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# ENVIRONMENTAL RESEARCH BRIEF

## Waste Minimization Assessment for a Bumper Refinishing Plant

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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 hazardous waste but 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 Colorado State University inspected a plant refinishing steel, aluminum, and plastic bumpers. The plant is new and already incorporates many hazardous waste management features. After the bumpers are straightened, the processes to remove old plating and coating, the rinsing, the caustic cleaning for steel bumpers and desmutting for aluminum ones, followed by more rinsing generate significant quantities of waste. Aluminum bumpers are then reanodized at another location; the steel bumpers are soaked in cleaning solutions and rinsed (and soaked and rinsed), creating still more waste, before being electrolytically replated with nickel and chromium. The team's report, detailing findings and recommendations, indicated that the greatest waste reduction could occur with the use of additional filtration along with the existing deionization systems. Their use would reduce chromium and nickel levels in rinse waters and other liquid streams to levels acceptable for recycle to the plant. The collected solids would go to a landfill for disposal. Because steel and aluminum bumpers generate the most waste, plastic bumpers were not considered for the purpose of this assessment.

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 hazardous 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 hazardous 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 hazardous waste but lack the inhouse 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 hazardous 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 inhouse 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

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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 hazardous 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

Refinished automobile bumpers -- steel, aluminum, and plastic -- are the chief products of this plant, which operates for 52 wk/yr and spends almost $15,000/yr to treat and dispose of its wastes. Those costs would be considerably higher if this plant, which was built only 3 to 4 yr ago, had not incorporated certain features to aid in hazardous waste management into its basic design. The WMAC team therefore faced a more difficult challenge in further reducing hazardous waste emissions.

For example, the design of this plant had eliminated direct drains from production areas to the sewer, had surrounded certain chemical tanks with dikes so that any spillage or overflow would be channeled to a central sump pump, and had taken other precautions to reduce migration from spillage, such as locating tanks below ground level.

In general, raw materials (used bumpers) follow one of three possible paths in this plant:

- Steel bumpers are straightened and cleaned before being plated with nickel and chromium.
- Aluminum bumpers are straightened and cleaned before being reanodized (off-site).
- Urethane bumpers (plastic) are treated to remove paint before being repaired and repainted.

The direct focus of the WMAC team was on the first two because they account for the bulk of the production and virtually all of the hazardous waste generated at this plant. For metal bumpers, the production level averaged almost 16,000/yr, and about 80% of that was steel.

### *Steel Bumper Refinishing*

After being straightened, the steel bumpers are prepared for refinishing by soaking in hydrochloric acid to remove old plating; rinsing; immersing in metal cleaning solution (caustic and sodium silicate); polishing; and grinding. Then the bumpers are put through the plating line, where they are successively soaked in a dilute cleaning solution and a sodium fluoride acid soap solution with intermediate rinses, before being electrolytically replated with nickel first and then with chromium. A so-called drag-out tank reduces liquid carryover from plating, and deionized water is used for multi stage countercurrent rinsing.

This sequence of operations includes several steps already adopted by the plant to reduce the quantity of waste generated, such as the use of:

- Air agitation to ensure good circulation in the rinse tanks and to lower the volume of rinse needed.
- Deionized water for making process solutions and for rinsing, because otherwise the calcium and magnesium in the water supply would add to the amount of sludge formed.
- Less toxic trivalent chromium in the plating solution to lessen the concentration (weight of chromium per unit volume) and reduce treatment costs.
- Drag-out tanks to capture most of the solution carried out of the plating tanks before it reaches the rinse. When the metal concentration in the drag-out tank increases over a period of time, the solution is recycled to the plating tank (for chromium) or sent to a holding tank (for nickel), where it is heated to decrease its volume by evaporation.
- Multi-stage countercurrent rinsing (rather than a continuous flow) so that the bumpers are placed in the most contaminated stage first and the cleanest stage last.
- Continuous filtration of the chromium and nickel plating solutions to remove solid contaminants and to allow the filtrate to be returned to the plating tanks.

Periodically the cleaning solutions and the rinse tanks are dumped into a sump and transferred to a storage and evaporation tank. The metals are removed by adding sodium bicarbonate, and the resulting sludge settles to the bottom. The remaining liquid, after pH adjustment, has been hauled to a sanitary landfill. The sludge has been sent to a hazardous waste landfill, even though not all the metals are hazardous.

### *Aluminum Bumper Refinishing*

The potential for hazardous waste to be derived from aluminum bumper refinishing at this plant is considerably less than it is for steel. First, the number of aluminum bumpers among the plant's raw materials is only about one-fourth that of the steel ones. Second, only part of the overall refinishing occurs at this plant, and the operations that are carried out have generated less hazardous waste than do those for refinishing steel.

To remove the anodized coating on the bumpers brought into the plant, they are first soaked in a tank of heated alkaline de-ruster. After rinsing with tap water, the aluminum bumpers are immersed in a de-smut tank and then rinsed again with tap water. Aluminum bumpers are then reanodized at another location.

Spent solutions and rinse water containing suspended solids are accumulated in a sump, from which they are pumped periodically to a storage and evaporation tank.

## Summary of Hazardous Waste Generation and Minimization

Table 1 integrates the information on hazardous waste generation, listing the origins of hazardous liquid and solid wastes, their quantities, and the magnitudes of their treatment and disposal costs before the WMAC team came to the plant.

Three waste minimization opportunities (WMOs) recommended to the manufacturer will, if implemented, save about half the current hazardous waste management costs at this plant. They are summarized in Table 2, together with the reductions in emissions and the associated savings and costs.

The quantities of hazardous waste emitted before and after the WMOs are implemented will depend on the production level of the plant. All values stated should be considered in that context.

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**Table 1. Summary of Current Waste Generation**

| Waste Stream | Hazardous Waste Generated | Annual Quantity Generated | Annual Waste Management Costs: Treatment | Annual Waste Management Costs: Disposal |
|---|---|---|---|---|
| Hazardous Liquid Waste | | | | |
| Stripping Line: | | | | |
| Rinse tank | Hydrochloric acid drag-out | 11,100 gal | | |
| Hot soak | Spent metal cleaner | 9,700 gal | | |
| Rinse hose | Alkaline de-ruster and de-smut | 16,500 gal | | |
| Plating Line: | | | | |
| Metal cleaner rinse | Metal cleaner drag-out | 21,900 gal | | |
| Acid soap rinse | Sodium fluoride acid soap drag-out | 14,500 gal | | |
| Nickel rinse | Nickel plating drag-out | 10,900 gal | | |
| | Total | 84,600 gal | $6,800[1] | $3,910 |
| Hazardous Solid Waste | | | | |
| Storage Tank: | | | | |
| Combination of stripping and plating lines | Metal hydroxide sludge | 4,500 lb | | |
| Filters: | | | | |
| Nickel plating | Filter cake and filters[2] | 500 lb | | |
| Chromium plating | Filter cake | 500 lb | | |
| | Total | 5,500 lb | | 4,200[3] |

[1] All liquids, after transfer to storage tank, are treated before disposal.

[2] Note that although the filter cakes and filters from the nickel plating tank are presently classified as nonhazardous, management has chosen to treat this waste as hazardous in the event that nickel is reclassified in the near future.

[3] Cost of solids testing, hauling, and disposal.



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**Table 2. Summary of Recommended Waste Minimization Opportunities**

| Present Practice | Proposed Action | Waste Reduction and Associated Savings |
|---|---|---|
| Rinse water and other liquid streams are collected and treated with sodium bicarbonate to precipitate most of the metals as sludge. | Use additional filtration and existing deionization systems to reduce chromium and nickel levels to acceptable limits and to ensure quality of water for recycle to plant. Add small additional solid collected to hazardous waste going to landfill for disposal. This WMO is a volumetric reduction only. | Waste reduction = 84,600 gal/yr<br>Net cost saving = $ 3,625/yr<br>Implementation cost = $ 4,500<br>Simple payback = 1.3 yr |
| Sludge from precipitation of metals is combined with residue from filtration of plating solutions and sent to hazardous waste landfill. Weight = 5500 lb/yr. | Dewater the sludge by heating it. Continuous dewatering is possible by loading the sludge into a hopper and feeding it by an auger to a burner tube fueled by natural gas or LPG. The weight of hazardous waste sent to the landfill will be reduced. | Waste reduction = 3,874 lb/yr<br>Net cost saving = $ 2,914/yr<br>Implementation cost = $ 10,000<br>Simple payback = 3.4 yr |
| Tap water is used freely to rinse aluminum bumpers after they are stripped of anodized coating. This rinse is combined with other liquids and the total is sent for landfill disposal. | Constrict the flow of tap water from 6 to 3 gal/min. If a higher pressure water,stream is needed, substitute a wand spray gun. Then a booster pump will be needed, but the flow can be reduced to about 0.6 gal/min. | Estimated waste reduction = 8,246 gal/yr<br>Estimated cost reduction = $ 1,039/yr (based on the cost to haul liquids to landfill)<br>Estimated implementation cost = less than $10<br>Simple payback = less than 1 mo |

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