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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Aluminum and Steel Parts

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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. In an effort to assist these manufacturers, 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). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at Colorado State University performed an assessment at a plant that manufactures a variety of steel and aluminum parts. Raw material is machined and the resulting parts are welded, ground, and chromated. Parts are then painted and logos and other lettering are screened onto the parts. The parts are shipped following inspection, assembly, and packaging. The team's report, detailing findings and recommendations, indicated that the waste streams generated in greatest quantity are rinse water and paint wastes, and that the greatest cost savings could be achieved by replacing the conventional paint guns currently used with more efficient substitutes.

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 University City Science Center.

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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 generation 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 generation 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 Colorado State University's (Fort Collins) 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 $75 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, and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides 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 identify 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 a variety of aluminum and steel parts, primarily for local medical and computer products manufacturers. It operates 5,600 hr/yr to produce approximately 750,000 parts/yr.

Manufacturing Process

Steel and aluminum undergo shearing, punching, and bending operations to form desired parts. Welding and grinding are performed on the resulting parts as needed. Large parts are hung on an overhead conveyor and small parts are placed in a hanging basket prior to undergoing chromating. The process baths used in the chromating line are dependent on the type of part being coated.

After chromating, the parts are prepared for painting and hung on an overhead conveyor. The conveyor runs to four spray booths where the parts are painted with solvent-based paints, water-based paints, or powder-based coatings. Parts are dried in a natural gas-fired oven following painting.

Logos and other lettering are screened onto the parts, which are then inspected, assembled, packaged, and shipped.

An abbreviated process flow diagram for Aluminum and Steel Part Manufacturer is shown in figure 1.

Existing Waste Management Practices

This plant already has implemented the following techniques to manage and minimize its wastes.

- The use of "Just-in-Time" ordering reduces stock and misordering that could lead to waste generation.
- Scrap metal from machining processes is recycled.
- Flat sanding using a water knife and a baghouse reduces dust.
- Reactive rinsing (using the same rinse tank after dipping in the caustic soap and dipping in the acid tank) neutralizes the water and reduces water usage.
- Solvent recycling and reuse reduces the amount of solvent wastes generated.

Waste Minimization Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the waste management cost for each waste stream identified are given in Table 1.

Table 2 shows the opportunities for waste minimization that the WMAC team recommended for the plant. The minimization opportunity, the type of waste, the possible waste reduction and associated savings, and the implementation cost along with the simple 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 asso-

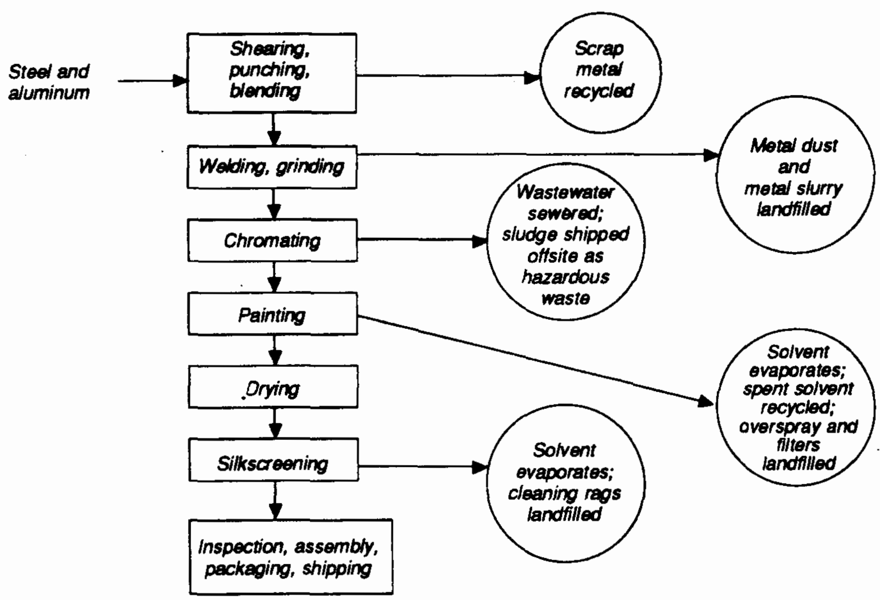

Figure 1. Abbreviated Process Flow diagram for aluminum and steel part manufacture.

ciated with waste 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 also should 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 may result when the opportunities are implemented in a package.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, one additional measure was considered. The potential savings of this measure are somewhat hypothetical in nature, but it was brought to the plant's attention for consideration.

- Replace the present deoxidizer used in the chromating line with a nonchromated deoxidizer in order to reduce chromium concentrations in the waste rinse water. If chromium levels continue to be problematic, the plant may need to install a chromium reduction unit. This measure would make the purchase of that unit unnecessary.

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 Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb)	Annual Waste Management Cost
Metal dust/grit	Grinding of metal	Shipped offsite as municipal trash	440	$0 [1]
Rinse water	Cleaning and chromating	Discharged to sewer	12,560,000	2,540
Evaporated solvent (lacquer thinner)	Paint gun cleaning	Evaporates to plant air	18,100	7,070 [2]
Solvent still bottoms	Onsite solvent recovery unit	Shipped offsite as hazardous waste	3,300	1,780
Paint filters/overspray	Paint spray booths	Shipped offsite as municipal trash	11,19	47,710 [3]
Evaporated mixing materials (catalyst, reducer, thinner)	Painting	Evaporates to plant air	8,590	14,000 [4]
Evaporated paint solvent	Painting	Evaporates to plant air	11,87	0 [5]
Cleaning rags	Cleaning of silkscreens	Shipped offsite as municipal trash	3,900	1,070 [6]
Evaporated solvent (screen wash)	Cleaning of silkscreens	Evaporates to plant air	1,130	1,670 [2]

[1] Plant pays a monthly fee for trash disposal.
[2] Raw material cost of solvent evaporated.
[3] Raw material cost of filters and paint captured in filters.
[4] Raw material cost of material evaporated.
[5] No value to plant.
[6] Purchase cost of material.

Table 2. Summary of Recommended Waste Minimization Opportunities

Minimization Opportunity	Waste Stream Reduced	Annual Waste Reduction: Quantity (lb)	Annual Waste Reduction: Per cent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Replace the presently used conventional paint spray guns with high-volume, low pressure (HVLP) paint spray guns in order to increase paint transfer efficiency and reduce consumption of paint, catalyst, reducer, and thinner. Paint overspray losses will be reduced considerably, leading to significant cost savings.	Paint filters/overspray Evaporated mixing materials Evaporated paint solvent	1,000 2,190 2,850	9 25 25	$33,920	$2,800	0.1
Install a closed-loop paint spray gun washer to reduce the quantity of solvent that evaporates during paint gun cleaning. Recovered spent solvent can be processed in the plant's solvent recovery unit; a small additional quantity of still bottoms will be generated.	Evaporated solvent (paint gun cleaning)	16,300	90	5,120	1,500	0.3
Replace the solvent-based wash currently used for silkscreens with a low-solvent wash, a recirculating system, and a wash booth.	Cleaning rags Evaporated solvent (cleaning of silk screens)	2,600 1,130	67 100	3,510	2,150	0.6
Replace a portion of the solvent-based paints used currently with water-based paint.	Solvent still bottoms Evaporated solvent (paint gun cleaning) Evaporated mixing materials	1,150 6,290 2,980	35 35 35	3,570	0	Immediate
Install an additional counter-flowing rinse at the end of the chromating line to reduce water consumption.	Rinse water	4,480,000	35	910	3,680	4.1
Redesign plating baskets to reduce chromium dragout from the solution tanks to the rinse tanks.	Rinse water	1,380,000	11	250	500	2.0

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