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ENVIRONMENTAL RESEARCH BRIEF

Waste Minimization Assessment for a Manufacturer of Military Furniture

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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. 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 military furniture—approximately 12,000 units/yr. Wood and formica are laminated together via glue curing and then undergo woodworking operations including cutting, drilling, and routing. Finished boards are either packaged and shipped or transported to assembly. Metal stock is cleaned with solvent and then undergoes various metalworking operations. Metal pieces are partially assembled, painted, then either packaged and shipped or transferred to assembly before being packaged and shipped. The team's report, detailing findings and recommendations, indicated that the majority of waste was generated during the painting operations and that the greatest savings could be obtained by installing an electrostatic powder coating system to completely eliminate paint solvent evaporation, paint solids waste, and paint-laden air filters.

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 document 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.

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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. Figure 1 shows a simplified process flow diagram of the operation of the plant.

Plant Background

The plant manufactures military-specification furniture for use in military barracks. Ninety employees operate the plant 2,080 hr/yr to produce approximately 12,000 units of furniture annually.

Manufacturing Process

The plant produces wooden, wood with steel frame, and steel furniture. Raw materials include heavy-density particle board, steel frame, rolls and strips of sheet steel, formica, and assorted hardware.

Unit operations performed in processing wood include the following:

- Raw wood and formica are glued together to form a laminate. Several laminations are then positioned in a press for glue curing. Next, the boards undergo various woodworking operations including cutting, drilling, and routing. Boards are either transferred to assembly or directly packaged and shipped.

Metal processing involves the following unit operations:

- Metal stock is cleaned by immersion in a toluene dip tank. Waste from this process includes evaporated toluene and sludge containing toluene, grease, and dirt, which is pumped from the bottom of the tank. After cleaning, the metal undergoes various metalworking operations including cutting, punching, fold-

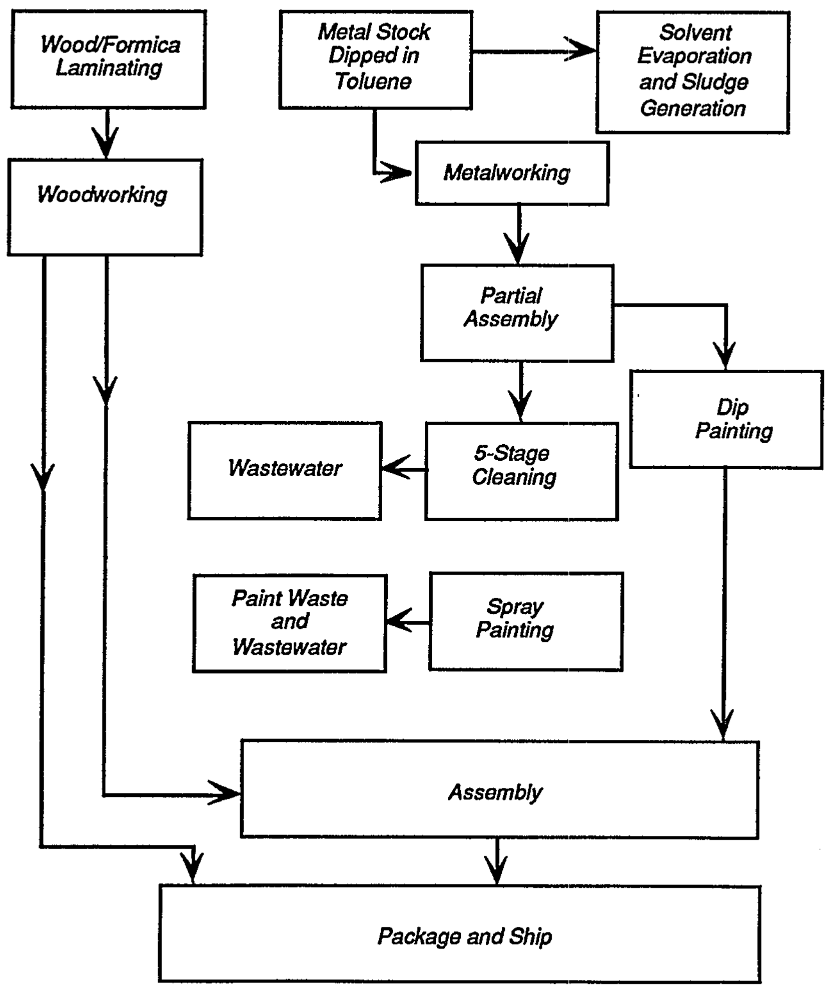

Figure 1. *Simplified process flow diagram.*

ing, and welding. Pieces are partially assembled, then transferred to one of two spray-paint lines or a dip-paint line.

- In the spray-paint line, parts undergo a five-stage cleaning in preparation for spray-painting. The first stage is an alkaline-wash tank held at 110°F. That wash stage is followed by a rinse tank. Next, parts are sprayed with an iron phosphate solution. The fourth stage is a rinse tank. In the final stage, parts are sprayed with a rust preventive. After cleaning, the parts are conveyed first through a dry-off oven and then through the spray-painting process.
- In spray-painting, paint is applied to the parts with hand-held spray guns. The paint booths are equipped with continuously recirculating water curtains to entrap paint overspray. Entrapped paint solids and wastewater are dumped to a holding tank periodically. Air filters which are used in two of the four booths to collect overspray are also disposed of periodically. After painting, the parts are conveyed through a dry-off oven and undergo further assembly.
- Small metal parts are dip-painted, allowed to air dry, and then transferred to the assembly area.
- Assembly and packaging.

Existing Waste Management Practices

- A steam-cleaning operation to eliminate the five-stage cleaning of some metal parts is being investigated.
- The use of dip-painting has been minimized.

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 management 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, in most cases, the economic savings of the minimization opportunities result from the need for less raw material and from reduced present and future costs associated 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 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.

Additional Recommendations

In addition to the opportunities recommended and analyzed by the WMAC team, two additional measures were considered. These measures were not analyzed completely because of insufficient data or minimal savings as indicated below. They were brought to the plant's attention for future reference, however, since these approaches to waste reduction may increase in attractiveness with changing plant conditions.

- If the spray paint process is not replaced as recommended in the WMOs, there are two other possible improvements to be considered. A state-of-the-art dip paint line with safeguards to minimize paint dripping on floors could be installed to replace the paint lines. Another alternative is to switch from solvent-based to water-based paints.
- Use air-tight spray gun cleaning tanks to reduce evaporative losses of toluene.

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*	*Annual Quantity Generated*	*Annual Waste Management Cost*
Toluene sludge	*Toluene-dip tank for cleaning of metal stock. The sludge, which contains toluene, grease, and dirt, is hauled offsite as a hazardous waste.*	*715 gal*	*$8,230*
Evaporated toluene	*Toluene-dip tank for cleaning of metal stock.*	*172 gal*	*0*[1]
Evaporated paint solvent	*Spray-paint booths.*	*915 gal*	*0*[1]
Paint-laden air filters	*Spray-paint booths.*	*832 filters 3,390 gal paint*	*1,020*
Toluene sludge	*Cleaning of paint guns. The sludge, which contains toluene and paint, is hauled offsite as a hazardous waste.*	*55 gal*	*630*
Evaporated toluene	*Cleaning of paint guns.*	*44 gal*	*0*[1]
Paint solids	*Holding tanks which receive wastewater from the five-stage cleaner and the painting operation.*	*7,515 gal*	*3,750*

[1] *According to plant personnel, there are no waste management costs associated with evaporation of solvents.*

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Table 2. Summary of Recommended Waste Minimization Opportunities

Waste Stream Reduced	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years
Evaporated paint solvent	Install an electrostatic powder coating system to replace the paint-spray and dip-paint lines. The proposed system will provide more even coating of parts and easy collection and reuse of overspray powder.	915 gal	100	$49,770[1]	$145,880	2.9
Paint-laden air filters		832 filters	100			
		3,390 gal paint[2]	100			
Evaporated toluene		44 gal	100			
Paint solids		7,515 gal	100			
Toluene sludge	Protect the clean metal stock from environmental dirt to eliminate the need for subsequent cleaning in the toluene-dip tank.	715 gal	100	8,400[1]	3,800	0.5
Evaporated toluene		172 gal	100			
Evaporated toluene	Repair the lid of the toluene-dip tank to reduce evaporative losses. Institute a program to keep lid closed whenever possible.	86 gal	50	180[1]	100	0.5
Paint solids	Re-install the existing electrostatic spray paint system in building 4 and install an electrostatic spray paint system in building 3. The electrostatic spray paint systems will be considerably more efficient than the current spray-paint systems.	2,210 gal	29	39,880[1,3]	66,900	1.7

[1] Includes raw material cost savings and waste management savings.
[2] Paint associated with the spent air filters.
[3] Total savings have been reduced by the operating cost of the proposed system.

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