United States Environmental Protection Agency
Research and Development

Risk Reduction Engineering Laboratory
Cincinnati, OH 45268

EPA/600/S-92/053 October 1992

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Printing Plate Preparation Section of a Newspaper

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Abstract

The U.S. Environmental Protection Agency (EPA) funded a project with the New Jersey Department of Environmental Protection and Energy (NJDEPE) to assist in conducting waste minimization assessments at 30 small- to medium-sized businesses in the state of New Jersey. One of the sites selected was a printing plate preparation area of a large circulation newspaper printing facility. The areas of concern on the part of the publishing company that lead to the waste minimization opportunities assessment were levels of contaminants in their wastewater which were above the limits established by the local sewage authority. The process used for plate preparation is fundamentally a photographic transfer operation involving developing and fixing photographic films. A site visit was made in 1990 during which several opportunities for waste minimization were identified. Options included changes in some of the chemicals used in the process, reduced levels of rinse water, and improved silver recovery technology. Implementation of the identified waste minimization opportunities was not part of the program. Percent waste reduction, net annual savings, implementation costs and payback periods were estimated.

This Research Brief was developed by the Principal Investigators and EPA's Risk Reduction Engineering Laboratory in Cincinnati, OH, to announce key findings of this completed assessment.

Introduction

The environmental issues facing industry today have expanded considerably beyond traditional concerns. Wastewater, air emissions, potential soil and groundwater contamination, solid waste disposal, and employee health and safety have become increasingly important concerns. The management and disposal of hazardous substances, including both process-related wastes and residues from waste treatment, receive significant attention because of regulation and economics.

As environmental issues have become more complex, the strategies for waste management and control have become more systematic and integrated. The positive role of waste minimization and pollution prevention within industrial operations at each stage of product life is recognized throughout the world. An ideal goal is to manufacture products while generating the least amount of waste possible.

The Hazardous Waste Advisement Program (HWAP) of the Division of Hazardous Waste Management, NJDEPE, is pursuing the goals of waste minimization awareness and program implementation in the state. HWAP, with the help of an EPA grant from the Risk Reduction Engineering Laboratory, conducted an Assessment of Reduction and Recycling Opportunities for Hazardous Waste (ARROW) project. ARROW was designed to assess waste minimization potential across a broad range of New Jersey industries. The project targeted 30 sites to perform waste minimization assessments following the approach outlined in EPA's *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003). Under contract to NJDEPE, the Hazardous Substance Management Research Center at the New Jersey Institute of Technology (NJIT) assisted in conducting the assessments. This research brief presents an assessment of the preparation of printing plates at a newspaper printing facility (1 of the 30 assessments performed) and provides recommendations for waste minimization options resulting from the assessment.

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Printed on Recycled Paper

Methodology of Assessments

The assessment process was coordinated by a team of technical staff from NJIT with experience in process operations, basic chemistry, and environmental concerns and needs. Because the EPA waste minimization manual is designed to be primarily applied by the inhouse staff of the facility, the degree of involvement of the NJIT team varied according to the ease with which the facility staff could apply the manual. In some cases, NJIT's role was to provide advice. In others, NJIT conducted essentially the entire evaluation.

The goal of the project was to encourage participation in the assessment process by management and staff at the facility. To do this, the participants were encouraged to proceed through the organizational steps outlined in the manual. These steps can be summarized as follows:

- Obtaining corporate commitment to a waste minimization initiative
- Organizing a task force or similar group to carry out the assessment
- Developing a policy statement regarding waste minimization for issuance by corporate management
- Establishing tentative waste reduction goals to be achieved by the program
- Identifying waste-generating sites and processes
- Conducting a detailed site inspection
- Developing a list of options which may lead to the waste reduction goal
- Formally analyzing the feasibility of the various options
- Measuring the effectiveness of the options and continuing the assessment.

Not every facility was able to follow these steps as presented. In each case, however, the identification of waste-generating sites and processes, detailed site inspections, and development of options was carried out. Frequently, it was necessary for a high degree of involvement by NJIT to accomplish these steps. Two common reasons for needing outside participation were a shortage of technical staff within the company and a need to develop an agenda for technical action before corporate commitment and policy statements could be obtained.

It was not a goal of the ARROW project to participate in the feasibility analysis or implementation steps. However, NJIT offered to provide advice for feasibility analysis if requested.

In each case, the NJIT team made several site visits to the facility. Initially, visits were made to explain the EPA manual and to encourage the facility through the organizational stages. If delays and complications developed, the team offered assistance in the technical review, inspections, and option development.

No sampling or laboratory analysis was undertaken as part of these assessments.

Facility Background

The facility is a printer of newspapers which circulate through a large geographical area. Press runs are frequently in the hundreds of thousands of copies. The facility has been in its present suburban location since the early sixties and currently employs 1200 people. The local sewage authority samples wastewater at a manhole which receives effluent flow from the administrative areas as well as the printing plant. It was necessary to identify processes throughout the facility which might impact upon the contaminants in the wastewater.

Manufacturing Processes

The physical production of the newspaper begins by arrangement of the copy and artwork which is to appear on the printed page. The layout and pasteup is photographed to produce an image of the page. A proof is prepared for comparison with the final print and to permit the printer to make any necessary adjustments to the press. The photographic image is transferred to a plate through another photographic developing and fixing step and the plate serves. The plate is inked in the areas which are to appear on the paper and the ink is transferred to the paper.

The portions of the operation which impact upon the wastewater effluent are primarily the photographic image processing steps. The facility has six film processors, each of which has three sections—the developer, the fixer, and the rinser.

To prepare the image, a light-sensitive coating (or photographic emulsion) is exposed to light which is reflected from or passed through the image (depending upon whether a photograph is being taken or if a photographic negative is being used). The photographic emulsion is composed of silver halides in a gelatin base. The emulsion may be spread upon paper, a plastic base, or a glass plate, depending upon the intended use for the image. The photographic process produces a negative image in which the light parts of the copy or artwork which was photographed produce heavy deposits of silver causing them to appear dark. The dark parts produce little or no silver deposits and therefore appear to be light when developed. The exposed film is developed and fixed by sequential oxidation and reduction steps.

The development step is accomplished by oxidation, typically with a hydroquinone solution, to oxidize the photoexposed silver halide to metallic silver. The fixing step is a reduction with either sodium or ammonium thiosulfate. The fixing step terminates the oxidation and aids in removal of the unexposed silver halide from the photographic emulsion.

Following the fixing process, the plate is rinsed with water to remove any of the chemicals which may still be present on or in the gelatin layer. Any fixing chemicals which are not removed can continue to react with the metallic silver to produce silver sulfide and impact the quality of the image. After rinsing the plate is dried.

Existing Waste Management Activities

The company has already instituted a significant pollution prevention activity. Because of the intrinsic value of silver and the high volume of photographic developing done at the facility, a silver recovery system has been installed. The system involves a silver recovery unit which essentially operates as an electroplating process by plating out much of the silver from solution. At this facility, the effluent from the silver recovery unit passes to an iron exchange cannister, where the silver ion is chemically transformed to silver metal through an oxidation/reduction reaction with iron. The effluent from this process goes to the sewer.

In sequence, the effluent from the developer section goes by direct discharge to the sewer. The potential contaminants from this section could be hydroquinone from the developer solution and silver from the film.

Discharge from the fixer goes to the silver recovery unit mentioned above. Potential contaminants contained in this effluent are hydroquinone dragged in from the developer, silver not removed by the silver recovery units, and nitrogen containing compounds from the fixer solution, such as ammonium thiosulfate.

Most of the overflow discharge from the film processing system comes from the rinsing section. This discharge goes directly to the sewer and contains potentially the same contaminants as found in the fixer section effluent.

The annual discharge from the facility to the sewer authority is about 5,200,000 gal. At the time of this assessment, the sewage authority had fixed limits of acceptability for discharge from this type of facility. Three levels of particular concern were: silver 0.03 mg/l, Biological Oxygen Demand (BOD) 300 mg/l, and Total Kjeldahl Nitrogen 40 mg/l. At the time of the assessment, the effluent from the plant was occasionally reaching higher levels such as: 1.0 mg/l for silver and 50-75 mg/l for Total Kjeldahl Nitrogen. The BOD during this period was no higher than 150 mg/l. The goal of the assessment was to identify options which would maintain the silver and Kjeldahl nitrogen levels below the levels acceptable to the sewer authority.

Waste Minimization Opportunities

The type of waste currently generated by the facility, the source of the waste, the quantity of the waste and the annual treatment and disposal costs are given in Table 1.

Table 2 shows the opportunities for waste minimization recommended for the facility. The type of waste, the minimization opportunity, the possible waste reduction and associated savings, and the implementation cost along with the payback time are given in the table. The quantities of waste currently generated at the facility and possible waste reduction depend on the level of activity of the facility.

It should be noted that the economic savings of the minimization opportunity, in most cases, results from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal. It should also be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that would result when the opportunities are implemented in a package. Also, no equipment depreciation is factored into the calculations.

A search was made for chemicals used in the facility which might contribute to the Total Kjeldahl Nitrogen. Examination of the Material Safety Data Sheets, revealed only a cleaning compound which contained ammonia. It was found however that only about 30 gal/yr of this material is used at the facility and this would not impact the Kjeldahl Nitrogen value substantially. The other alternative identified was to consider changing the chemical used as the photographic fixer from ammonium thiosulfate to sodium thiosulfate. Such a change has been reported to have an adverse impact on image quality and would not be implemented by the company.

It is also possible to recycle the fixer solution. This requires a dedicated continuously operating electrolytic silver recovery system, because a controlled low level of silver in the fixer solution is the key to longer life of the system. This recycling capability would also require control of pH and monitoring to assure that no appreciable level of sulfur was generated. This degree of monitoring and control was not seen as possible by the processing staff; therefore this was not seen as a viable option.

In order to provide a better understanding of the relationship between industrial activity and Total Kjeldahl Nitrogen levels throughout the facility, a special sampling of effluent from selected sections of the facility was carried out. It was found that the highest level of Kjeldahl Nitrogen (75 mg/l) was in the effluent from a section of the facility which generated only sanitary waste. That is, it had no chemical activity at all.

In contrast to that finding, the highest levels of silver were found in the effluent from areas where photo processing occurred. In the area with both the electrolytic silver recovery process and iron exchange technology operating, the silver level was 0.02 mg/l. In another area which had a silver recovery system, but no iron exchange capability, the silver level was 1.0 mg/l. Literature values suggest that the silver recovery system can reduce silver levels to 100 mg/l and the iron exchange technology can reduce it further to 5 mg/l. In the present system the lower levels result from dilution with other aqueous waste streams. The levels can be reduced even lower through use of an ion exchange resin system, following the iron exchange cartridge.

It is not known at present whether significant levels of silver are contained in the effluent from the developer and from the rinse section. It is recommended that analyses be carried out and the silver recovery systems be used if significant silver levels are found in these streams. Such use would allow recovery of silver and reduce the silver loading to the sewage authority.

Table 1. *Summary of Current Waste Generation*

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
Aqueous Discharge to Sewer	*Effluent from photo processing equipment and sanitary discharges. Based on a flow meter reading, the volume from the photo system is about 20% of the total flow from the entire facility.*	*5,200,000 gal*	*$2050*

☆U.S. GOVERNMENT PRINTING OFFICE: 1994 - 550-067/80184

This Research Brief summarizes a part of the work done under cooperative Agreement No. CR-815165 by the New Jersey Institute of Technology under the sponsorship of the New Jersey Department of Environmental Protection and Energy and the U.S. Environmental Protection Agency. The EPA Project Officer was Mary Ann Curran. She can be reached at:

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Table 2. *Summary of Recommended Waste Minimization Opportunities*

Waste Stream Reduced	*Minimization Opportunity*	*Annual Waste Reduction*		*Net Annual Savings*	*Implementation Cost*	*Payback Years **
		Quantity	*Percent*			
Outflow from Photo Processing	*Install iron exchange canister and ion exchange unit on all processing units of the silver recovery system.*	*This will not have a significant impact on the volume of water emitted. It should however be able to recover about 44 lb cf silver.*		*$5000*	*$25,000*	*5.0*

* Savings result from reduced raw materials and treatment and disposal costs when implementing each minimization opportunity independently.

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