United States Environmental Protection Agency
Research and Development

Risk Reduction Engineering Laboratory
Cincinnati OH 45268

EPA/600/S-92/019 May 1992

EPA

ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Metal-Plated Display Racks

Gwen P. Looby and F. William Kirsch*

Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small- and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC team at the University of Tennessee performed an assessment at a plant manufacturing metal-plated display racks. Steel wire, tubing, and sheets undergo machining operations, and the resulting parts are then nickel and brass-plated, nickel-plated, zinc-plated, nickel and chrome-plated, or painted. The various finished parts are assembled into display racks. The team's report, detailing findings and recommendations, indicated that the majority of waste was generated by the plating lines and that the greatest waste reduction would result from utilizing a Zero Discharge Recovery system in the nickel-plating baths.

This Research Brief was developed by the principal investigators and EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from the authors.

Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small- and medium-size manufacturers who want to minimize their formation of waste but who lack the in-house expertise to do so. Under agreement with EPA's Risk Reduction Engineering Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at the University of Tennessee's (Knoxville) WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The waste minimization assessments are done for small- and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $50 million, employ no more than 500 persons, and lack in-house expertise in waste minimization.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers, reduced waste treatment and disposal costs for participating plants, valuable experience for graduate and undergraduate students who participate in the program, and a cleaner environment without more regulations and higher costs for manufacturers.

Methodology of Assessments

The waste minimization assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locates the sources of waste in the plant and identifies the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

This plant manufactures metal-plated display racks. The plant's 200 employees process approximately ten million lbs of metal annually and operate the plant 4,160 hr/yr.

Manufacturing Process

Raw materials for the display racks include steel wire, tubing, and sheets; nickel, zinc, and brass plating anodes; cleaning agents and plating solution chemicals; and powder and liquid paints. Approximately 40% of the finished products are nickel and brass-plated, 26% are nickel-plated, 24% are zinc-plated, and 10% are nickel and chrome-plated.

The steel wire, tubing, and sheets undergo stamping, bending, forming, shaping, welding, and riveting. The parts to be plated are then sent through one of the three following plating lines. Other parts are sent to the paint line, which is also described here.

Barrel Plating Line

Small fabricated parts are cleaned prior to plating to remove residual oils and grease by using either a vibrating cleaning unit or a rotating abrasive tub. The vibrating tub cleans parts by vibrating them in a chemical solution. Spent cleaning solution and rinse water are sent to the plant's wastewater treatment facility. In the other method, the parts and abrasive pellets are placed in small rotating tubs for cleaning. Spent abrasive is disposed of in a landfill.

The cleaned parts are placed in hollow barrels which are attached to an overhead conveyor system. The barrels, which have holes along the length of their surfaces, are slowly rotated while being submerged for a specified amount of time in the various tanks of the plating line.

Each batch of parts to be plated undergoes specific steps in the line. All of the pieces pass through most of the same preparatory stages, while later stages in the line are reserved for one type of plated part only. Spent solutions from all tanks except the plating baths are dumped to the plant's wastewater treatment facility. Plated parts are then sent to other areas of the plant for assembly.

Zinc Plating Line

Larger-sized metal pieces are manually hung on racks attached to an overhead conveyor system which is used to dip parts in the 22 tanks of the line. All spent tank solutions are piped to the plant's wastewater treatment facility. Plated parts are transferred to the assembly areas of the plant.

Frame Plating Line

The frame plating line is used to plate nickel, nickel and chrome, and nickel and brass onto large display rack frames. Parts are hung on racks as in the zinc-plating line; some tanks in this line are bypassed depending on which type of plating is required. Spent tank solutions are sent to the plant's wastewater treatment facility. Finished parts are transferred to the assembly areas of the plant.

Paint Line

Miscellaneous metal pieces which do not require plating are sent to the three-stage washer and paint areas. The parts are hung on a small conveyer system which transports them through an enclosed washer line containing three different solution-filled tanks. Spent solutions are dumped directly to the municipal sewer.

After cleaning and drying, parts are painted using electrostatic powder coating or liquid dip painting. Overspray powder is collected and reused. Drag-out from dip painting is collected on cardboard or plastic sheets which are disposed of in a landfill. After drying, the painted parts are transferred to the assembly areas of the plant.

Existing Waste Minimization Practices

- The plant operates an electrostatic powder paint system to reduce the amount of paint wastes it generates.
- Water-based, nonhazardous liquid paints are used.
- Filtering systems recover zinc and nickel from spent plating solutions.
- Cyanide-laden brass plating water is stored in a holding tank and used as rinse water in several of the plating line stages.
- All wastewater is treated onsite before release to the municipal sewer.
- A natural gas-fired dryer is used to reduce the volume of sludge resulting from the filter press operation.

Waste Minimization Opportunities

The type of waste currently generated by the plant, 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 that the WMAC team recommended for the plant. 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 by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

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 treatment and disposal. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. 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.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-814903 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. The EPA Project Officer was Emma Lou George.

Table 1. Summary of Current Waste Generation

Waste Stream	Waste Management Method	Annual Quantity Generated	Annual Waste Management Cost
Barrel Plating Line	Treated onsite and sewered	208,000 gal	$2,290
Contaminated wash and rinse water from cleaning process			
Spent abrasive from cleaning process	Offsite landfill	6,000 lb	2,290
Contaminated plating, wash, and rinse water	Treated onsite and sewered	817,860 gal	18,860
Zinc-Plating Line			
Contaminated plating, wash, and rinse water	Treated onsite and sewered	1,201,080 gal	18,860
Frame Plating Line			
Contaminated plating, wash, and rinse water	Treated onsite and sewered	1,067,260 gal	24,150
Paint Line			
Contaminated wash and rinse water	Sewered	153,360 gal	2,290
Paint overspray on cardboard and plastic sheets	Offisite landfill	110 gal	2,290
Boiler			
Condensate	Treated onsite and sewered	262,000 gal	940
Wastewater Treatment			
Waste solids	Offsite landfill	4,180 gal	59,050

Table 2. Summary of Recommended Waste Minimization Opportunities

Present Practice	Proposed Action	Waste Reduction and Associated Savings
Contaminated plating, wash, and rinse water from the barrel, zinc and frame plating lines and contaminated wash and rinse water from the paint line are treated onsite and sewered.	Install a piping system to recycle treated waste water within the plant to reduce purchases of water. If necessary, improve the current methods of waste water filtering to provide sufficiently clean water.	Estimated waste reduction = 3,114,290 gal/yr Raw material cost savings = $11,120/yr Operating cost = $3,840/yr Total cost savings = $7,280/yr Implementation cost = $56,380/yr Simple payback = 7.8 yr
As the nickel plating baths in the barrel and frame plating lines become contaminated, they are emptied into dedicated filtering units which are used to recover a large portion of the particulate nickel in the solutions. The filtering units are periodically cleaned by back-flushing with a weak acid solution. The acid solution, which contains contaminants, is sent to the plant's waste water treatment facility. Currently, a significant amount of nickel is discharged in the waste water sludge which, as a result, is classified as hazardous waste.	Modify the plating lines in question to incorporated the utilization of a Zero Discharge Recovery (ZDR) system. It is recommended that the sytem use reverse osmosis technology to recover plating bath solutions at plant-specific concentration levels. The system will operate in a closed-loop manner and therefore the amount of nickel dishcarged to the waste water treatment facility will be reduced. A portion of the chemicals required by the baths and by the water treatment facility will no longer be needed. Approximately the same amount of sludge will be generated, but it will be classified as nonhazardous.	Estimated waste reduction = none Waste disposal cost savings = $24,460/yr Raw material cost savings = $6,250/yr Operating cost = $8,000/yr Total cost savings = $22,710/yr Implementation cost = $70,000 Simple Payback = 3.1 yr

☆U.S. GOVERNMENT PRINTING OFFICE: 1992 - 648-080/40267

Table 2. *Summary of Recommended Waste Minimization Opportunities (concluded)*

Present Practice	Proposed Action	Waste Reduction and Associated Savings
Acid wash tanks, which are used in each of the plating lines for cleaning of metal parts, are dumped to the waste water treatment facilitiy as they become contaminated	Recover and reuse the spent salt/acid solution from the contaminated wash tanks. It is estimated that 70% of the acid salt can be recovered using an evaporator and reused. Implementation of this recommendation will lead to a reduction in the amount of acid salt purchases.	Estimated waste reduction = 42 gal/yr (waste solids) + 30,860 gal/yr water Waste management cost savings = $390/yr Rasw material cost savings = $7,700/yr Total cost savings = $8,090/yr Implementation cost = $29,440 Simple payback = 3.6 yr
Rinsing in the plating lines is accomplished by dipping parts in rinse tanks. As a result, considerable drag-out and contamination occur. Spent water from the rinsing tanks is dumped to the onsite waste water treatment facility, treated, and released to the municipal sewer.	Wherever possible, modify the zinc and frame plating lines to utilize spray rinsing techniques instead of dipping in tanks.	Estimated waste reduction = 617,760 gal/yr Raw material cost savings = $2,200/yr Implementation cost = $16,900 Simple payback = 7.7 yr
Drag-out in the three plating lines currently accounts for an estimated 10% loss in chemical solutions.	Install rinse devices above each plating and wash tank in the zinc and frame plating lines to spray water on parts as they are removed from tanks. As a result, plating solutions will be returned to their tanks before drag-out occurs.	Estimated waste reduction = none Raw material cost savings = $2,800/yr Implementation cost = $17,940 Simple payback = 6.4 yr
Varous tanks in the plating and paint lines are steam-heated. Condensate is not returned to boiler because of concerns about possible contamination; it is sent to the waste water treatment facility.	Install individual heat exhangers to serve each heated wash tank and plating bath. The proposed units should transfer heat from the main steam line to smaller lines feeding each tank. Therefore, the steam will not come in contact with any process fluids and can be returned to the boiler.	Estimated waste reduction = 262,00 gal/yr Raw material cost savings = $940/yr Energy cost savings = $870/yr Boiler feedwater chemical cost savings = $3,500/yr Total cost savings = $5,310/yr Implementation cost = $33,700 Simple payback = 6.3 yr

Printed on Recycled Paper

United States
Environmental Protection
Agency

Center for Environmental
Research Information
Cincinnati, OH 45268

BULK RATE
POSTAGE & FEES PAID
EPA PERMIT NO. G-35

Official Business
Penalty for Private Use $300

EPA/600/S-92/019