United States Environmental Protection Agency Risk Reduction Engineering Laboratory Cincinnati, OH 45268

Research and Development

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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,

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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.

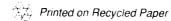
#### Introduction

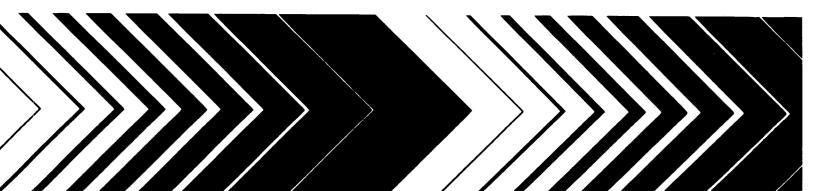
The amount of hazardous waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of hazardous waste is to reduce or eliminate the waste at its source.

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 smalland 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





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. 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 Brian A. Westfall.

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

Waste Stream	Hazardous Waste Generated	Annual Quantity Generated	Annual Waste Management Costs	
			Treatment	Disposal
Hazardous Liquid Waste				
Stripping Line: Rinse tank Hot soak Rinse hose	Hydrochloric acid drag-out Spent metal cleaner Alkaline de-ruster and de-smut	11,100 gal 9,700 gal 16,500 gal		
Plating Line: Metal cleaner rinse Acid soap rinse Nickel rinse	Metal cleaner drag-out Sodium fluoride acid soap drag-out Nickel plating drag-out Total	21,900 gal	\$6,8001	\$3,910
Hazardous Solid Waste				
Storage Tank: Combination of stripping and plating lines	Metal hydroxide sludge	4,500 lb		
Filters: Nickel plating Chromium plating	Filter cake and filters <sup>2</sup> Filter cake Total	500 lb 500 lb 5,500 lb		4,200³

<sup>&</sup>lt;sup>1</sup> All liquids, after transfer to storage tank, are treated before disposal.

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.

<sup>&</sup>lt;sup>3</sup> Cost of solids testing, hauling, and disposal.

Table 2. Summary of Recommended Waste Minimization Opportunities

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

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