazardous waste.
- Meet record keeping and reporting requirements.
- Submit an annual report on your waste management activities to the necessary state agency. If you become a LQG, comply with the LQG requirements.

❑ Requirements for Hazardous Waste Generators

(from AA Small-Business Guide to Hazardous Waste Generator Requirements, CO P2 Program)	**CESQG** (conditionally exempt small qty. Generator)	**SQG** (small qty. generator)	**LQG** (large qty. generator)
Quantity Limits: The amount of all hazardous waste generated in any one month, not averaged over 12 months.	Less than 220 lbs. of hazardous waste per month or less that 2.2 lbs. of acutely hazardous waste per month.	Between 220-2200 lbs. of hazardous waste per month or ~2.2 lbs. of acutely hazardous waste per month.	2200 or greater lbs. of hazardous waste per month or more than 2.2 lbs. Of acutely hazardous waste per month.
Management of Waste: Where you must send your waste for treatment, storage and disposal.	RCRA Permitted Facility	RCRA Permitted Facility	RCRA Permitted Facility
Manifest: A multicopy shipping document designed so that shipments of hazardous waste can be tracked from "cradle to grave."	**Not Required**	**Required**	**Required**
Exception Report: This is required when the signed copy of the manifest is not returned from the treatment/disposal facility.	**Not Required**	**Required after 60 days**	**Required after 45 days**
Biennial Report: A summary of a facilities hazardous waste generation activities during the previous year.	**Not Required**	**Not Required**	**Required**
Personnel Training: Classroom and on-the-job training that teaches facility personnel to perform their duties in a way that complies with RCRA.	**Not Required**	**Basic Training Required**	**Required training** for all employees with job responsibilities related to the generation or management of hazardous waste.
Contingency Plan: An emergency response plan that is designed to minimize hazards to human health or the environment in the event of an hazardous waste accident.	**Not Required**	**Basic Plan Required**	**Full Plan Required**
EPA ID Number: Must be filed with the EPA	**Not Required**	**Required**	**Required**
Total On-Site Haz. Waste Storage Limits:	May accumulate up to 2197 lbs.	May accumulate op to 13,200 lbs. For up to 180 days or 270 days if waste is to be transported over 200 miles.	May accumulate any quantity up to 90 days.
Storage Requirements:	None	Basic compliance with the technical standards under Part 265 for containers and tanks.	Full compliance with the technical standards under Part 265 for containers and tanks.

❑ Changing Generator Categories

Under the federal hazardous waste management system, you may be regulated under different rules at different times, depending on the amount of hazardous waste you generate in a given month. For example, if in June, you generate 100 kg (220 lbs) or less of hazardous waste, you would be a conditionally exempt small quantity generator (CESQG) for the month of June.

If, in July, your hazardous wastes total 100 kg but less than 1,000 kg, your status changes to a small quantity generator (SQG) and your July hazardous wastes would be subject to the regulations and requirements for this level of hazardous waste generator. Then, if in September, you generate 1,000 kg or more of hazardous waste, your September hazardous waste generated would be subject to all the requirements of a large quantity generator (LQG), including any previous months waste that was mixed with the September wastes.

❑ Managing Hazardous Waste

On-Site Storage

Three important things you should know about managing your hazardous wastes on-site are:

A Comply with storage time, quantity, and handling requirements for containers and tanks.

B Obtain a storage, treatment, or disposal permit if you store, treat, or dispose of your hazardous waste on-site in a manner requiring a permit.

C Take adequate precautions to prevent accidents, and be prepared to handle them properly in the event that they do occur.

Storing On-Site

You can store hazardous waste in 55-gallon drums, tanks, or other containers suitable for the type of waste. You should follow certain common sense rules that are meant to protect human health and the environment, and reduce the possibility of damages or injuries caused by leaks or spills.

If you store your hazardous waste in containers

Residues of hazardous waste in empty containers that previously contained hazardous waste are exempt from hazardous waste regulation and can be managed as nonhazardous waste. A container is empty if all wastes have been removed using common methods for that type of container (e.g. pumping or pouring).

The container must also have

- Less than one inch of waste remaining; or
- 3% or less by weight of waste remaining if the container holds 110 gallons or less; or
- 0.3% or less by weight of waste remaining if the container holds more than 110 gallons.

Containers that hold acutely hazardous waste must be triple rinsed to be considered empty. Rinsewater from the cleaning of the containers is regulated as hazardous waste if it has any of the hazardous waste characteristics.

You should also:

- Provide **secondary containment** to prevent accidental discharge to the sewer system or storm water drains.
- **Clearly mark** each container with the words "**HAZARDOUS WASTE**" (see Figure 1 and 2), with the date you began to collect waste in that container.
- **Replace leaking containers**, keep in good condition, and handle carefully.
- Do not store hazardous waste in a container that may rupture, leak, corrode, or otherwise fail.
- **Keep containers closed** except when you fill or empty them.
- **Inspect the containers** for leaks or corrosion every week.
- When storing ignitable or reactive wastes, containers should be covered and stored as far as possible from the site property line to create a buffer zone.
- **Cover** outside storage to prevent storm water pollution.
- Make sure that the stored waste is taken off-site or treated on-site within 180 days (or 270 days if waste is to be transported over 200 miles).

Figure 1. Example of Proper Hazardous Waste Container Label

Figure 2. Example of DOT Labels

NOTE: Many haulers and disposal facilities require labels identifying the **Health, Flammability** and **Reactivity** ratings plus **Personal Protection** codes. NFPA or HMIS labels are acceptable.

❑ Preparing for and Preventing Accidents

CESQG's are exempt from this requirement, but it is good practice. Whenever you generate hazardous waste and store it on-site, you must take precautions and steps necessary to prevent sudden or accidental releases to the environment. This requires careful operation and maintenance of the facility to reduce the possibility of fire, explosion, or release of hazardous waste.

Your facility must have appropriate types of emergency communication and fire equipment for the kinds of waste handled at your site. You must also attempt to make arrangements with local fire, police, or hospital officials as needed to ensure that they will be able to respond to any potential emergencies that could arise. Some of the steps you may need to take to prepare for emergencies at your facility include:

- **Install and maintain emergency equipment** such as alarms, a telephone or two-way portable radio, fire extinguishers (appropriate to your waste type), hoses, automatic sprinklers, or spray equipment that is immediately available to employees in case of an emergency.
- **Provide enough room for emergency equipment and response teams** to get into any area of your facility in the event of an emergency.
- **Write to local fire, police, hospital officials, and state or local emergency response teams explaining the types of wastes** you handle and ask for their cooperation and assistance in handling emergency situations.
- **Prepare an adequate "EMERGENCY EVACUATION PLAN"** for your facility and employees.
- **Employees who are designated to handle hazardous waste** or could be actively involved in cleanup operations **must receive at least 8 hours of training** in accordance with OSHA regulations.

Planning for Emergencies:

A contingency plan attempts to look ahead and prepare for any accidents that could possibly occur. It can be thought of as a set of answers to a series of "what if" questions. For example: "What if there is

a fire in the area where hazardous waste is stored?" or "What if I have a spill of hazardous waste or one of my containers leaks?" Emergency procedures are the steps you should follow if you have an emergency, that is, if one of the "contingencies" or "what ifs" occurs. While a specific written contingency plan is not required, it may be a good idea to make a list of these questions and answer them on paper. This also may be helpful in informing your employees about their responsibilities in the event of an emergency. For an emergency in your plant:

A **In the event of a fire**, call the fire department or attempt to extinguish it using the appropriate type of fire extinguisher.

B **In the event of a spill**, contain the hazardous waste flow to the extent possible and notify the National Response Center. The Center operates a 24-hour toll free number: 800-424-8802. As soon as possible, clean up the hazardous waste and any contaminated materials or soil, and package in approved containers with proper labels.

C **In the event of a fire, explosion, or other release**, immediately notify the National Response Center as required by Superfund regulations. (Superfund is the law that deals with the cleanup of spills and leaks of hazardous waste at abandoned hazardous waste sites.)

Emergency phone numbers and locations of emergency equipment must be posted near telephones and all employees must know proper waste handling and emergency procedures. You must appoint an employee to act as the primary emergency coordinator to ensure that emergency procedures are carried out in the event an emergency arises. The responsibilities of the emergency coordinator are generally:

- The primary emergency coordinator must be on 24 hour call. It is recommended that the coordinator be on a personal paging system to meet this requirement;
- Activate alarms/communication systems;
- Make appropriate phone calls;
- Arrange for cleanup and removal of the wastes.
- Know where all MSDS and other material data is located.

Sample emergency preparedness form - post near phones and have available to all employees:

Primary Emergency Coordinator:			
Home Phone:	Office Phone:	Office:	Home Address:
Alternate Emergency Coordinator:			
Home Phone:	Office Phone:	Office:	Home Address:
Local Emergency Numbers:			
Fire. Dept.: 911		Hospital:	
Ambulance: 911		Waste Treatment Plant: 873-6200	
Poison Control: 843-2551		LEPC: 764-6353/6322 or 243-6601	
State Emergency Numbers:			
Environment Dept.: 1-505-841-9450		Haz. Waste Mgt. Agency: 1-(505)827-4308	
Emergency Response: 1-(505)827-9300			
Federal Emergency Numbers:			
USEPA Reg. 6: 1-(214)767-2600		US Nat. Response Center: 1-800-424-8802	

It is important to avoid potential risks in this area. If you have a serious emergency and you have to call your local fire department or you have a spill that extends outside your plant or that could reach surface waters, immediately call the National Response Center (800-424-8802) and give them the information they request. **If you didn't need to call, they will tell you so.**

❑ Good Housekeeping and a safe environment

The four most important things to remember about managing your wastes properly are:

A **Reduce** the amount of your hazardous waste, don't mix hazardous with non-hazardous.

B **Conduct** your own self-inspection, determine your hazardous and non-hazardous wastes and document the results. Why are non-hazardous wastes non-hazardous? Do you have laboratory data to verify the non-hazardous status where necessary?

C **Cooperate** with state and local inspectors.

D **Call** your local or state hazardous waste agency or the USEPA with questions.

Good hazardous waste management can be thought of simply as using "good housekeeping" practices such as: using and reusing materials as much as possible; recycling or reclaiming waste; treating waste to reduce its hazards; or reducing the amount of waste you generate. To reduce the amount of waste you generate:

- Do not mix non-hazardous wastes with hazardous wastes. If you put nonhazardous material in the same container as a hazardous material, the entire contents become a hazardous waste.
- Avoid mixing several different hazardous wastes. Doing so may make recycling very difficult, if not more expensive.
- Avoid spills or leaks of hazardous products. The materials used to clean up such spills or leaks will also become hazardous. Make sure that original containers of hazardous products are completely empty before you throw them away. Use ALL the product.
- Avoid using more of a hazardous product than you need. For example, use no more degreasing solvent or pesticide than you need to do the job. Do not throw away a container with unused solvent or pesticide in it, use the material for its intended purpose then discard the container.

Reducing your hazardous waste means saving money on raw materials and reducing the costs to your business for managing and disposing of your hazardous wastes. Another aspect of "good housekeeping" is cooperating with inspection agencies and using a visit by an inspector as an opportunity to identify and correct problems. Accompanying state or local inspectors on a tour of your facility will enable you to ask any questions you may have and receive advice on more effective ways of handling your hazardous products and wastes. In addition, guiding the inspectors through your property and explaining your operations may help them to be more sensitive to the particular problems or needs of your business. Inspectors can also serve as a valuable source of information on record keeping, manifests, and safety requirements specific to your facility.

Remember: If you are still uncertain about how to handle your hazardous waste, or have any questions concerning the rules for Small and Large Quantity Generators please give us a call and we will direct you to the appropriate contacts. Taking responsibility for proper handling of hazardous waste will not only ensure a safer environment and work place for everyone, but will save your business money. So write or call your local or state hazardous waste management agency or the U.S. EPA with your questions today.

Appendix G

VOC AIR EMISSIONS: WHERE THEY COME FROM

- Inks - xylenes, ketones, alcohols, aliphates
- Fountain Solutions - isopropyl alcohol, VOC substitutes for IPA
- Adhesives - binding, labels
- Cleanup - toluene, naptha, kerosene, methanol, chlorinated solvents

❑ Reducing Alcohol in Fountain Solutions

From: Colorado Department of Public Health and Environment's Pollution Prevention Program

Advantages of reducing alcohol in your fountain solutions:

1. Lower VOC emissions
2. Safer, healthier work environment
3. Longer roller and blanket life (alcohol is hard on rollers and blankets)
4. Improved printing quality (alcohol deglosses ink)
5. Possible reduction in operating costs

For lithographic printers, the use of isopropyl alcohol in fountain solutions is a significant source of VOC emissions. Most printers use concentrations of 15-25% alcohol in their fountain solutions, with some small printers using concentrations up to 35% or more.

Many printers, without too much difficulty, have been able to reduce the alcohol concentration in their fountain solution to 5-10%. For most printers achieving this concentration would be a significant improvement and would result in a significant reduction in VOC emissions. While it is also to eliminate alcohol use completely (through the use of alcohol substitutes), complete elimination requires more changes to the printing system and tends to be more difficult to implement. The following information focuses on achieving a significant reduction in alcohol use without alcohol replacements.

How do I reduce alcohol in my fountain solutions?

You may need to modify your current system, including your operating practices, to maintain consistent printing quality while you are reducing the alcohol concentration in your fountain solution. The key system changes are:

- **MAINTAIN CONSISTENT WATER QUALITY**

You may need to switch to higher quality water for your fountain solutions, by either purchasing distilled or installing a reverse osmosis water treatment system.

Note: Most larger shops have reverse osmosis units and many smaller shops purchase distilled water.

- **MONITOR AND MAINTAIN FOUNTAIN SOLUTIONS**

You may need to monitor pH and/or conductivity to maintain your fountain solutions and your printing quality. You should add water, fountain solution concentrate, or alcohol only as needed. If you have a recirculating fountain solution and also extend its life. Filters can remove impurities such as paper dust and lint, as well as ink residue.

- **LOWER DUROMETER ROLLERS**

You should use lower durometer rollers (22-25) and properly maintain your rollers and blankets.

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